Vermont's

Wildlife Action Plan

2015

Vermont Fish & Wildlife Department

Protecting and conserving our fish, wildlife, plants and their habitats for the people of Vermont

Sport Fish & Wildlife Restoration

State Wildlife Grants

2015 Vermont Wildlife Action Plan

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We thank Vermont's congressional delegation who helped create the opportunity for this Wildlife Action Plan and for establishing and maintaining the State Wildlife Grants program that helps fund Action Plan development and implementation. State Wildlife Grants together with the other federal wildlife conservation funding programs are vital to keeping common species common.

We humbly note that our goal would have been unattainable without a solid foundation—the rich legacy of Vermont's wildlife conservation history—the observations, stories, data, research, planning efforts, conservation, education and wildlife-recreation programs, institutions and traditions established and nurtured by those passionate about wildlife and Vermont's natural heritage over the past two centuries.

Finally, to all those furry, finned, feathered, scaled, slimy and shelled creatures that also call Vermont home, the charismatic megafauna and the enigmatic microfauna which so fascinate and enrich our lives and economies, we look forward to a bright and healthy future together in the Green Mountain State.

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II. Executive Summary: Vermont's Wildlife Action Plan

Over the past 10-years Vermont's Wildlife Action Plan helped guide the Fish & Wildlife Department, partners, stakeholders and others in the conservation of our Species of Greatest Conservation Need and efforts to keep common species common. This 10-year revision to the Action Plan has allowed us to: evaluate our implementation efforts; reassess the status of our wildlife and their habitats; investigate emerging issues; and, renew our vision for fish and wildlife conservation in Vermont.

Notable in this revision are the growing specters of climate change and diseases, the role pollinators play in the environment and the reminder that habitat loss and degradation remain the primary threats to most wildlife.

This Wildlife Action Plan has not changed its focus on implementation through collaboration. Conserving and managing Vermont's wildlife requires everyone's help. From landowners and land managers, to municipalities and regional planning commissions, state and federal agencies, and non-profit organizations and for-profit businesses all need to work together if we are to achieve our goal.

Problems and Solutions

The problems most frequently identified as impacting Species of Greatest Conservation Need have not changed from our first Wildlife Action Plan, and are not new to those concerned about wildlife conservation, they include:

- Loss of habitat (from conversion, degradation, fragmentation)
- Impacts of roads and transportation systems
- Pollution and sedimentation
- Invasive species
- Information needs and data gaps critical to conservation success
- Climate change

As a wildlife conservation guide for the entire state—not just the Fish & Wildlife Department—the Wildlife Action Plan includes strategies that almost any individual or organization can implement. The most common strategies proposed here to alleviate problems impacting Species of Greatest Conservation Need also aren't new: they include habitat restoration; the provision of education and technical assistance to landowner and land managers; providing financial and economic incentives and encouraging wildlife-compatible resource use.

Moreover, the recommendations in this report underscore the need for proactive, cost-effective conservation efforts and increased collaboration, coordination and sharing of data and expertise among all those interested in wildlife conservation. The Wildlife Action Plan and its recommended strategies help realize these needs by:

- Providing a common conservation vision to guide state and federal agencies as well as non-profit conservation and sportsmen's organizations.

- Putting existing land and resource management and conservation needs into a broader context, providing recognition for the contributions that landowners and land managers are already making towards a long-term conservation strategy.
- Building a reliable, science-based data set to provide a "big picture" view (biophysical region and statewide) of Vermont's wildlife resources to establish current conditions and to measure changes into the future. These data will allow state agencies to work with the public and private sector more effectively.
- Identifying areas where conservation activities will provide the greatest benefit to cost ratio (thereby increasing the effectiveness of limited conservation resources).
- Allowing use of existing programs to more effectively provide incentives or technical assistance to private landowners for voluntary actions to conserve natural resources on private lands and identify the need for additional landowner incentive or technical assistance programs.

The Future of Wildlife Conservation

State Wildlife Grants funding comes at a critical time. The traditional funding source for wildlife conservation by state fish and wildlife agencies has been sportsmen. Hunting, fishing and trapping licenses and taxes on their gear account for nearly 70% of Vermont's wildlife conservation funds (down 10% since our first Wildlife Action Plan was released in 2005). But the pressures on wildlife have both changed and increased in intensity since these funding programs began in the early decades of the 1900's. Today, these funds, most of which are dedicated for game and sportfish species, are stretched thin as the Fish & Wildlife Department addresses new issues and problems such as development, Act 250 reviews, pollution, invasive species and overabundant wildlife. Furthermore, there are new and expanding constituencies interested in wildlife and putting pressure on wildlife including hikers and mountain bikers, bird watchers, and off-road vehicle users.

The State Wildlife Grants program is not intended to replace sportsmen's contributions. Rather, it will take some of the weight of conservation funding off the shoulders of sportsmen and broaden our capacity to conserve wildlife.

The task of conserving our Species of Greatest Conservation Need is challenging but we know success is possible from our history with wildlife conservation successes such as the wild turkey, white-tailed deer, moose, common loon, fisher and peregrine falcon. Conserving wildlife is in all our best interests. It means reducing the potential imposition of regulatory requirements on Vermont businesses and communities that come with threatened and endangered species listings. It means healthier ecosystems upon which we all depend. And it means a Vermont rich in wildlife which we can all enjoy.

The Wildlife Action Plan and State Wildlife Grants dollars mark the start of a new era in wildlife conservation, one where we can keep common species common.

Action Plan Overview

Congress created the State and Tribal Wildlife Grants Program (SWG) in 2001. To receive SWG funds, each state and territory is required to develop a Wildlife Action Plan. The goal of both the State Wildlife Grants program and the Action Plan is to prevent wildlife from becoming endangered through early, strategic efforts to conserve wildlife and habitat. SWG provides funding and the Action Plan provides the strategic guidance. SWG is now the nation's core program for preventing endangered species listings. Since 2001, Vermont has received or become eligible for more than $8 million in State Wildlife Grant funds.

According to Congressional mandate, Wildlife Action Plan's must be updated at least every 10 years. This report represents the first revision of Vermont's Wildlife Action Plan, originally created in 2005. This revision has nine chapters and eight appendices as outlined here:

Chapter 1. Introduction describes the Vermont Fish & Wildlife Department's mission and approach to revising the Wildlife Action Plan. It discusses Vermonter's deep and abiding interest in fish and wildlife conservation, and the difficulties of conserving Vermont's natural heritage without stable and secure funding. The Congressional requirements for Wildlife Action Plans are presented along with a summary of the revision process and notable changes and additions to the 2015 Vermont Wildlife Action Plan, including: an in-depth consideration of climate change impacts to wildlife conservation; a design for landscape and habitat connectivity; greater attention to disease and pollinators. This chapter also contains the statewide goals and objectives for Wildlife Action Plan implementation.

Chapter 2. Vermont Overview describes Vermont's landscape and the ecological and land-use factors that contribute to Vermont's natural heritage. It provides both a historic and contemporary perspective on land use history and summarizes the significant threats and problems to Vermont's wildlife. It looks back at conservation successes and at the importance of education, law enforcement and recreation to wildlife conservation efforts—three areas not eligible for SWG funding.

Chapter 3. Climate Change and Wildlife Conservation is an in-depth look at climate change and wildlife conservation. It reviews the historic climate trends and predictions for future climate and summarizes the impacts of a changing climate on Vermont's ecology.

Chapter 4. Conservation at Multiple Scales explains how conservation is organized in this Wildlife Action Plan and how habitat classifications were developed for aquatic species and terrestrial species. From a focus on the status and needs of individual Species of Greatest Conservation Need (Appendix A) to their habitats (Appendix B) to taxon-wide conservation (Chapter 5) and landscape-scale conservation (chapter 6)

Chapter 5. Species of Greatest Conservation Need provides lists of Vermont's Species of Greatest Conservation Need and summarizes SGCN conservation needs by taxonomic group (amphibians and reptiles, birds, fishes, invertebrates, mammals and plants).

Chapter 6. Landscape Conservation describes the condition of Vermont's landscapes (historic, current and desired), provides a framework for identifying and prioritizing landscapes important to SGCN and natural heritage conservation based on six key landscape components (Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings), identifies SGCN benefitting from landscape conservation, and identifies significant threats and priority conservation strategies.

Chapter 7. Monitoring, Implementation & Review outlines plans to track the status of Species of Greatest Conservation Need and their habitats, evaluate the effectiveness of conservation actions, implement the Wildlife Action Plan and keep it up-to-date.

Chapter 8. Action Plan Revision describes the efforts made to review and revise the Wildlife Action Plan. It describes the revision timeline, the planning team structure and outreach and public involvement efforts. It explains how SGCN were selected and how conservation actions were developed.

Chapter 9. Glossary and Acronym Key is our best effort to round-up and explain all the terms and acronyms used in this report.

Appendices A1-A5. Species of Greatest Conservation Need Conservation contains detailed reports on each SGCN exploring species status, distribution, habitat usage, threats and problems, research and monitoring needs and conservation actions.

Appendix B. Habitat & Community Summaries contains detailed reports on the 25 major habitat types found in Vermont. Reports explore habitat characteristics and locations, habitat condition (historic, current and desired future), efforts to benefit these habitats as part of 2005 Action Plan implementation, SGCN typically found in each habitat, threats and information needs, and priority conservation actions.

Appendix C. Threats and Actions defines the categories of threats, problems and conservation actions used in this report.

Appendix D. Vermont Species & Habitat Climate Vulnerability Assessment provides data from a 2013 effort to assess the vulnerability of fish, wildlife, plants and their habitats to climate changes. This Vermont Species & Habitat Climate Vulnerability Assessment investigated 18 species, 20 upland habitats, 11 wetland habitats, and 13 freshwater habitats.

Appendix E. Implementing the 2005 Wildlife Action Plan illustrates how that Action Plan has guided conservation in Vermont over the past decade. It provides multiple examples of how SWG funding has supported habitat and species population restoration, has helped leverage the conservation expenditures of other organizations, and has supported research and monitoring for a wide variety of species and the status of emerging threats such as White-nose Syndrome in bats.

Appendix F. Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape presents a landscape-level conservation design for protecting and enhancing ecological function. The lands and waters identified in this document are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. When conserved or managed appropriately to retain or enhance ecological function, these lands are expected to sustain Vermont's natural legacy into the future.

Appendix G. Mapping Vermont's Natural Heritage was developed to help municipal partners implement the Wildlife Action Plan. It is an essential guide to understanding natural resource data designed specifically for Vermont towns. It provides an understanding of available datasets, what they mean, and how to access them. It also serves as an important compliment to the 2004 "Conserving Vermont's Natural Heritage" that makes the case for why certain resources are critically important for conservation planning and provides an essential framework for looking at the landscape at different ecological scales. Using this same framework, "Mapping Vermont's Natural Heritage" provides the specific local data to help users connect ecological concepts to land-use planning tools and guides users through the next steps in ecological prioritization.

Appendix H. Vermont Big Game Management Plan is Vermont Fish & Wildlife Department's guide to managing the state's White-tailed Deer, Moose, Black Bear and Wild Turkey populations through 2020.

Appendix I. Crosswalk of Plant Species of Greatest Conservation Need by Habitat Type will help with coarse filter conservation planning.

Appendix J. A Landowner's Guide: Wildlife Habitat Management for Lands in Vermont

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Chapter 1

Introduction to Vermont's Wildlife Action Plan

2015

Introduction

Vermont is known for its beautiful juxtaposition of forests and farms, streams and ponds, Lake Champlain and the Green Mountains. Fish and wildlife are an integral part of the Vermont experience and quality of life for Vermonters. White-tailed Deer, Black Bear, Wild Turkey, and geese are thriving and offer sustainable hunting and viewing opportunities. In recent years, and after a lot of effort, Common Loon, Osprey and Peregrine Falcon populations have recovered allowing for their removal from the state threatened and endangered species list, the Bald Eagle is again nesting in Vermont and many of our waters teem with healthy fish communities. The landscape and the wildlife attest to the state's meaningful conservation ethic.

Over the past 10 years Vermont's Wildlife Action Plan helped guide the Vermont Fish & Wildlife Department, partners, stakeholders and others in the conservation of our Species of Greatest Conservation Need and efforts to keep common species common. This 10-year revision to the Action Plan has allowed us to: evaluate our implementation efforts; reassess the status of our Species of Greatest Conservation Need (SGCN) and their habitats; investigate emerging issues; and, renew our vision for fish and wildlife conservation in Vermont.

Notable in this 2015-2025 Wildlife Action Plan are the addition of a climate change chapter; the re-recognition of diseases as significant threats to some species, and of the vital role pollinators play in the environment (a suite of bumble bees is included as SGCN); and, that habitat loss and degradation remains the primary threat to most SGCN.

This Wildlife Action Plan's emphasis on landscapes reflects a doubling-down on habitat conservation as the most effective and efficient strategy for keeping common species common and reducing the need to place species on the endangered species list. By maintaining and enhancing healthy, connected, landscapes we maintain the habitat integrity, help a wide range of species, improve climate change resiliency, and reduce the potential impacts of diseases and non-native invasives. Moreover, healthy landscapes support healthy economies, human communities and our quality of life, and ensure that wildlife and the places they live will be there for future generations to enjoy.

This Wildlife Action Plan has not changed its focus on implementation through collaboration and partnership. Conserving and managing Vermont's wildlife requires everyone's help. From landowners and land managers, to municipalities and regional planning commissions, state and federal agencies, and non-profit organizations and for-profit businesses all need to work together if we are to achieve our goal.

The Vermont Fish & Wildlife Department: Mission and Strategic Focus

The Vermont Fish & Wildlife Department's mission is to protect and conserve our fish, wildlife, plants and their habitats for the people of Vermont. The Department's planning goals are:

> *Conserve, enhance, and restore Vermont's natural communities, habitats, and plant and wildlife species along with the ecological processes that sustain them as informed by the Vermont Conservation Design.*
>
> *Provide a diversity of fish and wildlife-based activities, opportunities, and access that allow hunting, fishing, trapping, and viewing consistent with the public trust.*
>
> *Increase public understanding and support for natural resource conservation issues and promote and facilitate a land stewardship ethic in Vermont that includes the safe and ethical utilization of wildlife. Maintain department relevancy with the public and our traditional constituents.*

Maintain safe and lawful fish and wildlife–based activities to protect species and their habitats and, to limit harmful human encounters.

Strengthen the framework of fish and wildlife conservation through efficient operations and effective and adaptive management to better accomplish the mission

Throughout its 100-year history, many of the Fish & Wildlife Department's initiatives focused on game species, in part because of constituent interest, as well as the user-pay system of funding fish and wildlife conservation through license sales and excise taxes on hunting and fishing equipment. As our mission statement suggests, the scope of conservation challenges facing Vermont extends beyond species which people choose to harvest.

Vermonters Care about Wildlife

Wildlife is very important to the people of Vermont. This love of wildlife is more than anecdotal. The 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation conducted by the U.S. Fish and Wildlife Service documented that 62 percent of Vermonters went fishing, hunting, or wildlife watching. Vermont ranked second, only two points behind Alaska in participation (U.S. Dept of Interior 2011). When it comes to wildlife watching, however, Vermont was first in the nation with an impressive 53 percent of residents enjoying this activity. This same survey estimates more than $704 million was spent on fish-and wildlife-based recreation in Vermont.

A July 2015 public attitude survey measured trends in Vermonters' support for the Department's mission: "The conservation of fish, wildlife, plants, and habitats for the people of Vermont" (Duda et al 2015). Findings included:

- 83 percent responded, when asked to compare the importance of wildlife with economic development that the use and development of land should be restricted to protect fish and wildlife; and 81 percent responded that wildlife habitat must be protected even if it reduces the land use options of some landowners and developers.
- 81 percent strongly agreed that endangered species must be protected (only 2% moderately or strongly disagreed). 86 percent of hunters and anglers strongly agree that endangered species should be protected.
- When asked which of the following were big problems, residents listed invasive species (71%), climate change (64%), forest and habitat fragmentation (46%), fish and wildlife habitat loss (46%), loss of Vermont's scenic landscape (41%), and posting land closed to hunting/recreation (26%).

Problem and Need: Secure Funding

Historically, dedicated funds have been available for the conservation and management of game and sportfish species, and to a lesser extent for Threatened and Endangered species. Unfortunately, there has not been a dedicated revenue stream supporting management for most wild animals that do not fall within either category. For example, 269 species of birds are found in Vermont. Only about 30 of these are hunted and only a handful (e.g., Common Loon, Osprey, Peregrine Falcon) have benefitted from Endangered Species recovery funding.

In 1985, Vermont's Nongame and Natural Heritage Program (now the Wildlife Diversity Program) was established within the Fish and Wildlife Department. Both an income tax check-off and a conservation license plate were important funding mechanisms for the management and recovery of non-game species, generating approximately $200,000 per year, but has never adequately met program needs.

Congress responded to the funding need in 2001 with a new annual appropriation, first called the Wildlife Conservation and Reinvestment Act and later the State Wildlife Grants Program (SWG). SWG funds were to be targeted to fish and wildlife species (plants are not eligible) in need, including those that had not previously benefitted from traditional funding. Since that time, the Vermont Fish and Wildlife Department has received $8.1 million in SWG appropriations and have vastly improved Vermont's ability to fund new research, inventory, and management initiatives for species such as Timber Rattlesnake, Lake Sturgeon, butterflies, and the Bicknell's Thrush. Education and law enforcement are not eligible activities.

To receive SWG funds, Congress requires states to develop Wildlife Action Plans to guide use of the funds. But SWG funds are not sufficient to fully implement the Vermont Wildlife Action Plan. Annual SWG allocations have declined by 40% since 2002 and additional cuts are threatened every year. Currently Vermont receives less than 10% of what would be needed for full Wildlife Action Plan implementation.

Within the State of Vermont, the annual funding picture is rosier. Thanks to the strong support of the Governor and Legislature, general fund allocations to the Fish & Wildlife Department have increased approximately four-fold from $1.25 million in 2011 to over $5 million annually in 2015. While only a small portion of these funds are directly invested in Wildlife Action Plan implementation, it all helps the Department meet its broader mission. In 2015 the Vermont Habitat Stamp was created to provide additional opportunities for Vermonters and friends of Vermont to contribute to the purchase and maintenance of Wildlife Management Areas.

Revising Vermont's Wildlife Action Plan

The revision of Vermont's Wildlife Action Plan followed the eight required elements, revision guidance provided by the U.S. Fish & Wildlife Service and that published in Best Practices for State Wildlife Action Plans (AFWA 2012) and The Northeast Lexicon: Terminology Conventions and Data Framework for State Wildlife Action Plans in the Northeast Region (Crisfield 2014).

Revision began with a close review of the 2005 Action Plan. We found that it had weathered the decade surprisingly well. Much of the plan, in terms of focus, organization and goals, did not need change, only some updating. The foundation of both the 2005 and 2015 plans are the detailed reports on individual SGCN (Appendix A1-4). Both Action Plans focus on habitat conservation as a primary means of conserving SGCN (the 2015 Action Plan provides additional emphasis on landscape conservation and connectivity). And, both stress collaborations and partnerships in implementation.

With this revision, we take advantage of the many tools, guidance documents and programs developed since 2005 designed to support the conservation and management of wildlife by partners and the public—several of which were created as a direct result of the first Wildlife Action Plan. These include the Community Wildlife Program, Foresters for the Birds, BioFinder, Vermont Invasives the Landowners Guide - Wildlife Habitat Management for Lands in Vermont and Community Strategies for Vermont's Forests and Wildlife among many.

Notable changes/additions to the Vermont's Wildlife Action Plan with this revision include:

- An expanded discussion of climate change impacts to SGCN and their habitats and strategies to help wildlife adapt and to improve resiliency (chapter 3).
- A focus on landscape conservation and habitat connectivity (chapter 6) and a design for landscape conservation (appendix F).
- Greater attention to diseases as significant threats to some species.

- Recognition of the important role pollinators play in their ecosystems and the addition of a suite of nine bumble bee species included as SGCN (Appendix A4). The 2005 Action Plan was silent on pollinators.
- A plant conservation summary (chapter 5). The 2005 Action Plan included only a list of plant SGCN.
- Expanded guidance to help municipalities implement the Action Plan (Appendix G).
- Addition of the state's Big Game Management Plan (for Black Bear, Moose, White-tailed Deer, and Wild Turkey) as an appendix (H).
- Revisions to Species of Greatest Conservation Need: SGCN lists have been updated (chapter 5) along with conservation summaries for each SGCN (appendices A1-A5). Table 1.1 summarizes these changes.

Table 1.1 Summary of Changes to SGCN Lists 2005:2015

Taxon	2005 SGCN	2015 SGCN	Change Notes
Amphibians & Reptiles	19	19	No changes
Birds	57	50	Removed: Long-eared Owl, Henslow's Sparrow, Osprey, Cooper's Hawk, Barn Owl, Veery, Blue-winged Teal Added: None
Fishes	33	29	Removed: Arctic Char, Atlantic Salmon (anadromous), Brassy Minnow, Muskellunge and Quillback Added: Northern Pearl Dace
Invertebrates	191	198	Removed: 19 species Added: 26 including 9 bumble bee species
Mammals	33	33	Removed: Black Bear and Mink Added: Moose and Snowshoe Hare
Plants	577	673	Added 96 species

The Eight Required Elements of a Wildlife Action Plan

Wildlife Action Plans are meant to guide the use of SWG funds. To remain eligible for State Wildlife Grants funding Congress requires that states develop Wildlife Action Plans and revise them at least every ten years. Congress prescribed the following eight required elements for Wildlife Action Plans:

1. Identify wildlife distribution and abundance: Provide information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife.
2. Describe location and condition of key habitats: Describe the locations and relative condition of key habitats and community types essential to conservation of species identified in (1).
3. Describe key problems and research needs: Describe problems that may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.
4. Describe and prioritize conservation actions: Describe conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions.

5. Monitor species, habitats and conservation actions: Describe plans to monitor species identified in (1) and their habitats; monitor the effectiveness of the conservation actions proposed in and, adapt these conservation actions to respond appropriately to new information or changing conditions.
6. Develop a plan review process: Describe procedures to review the Wildlife Action Plan at intervals not to exceed ten years.
7. Coordinate with other plans: Coordinate the development, implementation, review, and revision of the Action Plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats.
8. Include public participation: Describe public participation in the development, revision, and implementation of the Action Plan and projects and programs.

A Decade of Conservation: Implementing the 2005 Wildlife Action Plan

A summary of efforts to implement Vermont's first Wildlife Action Plan can be found in appendix E.

Statewide Goals, Objectives, Actions for Wildlife Action Plan Implementation

1. Goal: Conserve, restore, and enhance habitats, natural plant and animal communities, and ecosystem integrity to maintain suitability for SGCN and ecological function and to improve resiliency to climate change.

1.1. Objective: Prioritize and implement land acquisition based on conservation planning initiatives to protect important SGCN habitats through acquisition of easements or fee title.

1.1.1. Action: Acquire fee title of lands providing important SGCN habitat and habitat connectivity. Measure: Number of acres/miles protected.

1.1.2. Action: Acquire conservation easements on lands providing important SGCN habitats and habitat connectivity. Measure: Number of acres/miles protected.

1.1.3. Track the number of acres of contiguous forest lost to fragmentation/development. Measure: Number of acres lost to fragmentation/development.

1.2. Objective: Participate in regulatory permitting and enforcement activities to protect significant natural communities, endangered and threatened species, and fish and wildlife habitats.

1.2.1. Action: Participate in Section 248 and Act 250 development processes to reduce negative impacts from development. Measure: Number of acres of habitat protected from development.

1.2.2. Action: Participate in regulatory review processes to reduce negative impacts of altered flow in streams and rivers. Measure: Number of permits modified or issued that ensure sufficient flows.

1.2.3. Action: Participate in regulatory review processes to reduce negative impacts of shoreline development to prevent increases in improperly hardened shorelines on lakes and streams through regulatory review and enforcement. Measure: Linear feet of shoreline habitat protected from improper development through project review and permitting; miles of riparian connectivity maintained.

1.2.4. Action: Participate in development review processes to reduce negative impacts of development near wetlands and insure that projects don't disrupt riparian connectivity.

1.2.5. Action: Support the updating of wetland delineations and maps, particularly for Class 1 wetlands. Measure: Acres of wetlands added to the state wetland maps.

1.3. Objective: Maintain, restore and promote management of public and private lands and waters to enhance their suitability for SGCN, integrity and ecological function, and climate change resiliency.

1.3.1. Action: Implement ecosystem and landscape-level management on lands managed by ANR and other agencies. Measure: Number of state lands with Long Range Management Plans addressing landscape management goals.

1.3.2. Action: Restore or enhance floodplain and riparian buffers at key locations. Measure: acres of floodplain and riparian forest buffer restored.

1.3.3. Action: Restore or enhance wetlands at key locations. Measure: acres of wetlands restored.

1.3.4. Action: Restore aquatic organism passage through barrier mitigation in waters critical to SGCN. Measure: Miles of natural passage reconnected in SGCN habitats.

1.3.5. Action: Restore natural hydrologic flow regime through barrier mitigation in waters critical to SGCN. Measure: Miles of natural stream flow reconnected in key SGCN habitats.

1.3.6. Action: Restore and maintain grassland habitats within grassland focus areas. Measure: Number of acres appropriately managed for grassland SGCN.

1.3.7. Action: Implement management to restore and maintain habitat for young forests (early successional) and old forests (late succession) dependent species on state lands to meet objectives of landscape conservation plans. Measure: Percentage of forest meeting target successional stages.

1.3.8. Action: In collaboration with FPR, provide technical and financial assistance to private forest owners to support land management to meet habitat goals within targeted successional stages for SGCN. Measure: Acres of private forest land primarily managed for young forest/old forest SGCN; Number of landowners and acres enrolled in the Current Use Ecologically Sensitive Treatment Area (ESTA) program.

1.3.9. Action Provide technical assistance to local state and federal agencies that own or manage lands or set policies affecting land management and SGCN. Measure: the number of municipalities with town plans that address SGCN needs.

1.3.10. Support efforts to educate landowners about estate planning and other multi-generational planning to help protect and manage habitat for SGCN.

1.4. Objective: Integrate SGCN conservation into natural resource planning and support conservation planning efforts at local, statewide and regional scales.

1.4.1. Action: Develop and maintain interagency cooperatives and enhanced coordination among organizations and agencies to protect and manage SGCN.

1.4.2. Action: Participate in DEC basin planning processes to ensure that SGCN where present, are included in these agency watershed plans.

1.4.3. Action: Work with FPR to implement Act 171 (H.857) that encourages forestland management to improve forest blocks and habitat connectors and encourage the use of locally grown forest products.

1.4.4. Action: Participate in existing cooperatives to include SGCN in program implementation, including the interstate fish and wildlife cooperatives, Lake Champlain Basin Program, and Staying Connected. Measure: Number of interagency cooperatives incorporating SGCN needs into planning documents.

1.4.5. Action: Implement existing cooperative natural resource plans including the Lake Champlain Opportunities for Action Management Plan. Measure: Number of implementation actions conserving SGCN habitats or populations.

1.4.6. Action: Continue the collaborative biodiversity conservation work of the northeastern states, including the Regional Conservation Needs Program and the Northeast Fish and Wildlife Diversity Technical Committee. Measure: Number of regional conservation projects.

1.4.7. Action: Continue engagement with the, North Atlantic Landscape Conservation Cooperatives (LCC). Measure: Number of LCC projects in Vermont benefitting SGCN.

1.4.8. Action: Continue coordinating with regional and local planning commissions and conservation commissions to address SGCN conservation, habitat protection and the maintenance of habitat blocks through land use planning at the municipal and regional levels.

1.4.9. Action: Support regional, multi-town and local planning efforts with technical and financial assistance, training and education. Support efforts to build capacity within the RPCs to add natural resource planners to staff.

1.5. Objective: Identify, prioritize and control problematic native species and invasive species deleterious to SGCN and prevent introduction of these species.

1.5.1. Action: Develop and adopt guidelines and best management practices for invasives and problem native species surveys and mapping, prioritization, introduction prevention, and control in cooperation with the Agency of Natural Resources for the management of riparian buffers, vernal pools, and other ecologically significant habitats; and, incorporate same in Long Range Management Plans for lands and waters managed by ANR. Measure: Number of guidelines/BMPs/LRMPs developed and implemented.

1.5.2. Action: Prevent introductions and control invasive species in priority SGCN habitats to protect ecosystem health and stability. Measure: acres surveyed/mapped; acres with dominant native vegetation protected or restored.

1.5.3. Action: Implement invasive plant and pest surveys, prevent introductions and control on priority lands and waters managed by ANR and other agencies. Measure: Number of state lands with Long Range Management Plans addressing invasive species implemented.

1.5.4. Action: Manage and control the spread of insect invasive species in priority forested SGCN habitats. Measure: Acres of priority areas protected from invasive encroachment; Estimate of reduction or prevention of forest damage.

1.5.5. Action: Manage white-tailed deer and moose populations to foster forest regeneration and understory growth in areas of very high deer or moose population density per VFWD's Big Game Management Plan. Measure: Deer/moose density.

1.5.6. Action: Control double-crested cormorant, gull, and problematic mammalian predators at locations where they are negatively impacting nesting birds, turtles and other SGCN. Measure: Nesting success of SGCN species.

1.5.7. Action: Continue efforts to limit the introduction of aquatic invasive species. Measure:

1.5.8. Action: Continue efforts to limit the introduction of emerald ash borer, Asian long-horn beetle, hemlock wooly adelgid and other forest pests. Measure: Number of confirmed infestations.

1.5.9. Action: Work with the Forests, Parks & Recreation Department and researchers to identify examples of hemlock and other forest types to be protected from forest pests and diseases, and strategies to combat infestations while limiting impacts to non-target species.

1.5.10. Action: Prevent introduction of feral swine. Measure: Number of feral swine in the state.

1.6. Objective: Protect habitat viability by developing and maintaining programs to reduce environmental contamination and pollution, atmospheric mercury and acid deposition and the atmospheric discharges of greenhouse gases that are contributing to climate change.

1.6.1. Action: Implement the Lake Champlain restoration plan to reduce phosphorous and other nutrient pollutant inputs into the Lake Champlain watershed. Measure: Progress toward meeting the Total Maximum Daily Load (TMDL) goals for the lake and its tributaries.

1.6.2. Action: Reduce the occurrence of combined sewer overflow discharges. Measure: The number of waste water treatment systems that have been updated to reduce combined sewer overflow events.

1.6.3. Action: Continue controlling mercury discharges from energy generating and industrial facilities. Measure: Decline in mercury levels in impacted SGCN.

1.6.4. Action: Continue controlling acid discharges from combustion sources. Measure: Increase in pH in impacted waters.

1.6.5. Action: Continue participating in the Regional Greenhouse Gas Initiative. Measure: Number of carbon pollution credits sold.

1.6.6. Work with state and federal agencies, legislators, and partners to reduce water and air pollution and greenhouse gas emissions.

1.7. Objective: Manage human disturbance in SGCN habitats.

1.7.1. Action: Restrict public access to bat hibernacula to protect bats and continue closures of cliff areas and turtle nesting beaches to protect peregrine falcons and turtles during the nesting seasons. Measures: Number of hibernacula with restricted access; nesting success of Peregrine Falcons and Spiny Softshell Turtles in protected areas.

1.7.2. Action: Manage recreational use of off-road vehicles in important SGCN habitats. Measure: Number of acres protected.

1.7.3. Support changes in laws to minimize degradation to fish and wildlife habitat.

1.8. Objective: Promote habitat connectivity for SGCN.

1.8.1. Action: Restore and maintain natural habitats in linkage areas between large blocks of habitat for SGCN. Measure: Number of acres of viable habitat in identified linkage areas.

1.8.2. Action: Remove or replace culverts and dams that impede passage of aquatic SGCN in high priority areas. Measure: Miles of SGCN habitat with restored connectivity.

1.8.3. Action: Work with VTrans to identify and mitigate barriers to habitat connectivity. Measure: Number of projects implemented to reduce road mortality and increase connectivity.

1.8.4. Action: Work with regional and local planning commissions and conservation commissions to address connectivity for SGCN through land use planning at the municipal and regional levels.

1.8.5. Action: Foster northeast regional habitat connectivity projects for wide-ranging SGCN. Measure: Identification and conservation of important habitat linkages between Vermont and neighboring states and provinces.

1.9. Objective: Promote practices to improve habitat for pollinator species by providing a diversity of flowering plants throughout the active season.

1.9.1. Action: Enhance pollinator habitat on state lands. Measure: acres of pollinator habitat enhanced.

1.9.2. Provide technical and financial assistance to private landowners to support land management that supports pollinator species. Measure: Acres of private land primarily managed for pollinators.

1.9.3. Action: Provide information on pollinator-friendly landscaping and agricultural practices to the public via the VFWD website. Measure: Number of visits to pollinator habitat management webpage.

1.9.4. Action: Develop vegetation management plans for state lands (e.g., parks, roadsides, rest stops, old fields and rights-of-way) to benefit SGCN pollinators and to limit the spread of invasive plants. Develop similar mowing best management practices for use by partners including VTrans and municipal highway departments. Measure: Completion and implementation of plans and best management practices.

2. Goal: Conserve and manage Vermont's Species of Greatest Conservation Need for self-sustaining populations.

2.1. Objective: Maintain appropriate legal protection for all SGCN.

2.1.1. Action: Revise Vermont's Endangered/Threatened statues to better support habitat protection.

2.1.2. Action: Update rules and policies for plant and animal importation, possession and collection/harvest to protect populations and to prevent disease introductions.

2.1.3. Through policy and education support the enforcement of existing laws that protect Species of Greatest Conservation Need.

2.2. Objective: Recover populations of Species of Greatest Conservation Need.

2.2.1. Action: Continue spiny softshell turtle, spotted turtle, lake sturgeon, spruce grouse, Canada Lynx, American Martin recovery projects. Measure: Status of species populations.

2.2.2. Action: Collaborate with neighboring states to manage SGCN populations that cross state boundaries. Measure: Number of collaborative projects with neighboring states.

2.2.3. Action: Evaluate the need for recovery plans for additional SGCN and develop such plans where feasible. Measure: the number of recovery plans developed for targeted species.

2.3. Objective: Maintain fish and wildlife health programs and biosecurity to document the causes of SGCN mortality and occurrence and to track disease outbreaks impacting SGCN.

2.3.1. Action: Investigate and report mortality of fish SGCN as appropriate, and report unusual incidences of mortality. Measure: Annual reports on causes of fish mortality in Vermont.

2.3.2. Action: Investigate and report mortality of animal SGCN as appropriate, and report unusual incidences of mortality through the Northeast Wildlife Disease Cooperative. Measure: Annual summary reports on causes of wildlife mortality in Vermont.

2.3.3. Action: Prevent the transmission of diseases, and invasive species, through the practice of standard disinfection procedures.

2.3.4. Action: Monitor chemical contaminants in fish, bird, and mammal top predators. Measure: Number of species monitored for contaminants.

3. **Goal: Inventory, monitor, and research SGCN, their habitats and natural communities to provide baselines for conservation and to maintain ecological integrity.**

3.1. Objective: Inventory and monitor the abundance, distribution and status of Vermont's SGCN.

3.1.1. Action: Identify and prioritize inventory and research needs, and collect information according to priority.

3.1.2. Action: Develop abundance and distribution objectives for fish and wildlife species and, where appropriate, prepare species management plans to maintain sustainable species population levels within ecological limits while considering social implications.

3.1.3. Action: Develop a collaborative, statewide monitoring and adaptive management program to determine SGCN baselines, measure progress toward desired SGCN outcomes, and to evaluate and improve the effectiveness of conservation strategies.

3.1.4. Action: Continue and enhance habitat monitoring programs to better track the distribution, abundance and status of SGCN habitats.

3.2. Objective: Maintain data management systems to share data among partnerships and better integrate Vermont data into regional collaborations.

3.2.1. Action: Maintain and enhance the Natural Heritage Inventory and other data collection and management programs to inform SGCN and habitat conservation.

3.2.2. Action: Continue participation in regional efforts including those with other Northeast states to assess SGCN and their habitats, share data and to implement regional conservation actions. Measure: Number of regional actions implemented.

3.3. Objective: Foster research that improves our understanding of SGCN population dynamics and habitat utilization.

3.3.1. Action: Partner with universities fish and wildlife cooperative research units and nongovernmental organizations on research into species and habitat issues.

4. **Goal: Maintain and enhance public support for SGCN conservation**

4.1. Objective: Inform and engage the public and conservation communities about SGCN conservation and the Wildlife Action Plan.

4.1.1. Action: Distribute information on SGCN conservation to the public.

4.1.2. Action: Support Citizen Science programs for SGCN monitoring.

4.2. Objective: Consult with all levels of government and conservation partners to seek unity of effort in conserving SGCN.

4.2.1. Action: Share information regarding important SGCN, their habitats, and best- practices conservation actions with county and town governments to inform their land use decision making and conservation efforts. Measure: Number of local governments that adopt modified practices to conserve SGCN and their habitats.

4.3. Increase funding and support for local, state and federal conservation programs.

4.3.1. Action: Collaborate and support partners (NGO's, municipalities, state and federal agencies, etc.) to build capacity for conservation initiatives.

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Chapter 2

Vermont Overview

2015

Vermont Overview

Vermont Cares about Wildlife Conservation

It is no mystery why people enjoy living in and visiting Vermont. This state has what so many other once rural places have lost: a wealth of wildlife and scenic beauty, traditional working landscapes that support viable local economies, and desirable social and cultural attributes – low crime rate, helpful neighbors, and close-knit villages and towns.

Wildlife, scenic beauty, and the landscape that supports this way of life are not only vital parts of Vermont's rural character and identity, but are highly valued by Vermont residents. Based on 2011 public opinion survey results from the U.S. Fish and Wildlife Service, Vermont ranked first in the nation in percentage of residents that actively observed wildlife (53%). The results also show that resident and non-resident hunting, fishing, and wildlife viewing expenditures in Vermont totaled $704 million. These statistics represent a significant contribution to the state's economy and underscore the strong connection Vermont residents and non-residents with the land and wildlife.

Vermont's natural diversity, which include forests, clean waters, vibrant fisheries, healthy wildlife populations, rare species, significant natural communities, and a working landscape, provide people with the opportunity to, among other things, hunt, fish, trap, watch wildlife, hike and work the land.

The Vermont Landscape—an Overview

Vermont's landscape is a rich tapestry of mountains, valleys, woods and wetlands, with a fascinating geological history. It is Vermont's natural landscape that enriches the lives of those who live here and draws so many visitors to the state. It is this same landscape that provides us with clean air, clean water, and habitat for thousands of species of plants and animals.

Understanding Vermont's natural heritage requires understanding the physical landscape. The configuration of mountains, valleys, wetlands, lakes, and rivers is crucial in determining the distribution of natural communities, habitats, and native species.

The following broad environmental factors influence the distribution of species, habitats and natural communities: climate, bedrock geology, surficial geology, topography, hydrology, and land use history. These factors that comprise and influence the Vermont landscape and subsequently the flora and fauna of the state are explained below.

Climate

Vermont's lowest land point is the shore of Lake Champlain, only 95 feet above sea level. Vermont's highest point is the Chin on Mount Mansfield, which juts to 4,393 feet. The distance between Lake Champlain and the summit of Mount Mansfield is only 20 miles, but in that short distance, the climate, topography, and vegetation change considerably. On warm limy sites in the Champlain Valley, where the growing season is 150 days, shagbark hickory trees grow. Apple orchards are common in this environment as well as dairy farming due to the influence of climate on growing season. On the summit of Mount Mansfield, where the growing season is limited to 90 days, red spruce and balsam fir grows in stunted and contorted mats, bending to the direction of incessant winds.

Climate is major factor in determining the distribution of natural communities, habitats, plants and animals. Elevation provides a means for understanding the influence of climate on wildlife and habitats in Vermont because climate changes in relatively short distances with change in elevation. Thus, climate's effect on biota can easily be observed.

Geology

Vermont's bedrock composition is varied and thus, Vermont's soils, hydrology, and subsequently plant distribution and abundance vary. The variations influence, in part, wildlife and plant distribution. The rocks comprising the Southern Green Mountains were formed more than 570 million years ago. The rocks of the Champlain Valley and the Northern Green Mountains date from a time 540 to 443 million years ago when Vermont was the edge of a warm, tropical sea. The remains of marine mammals that inhabited that sea can be found in the Champlain Valley's limestone rock. The youngest rocks in Vermont are the granites, including the stone that makes up the Barre granite quarries. These rocks were formed 200 to 400 million years ago because of deep underground magma welling up and hardening.

Whether the bedrock is limestone or granite (or other type) is particularly important in the distribution of natural communities and plants because each rock type has its own particular physical and chemical composition. For instance, rich fens, a rare type of wetland with plants that require high levels of calcium, occur almost exclusively in areas where limestone or similar calcium-rich rock is found.

Vermont's surficial geology is defined by the sands, gravels, clays, peats, and other deposits found on top of the bedrock. They are a result of both glacial activity and post-glacial events (such as flooding) that continue today. Bedrock and surficial geology together have a profound influence on the soils in which Vermont's plants grow.

Topography

Topography describes the physical landscape and influences the distribution of plants, animals, and natural communities. The soil on the top of a mountain tends to be shallow and dry, whereas the soil at the base of a slope tends to be deep, moist, and rich in organic matter because of the downslope movement of plant litter and soil. Cliffs, for example, offer a specialized habitat for specialized groups of plants, as well as denning habitat for Bobcat and nesting sites for Peregrine Falcon. Certainly, topography influences the quality and distribution of winter habitat for White-tailed Deer in Vermont.

Hydrology

Water and its movement have a profound influence on animals, plants and natural communities, and ecosystem processes. Lakes, ponds, rivers, and streams provide habitat for a diversity of fish, aquatic plants, aquatic invertebrates, and other organisms. Wetlands form in waterlogged soils, either in low-lands where water collects by gravity, in uplands where impermeable soils create perched water tables, or at the highest elevations where fog and abundant rain provide a constant supply of water for wetland plants and animals.

Land Use History

Land use history has influenced the distribution of plants and animals across Vermont. For instance, the degree and type of forest cover have a great influence on the species that occur in an area. Vermont has more forest today (75%) than it had in the mid-1800s (25%), and the effect of this change on wildlife has been dramatic. Additionally, Vermont's agricultural activity also affected the soils and the plants that grow in them.

Biophysical Regions of Vermont

The five factors described previously combine to create nine distinct biophysical regions. It is important to consider Vermont's biophysical regions when assessing and planning for the conservation of wildlife (Fig 2.1). For example, what may be a common species in one biophysical region may be rare in another, thus, increasing the importance of conserving habitat for that species in the region in which it is rare. Vermont's biophysical regions are described below.

Northeast Highlands: Granite bedrock dominates this cool region, which is characterized by large wetlands, remote mountains, and lakes and ponds. Spruce and fir dominate the lowlands as well as the high elevations, whereas northern hardwoods cloak the mid-elevations. Forty-three percent of this region is conserved, the highest percentage of any of Vermont's biophysical regions.

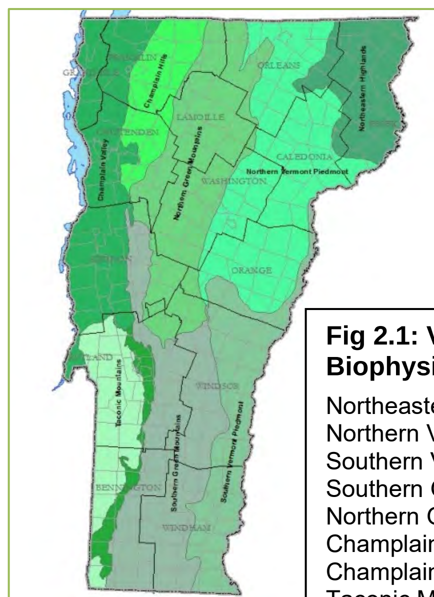

Fig 2.1: Vermont Biophysical Regions

Northeastern Highlands
Northern VT Piedmont
Southern VT Piedmont
Southern Green Mountains
Northern Green Mountains
Champlain Hills
Champlain Valley
Taconic Mountains
Vermont Valley

Northern Vermont Piedmont: Calcium-rich soils combine with a cool climate to support mixed forests and Northern White Cedar Swamps, Fens and other interesting natural communities in this region. The uplands have fine agricultural soils, but a short growing season. Eight percent of the region is conserved.

Southern Vermont Piedmont: Calcium-rich soils and rolling hills make this a good place for agriculture. The climate is average for Vermont, except in the extreme southeast where it is quite warm. Northern hardwoods and red oak dominate the vegetation. Seven percent of the region is conserved.

Southern Green Mountains: A broad plateau dotted with a few dominant peaks and several ski areas. Climate is cold and rainfall is relatively high. Northern hardwoods, spruce, and fir dominate, and there are many small lakes and ponds. Thirty-three percent of this region is conserved.

Northern Green Mountains: This area has a cool climate and high elevations and is mostly forested. Northern hardwoods dominate the side slopes, whereas high elevations have spruce and fir as well as Alpine meadow habitat. Twenty-six percent of the region is conserved.

Champlain Hills: This region is transitional between the Champlain Valley and the Northern Green Mountains. Northern Hardwood Forests dominate on the low hills, but oak-pine forests extend up the major river valleys where there are warmer conditions.

Champlain Valley: This region of Vermont has a warm climate and abundant fertile farmland. The Champlain Valley contains both northern hardwood forest and various species of oaks and hickory. It has some of the state's most significant natural diversity, and the state's most densely populated areas. Nine percent of the region is conserved.

Taconic Mountains: The slate belt of Vermont and New York is found in this region. The Taconics are dramatic wooded hills dominated by sugar maple, beech, and yellow birch forests. Dry oak and hickory forests are found on the lower elevation knolls, while spruce and fir occur at the highest elevations. Ten percent of the region is conserved.

Vermont Valley: The Marble Valley has marble and limestone with glacial deposits on the valley walls, abundant springs, and wetlands. About 10 percent of the region is conserved.

Vermont's Landscape—an Historical Perspective

Vermont's landscape has long been altered by people. Native cultures grew crops, harvested animals for food and clothing and lived in established settlements. During the 17th and 18th centuries, land was cleared for the development of agricultural economies. By the mid-1800s, 75% of Vermont's forests were cleared for agriculture, and in particular, sheep farming. These changes affected the state's waters, forests, and wildlife. Even some wildlife species, such as beaver and deer, that had been common, nearly disappeared from the land. As other influences caused people to begin to move towards the western United States, lands were abandoned and forests began to regenerate.

With the return of the forest and the work of the Vermont Fish & Wildlife Department and partners the recolonization and reintroduction of animal species, Beaver, White-tailed Deer, Wild Turkey, Fisher, and others that had declined have now returned and are today abundant. These species and others stand as great testament to Vermont's commitment to wildlife conservation and the resiliency of the forests and wildlife. Many species of fauna and flora, however, have not recovered. The Passenger Pigeon, for instance, is now extinct, and some large predators such as wolves and mountain lions that once roamed the New England forests, are no longer present.

Vermont's Contemporary Land Use

Agriculture and forestry still support Vermont's economy in significant ways. These elements of Vermont's business and economic communities offer great opportunities for wildlife conservation because they allow private landowners to realize a financial return from their land while keeping the land in an undeveloped or natural condition. Many of these land-based business interests are excellent stewards of the land and wildlife.

Vermont non-industrial forestland owners have a long history of active engagement in the management of forest resources throughout the state. Since the advent of the Vermont Use Value Appraisal Program (a.k.a. Current Use Program) 16,000 landowners have brought more than 1.8 million acres of forestland under forest management. A 2008 update to the program now allows landowners to enroll lands as Ecologically Significant Treatment Areas rather than for timber production, if they support natural communities and wildlife habitats of statewide significance; rare, threatened, and endangered species; some riparian areas; vernal pools with amphibian breeding habitat; forested wetlands; and old forests. More than 2,800 acres are enrolled as Ecologically Significant Treatment Areas.

Many of Vermont forestland owners manage their lands for wildlife and forest resources and seek to enhance their management skill through their involvement in non-profit organizations advocating sustainable forest management such as Vermont Coverts: Woodlands for Wildlife, Vermont Woodlands Association, Vermont Family Forests and Audubon Vermont's Forestry for the Birds program. These stewards provide strong examples of Vermonters taking steps to conserve our wildlife resources.

Based on data from the U.S. Census Bureau's 2014 the population estimate, 626,562 people live in Vermont, an increase of 0.1% since 2010. While Vermont is considered the most rural of northeastern states, there is an increasing demand for residential and commercial development. The rate of development in Vermont is double the rate of population growth (Center for Rural Studies 2008) and this growth is occurring mostly in rural communities. Like other New England states, residential development is often dispersed in rural and suburban areas rather than in existing village and urban communities.

Parcelization describes the subdivision of land into smaller and smaller forested area and multiple ownerships--typically by roads, agriculture, utility corridors, subdivisions or other human development. This phenomenon drives habitat fragmentation that has been shown to reduce forest and habitat health, water quality and the sustainability of local forest product economies (VFPR 2015). With Vermont's population projected to increase by 85,000 in the next 15 years, the Vermont Forests, Parks & Recreation Department is leading efforts to balance population growth with Vermonters' interests in maintaining healthy forests and wildlife habitat, clean water and the state's traditional settlement pattern of village centers surrounded by fields, farms and working forests (VFPR 2015). Since 2006 the Vermont Natural Resources Council has hosted the Vermont Forest Roundtable, a venue for information exchange among consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. Addressing parcelization drivers has been a primary Roundtable focus.

Contemporary Problems and Threats to Vermont's Wildlife

The problems most frequently identified as impacting SGCN are loss of habitat (due to conversion, degradation, fragmentation and lack of needed successional stages), the impacts of roads and transportation systems, pollution and sedimentation, invasive species and climate change. Additionally, wildlife diseases and the decline of pollinators have been gaining greater attention in both the scientific community and among Vermonters in general. Each is summarized here:

Loss of Habitat: Due to Degradation, Conversion, Fragmentation or Lack of Needed Successional Stages

These four categories are not mutually exclusive and problems can often logically be placed into more than one category depending on the stress it causes for a species or habitat.

Habitat Conversion: The complete transformation or loss of a habitat by human action (examples include: filling a wetland to create a grassy field, converting a forest stand into a parking lot, or damming a stream to create a reservoir). Though many agencies and organizations work diligently to conserve important wildlife habitats, Vermont continues to lose approximately 4,800 acres of habitat each year to regulated development alone. According to the Vermont Environmental Board, regulated development in Vermont constitutes approximately one-third of the total development that occurs on an annual basis. Important habitats addressed by various statutes, largely Act 250, and include deer winter habitat, wetlands with significant wildlife functions, habitat for rare, threatened and endangered species and several types of habitat necessary for the survival of black bears. These habitats represent only a few of the many habitats that are affected by loss due to development.

Habitat Alteration/Degradation: A lessening of the quality of a habitat by human action stopping short of complete conversion (examples include: the reduction of mast (fruit and seed) production in a forest stand, riprapping a streambank, and significant land use changes adjacent to a habitat such as replacing a forest stand on the edge of a wetland with a housing development.

Habitat Fragmentation: The breaking up of habitats into smaller, non-contiguous patches because of habitat conversion (e.g., housing, commercial development, roads, utility lines). Fragmentation can: 1) render important habitats inaccessible (such as isolating a den site from a feeding site), 2) isolating populations (for example grassland butterflies, spotted salamander, and tiger beetles); and, 3) degrade remaining habitat patches through edge effects that favor edge-tolerant species such as raccoons and crows, as well as invasive exotic species that can out-compete native and rare species. The result of habitat fragmentation is often increased predation, increased mortality, reduced mobility and changes in habitat micro-climates. In the past decade, fragmentation research and efforts to maintain and restore habitat connectivity have increased significantly in Vermont and elsewhere. It's also a problem for forestry and rural economies (VFPR 2015).

Inadequate Distribution of Successional Stages: The lack of either late, mid or early successional habitat in appropriate patch size and/or juxtaposition can be a problem for some SGCN especially as fragmentation makes it harder for species to move between forest patches (examples include ruffed grouse and woodcock which prefer early successional forest stands, American marten which prefers late-successional stands and Canada Lynx and Snowshoe Hare which depend on a mix of forest stages).

Climate Change

Long-term changes linked to global warming and other climate issues are expected to drive major changes in habitat availability (e.g., high elevation habitats, wintering areas and migration stopovers) (Glick 2005), vegetative composition and location (e.g., the movement up in elevation or north in latitude, invasion by exotic pests), climate variability (e.g., change in snow depth, rainfall and/or natural disturbances). Many specific details as to how climate change is affecting Vermont's wildlife today remain unknown, but the pervasiveness and scale of the problem requires that we begin planning to address it now. Chapter three of this Wildlife Action Plan dives deep into the Climate Change threat.

Impacts of Roads and Transportation Systems

The number of vehicle miles traveled by Vermont residents is growing at seven times the rate of population growth, according to information from the Vermont Agency of Transportation (VTrans) (1999). Transportation systems can cause numerous problems for SGCN including: vehicle-wildlife collisions; reducing animal and fish passage, thus limiting habitat availability and isolating populations; vehicle emissions of pollutants such as ozone and greenhouse gases; and facilitating the spread of an exotic, invasive species into otherwise healthy areas. To address problems such as these, VFWD and VTrans established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans is now considered a leader nationally among transportation agencies in road ecology.

Pollution & Sedimentation

The introduction of exotic materials from point and non-point sources can significantly impact SGCN, particularly aquatic species. Pollutants and sediments include sands and silts, chemicals and toxins; excess nutrients from farm and municipal sewage plants; garbage and other solid waste; radioactive materials; road salt; excessive noise; excessive heat; and light pollution that disturbs animals and disrupts migration patterns. Sediments can be a problem for SGCN through their physical presence alone. For example, soils can wash into a stream from a construction site and smother fish eggs and other aquatic species living in the spaces between rocks and gravel streambed. The history of polluted runoff—rainwater and snowmelt draining from parking lots, roads and streets, logging roads, farm fields and croplands, and lawns—carrying sediments and nutrients, including phosphorus, into streams and rivers and directly into Lake Champlain is stimulating excessive growth of algae which is bad for lake species and people. The status of efforts to reduce the amount of pollutants getting into the lake can be found at Restoring Lake Champlain.

Invasive Exotic Species

The introduction and spread of invasive exotic and native species (plants and animals) may lead to the elimination of native wildlife populations, threaten long-term stability of habitats and even lead to extirpation through disease, by out-competing a native species, displacing its food source or altering a key process or function of a habitat. Invasive exotic species in Vermont include Eurasian watermilfoil, purple loosestrife, common buckthorn, Japanese knotweed, Morrow's honeysuckle, goutweed, black swallow-wort, hemlock wooly adelgid rusty crayfish, alewife and zebra mussels.

Since the 2005 Wildlife Action Plan was released, the ecological and economic problems caused by invasive exotic species have gained much more attention in Vermont. A clearinghouse of information and resources to help map, assess and combat the introduction and spread of these species is now available at VTInvasives.org. (vtinvasives.org). VDEC's Aquatic Invasive Species Program coordinates management activities associated with aquatic invasive and nuisance species. And, the state has an Invasive Forest Pest Action Plan ready for the eventual arrival of forest pests, including the Asian long-horned beetle and emerald ash borer, in order to prevent the establishment and/or limit their spread within Vermont (VFPR/VAAFM 2014).

Diseases

Shortly after the first Wildlife Action Plans were submitted, White-Nose Syndrome (WNS) was discovered in New York and then Vermont in 2008 followed quickly by several other states. In a few short years WNS nearly wiped-out several bat populations in the Northeast. The Little Brown and Northern Long-eared Bats, decimated by the disease were added to Vermont's endangered species list and the Northern Long-eared bat was listed federally as threatened in 2015. The threat caused by WNS was added as an 'emerging issue' to the Action Plans of several states, including Vermont's. Subsequently, Snake Fungal Disease was discovered killing Rattlesnakes in Vermont and elsewhere, and *Heterosporis* appeared in Yellow Perch in Lake Champlain. Additionally, diseases not yet found in Vermont are potential threats. They include: Chronic Wasting Disease (deer), Viral Hemorrhagic Septicemia (fishes), *Batrachochytrium salamandrivorans* (salamanders) and Avian Influenza (birds). The Vermont Fish & Wildlife Department has steadily increased surveillance and is devoting additional resources to the threats posed by these and other diseases.

The Vermont Fish & Wildlife Department developed a fish health and biosecurity program to reduce the risk of disease importation and spread that includes strict regulations for fish importation, the prohibition of live transfer of fish from one body of water to another, strict baitfish use regulations, the use of water filtration and disinfection equipment at fish culture station water source(s), regular use of disinfectants at fish culture stations and health inspections of both naturally produced fish and fish produced at fish culture stations. The Department works in close coordination with its counterparts in the northeast states through the Northeast Fish Health Committee to develop and share procedures and protocols to maintain fish health and reduce the threat and movement of fish diseases.

VFWD also strictly controls access to bat hibernacula to prevent the spread of WNS and has regulations governing the movement of rabies vector species as well as rules to help prevent the introduction of Chronic Wasting Disease into the state. The VFWD, collaborates regionally through the Northeast Wildlife Disease Cooperative, a consortium of states and veterinary diagnostic laboratories providing wildlife diagnostic services, expertise, training, and research support to state and federal wildlife agencies in the region.

The Forests, Parks & Recreation Department's Forest Health program monitors tree and forest condition statewide. The survival of tree species, in some cases entire genera, is at stake when non-native insects and diseases arrive in locations where they have no natural enemies and their tree hosts have no resistance. Some threatened species, including hemlock, beech, and ash, are currently an integral part of the state's forests. Others, including native red pine and flowering dogwood, are already uncommon. Conservation planning can identify individual trees or forest stands to be protected, and the best strategies to use while limiting impacts to non-target species. Other tree species are already decimated by pests that are well established in Vermont, including Dutch elm disease, chestnut blight, and butternut canker.

Pollinators

While the 2005 Wildlife Action Plan included 33 species of butterflies and moths, many of them pollinators, their role as pollinators was not critical to their selection as SGCN. Since 2005, concerns over the status of pollinators in general (e.g. flies, wasps, moths, butterflies, beetles, bees, bats and hummingbirds), and native bees in particular, has become a worldwide concern. Pollination is defined as a mutually beneficial relationship between plants and pollinators wherein the plant provides pollen and/or nectar to the pollinator and the pollinator provides reproductive services for the plant (National Research Council, 2007). Roughly 75 percent of the 240,000 species of flowering plants world-wide rely on pollinators for flower reproduction (NRC, 2007). This includes many plant species that provide browse or forage for larger wildlife, as well as seeds and fruits to support birds and small mammals. These invertebrates also pollinate many commercial crops. In Vermont this includes blueberries, tomatoes, squash, apples, and other produce. The many drivers of pollinator declines include habitat loss and degradation, intensive agricultural practices, use of certain pesticides, diseases and pathogens (Heinz Center, 2013). For this second Wildlife Action Plan nine bumble bee species and 31 species of butterflies and moths—including the Monarch butterfly—were selected as Species of Greatest Conservation Need.

Bad News & Good News

The preceding summary of threats is sobering to say the least. It challenges everyone concerned about wildlife and wildlife habitat to think smarter and work harder and more creatively. The good news here is that we can focus our limited conservation resources on the strategies that will provide the biggest bang for the buck, such as those outlined in this report that come up again and again including habitat restoration, encouraging wildlife-compatible resource use, providing education and technical assistance to landowners and managers, and providing economic incentives for conservation

But to do justice to this Action Plan, and to help the many SGCN and habitats in need, we need to add one problem to the list of major issues impacting Species of Greatest Conservation Need that our technical teams did not identify directly in their assessments, but it was often discussed during team meetings—the lack of sufficient funding for wildlife conservation. Without sufficient funding we will not be able to implement many of the conservation strategies identified in this report. The State Wildlife Grants program is a critical first step in funding SGCN conservation, but more is needed. And, to make the most of SWG funds, Vermont will have to develop the required matching stateside funds.

Conservation Success!
Keeping Common Species Common

Despite the changes to the Vermont landscape, the fact is, Vermont remains a relatively rural state with an abundance of conserved land, private landowners who are excellent stewards of the environment, and many wildlife conservation success stories. The public opinion survey results (U.S. Fish & Wildlife Service 2001) speak volumes for the bright future of wildlife conservation in Vermont—that is, the public has a strong interest in and support for the conservation of Vermont's natural heritage.

Moreover, a review of past and ongoing wildlife conservation efforts provides proof of our collective ability to recover and conserve wildlife and the habitats required for their survival. It also identifies the key building blocks for successful conservation.

In 1724, when the first European settlement was established at Fort Dummer, near Brattleboro, the state was primarily forested and had abundant fish and wildlife populations including Passenger Pigeons, fisher, wolves, deer, black bear, beaver, and salmon. However, by 1865 many of these species would be present in far fewer numbers or on the cusp of extirpation because of unregulated harvests, habitat loss and habitat degradation.

Hunting and fishing license fees, soon after the turn of the 20th century, coupled with federal wildlife and sportfish restoration act dollars, enacted in the 1930's and 1950's respectively, established a financial framework in support of conservation. These monetary resources enabled Vermont, and the other states, to conduct inventories and research, acquire habitats, and provide conservation education to the public. Today, some of the species of low abundance 150 years ago are now once again common throughout the State. Consider, for example:

> **White-tailed Deer:** Numbers were so low in the late 1800's that no open season was offered and deer were transported from New York. Through extensive research, harvest management, and habitat protection, Vermont can now support more than 150,000 deer with 48 days of hunting opportunity, annually.
>
> **Wild Turkey:** This bird was extirpated from the state in the 1800's. Birds were reintroduced to the state in 1969. We now have more than 40,000 Turkey and both fall and spring hunting opportunities.
>
> **Fisher:** This mid-sized carnivore was extirpated from the state. Animals were reintroduced to Vermont beginning in 1959 (to help control porcupine), and this predator now thrives on the Vermont landscape.
>
> **Anadromous fish on the Connecticut River:** Migratory fish in the Connecticut River, including Atlantic Salmon, American Shad, Striped Bass and River Herring were reduced or eliminated in 1798 by a dam built in Turners Falls, Massachusetts. With the construction of fish passage at dams, and active restoration programs Shad, Stripers and Herring are now abundant in the lower river.

Trout and salmon in Lake Champlain: Landlocked Atlantic Salmon disappeared from Lake Champlain in the 1850's, and native Lake Trout were gone by 1929. A restoration program was begun in the 1970's in cooperation with the State of New York and the US Fish and Wildlife Service, and these fish are plentiful once again in Lake Champlain where they support a popular fishery that brings hundreds of millions of dollars into the regional economy each year.

Lake Sturgeon: A combination of dam construction, pollution and over-fishing reduced Lake Sturgeon populations in Lake Champlain in the early 1900's to the point that the commercial fishery was abandoned and all fishing for sturgeon was prohibited in 1967. Since this fishing closure Sturgeon conservation has benefited from water quality improvements, better water flows at the dams, and outreach to anglers to release any sturgeon they catch. Recent studies have documented successful natural reproduction of sturgeon in three of their historic spawning rivers in Vermont (Lamoille, Winooski and Missisquoi).

Peregrine Falcon, Osprey, and Common Loon: These birds were gone or nearly gone from the state by the mid-1900's, through focused management (e.g., the construction of artificial nesting platforms, water level management, banning use of the pesticide DDT and public education), each of these three species has recovered sufficiently that they've recently been removed from the state's endangered species list—a first for any species in Vermont.

Bald Eagle and Common Tern: Listed as endangered in Vermont, the known nesting population of Bald Eagles in Vermont has grown from zero in 2007 to 21 nesting pairs with 34 fledglings in 2016. Vermont's Common Tern population dropped from 300-400 breeding pairs in the 1980s to approximately 50 in 1988 when it was listed as endangered. With monitoring, management and the protection of nesting islands their numbers have increased since then. Breeding numbers have recently exceeded the levels recommended for down-listing to Threatened (but continuing low productivity delays down-listing).

These success stories suggest that new dollars coupled with patient and persistent efforts can produce new success stories for the future. In other words, the fish and wildlife profession has demonstrated the will and the competence to restore and manage wildlife. The Wildlife Action Plan, coupled with sustained funding and the dedicated participation of partners, will offer a template for advancing the success stories to a new suite of species.

The Importance of Education, Law Enforcement and Recreation to Wildlife Conservation

Through the State Wildlife Grants program (SWG) Congress provides every state with critically needed funds for wildlife conservation. Congress' intention is to support proactive and strategic efforts to prevent future Endangered Species Act listings—in other words, to keep common species common. To meet Congressional intent, states are compelled to employ all their best conservation tools including education, wildlife-associated recreation and the creation and enforcement of wildlife protection laws and regulations. These are among the most proactive, strategic and time-tested tools in any conservation tool box.

The details of the SWG program legislation, however, currently preclude states from using SWG funds for law enforcement and recreation projects. A limited amount of SWG funds can be used for conservation education, but only in a supporting role in the implementation of a conservation strategy (e.g., signage explaining the purpose of a restoration project). This poses a dilemma for states trying to implement a truly comprehensive wildlife action plan because it restricts their use of three vital conservation tools. Moreover, it limits the participation of three significant conservation constituencies from participating in Wildlife Action Plan implementation—the law enforcement, education and outdoor recreation communities.

A limited number of education and law enforcement conservation strategies specific to individual species or habitat categories were addressed in the species and habitat conservation summaries of this report (Appendices A and B). We recognize that alternative funding sources are needed for their implementation. In this section of the Wildlife Action Plan report we present additional conservation strategies based on conservation education, wildlife-associated recreation and law enforcement. It is our hope that future renderings of the State Wildlife Grants program, along with other funding mechanisms, will more fully provide for the implementation of these strategies.

Conservation Education

Wildlife and human communities depend on healthy ecosystems and ecological processes. Their functions are essential for our quality of life and for the Vermont economy. Conservation strategies that follow a sound education model can foster healthy public behavior and attitudes toward land and wildlife conservation. Furthermore, strong educational programs that expand Vermonters' ecological literacy will enhance the credibility and effectiveness of other conservation efforts and build support for future efforts. Finally, the public plays a key role in influencing legislators, who in turn affect policy and funding decisions. Recommended strategies include:

- Foster and enhance educational partnerships to maximize efficiency (e.g., develop volunteers, outreach to teachers and youth group leaders to deliver programs)
- Ensure that sound messages, curricula, and best educational practices are followed to maximize our efforts (e.g., provide teacher training, curriculum support materials for teachers and students.
- Define a land stewardship message that promotes the conservation and ethical use of Vermont's fish, wildlife, and plants, and the habitats that sustain them.
- Focus outreach and education efforts to enable the public to make informed decisions on issues affecting ecosystems in Vermont such as: habitat degradation and fragmentation, threats to fish

and wildlife species and their habitats, the value of working rural landscapes and other rural lands, and the sustainable and ethical utilization of wildlife.

The connection of education to wildlife conservation is recognized nationwide. The Association of Fish and Wildlife Agencies developed the North American Conservation Education Strategy in 2010 to help make improve conservation education programs nationwide.

Wildlife-Associated Recreation

Hunting, fishing, trapping, and wildlife viewing have a long heritage in Vermont and Vermont leads the nation in wildlife viewing (U.S. Department of the Interior et al. 2011). By providing the means for more people to connect with wildlife, we can foster more and stronger relationships to the natural world. Applying the concept of stewardship through recreation Vermonters can become knowledgeable about and appreciate wildlife, natural communities, and conservation in ways that promote citizen interest in contributing to conservation. Recommended strategies include:

- Work with the broader community of recreation groups (e.g., outdoor guides, birders, sportsmen and women, hikers, paddlers, climbers, spelunkers, mountain bikers and snowmobile and ATV associations) to foster partnerships that build a stronger wildlife ethic among members.
- Expand educational programs on watchable wildlife, including such topics as birding, wildlife photography, animal track identification, and backyard habitat. Target population centers, with a focus on youths and families.
- Increase information available to the public on how and where to watch wildlife. Provide information to encourage watchable wildlife practices, such as viewing, photographing, and feeding, in a manner that is ethical, safe, and consistent with protecting the welfare wildlife resources.
- Foster a recreational ethic based on the concept of giving back to the natural world.
- Include an educational component in recreation activities making the connection between our actions and the impact on wildlife.
- Involve Vermonters in activities that will increase their understanding of wildlife, land stewardship and the influences of human activities on wildlife, to build public support for fish and wildlife conservation (e.g., citizen science projects such as the bird atlas, butterfly survey and other wildlife inventories, teacher training courses, streambank plantings, and field classrooms).
- Encourage responsible outdoor recreation through programs such as "Stop Aquatic Hitchhikers," "Leave No Trace," "Stay on the Trails," and "Be Bear Aware."

Statewide Comprehensive Outdoor Recreation Plan: In addition to the Wildlife Action Plan, states develop comprehensive plans for outdoor recreation as a requirement for receiving support from the federal Land and Water Conservation Fund (LWCF). The Statewide Comprehensive Outdoor Recreation Plan (2014-2018) developed by the Vermont Forests, Parks & Recreation Department helps guide efforts provide high quality outdoor recreation facilities, opportunities and experiences for Vermonters and visitors.

Law Enforcement

The creation and enforcement of fish and wildlife laws are among our society's oldest attempts to conserve wildlife. Vermont's first game wardens were appointed in 1779 to protect deer and were called

"Deer Reeves." Law enforcement is an effective conservation tool and has been at the core of wildlife conservation ever since.

State game wardens prevent the illegal taking, trade, sale, collection and importation of wildlife by proactive enforcement of fish and wildlife laws. Game wardens also prevent and investigate the unlawful destruction of important habitat, trespass and disturbance of refuge areas and sensitive breeding grounds and enforce the regulations and permits that govern wildlife research, education and rehabilitation.

Law enforcement professionals strive to be proactive: Game wardens are an integral part of the Fish & Wildlife Department's outreach and education programs. Wardens teach conservation at schools, civic organizations and conservation camps and are often the first, and sometimes only, contact that the public has with a conservation professional. Recommended strategies include:

- Maintain staffing of game wardens statewide sufficient to ensure the adherence of all laws pertaining to fish, wildlife and habitat conservation.
- Continue to conduct routine patrols, incidental to core duties, providing enforcement of boat, ATV and off road recreational vehicles to address the illegal operation and destruction of sensitive habitat and wildlife areas.
- Review, update, and enforce regulations controlling the importation and possession of exotic and potentially harmful fish and wildlife species and their pathogens.

Recent projects

As people interact more and more with wildlife, the number of wildlife-human conflicts increases. In 2014 Vermont game wardens responded to more than 500 calls from the public on issues such as rabies and damage to property. If not adequately addressed, members of the public might try to resolve the issues themselves in a manner unduly detrimental to wildlife. Many encounters require a physical response by a warden to prevent human injuries or disease exposure.

All for one and one for all: Law enforcement, Education & Recreation

It should be clear to a reader by this point that not only is each of these three tools critical to the long-term conservation of wildlife, but that they are all tightly intertwined. For example, our best opportunities to instill the message of conservation in the public are when they are out in nature recreating. And, state game wardens are often the ones to deliver the message. Furthermore, outdoor guides and other recreationalists often provide tips to wardens and compliance officers regarding habitat degradation or the illegal taking of wildlife, and by doing so they send a strong message to the public that Vermonters care about wildlife.

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Chapter 3

Climate Change & Conservation

2015

3. Climate Change & Conservation

Introduction

Ten years ago, when states across the nation were completing their Wildlife Action Plans, wildlife managers were just beginning to think through basic questions such as: 'How might climate change impact wildlife and wildlife habitat? 'How can we systematically identify wildlife, plants and habitats that might be vulnerable to climate change? And, 'What types of actions can be taken to help wildlife survive climate change?'

Ten years later, many states, including Vermont, have begun identifying how wildlife and habitats might be affected by climate change, which are most vulnerable, and how to best manage for the future. There are few clear or simple answers. Identifying vulnerable species and habitats requires teasing out myriad factors that climate change could influence, such as changes in precipitation rates, snow pack and soil moisture; changes in the number of freezing days; new diseases and invasive species; flooding, lack of flooding; movement of species and their habitats, and changes in predator-prey and plant-pollinator relationships. And, we don't know the capacity of species to respond to a changing climate.

An honest response to these very complicated questions is 'we don't know how most species will fare in the coming decades.' We can assume there will be winners and losers. Bicknell's Thrush and other alpine plants and animals found only at the tops of Vermont's highest peaks, for example, are likely to be losers here (though they may fare better north of here). Other species, such as the Virginia Opossum and Tufted Titmouse, which have been slowly moving north, might do better in Vermont in the coming decades.

What to do? We need to remain vigilant, expect to be surprised, foster adaptability and reduce other stresses on wildlife and wildlife habitat. In the short-term, riparian areas (the banks of rivers and streams) and adjacent land, including their floodplains, may be the best places to invest our conservation efforts because when healthy these areas are more resilient to flooding, reduce downstream flood impacts, keep waters cool and provide important habitat and connectivity to many wildlife species. Table 3.1 lists actions that are generally most important if we want to help wildlife in the coming decades.

Table 3.1. General adaptation goals to inform the identification of specific strategies that serve to increase the resiliency and/or adaptive capacity of wildlife and their habitats (Stain, B. et al. 2014). **Note**: There is significant debate over the pros and cons of assisted migration (relocating organisms).

Adaptation Strategy	Definition
Reduce non-climate stresses	Minimize localized human stressors (e.g., pollution) that hinder the ability of species or ecosystems to withstand or adjust to climatic events
Protect key ecosystem features	Focus management on structural characteristics (e.g., geophysical stage), organisms, or areas (e.g., spawning sites) that represent important "underpinnings" or "keystones" of the current or future system of interest
Ensure connectivity	Protect, restore, and create landscape features (e.g., land corridors, stream connections) that facilitate movement of water, energy, nutrients, and organisms among resource patches
Restore structure and function	Rebuild, modify, or transform ecosystems that have been lost or compromised, in order to restore desired structures (e.g., habitat complexity) and functions (e.g., nutrient cycling)
Support evolutionary potential	Protect a variety of species, populations, and ecosystems in multiple places to bet-hedge against losses from climate disturbances, and where possible manage these systems to assist positive evolutionary change
Protect refugia	Protect areas less affected by climate change, as sources of "seed" for recovery (in the present) or as destinations for climate-sensitive migrants (in the future)
Relocate organisms	Engage in human-facilitated transplanting of organisms from one location to another in order to bypass a barrier (e.g., urban area)

The remainder of this chapter is a deeper exploration of the climate change threat. It includes a summary of historic climate trends and projections of future climate; a look at the ecological impacts of climate change on species, forests wetlands and aquatic habitats. It also delves deeper into efforts to conserve wildlife in the face of climate change both in Vermont and regionally. This chapter concludes with a list of conservation strategies to help Vermont's wildlife, plants and wildlife habitat.

Taken in a broader context, this chapter will help to illustrate the interconnection between climate and non-climate stressors and conclude with a list of conservation strategies to help Vermont's wildlife, plants, and habitat.

From the waters of our lakes and rivers to the forests and wetlands abutting our communities, Vermont's diverse ecosystems are essential to a healthy and sustainable future for wildlife and people.

Vermont's fish, wildlife and plants and their habitats are already responding to climate change. Plants are leafing out and blooming earlier; birds, butterflies, amphibians, and other wildlife are breeding, feeding, metamorphosing or migrating earlier; and many species that can migrate are shifting ranges northward and to higher elevations (Betts, A. K. 2011a, Stager, C., and Thill, M. 2010, U.S. Global Change Research Program 2009). Of concern is the potential disruption of entire ecosystems. As diverse species and habitats in Vermont respond to climatic fluctuations in different ways, important inter-specific connections—such as between pollinators and the flowers they fertilize, or breeding birds and the insects on which they feed—will likely be disrupted. Further, the ecological impacts associated with climate change do not exist in isolation, but combine with and exacerbate other stresses on our natural systems. For instance, although climate pressures may be causing species ranges to shift, development and roadways have created a matrix of inhospitable habitat that may inhibit such movement. And while invasive species already have a major negative impact on many ecosystems in Vermont, many invasives may be favored under future climate conditions, making it even more difficult for native species to adjust and survive under new climatic regimes. These are just a few examples of the challenges that species and habitats in Vermont face under climate change.

Historic Trends and Future Projections

Since 1895, the average annual temperature in the U.S. has increased between 1.3°F and 1.9°F. Over the next 30 to 40 years, temperatures are expected to rise on average another 2°F to 4°F across most of the nation. By the end of the century, should carbon emissions continue to rise at the current rate (higher emission scenario) the U.S. can expect a rise in average annual temperature between 5°F to 10°F. On the other hand, if significant reductions in carbon emissions can be achieved (lower emission scenario), average annual temperature across the U.S. would rise approximately 3°F to 5°F by the end of the century (Melillo, J.M. et al. 2014) (Fig 1).

While the last decade has been the hottest on record, it is evident that there is significant regional variation - with northern latitudes experiencing greater warming. Therefore, the Northeast can expect a greater rise in average annual temperature. Depending on the different emission scenarios, temperatures in the Northeast are projected to increase by either 4.5°F to 10°F (under a higher emission scenario) or 3°F to 6°F (under a lower emissions scenario) by the 2080's (Horton, R. et al. 2014).

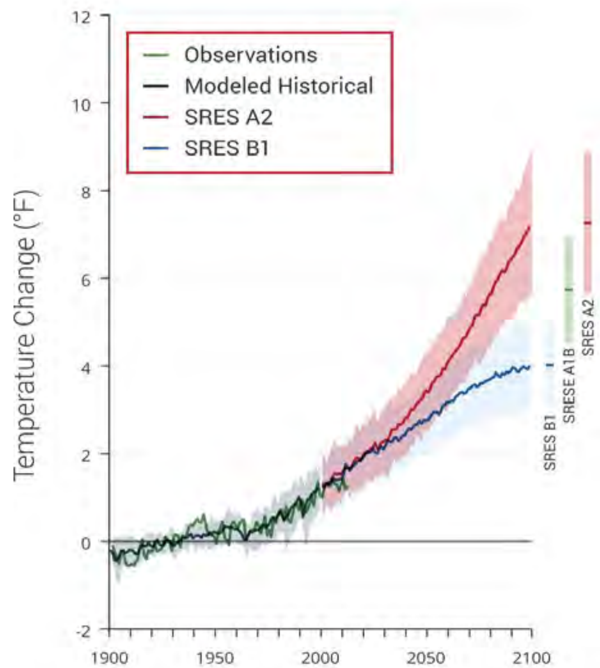

Figure 1. Estimated average rise in global temperature (relative to the 1901-1960 average) for the higher emissions scenario (A2) and lower emissions scenario (B1). A higher emissions scenario assumes a continued increase in emissions throughout this century, whereas a lower emissions scenario assumes a significant reduction. Shading represents the range (5th to 95th percentile) of results from a suite of climate models. Average temperatures are predicted to increase in both scenarios, however the difference between lower and higher emissions pathways is significant (Melillo, J.M. et al. 2014) (Figure source: NOAA NCDC / CICS-NC).

In Vermont, average annual temperatures have increased 1.6°F since 1960 and 0.9°F since 1990, with temperature increases even more significant in recent decades. For example, mountainous highland regions in Vermont have experienced average annual temperature increases of 1.8°F per decade from 1990-2012 and 2.5°F from 2000-2010. In addition, average annual winter temperatures are rising twice as fast as average summer temperatures. These trends are resulting in significant changes to Vermont's climate (Galford, G.L. et al. 2014).

Vermont's Changing Seasons

As temperatures continue to climb, the severity of Vermont's winters is decreasing. Compared to the 1940s-1960s, Vermont had a 20% decrease in the number of days below freezing in the last decade alone. As a result, lakes and ponds are experiencing an average of seven fewer freezing days per decade. Simultaneously, average precipitation rates have also increased in Vermont. For example, since 1960, decadal precipitation averages have increased by 0.9" in lowland areas and 2.3" in highland regions. The result has been increases in snowfall amounts at higher elevations. However, the projections suggest that while snowfall amounts will increase over the short term (20-25 years), as temperatures increase over the long-term winter precipitation will increasingly come in the form of rain (Galford, G.L. et al. 2014).

> "Warmer winters will lead to reduced accumulation of snow during some years. Less snowpack may mean less runoff during the late winter/early spring thaw. This effect may be offset by increased rains falling on frozen ground, leading to greater runoff. However, if winter temperatures rise to levels that decrease the duration of frost conditions by late in the century, runoff may be moderated by increases in soil infiltration – if soils do not become saturated by a rain event (Galford, G.L. et al. 2014)."

Overall, projections suggest more winter and spring precipitation over the coming century. "Average monthly flows in January and March, as well as July, August, and October through December, have increased while average monthly flows in April and May have decreased (Galford, G.L. et al. 2014)."

Moreover, high intensity precipitation events greater than one inch increased an average of four days between 1960-1980 and an average of 7-10 days a year over the past two decades. One of the outcomes of more frequent high-intensity rain events is that stream high flows are larger, more frequent, and are projected to occur more frequently in winter. An increased number of high-intensity rain events in conjunction with warmer temperatures will result in more flooding along Vermont's rivers and shorelines. At the same time, rising temperatures over the longer term and increased seasonal variability in rainfall suggest a potential increase in the number of short-term summer droughts resulting in periods of very low stream base flows and lake levels, and slow groundwater recharge rates by centuries end (Galford, G.L. et al. 2014).

Impacts of Climate Change on Vermont's Ecology

Significant deviations in the variability around historic climatic norms, including increased variability in temperature, precipitation and extreme weather events, has direct implications on the vulnerability of species and the habitats upon which they depend. In this context, vulnerability is defined as "the susceptibility of a species, system or resource to be negatively affected by climate change" and interactions with other non-climate stressors such as habitat degradation and habitat loss (Staudinger, M.D. et al. 2015). Climate change already presents a variety of challenges for species and ecosystems across the Northeast. These include the reduction in the "quality and distribution of habitats, the availability of food, increases in the abundance of parasites and diseases, and the increased incidence of stress from heat and drought (Rustad, L. et al. 2012)." How do the challenges driven by climate change affect the ecosystems in Vermont? To explore this question, we'll look at how Vermont's species and natural communities, including forests, wetlands, waterbodies and other habitats are currently responding to climate change and how such communities are likely to shift in abundance, composition, and range in the coming decades.

Forests

Vermont is predominately a forested landscape so climate-driven impacts to forests are of significant concern for Vermont wildlife as well as the forest products industry, rural communities and the Vermont way of life. Forest communities provide many important and complex ecosystem services including protecting water quality, reducing runoff, nutrient cycling, capturing air pollutants, providing wildlife habitat, and carbon sequestration among others (Galford, G.L. et al. 2014, Rustad, L. et al. 2012). However, predicting the specific future impacts of climate change on systems comprised in large part of long-lived species is difficult. Historic pollen and microfossil data tell us that in the past forest systems migrated, albeit slowly, to changes in climatic conditions (Rustad, L. et al. 2012). Over the past 12,000 years northern forests once dominated with spruce and jack pine have transitioned into larger ratios of white pine, oak, and eastern hemlock, and then to beech and maple dominance in the north, white pine, hickory and birch dominance in southern areas, and spruce and fir at higher elevations (Rustad, L. et al. 2012). While evidence suggest that forests have been able to migrate in the past, models of predicted climates, suggest that past migration rates are too slow to keep up with current and future changes climatic conditions (Rustad, L. et al. 2012).

Current evidence indicates that forests will increase evapotranspiration and water use due to warmer seasonal temperatures and an increase in the number of growing days (Rustad, L. et al. 2012). This scenario may lower overall soil moisture, increasing the persistence of droughts, reduce forest productivity, and in turn increase the susceptibility of forests to insect and disease outbreaks (Rustad, L. et al. 2012).

As a result, several dominant tree species may undergo significant range shifts as forest communities adjust to new conditions over time (fig. 3. 2) (Rustad, L. et al. 2012).

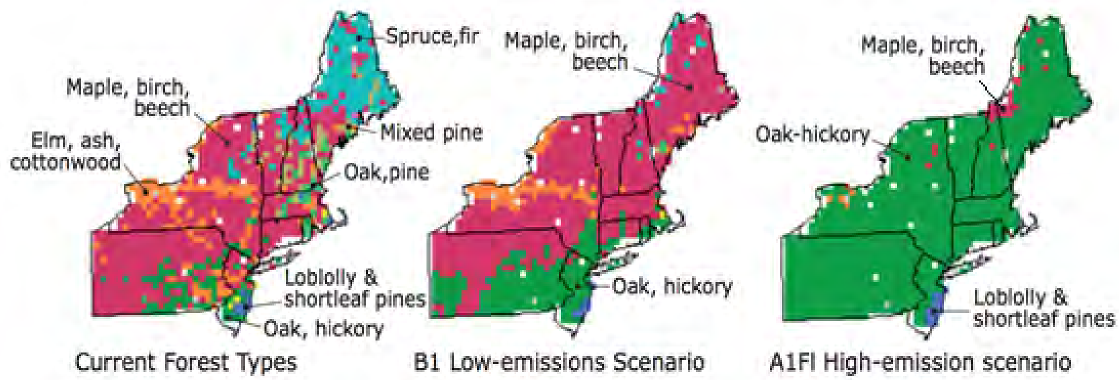

Figure 3.2. Current and projected suitable habitat for major forest types in New England under low and high emissions scenarios. See Figure 5 for details of the scenarios. Under the low emissions scenario, the conditions will favor maple- birch-beech forests, while under the high emissions scenario suggest that conditions they will favor oak-hickory forests. Adapted from Iverson et al. 2008 (Rustad et al. 2012).

Models predicting the ways in which forests will respond to long-term climate trends show that species such as sugar maple and balsam fir are likely to lose suitable habitat in Vermont, while several species of oak are projected to expand in the extent of suitable habitat (Rustad, L. et al. 2012). Moreover, shorter winters, longer growing seasons, and increased concentrations of CO_2 should result in an overall increase in forest productivity (net forest growth rate) (Rustad, L. et al. 2012). However, many factors, including life spans, dispersal rates, invasive species, and changes in soil moisture, will make it difficult to predict when, and if, tree populations will be able to reach predicted, suitable habitat (Rustad, L. et al. 2012).

Forest managers can play a critical role addressing these uncertainties by promoting healthy forests and their successful adaptation to climate change. According to the Vermont Department of Forests, Parks and Recreation (VFPR) (2015), human activity is one of the primary drivers of change in Vermont's forested communities. Therefore, influencing change through forest management in ways that improve forest resiliency could increase future suitable habitat.

Table 3.2. Tree decline and associated climate factors. A review of decline episodes for five different tree species in the Northeast indicates that there have been important associations with changes in climate and weather-related conditions, which may be further exacerbated as climate changes in the future. Adapted from Mohan 2009 (Rustad et al. 2012).

Species/ Group	History	Role of Climate	Other Factors	References
Birch	Widespread declines since 1944	Maps of birch decline areas coincide with areas of experiencing extended winter thaw cycles	None	Balch 1944 Bourque et al. 2005 Braathe 1995
Sugar maple	26 widespread decline episodes between 1912 and 1986	Prolonged thaw-freeze events and associated fine root damage have been implicated in sugar maple decline	Insects, disease, loss of soil nutrients	Millers et al 1989 Bertrand et al. 1994 Decker et al. 2003 Fitzhugh et al. 2003
Oak	Large areas of oak mortality recorded in New England and the Appalachian Mountains in the early 1900s	Drought stresses have been reported as important initiating factors in oak decline.	Insects, secondary pathogens	Millers et al. 1989
Ash	Widespread dieback in the Northeast since 1920	Drought and freezing damage have been identified as inciting factors, with drought playing a particularly important role	Phytoplasmal disease, Asian beetle, emerald ash borer	Millers et al. 1989 Poland and McCullough 2006
Red spruce	Widespread decline through the Northeast after 1960, increasing over the last few decades	Reduced cold tolerance leads to winter injury which is intensified rapid rates of thaw and subsequent exposure to refreezing	Acid deposition, anomalous weather	Friedland et al. 1984 Johnson 1992 Schaberg and DeHayes 2000 Bourque et al. 2005

Waterbodies

In Vermont and across the Northeast, hydrological cycles and processes are being affected by climate change. Increased average annual rainfall in conjunction with a larger fraction of precipitation falling as rain is increasing average annual streamflows resulting in more frequent and greater magnitude high flows (Galford, G.L. et al. 2014). Moreover, these high flows are occurring more frequently in winter months due to early snowpack thaw dates driven by warming temperatures (Galford, G.L. et al. 2014). Even though recent decades have seen higher summer base flows, projections suggest that warming temperatures in conjunction with greater variability in seasonal rainfall may increase the likelihood of short term summer droughts (Galford, G.L. et al. 2014). Together these changes in hydrological processes have serious implications for northeastern ecosystems.

One concern is the likely increase in frequency and amount of stormwater runoff. Nutrient and sediment loading into rivers exacerbates siltation and algae production and can limit the capacity of the waterway to support macroinvertebrates, fish, freshwater mussels, and other aquatic organisms. "In lakes, warmer temperatures and greater nutrient loading can result in more frequent blue-green algae blooms which are known to be detrimental to both animals and humans" (Galford, G.L. et al. 2014). Another concern is the expected increase in the "wider range of lake level fluctuations over the course of the year (Galford, G.L. et al. 2014, Stager, J. & Thill, M. 2010).

Changes in river hydrology, with larger and more frequent peak discharges, may trigger significant changes in river channel formation (Allan, 1995) which can result in greater channel instability and channel movement. The response to such instability in the past has been to channelize and harden riverbanks to prevent channel movement. This practice often has deleterious and homogenizing effects on in-stream and riparian habitat features (Poff and Zimmerman 2009). Moreover, catastrophic results can be expected when hardened and channelized banks fail during very high flow situations—as was seen many times over during Tropical Storm Irene-driven flooding.

Wetlands

Vermont has more than 290,000 acres of wetlands that provide critical habitat for many species of fish, wildlife and plants. Wetlands play an important role in the attenuation of storm water, sediment transport, and naturally improve water quality (Galford, G.L. et al. 2014). Similar to waterbodies in Vermont, increases in variability and overall seasonal extent of precipitation are a significant challenge to wetland ecosystems, with potential for greater frequency of flood events and short to mid-term droughts. Increased flooding will bring about changes to wetland shorelines, may facilitate the spread of invasive aquatic species (e.g., Japanese Knotweed), and cause an influx of runoff sediment. Reduced water clarity due to flooding will, reduce light penetration and greatly affect the productivity of aquatic organisms (Galford, G.L. et al. 2014). In addition, projected increases in summer temperatures and earlier snowmelt present a threat to wetlands as water levels may intermittently decrease or completely dry up because of drought in conjunction with increased evapotranspiration rates. If this were to occur, the breeding cycles and survival of amphibians, such as the Spotted Salamander, would be adversely impacted (Galford, G.L. et al. 2014). The potential for increased dry spells and low water conditions will have water quality implications too. With shallower water depths and warm temperatures, toxins and nutrients will be more concentrated and algae blooms will be more frequent (Galford, G.L. et al. 2014). Furthermore, non-climate stressors, such as habitat fragmentation and pollution, also threaten wetland ecosystems in Vermont. In assessing the vulnerability of wetland habitats, the Vermont Fish and Wildlife Department (VFWD), National Wildlife Federation (NWF) and others found Basin Swamps & Wetlands and Wet Shores to be particularly vulnerable to climate-driven impacts.

Habitats and Species

The interactions between climate-driven stressors including changes in temperature, precipitation, and storm events and non-climate stressors such as development-driven habitat loss and habitat degradation is currently impacting Vermont's habitats and the species that depend on them. Moreover, synergistic impacts are likely to increase over the coming decades.

Projections suggest that warming temperatures will expand the extent of suitable habitat for tree species such as oak, hickory, and red maple, while significantly decreasing the extent of suitable habitat for more cold-tolerant species such balsam fir currently found in Vermont's higher elevations (Galford, G.L. et al. 2014). With earlier leaf-out and flowering periods because of this warming, many species may be more susceptible to pests and pathogens

(Galford, G.L. et al. 2014). Changes in habitat suitability for many species can prompt a reshuffling and unraveling of currently recognized species assemblages and natural communities. Invasive species, which generally exhibit a competitive edge under warmer conditions, could further spread. Species that are ecological specialists are particularly vulnerable as their ranges are restricted, they are limited to a specific habitat, or they are geographically isolated (Rustad, L. et al. 2012). For example, ecological specialists [such as the Fowlers Toad, found in sandy outwash areas along Connecticut River], or those with populations already in decline [such as the Rusty Blackbird, a boreal wetland species], may be particularly vulnerable under changing habitat conditions (Rustad, L. et al. 2012). Bicknell's thrush is limited to high-elevation spruce-fir forests and is a good example of a species particularly vulnerable to climate-driven habitat change. Moreover, data suggests that many migratory bird species are arriving and breeding earlier in Vermont, and that the ranges of numerous migratory bird species are changing in response to climate change (Rustad, L. et al. 2012).

Climate change is also affecting the phenology, or timing of life-history events of many plant and animal species. Due to increasing spring air temperatures, many plants are leafing out and blooming earlier and numerous wildlife species are breeding or migrating earlier than they did during the previous century (Betts, 2011; Stein, B.A. et al. 2014). Current evidence, including shifts in entire ecoregions in some locations, suggests that over time these changes could exceed the ability of many species to adjust, leading to predictions of species declines and higher extinction rates globally (Loarie, S.R. et al. 2009). However, predictions ought to be species-specific as different species respond to climate-driven impacts in different ways and at different rates (Stein, B.A. et al. 2014). Evidence suggests that there are significant differences in response capacity between "short-lived species with high dispersal capacity (such as birds) and long-lived species with limited dispersal capacity (such as many trees)" (Stein, B.A. et al. 2014). Those species that have a greater capacity to adapt to new conditions, or have greater climatic tolerances, will have a competitive advantage and may expand their ranges while those with narrower climatic tolerances may experience range contraction.

In addition, climate-driven impacts from extreme weather events, direct thermal stress, changes in habitat availability, and increases in parasites and diseases will affect native wildlife "at all levels of organization from the physiology of individual animals to changes at the population level" (Rustad, L. et al. 2012). Two species that provide examples of the extent to which different suites of climate-driven stressors can increase vulnerability are the Little Brown Bat and Moose. The Little Brown Bat relies largely on insects with aquatic larval stages as a food resource (Rustad, L. et al. 2012). Changing precipitation patterns, alterations to stream flow and reduced soil moisture can significantly affect the availability of these insects (Rustad, L. et al. 2012). Apart from the vulnerability of Little Brown Bats to altered hydrology, there have been significant declines in the population because of White Nose Syndrome. Altered precipitation and disease may interact synergistically to exacerbate stress on this species in Vermont, though more water and shorter hibernation periods in a warmer climate could potentially be a direct benefit.

Moose appears to be vulnerable to climate change in Vermont. As a cold-adapted species, Moose begin to reduce food intake in response to high summer temperatures (Renecker and Hudson 1986). As annual summer high temperatures increase under climate change, the habitat range of Moose may shift northward. Warming winter temperatures may reduce the area of permanent winter snowpack. The reduction in snowpack may increase contact between Moose and White-tailed Deer, which are carries of a brain parasite (*Parelaphostrongylus tenuis*) that is potentially lethal to Moose (Whitlaw and Lankester 1994). In addition, Winter Ticks (*Dermacentor albipictus*) are becoming an increasing problem for Moose with the early loss of snowpack. When ticks fall off Moose in the spring, they have a greater likelihood of survival if they fall onto soil as opposed to snow.

Amphibians are particularly vulnerable to the interactions between altered hydrology and increasing temperature. With most amphibians breeding in water, the hydroperiod (the time that there is standing water) of ephemeral ponds is a critical component of their life cycle (Rustad, L. et al. 2012). Altered precipitation and increased seasonal warming which drive evaporation and the frequency and severity of droughts are of concern (Rustad, L. et al. 2012). "A reduced hydroperiod can increase competition, decrease size at metamorphosis, and kill larvae as ponds dry out (Rustad, L. et al. 2012)."

Conserving Wildlife in the Face of Climate Change

What makes the issue of climate change particularly intractable is the breadth of interconnections between these climate-driven impacts and numerous non-climate stressors such as habitat fragmentation, habitat degradation, and pollution – which have been the focus of conservation efforts for some time. Given the magnitude of climate impacts, rates of increasing variability, and the synergy between climate and non-climate stressors on wildlife and the habitats upon which they depend, there is an urgent need to prepare for and respond to these impacts (Stein, B. et al. 2014).

In planning for this new future, we face questions such as: (a) which species and habitats are likely to be more vulnerable; (b) which may benefit or be unaffected by climate change; (c) how will non-climate stressors contribute to vulnerability; (d) how might species adapt; (e) which strategies will be most effective and where should we apply our efforts; and, (f) how can we feasibly monitor species and habitats to inform our management actions? Significant efforts have been made at the Federal, regional, State and local levels to address these questions and identify strategies that benefit wildlife and their habitats under climate change.

Regional Efforts to Conserve Wildlife in the Era of Climate Change

The Northeast is well known for collaborative conservation efforts between states, municipalities, conservation organizations, and federal entities. A prime example is the Northeast Association of Fish and Wildlife Agencies (NEAFWA), which is a collaboration between State Fish and Wildlife Departments across the thirteen Northeastern States. Since 2007, the NEAFWA sponsored Regional Conservation Needs Grant Program has funded a large number of projects focused on identifying both the threats facing wildlife and their habitats under climate change as well as identifying strategies to benefit those species in a warming world.

Recognizing the need to conserve and restore habitat connectivity in the Northeast, the Staying Connected Initiative (SCI) was developed among a partnership of twenty-four private and public entities across New York, Vermont, New Hampshire, Maine, and Canada. The mission of this collaboration is to sustain connectivity for wildlife by protecting against habitat fragmentation and climate change. In doing so, SCI brings its partners together in an interdisciplinary approach that utilizes tools of conservation science, land protection, community outreach, land use planning, transportation, and policy to ensure that connectivity across the landscape is healthy for both wildlife and human communities.

In September 2012, the National Wildlife Federation (NWF) in partnership with Manomet Center for Conservation Sciences (MCCS) completed the Northeast's first regional vulnerability assessment (RVA) (MCCS & NWF 2012). The assessment utilized facilitated expert elicitation from a panel of 27 natural resource practitioners including staff from state fish and wildlife agencies in all Northeastern states, as well as other state and federal habitat professionals. The goal of the assessment was to (a) quantify the vulnerabilities to climate change of fish and wildlife habitats, and how these vulnerabilities vary spatially across the region, (b) project how the status and distributions of these habitats and species may be affected by climate change, and (c) to work with states to increase their institutional knowledge and capabilities to respond to climate change.

Another important regional collaboration working to "to address increasing land use pressures and widespread resource threats and uncertainties amplified by a rapidly changing climate" is the North Atlantic Landscape Conservation Cooperative (NALCC). "The partners and partnerships in the cooperative address these regional threats and uncertainties by agreeing on common goals for land, water, fish, wildlife, plant and cultural resources and jointly developing the scientific information and tools needed to prioritize and guide more effective conservation actions by partners toward those goals (NALCC)."

Efforts to Address Climate Change Impacts in the Northeast

State-level land conservation efforts vary considerably from state to state across the Northeast. They include efforts by state agencies, departments, and programs such as Open Space Programs and Land Conservation Programs across different state environmental agencies. All the northeastern States are developing Action Plans that address climate change as a significant stressor for wildlife and their habitats. Several of them have specifically conducted climate change vulnerability assessments on priority SGCN and associated habitats.

In 2011 New York conducted a species vulnerability assessment on 119 SGCN using NatureServe's Climate Change Vulnerability Index (Schlesinger, M.D. et al. 2011). The assessment found that nearly all the species identified as Highly or Extremely Vulnerable were associated with aquatic or seasonally wet habitats, with mussels rated as particularly vulnerable due to limited mobility (Schlesinger, M.D. et al. 2011). Another interesting finding was that "vulnerability was only weakly associated with conservation status (Schlesinger, M.D. et al. 2011)." In addition, a vulnerability assessment of key habitats, conducted by NWF in partnership with the New York Department of Environmental Conservation's Division of Fish, Wildlife and Marine Resources, found Acadian- Appalachian Montane Spruce-Fir and Coastal Plain Basin Peat Swamp as Vulnerable to climate change, and Boreal Bog and Alpine Tundra habitats as Highly Vulnerable (Hilke, C. & Galbraith, H. 2013).

New Hampshire Fish and Game Department (NHFGD) (2013) conducted a habitat vulnerability assessment in 2014 on 25 key habitats across the state. Due to climate impacts on the hydrology of freshwater habitats, findings suggested that species that are "more tolerant of a wide range of hydrologic conditions will be favored, and the total species richness may decrease (NHFGD 2013)." For terrestrial habitats, high-elevation spruce fir forest was identified as particularly vulnerable to climate change (NHFGD 2013). Moreover, findings suggested that "hardwood-pine forests will move northwards and up slope, while Appalachian oak-pine forests are likely to increase in extent" because of long-term warming trends (NHFGD 2013). Other findings of interest identified Pine Barrens as less vulnerable to climate change given the predisposition of species within those habitats to warmer and drier conditions, and more generally predicted an increase in early successional habitats because of increased disturbance (NHFGD 2013).

In 2010, Massachusetts conducted the first climate change habitat vulnerability assessment in the Northeast. The assessment was directed towards answering: "(a) how do the targeted fish and wildlife habitats rank in terms of their likely comparative vulnerabilities to climate change; (b) how will the representation of these habitats in Massachusetts be altered by a changing climate; (c) which vertebrate Species in Greatest Need of Conservation [SGCN] are likely to be most vulnerable to climate change; and (d) what degree of confidence can be assigned to the above predictions" (MCCS & MA Department of Fisheries and Wildlife 2010)? The assessment was conducted under two emission scenarios, a doubling and a tripling of atmospheric CO_2. Spruce-fir forests, smaller coldwater lakes and ponds, spruce-fir boreal swamp, brackish marsh, and intertidal mudflats and sandflats were identified as highly vulnerable to climate change under both emission scenarios (MCCS & MA Department of Fisheries and Wildlife 2010). The highly vulnerable representative SGCN associated with those habitats include the Northern Leopard Frog, Green Heron, American Eel, Blackpoll Warbler, Moose and Bobcat (MCCS & MA Department of Fisheries and Wildlife 2010).

Table 3.3. Numbers and percentages of vertebrate SGNC [SGCN] most at risk from doubling (2X) and tripling (3X) of atmospheric CO2 concentration (Manomet & MA DFW 2010).

	Amphibians (7)	Reptiles (19)	Fish (28)	Birds (63)	Mammals (20)
2X CO_2	2 (28%)	1 (5%)	2 (7%)	26 (41%)	3 (15%)
3X CO_2	4 (57%)	4 (21%)	14 (50%)	36 (57%)	7 (35%)

Vermont Efforts to Understand and Address Climate Change Impacts to Species and Habitats

Vermont has been actively involved in addressing the impacts of climate change for some time. In 2011, Governor Peter Shumlin established the Vermont Climate Cabinet charged with coordinating climate change efforts specific to reduction of greenhouse gas emissions, reliance of fossil fuels, as well as the implementation of climate adaptation efforts across State agencies. While initial efforts to address climate change focused largely on mitigation efforts, the Vermont Agency of Natural Resources developed a series of white papers addressing climate adaptation across its Programs and Divisions. In 2012 and 2013, the Vermont Agency of Natural Resources developed the Climate Change Adaptation Framework to gather information about climate change in Vermont as it relates to natural resources and to propose a strategic framework for continued climate change vulnerability assessment and action planning (Tetra Tech Inc. 2013).

Building on this assessment the Fish & Wildlife Department and National Wildlife Federation developed the Species & Habitat Climate Vulnerability Assessment for 18 key species, 20 upland habitats, 11 wetland habitats, and 13 freshwater habitats as part of our Action Plan revision (Table 3.4 and Appendix D). Species included SGCN and important "surrogate" species that are widely considered representative of habitat types. Species assessments culminated in an overall vulnerability rating for climate-specific and non-climate stressors and an associated confidence score.

The most important lesson taken from this exercise is that species responses to climate change will not be uniform. For some, climate change may not be a significant threat, however if that species is already subjected to other stresses, climate change impacts may push that species over the edge. This is an important consideration to consider.

Vulnerability rating criteria were standardized and applied across all assessments. Criteria were selected from similar assessments conducted by other states and from current literature. Vulnerability scores were designated for each species, habitat and system. Ratings account for the extent of vulnerability (extremely vulnerable, highly vulnerable etc.) based upon percentage changes in abundance or extent expected by 2050 and include an associated confidence rating of high, medium or low based upon the percentage certainty of the vulnerability score (Low = Not very confident, 0-30% certainty in vulnerability score). See Vermont Climate Vulnerability Assessment Rating Key Appendix E for details.

Non-climate Stressors: Non-climate stressors included acidity & pollution, habitat alteration & altered hydrology, invasive species, channel erosion & sedimentation, encroachments, land erosion, nutrient loading, thermal stress, toxic substances/pollution, and habitat fragmentation.

Sensitivity Factors: assessments factored in how likely a species, habitat, or ecosystem is to be affected by or respond to climate change given (1) habitat specificity, (2) edge of range, (3) environmental or physiological tolerance, (4) interspecific or phenological dependence, (5) mobility, and (6) exotic pathogens or invasive species.

Exposure & Key Climate Change Factors: The four categories of climate change and exposure factors are temperature, hydrology, extreme events, and phenology. Within each category, several factors were selected along with an associated trend and specific projections for each trend (see Appendix D. Vermont Vulnerability Assessment Rating Key for details).

> ***Temperature:*** Annual temperature, seasonal temperature, number of hot days, number of cold days, and variability. Each factor has an associated trend and specific projections. As an example, annual temperature (code=A) had an increasing trend with projections suggesting a 3.7 to 5.8°F increase by 2050, and a 5.0 to 9.5°F increase by 2100.
>
> ***Hydrology:*** Ten hydrology factors were selected, including annual precipitation, seasonal precipitation, heavy rainfall events, soil moisture, snow, spring flows, summer low flows, ice dynamics, fluctuating lake levels, and lake stratification.
>
> ***Extreme Events:*** Extreme weather events include flood events, number of short-term droughts, storms, and fire.
>
> ***Phenology:*** Phenological factors include length of growing season, onset of spring, onset of fall, and biological interactions.

Of the 18-species assessed, eight were identified as highly vulnerable to climate-driven impacts. Of those, five are SGCN: Jefferson Salamander, Canada Lynx, Brook Trout, Eastern Pearlshell Mussel and Bicknell's Thrush.

Climate change vulnerability assessments were similarly conducted for Vermont's upland and wetland natural communities. For efficiently, the 95 natural community types were grouped into categories based on the environmental factors that drive their development and that could affect their susceptibility to climate change. Some natural community types were assessed individually.

Of the upland habitats, Subalpine Krummholz, Alpine Meadow, Cold-Air Talus Woodland, and Dry Oak Woodland were identified as highly vulnerable to climate-driven impacts, and Upland Shores and Hemlock Forests were identified as particularly vulnerable to non-climate stressors. Of the 11 wetland habitats, Basin Swamps and Wetlands, Floodplains, Floodplain Forests, and Wet Shores were identified as highly vulnerable to climate change. As with the species analyses, habitat assessments culminated in an overall vulnerability rating for climate-specific and non-climate stressors and an associated confidence score. The assessments also detailed key climate change/exposure factors and non-climate stressors that contributed to the overall vulnerability rating.

The effort also included an assessment of 13 freshwater habitats including six river types and seven lake types. River types were delineated primarily by stream order and pH, and include; high gradient, cold-water acidic, 1-2 order, high gradient, cold-water, not acidic, 1-2 order, medium-sized rivers (4-6 order) etc. Lake types were delineated by trophic type and extent of stratification and included; Oligotrophic lake (stratified), Mesotrophic-Eutrophic lake (stratified), Mesotrophic-Eutrophic Lake (unstratified) etc. For the 13 freshwater habitats, High gradient, cold water, not acidic (1-2 order), and High gradient, cold water acidic (1-2 order) lakes were also identified as highly vulnerable to climate change.

Table 3.4: Vermont Species & Habitat Climate Vulnerability Assessment (**SGCN in bold**)

Vulnerability Rating Key (Abundance and/or range extent in Vermont change by 2050)

- **E** = Extremely Vulnerable: Extremely likely to substantially decrease (>75% loss) or disappear
- **H** = Highly Vulnerable: Likely to decrease significantly (25-75% loss)
- **M** = Moderately Vulnerable: Likely to decrease (10-25% loss)
- **L** = Slightly Vulnerable: Available evidence does not suggest change (decrease, 5-10% loss)
- **N** = Not Vulnerable, No Effect: Likely to increase or decrease by less than 5%
- **B** = Increase Possible or Likely: Likely to increase (>15% increase)
- **U** = Unknown/Uncertain: Available evidence not available or not conclusive at this time.

Confidence Ratings

- **H** = High: Very confident (>60% certainty in vulnerability score)
- **M** = Moderate: Somewhat confident (30-60% certainty in vulnerability score)
- **L** = Low: Not very confident (0-30% certainty in vulnerability score)

Species and Habitats	Climate Vulnerability Rating	Confidence Score	Non-climate stressors Vulnerability
Key Species			
Jefferson salamander	H	H	H
Northern white cedar	M	M	H
Fingernail clam	L	H	M
Beaver	N	H	M
Bobcat	L	M	M
Lynx	H	H	M
Brook Trout	H	H	H
Wood Turtle	M	H	H
Pearlshell mussel	H	M	M
Fallfish	L	M	L
Smelt	M	H	M
Lake trout	H	H	H
Bald Eagle	L	M	L
Bicknell's Thrush	H	H	H
Common Loon	M	L	L
Red Oak	N	M	N
Sugar Maple	H	M	L
West Virginia White (butterfly)	H	H	M
Wetland Habitats			
Cattail Marsh	L	M	L
Shallow Emergent Marsh	M	M	M
Marsh and Sedge Meadow (Formation)	M	M	M
Alluvial Shrub Swamp	M	M	L
Basin swamps & wetlands	H	M	M
Floodplains	H	M	M
Ground water seepage & Flood swamp	L	M	L
Open peatlands (precipitation-dependent)	M	M	L
Open peatlands (ground-fed)	L	M	M

Species and Habitats	Climate Vulnerability Rating	Confidence Score	Non-climate stressors Vulnerability
Floodplain Forests	H	M	M
Wet Shores	H	M	M
Upland Habitats			
Alpine Meadow	E	M	M
Spruce-Fir-Northern Hardwood	M	M	M
Northern Hardwood Forest	L	M	L
Oak-Pine–Dry Mesic Forests & Woodlands w/deeper soils	L	M	M
Oak-Pine Northern Rocky–Northern Dry Rocky Forests and Woodlands	L	M	L
Oak-Pine Southern Rocky–Southern Dry Rocky Forests and Woodlands	M	L	L
Outcrops and upland meadows	N	L	L
Cliffs and Talus	L	M	L
Upland shores	M	M	H
Subalpine Krummholz	E	M	
Montane Spruce-fir	M	M	
Red Spruce-Heath Rocky Ridge	M	M	
Montane Yellow Birch-Red Spruce Forest	M	M	
Red Spruce-Northern Hardwood	L	M	
Lowland Spruce-Fir Forest	M	M	
Boreal Talus Woodland	M	M	
Cold-Air Talus Woodland	H	M	
Limestone Bluff Cedar-Pine Forest	L	M	
Transition Hardwood Talus Woodland	L	M	
Dry Oak Woodland	H	L	
Freshwater Habitats			
Medium-sized river (4-6 order)	M	M	
Large river (7+ stream order)	L	M	
High gradient, cold water acidic, 1-2 order	H	H	
High gradient, cold water, not acidic, 1-2 order	H	H	
Low gradient marsh	M	M	
Lake Champlain valley	M	M	
High Elevation Lake	M	L	L
Dystrophic Lake	M	L	L
Lake–Oligotrophic, Stratified	L	H	L
Mesotrophic-Eutrophic Lake (stratified)	M	M	M
Mesotrophic-Eutrophic Lake (unstratified)	H	M	M
Unstratified lakes	M	H	H
Stratified Lakes	M	H	H

Recent Projects Helping Address Climate Impacts to Species and Habitats

Vermont has developed several tools that provide a strong foundation for addressing the impacts of climate change on wildlife and their habitats. Examples include VFWD's 2014 BioFinder project, which identifies Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. BioFinder's 21 datasets represent biological, ecological, and natural heritage data stacked together for a co-occurrence analysis which identified the locations of greatest overlap (concentration) for priority ranking at the statewide scale. The Habitat Block project, another spatial analysis tool, prioritized 4,055 habitat blocks and identifies likely wildlife road crossing locations for all of Vermont's roads. Maintaining a connected network of unfragmented habitat blocks is recognized as a primary strategy for conserving biological diversity in the face of a rapidly changing climate, and is one of the most widely used of VFWD's datasets in conservation planning technical assistance provided to towns and Regional Planning Commissions.

Vermont's iMap Invasives database aids in assessing the spread of invasive species anticipated under climate change. The database allows ANR, TNC, and other land management organizations to document and track the spread of invasive species throughout the state, provides an early warning of the arrival of new invasives into the state or into new areas of the state, and allows ANR to follow management actions taken to control any given population. In 2015, a new ANR Invasive Plant Coordinator position was created to help further invasive species management.

Vermont is engaged in wildlife species monitoring and management efforts to further of understanding of climate impacts, which may help us develop management strategies. VFWD is monitoring Moose populations through indices of ticks, hair loss, and mortality; assessing the impacts of climate change on the interactions between Fisher and American Marten; surveying for recently documented Canada Lynx; and is actively engaged in management activities to raise the elevation of targeted turtle nesting beaches in response to higher Lake Champlain water levels. Similar activities include monitoring deer populations and the implications of deer browsing under climate change. Projects such as the Vermont Breeding Bird Atlas may also have significant value for monitoring changes over time that may be related to climate change.

VFWD has recently developed a sampling regime that includes annual trout population monitoring concurrent with stream temperature data. The resulting datasets will allow biologists to monitor changes in fish abundances and stream temperatures at specific locations. Stream temperature monitoring also takes place in various streams across the state for specific fisheries management projects.

Changes to state lands management planning: 1. Beginning in 2010 the ANR began addressing climate change in new Long-Range Management Plans (LRMPs) for state lands. 2. ANR is currently developing new LRMP for Victory State Forest and Wildlife Management Area with climate change as a key concept to drive management decisions. Key factors include boreal habitat conditions and the presence of rare and edge-of-range species (e.g., Canada Lynx, Spruce Grouse, American Marten, and Black-backed Woodpecker). 3. To address the uncertainty of assisted migration as a climate change strategy, the ANR Lands Team is reviewing options, impacts and management guidelines for state lands.

ANR has a new state lands management policy and guidelines for management and protection of riparian buffers. Good management of riparian areas is often referred to as a "No Regrets" climate strategy because it makes such good sense to maintain vegetated habitats along our rivers and streams for a variety of benefits. While the buffer policy is a work in progress, a draft is complete and is based on all currently available science on the values and protection strategies for riparian areas. The policy is not based solely on climate and flood resilience, but it intentionally addresses these important considerations.

In 2015 VFPR presented a report to the legislature on forest fragmentation. Strategies to address forest fragmentation complement habitat conservation efforts needed for climate change. The Vermont Forest Roundtable is focused on implementing solutions to address forest fragmentation that will be essential to wildlife species habitat protection goals.

Other important State efforts to address the impacts of climate change on wildlife species and habitats include:

- The ANR Stewardship Team funded a pilot project on four areas of state lands where the Department of Environmental Conservation (VDEC), in coordination with the Forests, Parks & Recreation Department (VFPR) and VFWD, is investigating flood resilience conditions and related management opportunities. This was intentionally developed to better understand state lands management decisions relative to climate change and flood resilience.

- VFWD and VDEC Rivers Program have been evaluating culverts for fish and aquatic organism passage and stream geomorphic compatibility since 2005. The objectives are to gain a greater understanding of the scope of fish and aquatic organism passage (AOP) barriers and undersized culverts that may be having a negative impact on physical stability and quality of stream habitat in Vermont and work toward addressing these issues where appropriate; and improve the understanding and communication between VFWD, VDEC, state and local road managers and state and federal regulators in addressing AOP and geomorphic compatibility issues at stream-road crossings.

- The Vermont Dam Task Force is dedicated to restoring rivers through the assessment, prioritization, and facilitation of dam removal or modification. This work is particularly important considering climate change because dams can significantly degrade a river's water quality (e.g., temperature and dissolved oxygen), aquatic habitat, the movement of aquatic organisms and the transport of sediments downstream. The Dames Task Force is a statewide cooperative effort among federal and state agencies (including VFWD and VDEC), private organizations, and individuals allows participants to share information and dam removal advice; coordinate efforts to accomplish the removal of dams whose negative effects exceed their benefits; and, to reach out to the public.

- The Narrows Wildlife Management Area in West Haven was selected for a pilot project by VFPR for assessing and monitoring timber management and its attendant consequences on climate change factors including the presence and movement of invasive species, and regeneration success. Additional demonstration areas are in development as part of the Mount Philo State Park, the Putnam State Forest, and the Okemo State Forests.

- VFWD recently updated the Conserving Vermont's Natural Heritage document to include a section that discusses climate change, how it may impact habitats, natural communities, plants and animals, and how to consider those effects in the context of local and regional land use planning.

- VFPR is working with private landowners to conserve and manage one of five priority habitat linkages identified by Two Countries, One Forest as critical to maintaining the integrity of the entire Northern Forest. This landowner cooperative involves over 13 properties known as Cold Hollow to Canada and employs climate smart forest management strategies.

- Forest changes are monitored by FPR through forest health monitoring plot networks to track current and future habitat suitability and tree species distributions.

- VFWD's Community Wildlife Program (CWP) provides technical assistance to municipalities and Regional Planning Commissions emphasizes the importance of integrating climate change effects on land, fish and wildlife conservation into planning. VFWD intentionally shifted to a greater focus on landscape and habitat connectivity through the efforts of this program for several reasons, including our understanding that creating a well-connected landscape is important for landscape resilience relative to climate change.

- Since Tropical Storm Irene in 2011, VFWD and VDEC has worked together with Vermont Agency of Transportation (VTrans) to change how we address road-stream crossings and other river/road conflicts. The net result is larger stream crossing structures, a more rigorous application of Aquatic Organism Passages (AOP), and a more holistic approach to river management practices driven in part by flood concerns related to climate-driven impacts. VFWD, VDEC and VTrans created a rivers and roads training program targeted at state and municipal employees and contractors that work on roads to increase the knowledge base of river/road best management practices, especially as they pertain to post-flood scenarios when the likelihood is greatest for in-channel work that can harm channel stability and in-stream habitat.

- In 2011, the VTDEC Lakes and Ponds Management and Protection Section identified 13 reference lakes across a gradient of lake sizes for a Sentinel Lakes Program Monitoring program to track the effects of climate change on Vermont's inland lakes. These lakes are visited annually at spring turnover to tease out trends related to climate change from trends related to land use and acid precipitation. In 2011, full summer lake assessments were conducted where littoral macroinvertebrates and sediment diatoms were collected along with other water chemistry. Over time, quantitative macrophyte surveys will be conducted to augment the existing data set. Ultimately, if funding can be secured, chains of continuous temperature and dissolved oxygen sensors will be deployed at the deep hole in the lakes. In addition, continuous water level monitoring devices will be deployed. Temperature, frequency of lake mixing and water levels are expected to change because of climate change. Understanding the magnitude and frequency of these changes due to climate change will be important for the management of other lakes in the state and contribute to our understanding of how Vermont's inland lakes are changing due to climate change.

- Currently, VFWD staff members are developing a guidance document that sets out a vision for future land acquisition efforts. This guidance will take into consideration important factors related to climate change and landscape resilience, in particular, landscape and habitat connectivity.
- VFWD staff and ANR's Office of Planning and Legal Affairs collaborated on revisions to Act 250 criterion 8 to better address necessary wildlife habitat, rare, threatened and endangered species and their habitats, rare and irreplaceable natural areas, forest blocks, and landscape connectivity. Riparian corridors are identified as especially important for wildlife movement, biological diversity, and river stability. The primary impetus for this work was to improve how Act 250 addresses habitat fragmentation and landscape connectivity, two factors recognized as being critical to climate change adaptation. These revisions must be implemented to achieve the desired results.
- To maintain the reciprocal flow of information between the State and Federal programs, Governor Shumlin serves on the Presidential Task Force on Climate Preparedness and Resilience. In this capacity, the Governor works to ensure that lessons learned from Vermont's climate-related activities inform Federal climate change considerations.

Identifying Climate Adaptation Strategies for Vermont's Species and Habitats

Before selecting actions to help wildlife species and their habitats respond to climate change it is important to bear in mind the ways in which climate change may impact the evaluation of management alternatives (Stein, B. et al. 2014).

Performance: Changing climate conditions that could affect the outcome of some conservation strategies. For example, shifts in the intensity of peak flows or extent of low stream flow may affect the performance of some of fish passages structures.

New constraints: Climate change may add new constraints, limiting what is technologically, ecologically, or culturally achievable. Changing conditions may make local persistence of some species or habitats impossible, or climate-related shifts in land uses may create new obstacles to species movements.

Relative weight: Because climate considerations could increase costs of some actions significantly these costs should be considered up front.

Perceived value: Climate change may affect the perceived value of various resources. For example, as floods become more frequent and severe in some places, marshes and wetlands may become increasingly valued for their ability to mitigate flood risk.

Priority Actions to Address Climate Change Impacts to Species and Habitats

1. Protect large habitat blocks, riparian habitats and climate refugia, and promote landscape integrity and connectivity to facilitate the movement of species across habitats based on the VFWD report "Vermont Conservation Design: Maintaining and

Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015), the Aquatic Organism Passage program, River Corridor Planning and other conservation plans.

2. Increase riverine, floodplain, and riparian connectivity based on Aquatic Organism Passage program and River Corridor Planning recommendations.
3. Restore rivers through the assessment, prioritization, and facilitation of dam removal or modification.
4. Support the Staying Connected Initiative, Cold Hollow to Canada, and similar programs focused on maintaining and enhancing landscape integrity and connectivity.
5. Complete and implement a state river corridor protection plan, riparian buffer policy and vernal pool management guidelines.
6. Expand river corridor and floodplain protections similar to the Lakeshore Protection Act.
7. Support and help implement the recommendations of VFPR's Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change
8. Support and help implement the recommendations of VFPR's Forest Fragmentation Plan.
9. Implement Vermont's Clean Water Initiative to improve water quality statewide particularly in Lake Champlain.
10. Protect and expand riparian habitats to increase habitat connectivity, increase cold water habitats, reduce the spread of invasive species, accommodate river channel dynamics and mitigate the impacts of flooding (Hilke, C. & Galbraith, H. 2013).
11. Protect ecosystem health and stability by preventing new introductions of invasive species and pests and controlling infestations of existing species via integrated pest management programs.
12. Minimize climate change impacts by employing management strategies that sustain fundamental ecological functions, promote habitat resiliency and adaptive capacity, and restore habitats with future conditions in mind.
13. Invest in research and monitoring programs that can inform species and habitat management with future conditions in mind such as monitoring indicators of changes in species distribution and abundance; stream temperatures, cold-water refugia and cold groundwater inputs to streams, Sentinel Lakes, early detection of invasive species, pests and pathogens; identification of genetically adapted species.
14. Develop incentive, education and technical assistance programs to help landowners, land managers, municipalities and others adopt and implement climate smart conservation programs, such as: culvert replacement, streamside shading, stream bank stabilization, sediment control river corridor easements and other types of conservation easements.

Managing Vermont's Wildlife and Habitats into the Future

As states across the country grapple with climate change impacts to our natural heritage, the need to set management priorities based on a sound understanding of projected impacts is becoming increasingly apparent. Climate change typically amplifies existing ecological stressors including rates of change, disturbance, habitat degradation and fragmentation. As such, isolating specific climate change impacts is difficult because it interacts with and compounds a host of non-climate stressors. To that end, this chapter provides important baseline information about how to protect Vermont's species and habitats under climate change including, (a) the climate-driven threats facing Vermont's wildlife and habitats, the vulnerability of key habitats and species to climate change, and (c) potential strategies for increasing the resiliency and/or adaptive capacity of select habitats and species. Climate change is not the singularly most detrimental stressor to Vermont's ecological systems, but it cannot be brushed aside with the thinking that what we are already doing is-sufficient. Complex problems often require holistic problem solving. Vermont's Wildlife Action Plan can serve as an important role in an integrated approach to protecting our wildlife and the habitats upon which they depend.

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Chapter 4

Conservation at Multiple Scales

2015

4. Conservation at Multiple Scales

Introduction

This chapter explains how conservation is organized in this Wildlife Action Plan.

Vermont's list of Species of Greatest Conservation Need (SGCN) comprises 133 vertebrate species 200 invertebrate species (such as the Tawny Emperor Butterfly, Cobblestone Tiger Beetle, and Giant Floater mussel) and 813 plants (vascular and bryophytes). Developing individual conservation plans for each of these species would have been exhausting and impractical. Moreover, implementing so many individual plans would be impossible due to insufficient staffing, resources and funds. In short, it would be monumentally inefficient.

Fortunately, an efficient approach exists. It consists of designing and implementing conservation at multiple scales. This is commonly referred to as the "coarse filter-fine filter" approach and is widely accepted by scientists, wildlife managers and planners. The underlying concept is that if examples of all coarse-filter features are conserved at the scale at which they naturally occur, many of the species they contain—from the largest trees and mammals to the smallest insects—may also be conserved (Hunter 1991; NCASI 2004; Schulte et al. 2006). The coarse-filter approach is well documented in the scientific literature (Jenkins 1985; Noss 1987; Hunter et al. 1988; Hunter 1991; Noss and Cooperrider 1994; Haufler et al. 1996; Jenkins 1996; Poiani et al. 2000; USDA 2004). Habitat management historically practiced by Fish and Wildlife agencies to create young forests and shrublands that benefit dozens of "shrub and early-successional species" including Moose, American Woodcock and Ruffed Grouse is an example of a 'habitat-scale' coarse filter.

To most efficiently conserve all our SGCN, this Wildlife Action Plan focuses on three scales of conservation:

1. **Landscapes**: Include the features that contribute to ecological function at the state and regional levels, including a network of large, connected habitat blocks and another of aquatic habitats and riparian areas. Species requiring large habitat blocks, mixes of forest, wetlands and waters and connections between them will benefit most from landscape-level conservation but most other SGCN can also benefit.

2. **Habitats and Natural Communities**: Include the range of naturally occurring and anthropogenic habitats (such as young forest and grasslands). Terrestrial natural communities follow the classification system developed by Sorenson and Thompson (2005) which ties in with the ecological systems classification developed for the Northeast Association of Fish & Wildlife Agencies (Gawler 2008) for the 13 northeastern states. Aquatic communities follow the classification developed by Langdon et.al. (1998).

3. **Species and Groups of Species**: these are the SGCN for which we have identified specific conservation needs that would not be covered sufficiently by conservation efforts at the other two scales.

Not all species, however, are best conserved by coarse-filters alone. For example, species dependent on multiple habitats at different times during their life cycles, those that occur in small geographic areas, those with highly specialized needs or unique threats, those that travel across large geographic areas and those that are particularly rare often require focused attention. To ensure that the needs of these species are also addressed, fine filter conservation strategies are also needed. Species-specific conservation reports can be found in Appendix A.

Efficiency in conservation effort can be realized by first identifying landscape conservation priorities that will effectively capture many natural communities, habitats, and species found within them. Natural community and habitat level conservation can effectively capture many of the remaining species. And finally, species-specific conservation action will be required for those species that are not captured at landscape or habitat/natural community scales. Typically, these are species that are very rare, are declining across their range, aggregate for breeding, and/or require large home ranges.

Given the species focus of the congressional requirements for Wildlife Action Plan development, we began at the species level by assessing SGCN individually (Appendix A). Then SGCN were organized by taxonomic group and by the habitats they use. This resulted in conservation strategies at the three levels listed above (and in table 4.1).

Table 4.1 Organization of Conservation Information in this Report

Level	Organization	Location in this Action Plan
1-Species	6 group summaries (amphibians & reptiles, birds, fishes, invertebrates, mammals and plants) 133 individual species and 15 invertebrates group reports	Chapter 5 Appendix A
2-Habitats & Natural Communities	125 communities & cultural habitats grouped into 24 summaries	Appendix B
3-Landscapes	Statewide and regional conservation strategies Landscapes Landscape Report	Chapter 1 Chapter 6 Appendix F

Selection of Classification Systems

We delineated landscapes based on the following elements: Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings. Landscape conservation is discussed in chapter 6 and Appendix F of this Wildlife Action Plan.

Though great strides have been made in developing vegetation classification systems that function at the site, landscape, region and national scales (Barnes 1979, Allen and Starr 1982, Forman and Godron 1986, Cleland et. al 1997, Grossman et. al 1998), they are incomplete. In particular, no system satisfactorily integrates aquatic and terrestrial communities and cultural habitats[1] used by wildlife nationwide.

In lieu of a unified habitat classification system, Vermont's Action Plan technical teams selected the best features of five peer-reviewed vegetation classification systems that can be crosswalked with those used in other states to support broader scale conservation efforts—regionally, nationally, and internationally. Forest Cover Types (Eyre 1980) and U.S Forest Service Forest Inventory & Analysis Types (USDA 2003) were used for early successional stage forests. Natural Communities (Thompson and Sorenson 2000) were the basis for most terrestrial vegetation. "A Classification of the Aquatic Communities of Vermont" by Langdon et al. (1998) was adapted for aquatic community designations and cultural habitats[1] were adapted from Reschke (1990). Landscape scale communities were adapted from Poiani et.al. (2000).

One hundred twenty-five aquatic and natural community types, cultural habitats and land cover types, capturing most of the habitat required by SGCN were selected from the five systems (table

[1] Cultural habitats are communities and sites that are either created and/or maintained by human activities or are modified by human influence to such a degree that the physical condition is substantially different from what existed prior to human influence (adapted from Reschke 1990).

4.2). Each was assigned to one of 22 categories. Because Lake Champlain and the Connecticut River harbor most of the fish diversity in Vermont, these two waterbodies were broken out from the taxonomy to provide for a more targeted assessment. Technical teams then developed assessment summaries for each that include descriptions and general locations; current conditions; desired conditions based on the needs of associated SGCN; priority problems; conservation strategies to address problems (along with the identification of potential conservation partners and funding sources); and a listing of relevant plans and planning processes pertinent to a habitat type.

Our terrestrial classification is designed to roll up to the Northeast Terrestrial Habitat Classification System (Gawler 2008) with standardized terminology and compatible habitat classifications. It allows the Action Plan to describe the aspects of conservation which are particular to Vermont, while facilitating conservation at a broader regional level. A Companion to the Terrestrial and Aquatic Maps has been published by The Nature Conservancy (Anderson et al. 2013). It includes profiles of each habitat type in the Northeast, distribution maps, state acreage figures, SGCN identification concern, and an assessment of overall conditions in the region. Habitat conservation summaries can be found in Appendix B.

Habitat Succession, Species of Greatest Conservation Need & the Action Plan

Plant succession produces cumulative change in the types of plant species occupying a given area through time. Succession is complicated by factors such as disturbance (large and small), local conditions, seed banks and soil legacies (Oliver 1981). A highly simplified timeline begins when land is cleared. Pioneer species typically return first followed by other species generally better adapted to the new and changing conditions created by the previous suite of species. Given sufficient time and appropriate conditions the area moves roughly through early, middle, and late successional stages—often referred to as mature or old growth. A disturbance, if sufficiently large, can re-set the clock anytime and succession begins again. The best-known examples are forest succession but it occurs in virtually all vegetated areas. For example, lichen communities on granite mountaintops experience successional changes (Wessels 2002).

Succession can significantly impact habitat for Species of Greatest Conservation Need and other wildlife as in the edge habitat example noted earlier. Generally, as succession moves from early (young forests) to late stages some wildlife will lose out (e.g., Spruce Grouse, American Woodcock, Cottontail Rabbit) and others will benefit (e.g., American Marten, Northern Goshawk). Others still prefer a mix of successional stages in appropriate configurations (e.g., Black Bear, Canada Lynx).

Over the past two centuries the mix of successional stages available to Vermont's wildlife has changed dramatically in both distribution and abundance. Though precise estimates (current and historic) are unavailable, prior to 1800 a significant percentage of Vermont's forests were in late-successional stages (>150-300 years and older) and forest stands provided greater structural diversity. One-hundred years later young forests (early-successional stages of 1-15 years) dominated the state and today mid-successional forests (60-100 years) are most abundant. Wildlife populations have responded in turn. Vermont's SGCN list contains relatively few species requiring mid-successional forests and more that thrive in early and late-successional representations.

Because the loss of late-successional forests in the eastern U.S. occurred prior to the advent of modern wildlife biology and the current scarcity of later-successional stages (particularly northern hardwood forest types) our understanding how wildlife utilized these stages is not as advanced as our knowledge of wildlife in early successional stages. Historic records and research in late-successional areas elsewhere indicate that the distribution and abundance of some wildlife species was much greater when late-successional forests were in greater abundance—even if these species can survive without them. Given the lack of this condition on the landscape it is advisable to increase its availability to wildlife.

The habitat, community and landscape summaries that follow in Chapter 6 and Appendix B address the habitat needs of Species of Greatest Conservation Need that use vegetation types in one or more successional stages. Conservation strategies address these particular successional stage needs as well as those of species that prefer a mosaic of successional stages.

Table 4.2: Landscape, Community, Habitat & Cover Type Categories

***** Categories marked with an asterisk "*" are considered major categories for the purposes of organizing this report (24 in all). Conservation summaries were developed addressing characteristics and location, current and desired condition, SGCN using this habitat category, priority problems impacting this category, conservation strategies to address the problems and a list of other plans and planning entities with significant interest in this area.

*Landscapes

- Interior Forest Blocks
- Connectivity Blocks
- Surface Waters and Riparian Areas
- Riparian Areas for Connectivity
- Physical Landscape Diversity Blocks
- Wildlife Road Crossing

Aquatic Communities

***Riparian Areas**

***Riverine** (Langdon et.al. 1998)

- Brook trout community
- Brook trout-slimy sculpin community
- Blacknose dace-slimy sculpin community
- Blacknose dace-bluntnose minnow community
- Blacknose dace-creek chub community
- Tessellated darter-fallfish community
- Blacknose dace-slimy sculpin community
- White sucker-tessellated darter community

***Lower Connecticut River**
(Atlantic salmon-American shad community)

***Lower Lake Champlain Tributaries**
(Redhorse-lake sturgeon community)

***Lakes & Ponds**

- Dystrophic lakes
- Meso-eutrophic lakes
- Oligotrophic lakes
- High elevation acidic lakes

***Lake Champlain**

Cultural Habitats

(Reschle 1990)

***Building & structures**

***Mine & Gravel Pits**

***Grassland & Hedgerows**

- Grasslands
- Hedgerow
- Old field/shrub
- Orchard

*Young Forests

(Successional Stages, Forest Cover Types, Eyre 1980, US Dept of Agriculture 2003)

Stages: Seedling/Sapling Sapling/Pole Timber, Pole Timber

Cover types

- Boreal Conifers
  - Balsam fir
  - Black spruce
  - White spruce
- Boreal Hardwoods
  - Aspen
  - Pin cherry
  - Paper birch
- Spruce-Fir
  - Red spruce
  - Red spruce-balsam fir
  - Paper birch-red spruce-balsam fir
- Pine and Hemlock
  - Eastern white pine

Table 4.2 continued: Terrestrial Natural Communities (Thompson & Sorenson 2005)

Open or Shrub Wetlands

*Open Peatlands
Alpine peatland
Dwarf shrub bog
Black spruce woodland bog
Pitch pine woodland bog
Poor fen
Rich fen
Intermediate fen

*Marshes & Sedge Meadows
Deep bulrush marsh
Deep broadleaf marsh
Shallow emergent marsh
Sedge meadow
Cattail marsh
Wild rice marsh

*Wet Shores
Calcareous riverside seep
River cobble shore
Lakeshore grassland
Riverside sand or gravel shore
Outwash plain pondshore
River mud shore
Rivershore grassland

*Shrub Swamps
Buttonbush basin swamp
Alder swamp
Alluvial shrub swamp
Sweet gale shoreline swamp
Buttonbush swamp

Forested Wetlands

*Floodplain Forests
Silver maple-ostrich fern riverine floodplain forest
Lakeside floodplain forest
Silver maple-sensitive fern riverine floodplain forest
Sugar maple-ostrich fern riverine floodplain forest

*Hardwood Swamps
Red maple-black ash swamp
Red maple-northern white cedar swamp
Calcareous red maple-tamarack swamp
Red or silver maple-green ash swamp
Red maple-black gum swamp
Red maple-white pine-huckleberry swamp

*Softwood Swamps
Northern white cedar swamp
Spruce-fir-tamarack swamp
Black spruce swamp
Hemlock swamp

*Seeps & Vernal Pools
Vernal pools
Seeps

Open Upland Communities

*Upland shores
Riverside outcrop
Lake sand beach
Lake shale or cobble beach
Erosional river bluff
Sand dune

*Outcrops & Upland Meadows
Alpine meadow
Boreal outcrop
Serpentine outcrop
Temperate acidic outcrop
Temperate calcareous outcrop

*Cliffs & Talus
Boreal acidic cliff
Boreal calcareous cliff
Temperate acidic cliff
Temperate calcareous cliff
Open talus

Upland Forests & Woodlands

*Spruce-Fir Northern Hardwood Forest
Subalpine krummholz
Montane spruce-fir forest
Lowland spruce-fir forest
Montane yellow birch-red spruce forest
Boreal talus woodland
Cold-air talus woodland
Red spruce-northern hardwood forest
Red Spruce-Heath Rocky Ridge Forest

*Northern Hardwood Forest
Northern hardwood forest
Rich northern hardwood forest
Mesic red oak-northern hardwood forest
Hemlock forest
Hemlock-northern hardwood forest
Northern hardwood talus woodland

*Oak-Pine-Northern Hardwood Forest
Limestone bluff cedar-pine forest
Mesic maple-ash-hickory-oak forest
Mesic Clayplain Forest
White pine-red oak-black oak forest
Dry oak forest
Dry Red Oak-White Pine Forest
Pine-oak-heath sandplain forest
Dry oak-hickory-hophornbeam forest
Red cedar woodland
Red pine forest or woodland
Pitch pine-oak-heath rocky summit
Dry oak woodland
Sand-Over-Clay Forest
Temperate Hemlock Forest
Temperate Hemlock-Hardwood Forest
Transition Hardwoods Limestone Forest

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Chapter 5

Species of Greatest Conservation Need

2015

5. Vermont's Species of Greatest Conservation Need

Vermonters love their wildlife. And wildlife love Vermont. During the past century, many wildlife species once rare or missing from the state have returned in larger numbers. The resurgence of Vermont's forests is a significant reason. From a low of 40% forest cover in the 1840s the state is now nearly 80% forested. However, more trees are not the whole story. Restoring wildlife to the state also required the hard work and dedication of scientists, wildlife and habitat managers, sportsmen, and other conservationists. Signature species such as deer, Moose, Beaver, Fisher, Osprey, Peregrine Falcon, and Common Loon, all missing or in perilously low numbers just decades ago are now faring well.

Keeping wildlife populations healthy offers a host of benefits: healthier ecosystems upon which we all depend; more wildlife to enjoy; and, fewer species on the brink of extirpation mean less need for regulatory restrictions.

Our work, however, is not complete. A significant number of wildlife species need help because of threats such as habitat loss, fragmentation and degradation; invasive exotic species; diseases; and climate change.

The State Wildlife Grants program helps Vermont meet these challenges. It provides federal funds for conservation to prevent fish and wildlife populations from becoming endangered. Per Congressional requirements, the Wildlife Action Plan is centered on the identification and conservation of Species of Greatest Conservation Need (SGCN).

Selecting Species of Greatest Conservation Need

Vermont's Species of Greatest Conservation Need include 134 amphibians and reptiles, birds, fishes, invertebrates, mammals (vertebrates) of 470 in the state and 198 invertebrate species from out of an estimated 21,000. For plants, 645 species of an estimated 1,500 vascular and non-vascular species were selected.

The term Species of Greatest Conservation Need is not a statutory designation and therefore differs from terms "endangered" or "threatened" which are codified by federal and state Endangered Species Acts. Some SGCN have official protection status (e.g., threatened, endangered) whereas others may be in decline but are not currently listed as part of either the Federal or State Endangered Species programs. One guiding principle of the Wildlife Action Plan is to direct conservation attention to species and habitats *before* they become imperiled and recovery becomes more difficult and costly. Some of the species on the list may be relatively common including some game species. It is our goal to keep them common.

In Vermont, six Species Teams, with expertise in amphibians and reptiles, birds, fish, invertebrates, mammals and plants assessed the status of Vermont's native species. They applied assessment criteria such as the degree of species rarity, species designated as at-risk, population trends, species whose habitat are vulnerable to loss, habitat fragmentation, habitat conversion or succession changes and species threatened by exotic plants or animals. Changes to the SGCN list are summarized in table 5.1 and details of the SGCN selection process can be found in Chapter 8.

Table 5.1 Summary of Changes to SGCN Lists 2005:2015

Taxon	2005 SGCN	2015 SGCN	Change Notes
Amphibians & Reptiles	19	19	No changes
Birds	58	50	Removed: Long-eared Owl, Henslow's Sparrow, Osprey, Cooper's Hawk, Barn Owl, Veery, Blue-winged Teal Added: None
Fishes	33	29	Removed: Arctic Char, Atlantic Salmon (anadromous), Brassy Minnow, Muskellunge and Quillback Added: Northern Pearl Dace
Invertebrates	191	198	Removed: 19 species Added: 26 including 9 bumble bee species
Mammals	33	33	Removed: Black Bea, Mink Added: Moose and Snowshoe Hare
Plants	577	645	Added 68 species

Teams used the best information available at the time from local, regional, and national sources. However, while a wealth of information is available for some species, others (especially invertebrates, fish, small mammals and some reptiles and amphibians) are poorly known. Species were ranked with a conservation priority of high, medium or low. Those ranked medium and high constitute Vermont's Species of Greatest Conservation Need. Those ranked low priority are considered relatively secure. It is expected that low priority species will benefit from conservation efforts directed toward species ranked medium and high as well as from other ongoing wildlife management programs (e.g., federal aid to sportfish and wildlife).

Ongoing wildlife monitoring will help track species status and progress toward greater security. Regular Action Plan review and revision will provide opportunities to add additional species to the list as warranted and to remove those species deemed less in need of conservation action secure.

Use of and Changes to SGCN Lists

The lists of Species of Greatest Conservation Need that follow will help prioritize the allocation of State Wildlife Grant and other conservation funds. The list will also provide a quick measure of our success conserving Vermont's wildlife. It also raises the profile of a species to a wider audience of conservation partners and can encourage others to initiate projects that may benefit the species. It is important to note that presence on this list does not necessarily mean that conservation resources *will* be directed towards the animal or plant, but that conservation actions for the animal species are *eligible* for State Wildlife Grants funding, and may be more competitive for other grant programs.

The Species of Greatest Conservation Need list can be amended if important information becomes available about a species' status. For example, there are several current and pending inventory and assessment projects funded by State Wildlife Grants that could significantly increase our understanding of a species' status.

Big Game: White-Tailed Deer, Black Bear & Wild Turkey

Nearly 20 game and sportfish species are listed on the following pages as Species of Greatest Conservation Need (SGCN) due to concerns about population declines and loss of habitat.

White-tailed deer and wild turkey, however, were not selected as SGCN. Black Bear, which was an SGCN in the 2005 Wildlife Action Plan is no longer considered a Species of Greatest Conservation Need. Though absent or nearly extirpated from the state by 1865, their populations are now sufficiently large and stable. And, relative to SGCN, our knowledge of deer, turkey and bear biology and management is great.

White-tailed Deer, Black Bear and Wild Turkey rank high among Vermont's greatest wildlife restoration successes. Still their management remains of utmost concern because of their great importance to Vermonters and because of the significant roles they play in their ecosystems. Fortunately, management plans (developed with significant public involvement), harvest regulations and monitoring protocols have long been in place for these species and dependable implementation funds come through license fees and the Federal Aid to Wildlife Restoration Act.

Vermont Fish & Wildlife Department's Big Game Management Plan (2010-2020) is incorporated into the Wildlife Action Plan as Appendix H.

Conserving Vermont's Amphibians & Reptiles

Reptile & Amphibian Team

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Team Charge

The Reptile and Amphibian Team was charged with identifying Species of Greatest Conservation Need (SGCN); describing the distribution and habitat usage for each SGCN; evaluating threats impacting SGCN and their habitat; identifying priority research needs to improve our ability to conserve these species; and, developing conservation strategies to address priority threats.

Introduction

For much of the year Vermont's 40 species of amphibians and reptiles, collectively known as herps or herptiles (from the Greek *Herpeton*), are secretive creatures shunning the fuss made over our more charismatic mega-fauna. But stand beside a Vermont wetland, pond or vernal pool on an early spring evening and the cacophony of calls from wood frogs, spring peepers, green frogs, and others and these enigmatic micro-fauna will make themselves noticed.

Vermont's reptiles and amphibians certainly deserve notice. As if their penchant for feasting on black flies, mosquitoes, garden slugs, rodents and other pests isn't reason enough to conserve them (some frogs are reported to eat as many as 3,000 insects a year), many also play critical roles in ecosystems, and serve as excellent indicators of the health of natural systems due to their sensitivity to toxic chemicals and habitat change.

Amphibians and reptiles face many conservation challenges in today's world, be it crossing high-traffic roads or the loss of habitat and connections between habitat patches. It could be argued that all 21 amphibians and 19 reptiles known to be extant in Vermont deserve Species of Greatest Conservation Need (SGCN) designation. The Action Plan Reptile and Amphibian Team took a conservative approach to selecting SGCN to highlight those species thought to be most in need of conservation assistance so that scarce resources can be directed toward their conservation.

Implementing the 2005 Wildlife Action Plan

A substantial amount of work, primarily through SWG funded projects, has been accomplished since the 2005 Action Plan to advance our knowledge of specific Vermont herps. Our on-going Rare Snakes of Vermont project, established in 2010 with SWG funding, focuses specifically on rare snake SGCN. It's significantly added to our knowledgebase of rattlesnake and ratsnake home ranges, their movements, mapping of critical SGCN snake habitats, population demographics, genetic assessment and other life history information. This investigation also revealed the presence of the lethal Snake Fungal Disease (SFD) in Vermont's rattlesnake population. A newly emerging skin fungus afflicting myriad snake species, SFD, is now an issue of serious regional concern and alarm in the eastern U.S. and has recently been detected in a dozen eastern states. The Rare Snakes project produced significant new findings and completion of a report on Vermont's two-year rattlesnake research study (Spear et. al.). Two Vermont Recovery Plans were also completed since 2005; one for the threatened spiny softshell turtle and the second for the endangered timber rattlesnake.

A wealth of reliable documentation has been added to the Vermont Reptile & Amphibian Atlas throughout the state resulting from hundreds of additional logged sightings/locations of reptiles and amphibians. A survey of vernal pools (also SWG-funded) has catalogued some 2500 vernal pool amphibian breeding sites statewide. Turtle species have also received attention, including documenting/protecting the endangered spotted turtle, the threatened spiny softshell, and wood turtles – a species of special concern. Additional genetic research/assessment has been directed to the Mudpuppy revealing two distinct populations in Vermont (one in the Lake Champlain basin and the second, in the Connecticut River basin). In 2015, the Fowler's Toad was listed as endangered in Vermont.

Northeast Partners in Reptile and Amphibian Conservation (NEPARC) and its national affiliate PARC have been particularly active recently in attempting to stem the tide of the ubiquitous international amphibian import trade to help protect US amphibians from imported, exotic diseases such as the newly identified salamander chytrid fungus *Batrachochytrium salamandrivorans* (Martel, A. et al.).

Selecting Amphibian & Reptile SGCN

The Herp Taxa Team deliberated extensively on SGCN selection criteria, and ultimately made no changes to the 2005 SGCN list of herp species, nor its priority rankings. No species were added nor deleted. Scientific nomenclature for several species was updated. Selection criteria included knowledge about current listing as endangered and threatened, population declines, rarity, vulnerability of habitat, life history traits, vulnerability to collection or take, other impacts from humans, and dispersal capability. Each species was examined across all criteria and the four-person team utilized a high, medium, and low conservation need ranking to attempt to separate species with greater need from those that may be more secure, at least in the short term. We assigned numerical rankings that assisted our assignment to high, medium, and low priority categories. This approach resulted in the selection of the same 12 species of high conservation need and seven of medium conservation need (table 5.2)

Table 5.1. Amphibian & Reptile Species of Greatest Conservation Need

High Priority	Medium Priority
Jefferson Salamander (*Ambystoma jeffersonianum- and hybrids*)[1]	Blue-spotted Salamander (*Ambystoma laterale*)[1]
Mudpuppy (*Nectar's maculosus*)[1]	Spotted Salamander (*Ambystoma maculatum*)
Fowler's Toad (*Bufo fowleri*)[1]	Four-toed Salamander (*Hemidactylium scutatum*)
Boreal Chorus Frog (*Pseudacris maculata*)	Common Musk Turtle (*Sternotherus odoratus*)
Spotted Turtle (*Clemmys guttata*)[1]	Northern Water Snake (*Nerodia sipedon*)
Wood Turtle (*Glyptemys insculpta*)[1]	DeKay's Brownsnake (*Storeria dekayi*)[1]
Spiny Softshell Turtle (*Apalone spinifera*)[1]	Smooth Greensnake (*Opheodrys vernalis*)[1]
Five-lined Skink (*Plestiodon fasciatus*)	
Eastern Ribbonsnake (*Thamnophis sauritus*)[1]	
North American Racer (*Coluber constrictor*)[1]	
Eastern Ratsnake (*Pantherophis alleghaniensis*)	
Timber Rattlesnake (*Crotalus horridus*)[1]	

[1] Regional Species of Greatest Conservation Need in the Northeastern United States (Terwilliger, 2013)

Though some of Vermont's amphibians and reptiles are at the periphery of their range (e.g., Boreal Chorus Frog, Mudpuppy, Fowlers Toad, and Mink Frog, a finding that challenges conventional wisdom is that species populations have been documented to be more at risk of loss at the core of their range than at the periphery (Channel & Lomolino 2000, Lomolino 1995). This argues for us giving serious consideration to SGCN that may be peripheral in Vermont.

Reports on each amphibian and reptile Species of Greatest Conservation Need are in Appendix A1 of this document. The following is a summary of those reports.

Habitat Needs

Since many reptiles and amphibians use a variety of habitats annually and over the course of their lives, maintaining healthy populations entails maintaining connectivity between habitats. Connectivity also enables individuals to find alternative cover, food sources, breeding, or over-wintering sites when natural disasters occur. Furthermore, connectivity between populations ensures vital genetic exchange and allows for the re-colonization of areas where populations have been eliminated due to drought, winterkill, disease, or anthropogenic forces. This can only occur if the landscape is permeable to these animals–that is, development proceeds in a way that allows amphibians and reptiles to move freely across the landscape. To conserve our native amphibians and reptiles, especially those considered SGCN, it will be essential to maintain a network of interconnected sites where natural processes can occur.

Discussion of Threats to Vermont's Amphibians & Reptiles

The threats identified most frequently for Vermont's reptile and amphibian populations are all closely related to habitat degradation: trampling and direct impacts, road and transportation system impacts, habitat fragmentation, habitat alteration, and habitat conversion.

We do not understand all the ramifications, but the pattern seen elsewhere in the US and the world is that increased human population density, higher consumption of land and other resources, and lack of awareness of the impacts to other species can lead to devastating losses of native biota (TWS 2004). Vermont is not immune from these sorts of impacts and our landscape is continuing to be developed (DeVillars 1999). Habitat alteration and loss is a near universal challenge to native amphibians and reptiles.

To address this threat, Vermont's Agency of Natural Resources remains vigilant in its efforts to minimize loss of critical habitats under its jurisdiction through formal regulatory authority and mechanisms provided under Vermont's Act 250 development law, Section 248 and wetlands protection permit processes. The Vermont Fish and Wildlife Dept. has developed some powerful new mapping (e.g., Natural Resources Atlas) and habitat/natural community analysis tools (Biofinder) to assist in identifying the states' most diverse, valuable and vulnerable lands as targets for eventual conservation.

A significant, newly identified threat is a lethal Snake Fungal Disease (SFD) which causes significant and debilitating skin lesions on snakes. Widespread detection of SFD in the eastern US has prompted an extensive, on-going, regional research investigation into this novel fungus to assess the causes and conservation significance of this extremely serious threat to free-ranging snakes. Concern has also recently arisen over a novel, salamander chytrid fungus *Batrachochytrium salamandrivorans* (Martel, A. et al. 2015) identified on the Asian and European continents, and the threat of spread to North America via a ubiquitous international pet trade. The national conservation organization

Partners in Amphibian and Reptile Conservation (PARC) is now attempting to promulgate US/international herptile trade regulations to protect against this threat.

Crossing roads is a real problem for both amphibians and reptiles in Vermont. Vernal migrations of salamanders and frogs to breeding pools result in many dead and wounded animals when a busy road must be crossed. At some sites in Vermont, thousands of amphibians are killed during a single night, which may overwhelm the reproductive capacity to sustain the populations and, according to the Vermont Agency of Transportation, constitutes a public safety issue (C. Slesar, VTrans, pers. comm). Female turtles seeking nest sites are more at risk of being killed on roads than more sedentary males, resulting in a sex bias in some populations and raises questions about population persistence (Sheen & Gibbs. 2004, Marchand & Litvaitis 2004). The still abundant, but believed to be declining, wood turtle often encounters roads in Vermont during its annual movements along and away from riparian corridors. Snakes emerging from hibernation often bask on warm pavement, increasing their risk of being struck by vehicles.

An emerging awareness of herps' need for improved connectivity and safer wildlife crossings is taking hold in Vermont and the construction of several highway culverts and underpasses at strategic wildlife crossings are being planned and/or contemplated. Some of these structures are relatively expensive and require a good deal of up-front planning, but collaborative efforts are increasingly embraced and accepted in the transportation and wildlife management communities. For example, the Monkton Crossing is currently in development and will connect upland woods and breeding pools for amphibians. The project is partially funded by SWG, a Federal Highway Enhancement Grant, and $119,000 of non-federal funds—mostly donations. VTrans, which recognizes that better crossings not only protect wildlife but also protect motorists, is a leader among state transportation agencies in road ecology.

Other factors that may negatively impact amphibians and reptiles now and in the foreseeable future include pollution, changes in hydrology, sedimentation, and global climate change.

Research & Monitoring Needs and Conservation Strategies

The Reptile and Amphibian Team identified priority research and monitoring projects to improve our ability to conserve Vermont's reptile and amphibian Species of Greatest Conservation Need. The Team also developed conservation strategies to address threats impacting each SGCN. Those recommended most frequently include:

Research & Monitoring Needs

1. Better determine habitat needs, identify significant breeding sites, vernal pools and habitat connections.
2. Better determine the distribution and relative abundance of populations in Vermont.
3. Better identify and evaluate threats.
4. Monitor trends in population size, distribution and habitat.

Conservation Strategies

5. Help people better value reptiles and amphibians and to understand the essential needs of all life stages, especially upland habitat in proximity to breeding pools.

6. Encourage reports of road-killed specimens, road crossings, and road basking areas to VFWD, VTrans, and the Vermont Reptile and Amphibian Atlas. Develop safer crossings at significant sites when roads are being upgraded.
7. Maintain habitat through appropriate management, direct habitat disturbance and site roadways away from sensitive sites such as breeding pools.
8. Continue to work cooperatively with landowners, habitat management agencies, towns and communities to protect habitat and maintain connectivity. Develop management guidelines for owners and managers of appropriate habitat.
9. Conserve known critical habitat through fee simple purchase, acquisition of development rights or easements, management agreements and education of private landowners and managers.
10. If loss of important sites is likely due to development, consider creating or enhancing other pools that might allow some adults to transfer to the new site if they encounter it or develop a new breeding population from dispersal of colonizers.
11. Protect turtle nests and adults by predator trapping.
12. Work with biologists to minimize impacts to SGCN populations and habitats during and following management activities for sport fish and game wildlife.
13. Participate in existing regulatory processes (e.g., Act 250, stream alteration permits) to protect and restore critical habitats.
14. Maintain continued vigilance, monitoring and research efforts for novel and lethal emerging herp disease issues including snake fungal disease, *Batrachochytrium salamandrivorans,* chytrid fungus, etc.
15. Begin implementation of vernal pool management guidelines as described by VFWD staff in "Conserving Pool-Specialist Amphibian Habitat". (Mark Ferguson, VFWD White Paper, 2015)

Conclusion

Vermont's reptiles and amphibians are fortunate for several reasons. We have a much less developed and rural landscape than many states. For example, even the eastern newt, a very abundant species in Vermont, is declining in Rhode Island due to development and roads (C.J. Raithel, RI Dept of Environmental Management pers comm). We have an engaged Scientific Advisory Group on Reptiles and Amphibians that provides advice to the Vermont Endangered Species Committee. We also have a well-developed Reptile and Amphibian Atlas (VtHerpAtlas.org) that, mostly though volunteer efforts, has collected, and continues to collect valuable information on the distribution of reptile and amphibian species in Vermont and raises awareness of conservation need in Vermont. Interest is increasing with schools and groups in Vermont that host 'salamander nights', helping small amphibians cross roads safely and raise awareness about the impacts of traffic. The Vermont Fish and Wildlife Department continues to work on conservation projects that raise awareness and benefit reptiles and amphibians, including species listed here as SGCN, and we are working collaboratively with other agencies including the Vermont Transportation Agency, as well as an expanding number of conservation partners. More needs to be done, but with the foundation we already have in place and the awareness and strengthening of partnerships promoted by Action Plan, we expect more conservation actions in our shared future.

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Conserving Vermont's Birds

Birds Team

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Team Charge

The Bird Team was charged with identifying Species of Greatest Conservation Need (SGCN); describing the distribution and habitat usage for each SGCN; evaluating threats impacting SGCN and their habitat; identifying priority research needs to improve our ability to conserve these species; and, developing conservation strategies to address priority threats.

Introduction

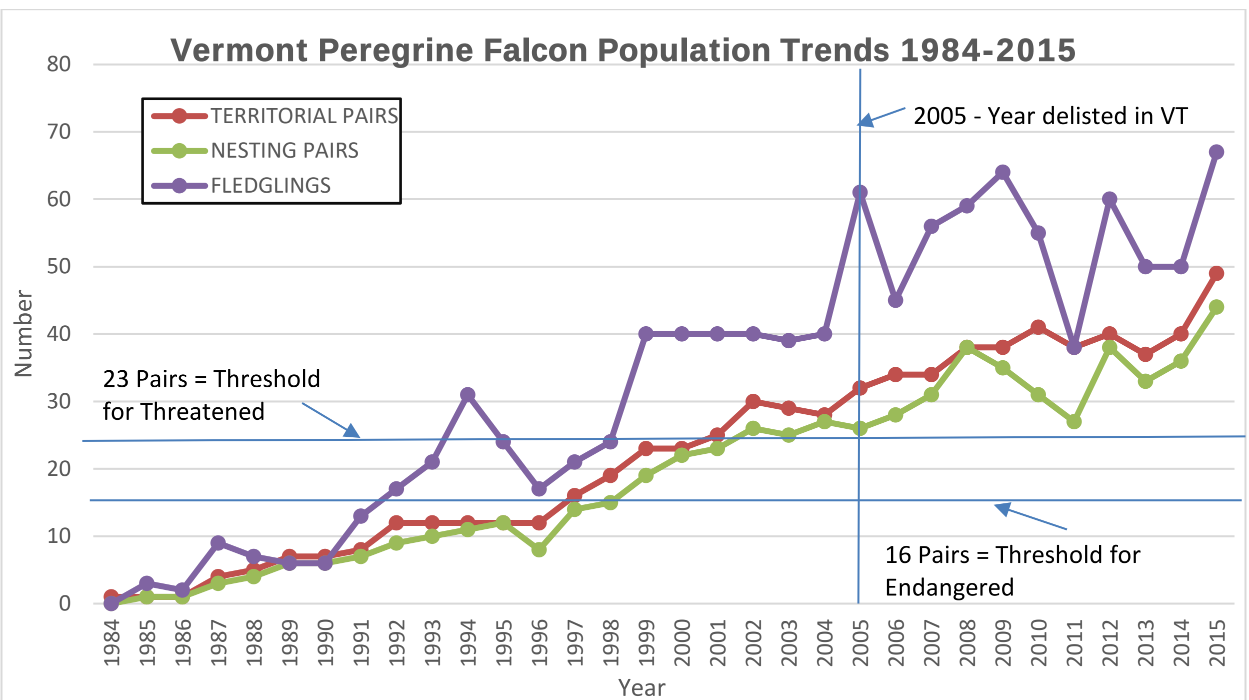
Vermont serves as host to 268 bird species for some, if not all, of their annual life cycle. These species occupy a wide variety of habitats ranging from Lake Champlain wetlands at about 100 feet above sea level to montane spruce-fir forests at elevations greater than 4000 feet above sea level. Included among these highs and lows are nine distinct biophysical regions all compressed into the 9600 square miles that constitute the small State of Vermont. Naturally following this diverse range of habitats are the diverse guilds of bird species that occupy them. Open water and marsh birds, grassland and shrub birds, deciduous, coniferous, boreal, and montane forest birds are all found within the small state of Vermont. Of the 268 species, 12 of them are listed as endangered or threatened. Another 39 are considered Species of Greatest Conservation Need.

The Action Plan Bird Team convened in October of 2014 to assess the status of SGCN species identified in the 2005 Action Plan species and determine the appropriate category ranking for each of them in the 2015 plan. Each team member reviewed a suite of species and updated the existing narratives with current information about population trends, management actions, and recent research. The result of this effort was identifying 22 changes in prioritization. No new species were added to the priority list except Sandhill Crane as an emerging issue species. Four species were revised from High to Medium, 11 were revised from Medium to High, and seven species were revised from Medium to Low. The remaining 36 species retained their priority status from the 2005 assessment. This assessment resulted in modifying the Species of Greatest Conservation Need list from 58 to 50 species.

The issue of lead in the environment continues to present itself most visibly in the Common Loon. This species continues to experience lead-based morbidity and mortality from residual lead fishing tackle. The loss of shrubland and grassland habitat to natural plant succession and human development pose a threat to the habitat specialists of these two habitats. These species include, Eastern Meadowlark, Grasshopper Sparrow, Bobolink, Golden-winged Warbler, Blue-winged Warbler, and Eastern Towhee.

Perhaps the single most significant emerging issue impacting birds in Vermont during the last 10 years has been the conversion of forest and grassland habitat to utility-scale wind and solar energy generation. Although descriptors such as 'renewable', 'sustainable', and 'environmentally friendly' create an image of energy development that is less harmful than fossil fuel, wind and solar energy development still involve habitat loss and impairment. In some cases, the habitat involved is rare and sensitive (i.e., montane forest) and supports rare and sensitive (e.g., Bicknell's Thrush). Furthermore, collision deaths of resident and migratory birds directly related to wind turbines presents a population loss factor that is difficult to assess due to the relatively small amount of comparative mortality data and the cumulative mortality impact as birds migrate north and south along the Atlantic Flyway. The seemingly benign impact of alternative energy development to the public will create a challenge to VFWD biologists when developing equitable habitat mitigation. A sound depiction of the problem and reasonable solutions will have to be narrated by VFWD to achieve bird conservation success.

We are particularly pleased to note that since 2005 Peregrine Falcon, Common Loon, and Osprey were all de-listed. Thanks to 30 years of effort by the VFWD and many partners, populations of these species have recovered sufficiently to where they no longer require heightened protection as Threatened or Endangered species (2005).



Looking forward, possibilities for additional de-listings in coming years are positive as Common Tern appears to be reaching its down-listing goal and Bald Eagle nesting results have been steadily increasing since the first pair nested successfully in 2008. Our first Breeding Bird Atlas (1982) had only one record of a possible nesting; the second Atlas (2013) showed an 800% increase from the first to the second atlas (Renfrew 2013). Additional population data has provided the background for revising the status of Coopers Hawk, and Veery from 'Medium' to 'Low'.

Implementing the 2005 Wildlife Action Plan

Conservation efforts expanded beyond the restoration of Osprey, Peregrine Falcon, and Common Loon during the 10-years since the first Wildlife Action Plan include more focused attention on Common Tern, Black Tern, Grasshopper Sparrow, Spruce Grouse, and Bald Eagle. Each of the latter species benefit from intensive survey efforts to better determine their respective population status and corresponding listing status. Closer working relations with state airport managers was cultivated during the last action plan period resulting is greater awareness of bird species needs and their uses of grassland habitat at airports It has led to a more diversified response to aircraft safety concerns. One profound outcome during this period is the completion and publication of Vermont's Second Breeding Bird Atlas completed in 2013. Very much a collaborative effort, the Atlas was developed with more than 350 citizen scientists contributing more than 50,000 hours over five years to document every bird species breeding across the state. The effort was led by the Vermont Center for Ecostudies, the Fish & Wildlife Department and others, with significant funding from the SWG program. Beginning in 2008 the Wildlife Management Institute led the implementation of the Woodcock Conservation Plan in the northeast. Audubon Vermont's Forest Bird Initiative and Foresters for the Birds provides technical assistance to landowners and foresters to support forest management and policies benefitting a suite of responsibility birds (include Wood Thrush, Black-throated Blue Warbler and Canada Warbler) in Vermont and along the Atlantic Flyway. The Champlain Valley Bird Initiative, a partnership of Audubon VT, the Natural Resources Conservation Service and the University of Vermont similarly provides landowner with technical and financial assistance to protect and manage grassland and shrubland habitat (benefitting many SGCN including the Eastern Towhee, Golden-winged Warbler, Field Sparrow and Bobolink).

Selecting Bird SGCN

In contrast to lesser-known taxa, the Bird Team benefited from the relative wealth of available data on bird distribution and abundance. Data from Vermont's original (1982) and current (2013) Breeding Bird Atlases and the USFWS Breeding Bird Surveys helped immensely in selecting the 50 SGCN. In addition to this hard data source, ongoing bird conservation programs, including the Vermont Endangered Species Scientific Advisory Group on Birds (SAG-Birds), Partners-In-Flight, North American Bird Conservation Initiative, National Audubon Society's Watch List, and the American Bird Conservancy's Green List all contributed to our understanding of which species belonged on Vermont's SGCN list.

Selection criteria included current listing as endangered or threatened, population declines, rarity, vulnerability of habitat, life history traits, impacts from humans, and recent range expansion or contraction. Each species was examined across all criteria and the team developed a high, medium, and low conservation need ranking to attempt to separate species with greater need from those that may be more secure, at least in the short term (table 5.3).

Of the 58-species identified by the bird team in 2005, 37 (64%) retained their priority ranking from that list. Four were moved from 'High' to 'Medium'. These were Peregrine Falcon, Common Loon, Purple Martin, and American Bittern. Moving from 'Medium' to 'Low', were Long-eared Owl, Henslow's Sparrow, Osprey, Cooper's Hawk, Barn Owl, Veery, and Blue-winged Teal. These seven were moved for different reasons that include better population information (Veery, and Cooper's

Hawk), unlikely conservation opportunities (Long-eared Owl, Blue-winged Teal, and Henslow's Sparrow) and significant increases in state-wide population (Osprey). A total of 11 species were moved from 'Medium' to 'High'. By and large these changes were made based on a combination of long-term population data (i.e., national Breeding Bird Survey) and the recently completed second Breeding Bird Atlas. Of the 11 species newly identified as high priority, only Rusty Blackbird was listed (Endangered) during the last 10 years. The other 10 species, while not meeting listing criteria, were raised to high priority based on the combination of habitat loss and long-term population decline and the likelihood that these two factors will continue during the next 10 years. The 10 High Priority species can be grouped by loss of their habitats: Wood Thrush and Red-shouldered Hawk (Deciduous Forest), American Kestrel, Eastern Meadowlark (Grassland), Brown Thrasher, Blue-winged Warbler (Shrubland), Olive-sided Flycatcher, Gray Jay, and Black-poll Warbler (Boreal Forest).

Table 5.3. Bird Species of Greatest Conservation Need

High Priority	**Medium Priority**
Pied-billed Grebe (*Podilymbus podiceps*)[1]	Common Loon (*Gavia immer*)[1]
Least Bittern (*Ixobrychus exilis*)[1]	American Bittern (*Botaurus lentiginosus*)[1]
American Black Duck (*Anas rubripes*)[1]	Great Blue Heron (*Ardea herodias*)
Bald Eagle (*Haliaeetus leucocephalus*)	Black-crowned Night-heron (*Nycticorax nycticorax*)[1]
Northern Harrier (*Circus cyaneus*)[1]	Northern Goshawk (*Accipiter gentilis*)[1]
Red-shouldered Hawk (*Buteo lineatus*)[1]	Peregrine Falcon (*Falco peregrinus*)[1]
American Kestrel (*Falco sparverius*)[1]	Ruffed Grouse (*Bonasa umbellus*)[1]
Spruce Grouse (*Falcipennis canadensis*)[1]	Sora (*Porzana carolina*)[1]
Upland Sandpiper (*Bartramia longicauda*)[1]	Lesser Yellowlegs (*Tringa flavipes*)
Common Tern (*Sterna hirundo*)[1]	American Woodcock (*Scolopax minor*)[1]
Black Tern (*Chlidonias niger*)[1]	Black-billed Cuckoo (*Coccyzus erythropthalmus*)[1]
Common Nighthawk (*Chordeiles minor*)[1]	Short-eared Owl (*Asio flammeus*)[1]
Whip-poor-will (*Caprimulgus vociferus*)[1]	Black-backed Woodpecker (*Picoides arcticus*)
Chimney Swift (*Chaetura pelagica*)[1]	Purple Martin (*Progne subis*)
Olive-sided Flycatcher (*Contopus cooperi*)[1]	Chestnut-sided Warbler (*Dendroica pensylvanica*)
Gray Jay (*Perisoreus canadensis*)	Black-throated Blue Warbler (*Dendroica caerulescens*)[1]
Sedge Wren (*Cistothorus platensis*)[1]	Prairie Warbler (*Dendroica discolor*)[1]
Bicknell's Thrush (*Catharus bicknelli*)[1]	Bay-breasted Warbler (*Dendroica castanea*)[1]
Wood Thrush (*Hylocichla mustelina*)[1]	Cerulean Warbler (*Dendroica cerulea*)[1]
Brown Thrasher (*Toxostoma rufum*)[1]	Field Sparrow (*Spizella pusilla*)[1]
Blue-winged Warbler (*Vermivora pinus*)[1]	Bobolink (*Dolichonyx oryzivorus*)[1]
Golden-winged Warbler (*Vermivora chrysoptera*)[1]	
Blackpoll Warbler (*Dendroica striata*)	
Canada Warbler (*Wilsonia canadensis*)[1]	
Eastern Towhee (*Pipilo erythrophthalmus*)[1]	
Vesper Sparrow (*Pooecetes gramineus*)[1]	
Grasshopper Sparrow (*Ammodramus savannarum*)[1]	
Eastern Meadowlark (*Sturnella magna*)[1]	
Rusty Blackbird (*Euphagus carolinus*)[1]	

[1] Regional Species of Greatest Conservation Need in the Northeastern United States (Terwilliger, 2013)

Bird species rare in Vermont did not always make the SGCN listing. Species that have expanded their range in recent decades due to a proliferation of winter bird feeders, such as Tufted Titmouse, were excluded, as we did not consider Vermont to be a geographic area of responsibility for that species. Other species for which Vermont is on the extreme periphery of their breeding range, and for which confirmed breeding records are very infrequent, such as the Three-toed Woodpecker, were also not selected.

Reports on each Bird Species of Greatest Conservation Need are in Appendix A2 of this document. The following is a summary of those reports.

Birds and Their Habitat Needs

Vermont's bird SGCN utilize a variety of habitats from open and shrub-dominated wetlands, mature hardwood or coniferous forests, young regenerating forests, old fields, grasslands, and other cultural habitats such as buildings and structures. As birds are generally more mobile relative to most species from other taxa, they are usually better able to exploit smaller, more widely distributed habitat patches. However, most species benefit from the larger assemblages of similar habitat types, such as a contiguous forest area or large, agricultural (grassland) complex.

The Bird Team organized most birds into one of several habitat guilds, for which a conservation strategy would often be appropriate for all species in the guild. These guilds match the major habitat categories used in this report:

Northern hardwood forest & Oak-pine-northern hardwood forest
Spruce-fir northern hardwood forest
Sub-alpine krummholz & Montane spruce-fir forests (high elevation areas)
Early successional forest stages
Riparian
Lakes and ponds
Wetlands (open, shrub and forested wetlands)
Cliff & Talus
Grassland
Grassland/Edge
Urban

Discussion of Threats Impacting Bird SGCN

New strains of avian influenza have been identified around the world, including western and central North America. To date these new viruses have had the greatest impact on commercial poultry farms and to some degree on the human population in Southeast Asia. Effects on wild bird populations have not been significant to date. However, the potential for viruses to adapt and thrive in a concentrated wintering ground could produce devastating effects. The impact of neonicotinoid pesticides on the continent's insect populations and ultimately on avian insectivores, remains poorly understood. More research is needed to fully understand any far-reaching consequences of this new breed of pesticide. It took more than thirty years and untold amount of money and of dedicated effort to recover populations of Eagle, Osprey, and other raptors after the 1972 ban of the pesticide DDT. It is hoped we will learn from this history lesson and not put bird species in a similar situation in the future. The impact of wind and solar electric generation facilities is still in its infancy. While the detrimental impact of habitat loss from the facilities is readily apparent, the cumulative impacts to populations created by local and cumulative collision mortality are not well understood yet. The rate of growth of these two industries far outpaces the rate of knowledge growth about their relative impacts to continental bird populations. Finally, some habitats may be at risk to climate change. It is generally agreed that large blocks of contiguous habitat are best able to resist or more gradually shift due to climate change. A discussion of any of these emerging issues cannot be complete in the absence of habitat loss.

The loss of habitat is the primary source of bird population declines. As the land area available for birds to exist continues to shrink, ever declining bird populations are increasingly concentrated into the remaining, sometimes marginal quality space, and places species at greater risk of nest failure, predation, and disease. The threats to Vermont's bird populations most frequently identified for are all related to changes in habitat. In the case of the 50 SGCN, conversion of habitat was identified 82% of the time (42 SGCN). Habitat alteration (67%), habitat fragmentation (47%), and distribution of successional stages (35%) were all identified in descending order of frequency. This is the same pattern that emerged in the first Wildlife Action Plan. Many bird species find optimum habitat in young regenerating forests, which have declined statewide in recent decades. Similarly, grassland-dependent species, which are declining throughout the Northeast, are finding less and less suitable habitat in Vermont as farms are managed more intensively or sold and either developed or revert to forestland. The increased roads, housing units, and other attendant disturbances associated with human development further fragment habitat into smaller and smaller habitat units.

In these smaller habitat units, nesting birds are more vulnerable to habitat generalist predators such as Raccoons, Skunks, and Crows. Greater access is also available to the nest parasitizing Brown-headed Cowbird. Finally, the increasing numbers of houses in bird habitat often come with house pets, namely dogs and cats. These familiar companion animals, not in need of shelter of food, add an additional layer of disturbance and predation to nesting birds. Pet cats have been attributed to over 250 million bird deaths nationally each year.

Research & Monitoring Needs and Conservation Strategies

The research and monitoring needs and conservation strategies most frequently identified by the Bird Team and those best applied for multiple bird SGCN are as follows:

Research & Monitoring Needs

1. Better determine habitat requirements and habitat availability.
2. Better determine the distribution and relative abundance of populations in Vermont.
3. Better identify and evaluate threats including the impacts of wind and solar energy infrastructure and emerging diseases.
4. Obtain better knowledge of basic life history traits.

Conservation Strategies

1. Habitat Restoration efforts on public lands and conservation payments or other financial incentives, fee simple purchase, easements, management guidelines, and cooperative agreements with user groups and private landowners. Existing technical assistance/cost-share programs (EQIP, CRP) were frequently identified as potential funding sources to implement conservation on private lands. Important Bird Area designations can aid in the development of needed funds. Common habitat restoration themes include incentives and

planning to slow the rate of fragmentation and development and maintain blocks of contiguous forest, grasslands, early and late-successional habitats.

2. Species Restoration projects, which may involve active translocation of individuals or eggs from source populations to suitable Vermont habitats, and/or may involve efforts to provide suitable nesting sites and reduce predation or human disturbances around nesting sites.
3. Raise awareness within the public to build support and opportunities for conservation. Important Bird Area designations can help focus public attention on opportunities.
4. Developing and evaluating forestry practices that can enhance habitat suitability such as maintaining or increasing aspen stands or the retention of coarse woody debris and snags. Provide technical assistance to landowners and communities about best management practices (e.g., Vermont Fish and Wildlife Department's Forest Landowner Assistance Program and Audubon's Forest Bird Initiative and Foresters for the Birds program.
5. Support and participate in an international effort to maintain large blocks of undeveloped forests linked together by habitat corridors to provide a network of interconnected habitats throughout northeastern New England and southeastern Canada.
6. Identify, prioritize and conserve existing contiguous forest blocks and associated linkages that allow for upward and northward movement in response to climate change.
7. Participate in existing regulatory processes (e.g., Act 250) to protect and restore important habitats.

Conclusion

We are fortunate that Vermont bird species may be in a better place than those in other states. Vermont has a rural landscape and an economy where agricultural, forest commodities, and tourism play important roles; and Vermonters value their natural resources committing tax dollars to conservation and supporting land-use laws. Still, 50 of the 268 (19%) bird species are Species of Greatest Conservation Need and 12 of those are listed as threatened or endangered. We have recent conservation successes in the form of Peregrine Falcon, Common Loon, and Osprey de-listing. However, these are but three species out of 50 (6%) listed as SGCN and their restoration required funding and staffing that would be unimaginable to apply to all the remaining Species of Greatest Conservation Need. Good collaborative work with our partners (Audubon Vermont, Vermont Center for Ecostudies, University of Vermont, and U.S. Fish and Wildlife Service) is underway toward the restoration of Common Tern and Bald Eagle, as well as important monitoring efforts for Black Tern, Grasshopper Sparrow, and Least Bittern. Future conservation opportunities exist with the expansion of grassland habitat conservation through cooperative landowner agreements and land development regulation. Continued work with the state airport managers will also add to the security of this limited habitat. Broader scrutiny of mountain top developments is required if the rare montane forest habitat is to be conserved as significant development pressure is placed on these fragile locations. For Bicknell's Thrush and Blackpoll Warblers to coincide with human use of their habitat a better understanding of the limits of human disturbance to their habitat is needed. Continued work with private forest landowners and state and local governments is needed to retain the habitat values associated with stable, long-term ownership of contiguous forestland. The Vermont Department of Forests, Parks, and Recreation, Audubon Vermont, the Vermont Woodlands Association and Vermont Coverts will be valuable partners in this effort. Finally, more intensive and purposeful inventory of the secretive marsh bird guild is necessary to accurately assess the status of these hard-to-sample species.

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Conserving Vermont's Fishes

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Team Charge

The Fish Team was charged with identifying Species of Greatest Conservation Need (SGCN); describing the distribution and habitat usage for each SGCN; evaluating problems impacting SGCN and their habitat; identifying priority research needs to improve our ability to conserve these species; and, developing conservation strategies to address priority problems.

Introduction

Vermont with its estimated 7,100 miles of rivers and streams and 809 lakes and ponds supports populations of 92 fish species (Langdon et al. 2006). Eighty of these are recognized as being native to the state. A native species is one that was present in the state prior to early European colonization. The remaining 12 species are non-indigenous to Vermont. These fishes were either purposely introduced, legally and illegally, to waters of the state, such as for sport fish enhancement (e.g., Brown and Rainbow trout), or gained access inadvertently to the state via interstate waterways, such as canals (e.g., Gizzard Shad). Lake Champlain has the most diverse fish community of any Vermont water with about 71 species documented to exist there.

Vermonters are probably aware of the existence of about one-third of the fish species occurring in the state. Our familiarity with most of these fishes is rooted in sport fishing; that is, their recognized value as game fish and to a lesser degree their use as bait fish. As for the remaining two-thirds of Vermont species, many exist here largely out-of-sight of the public and others are viewed with ambivalence. Nonetheless, the diversity of Vermont's ichthyofauna contributes significantly to the functional ecological complexity of our aquatic systems. Many species are excellent indicators of the health of our environment, such as their sensitivity to toxic chemicals (e.g., mercury and PCBs) and habitat change. Additionally, sport fisheries, utilized and valued by the public, are dependent directly and indirectly on healthy communities and ecosystems.

Native fishes face many conservation challenges. The threats of habitat alteration, loss and fragmentation are pervasive in Vermont's rapidly changing landscape. The introduction of non-indigenous fishes, including associated aquatic pathogens and parasites, also pose risks to aquatic ecosystem health and native species conservation. Just within the past 20 years, seven non-native fishes have shown up in state and interstate waters. Whirling disease, caused by the parasite *Myxobolus cerebralis*, first appeared in native Brook Trout inhabiting Vermont sections of the Batten Kill as recently as 2002. Two viral diseases have also recently appeared in Vermont waters. Largemouth Bass virus was first detected in Lake Champlain in 2002 and a year later in Lake St. Catherine; and esocid lymphosarcoma infecting Lake Champlain Northern Pike in 2002 (http://www.vtfishandwildlife.com/about_us/fish_division/fish_management/fish_health_program/). Viral hemorrhagic septicemia (VHS), which was first documented in 2005 infecting fishes in Lake Ontario has spread rapidly to the other Great Lakes and nearby inland waters and has been responsible for large and small-scale fish mortalities. Of 37 species of fish known to be susceptible to the VHS virus, 26 are found in the Great Lakes and 24 in Vermont. Unregulated or illegal transportation of fishes from out-of-state sources and between in-state waters is likely cause for the increasing incidences of disease-causing organisms appearing in fish populations in Vermont and other states. To date VHS infections have not been identified in Vermont fish populations; nonetheless, the Vermont Fish & Wildlife Department has taken proactive action to reduce the risks that the virus will find its way here, such as adopting more stringent bait fish and fish transportation regulations.

Implementing the 2005 Wildlife Action Plan

Since adoption of the 2005 Wildlife Action Plan, State Wildlife Grant funds have been used to increase our understanding and conservation of fish SGCN in the state. Some of the projects conducted under the 2005 Wildlife Action Plan include:

- Assessment of Lake Sturgeon in Large Vermont Tributaries to Lake Champlain;
- Development of Metrics to Assess the Quality of Riverine Habitat for Coldwater Fish Based on Stream Temperature;
- Aquatic Invasive Species – Hazard Analysis & Critical Control Point Training for Commercial Baitfish Dealers;
- Development of Guidelines for the Design of Stream Road Crossings for Passage of Aquatic Organisms in Vermont and the Vermont Culvert Aquatic Organism Passage Screening Tool;
- Aquatic Organism Passage at Stream & Road Crossings and Aquatic Organism Passage Barrier Assessments;
- Muskellunge Management & Conservation Planning in the Vermont Lake Champlain Basin;
- Development of In-House Capability to Detect Fish Disease Organisms by Polymerase Chain Reaction;
- Survey Design and Standard Operating Procedures for Forage Fish Assessment in Lake Champlain;
- Landlocked Atlantic Salmon Fry Stocking Evaluation;
- Development of Triploid Brook Trout Production Capability;
- Genetics of Lake Trout Populations in Northeastern Vermont Lakes
- Survey & Inventory of Round Whitefish Populations in Northeastern Vermont Lakes
- Survey of Fishes in the Large Lake Champlain Tributaries in Vermont
- Lacustrine Shoreline Planning
- Anadromous Atlantic Salmon Genetics
- Assessment of Stonecat Populations in the LaPlatte and Missisquoi Rivers of Vermont

- Genetic Examination of Lake Whitefish Population Sub-Structuring in Lake Champlain
- Development and Implementation of Disease Spread Prevention Systems to Minimize the Inadvertent Spread of Fish Diseases from Fisheries Management Activities, including the Rearing and Stocking of Cultured Fish, to Waters Supporting Fish SGCN.

Fish SGCN Selection

Selection criteria included 27 categories reflecting our knowledge about current listing as endangered and threatened; species rarity; population declines; vulnerability of habitats; life history traits; vulnerability to collection, harvest or other taking; other impacts from humans; and dispersal capability. Only native species were considered. Each species was examined across all criteria by the team. Based on this evaluation process the team assigned a high, medium and low rank to attempt to separate species with greater conservation needs from those with more secure status, at least in the short term. See Chapter 8 for details on selection criteria and process. This approach resulted in 27 species making either the rank of high conservation need or medium conservation need (table 5.4). Five species listed as SGCN in 2005 were removed from the list (Arctic Char, Atlantic Salmon-Anadromous, Brassy Minnow, Muskellunge and Quillback). One species, Northern Pearl Dace, has been added; and American Eel is now listed as two populations (Lake Champlain and Connecticut River) because their conservation needs differ.

Arctic Char has been removed as a SGCN after careful consideration of its status (extirpated) in the state and questions regarding if it was ever endemic to Vermont. Despite historical accounts of Arctic Char in Great and Little Averill ponds, the record is fraught with uncertainty. A specimen was collected in 1899 from Little Averill Pond and remains archived at the Smithsonian Institute (USNM 00061723). Unfortunately, the current condition of this fish defies taxonomic confirmation to species. Additionally, there is a morphological variant of Lake Trout, sometimes referred to as 'lunge', that remains to this day in Maidstone Lake in Essex County, and which bears external similarity to Arctic Char and possibly may have been misidentified to the latter species.

Atlantic Salmon, previously separated into anadromous (sea-run) and landlocked (freshwater resident) forms, have now been merged into a single category, Atlantic Salmon (naturally reproducing populations-Lake Champlain and Memphremagog basins). This was done for several reasons. First, anadromous Atlantic Salmon restoration in the Connecticut River was essentially terminated in 2012, when the U. S. Fish & Wildlife Service decided to withdraw from the program based on protracted years of poor adult returns to the river and the decision not to continue producing salmon fry at the White River National Fish Hatchery extensively damaged during the 2011 Tropical Storm Irene flood. State fishery agencies relied upon this fry production to stock salmon throughout much of the Connecticut River Basin distributed among the four cooperating states: Connecticut, Massachusetts, New Hampshire and Vermont. Second, there is conflicting accounts about the endemicity of landlocked salmon populations occurring in the state prior to European settlement. In contrast, there are historical accounts that anadromous salmon populations may have likely occurred in Lake Champlain and possibly had access to Lake Memphremagog. Lastly, all existing landlocked salmon populations in Vermont are introduced stocks exclusively or heavily dependent upon stocking hatchery-reared fish. A possible exception is Lake Champlain which historically may have supported a landlocked salmon population in addition to a sea-run one.

Brassy Minnow has been dropped as a SGCN on the basis that the species is reported to be currently of relatively low conservation concern and does not require significant additional protection or major management, monitoring, or research action. No major threats are known.

In 2008 the Vermont Fish and Wildlife Department decided to stock fingerling Muskellunge into the Missisquoi River to restore fishing opportunities for this important sport fish which has continued nearly every year since. About seven miles of the river between Swanton and Highgate Falls dams held the last known native population of the species in Vermont until sometime in the mid to late 1970s, when it appeared to become extirpated. Since the mid 1960s New York Department of Environmental Conservation has been stocking the Ohio River subspecies (Chautauqua line) Muskellunge into the Great Chazy River, a northern Lake Champlain tributary. Angler catches of Muskellunge on the Vermont side of the lake have been genetically tested and determined to be Chautauqua fish indicating straying is occurring. No fish of the St. Lawrence River subspecies to which the native Vermont population was related have yet to be identified among the fish genetically tested. The Department considered the possibility of maintaining a St. Lawrence line in its own hatchery system for species restoration purposes; however, it was decided this would be a too costly an option and hence juvenile fish are acquired from New York for stocking into the Missisquoi River and its delta for the purposes of developing a Muskellunge sport fishery. Development and management of a Muskellunge fishery qualifies for funding through license fees and the Federal Sport Fish Restoration Act.

Quillback has been dropped as a SGCN on the basis that the species is currently of relatively low conservation concern and does not require significant additional protection or major management, monitoring, or research action. No major threats are known.

Since the 2005 WAP American Eel in Vermont has been split into two populations: one having access to Lake Champlain via the St. Lawrence and Richelieu rivers and the other occupying the Connecticut River watershed. The reason for the separation is that different management strategies are being employed in each of the basins and commensurate population responses to these actions. Increases in Lake Champlain eel sightings in recent years are likely the result of management actions implemented by Canadian fishery agencies, such as closure of the Richelieu River commercial eel fishery in 1998, provision for eel passage on the Richelieu River at Chambly Dam in 1997 and St. Ours Dam in 2001, and experimental glass eel stocking in the Richelieu River (2.8 million eels) in 2005 to 2008. Eel management in the Connecticut River currently has focused American eel on construction of eelpasses (for enabling upstream juvenile eel movement around dams) and enumeration of immigrating eels.

Northern Pearl Dace (*Margariscus nachtriebi*) was formerly identified as a subspecies of the nominate Pearl Dace (*M. margarita*) but more recently is recognized as a distinct species by the American Fisheries Society (Page et al. 2013). The nominate species, now named Allegheny Pearl Dace, is relatively common to several watersheds located in southwestern Vermont. Northern Pearl Dace populations in Vermont are currently known from only two locations (upper Rock and Pike river drainages) near the Quebec border in the town of Franklin. Both rivers drain to Missisquoi Bay in Lake Champlain. More extensive fish community surveys are needed in northwestern part of the state to get a more complete understanding of its distribution, habitat use, and population threats.

Table 5.4. Fish Species of Greatest Conservation Need

High Priority	Medium Priority
Northern Brook Lamprey (*Ichthyomyzon fossor*) [1]	Sea lamprey (CT River) (*Petromyzon marinus*)
Silver Lamprey (*Ichthyomyzon unicuspis*) [1]	Blueback Herring (CT River) (*Alosa aestivalis*) [1]
American Brook Lamprey (*Lethenteron appendix*) [1]	Atlantic Salmon (naturally reproducing populations-Lake Champlain & Memphremagog basins) (*Salmo salar*) [1]
Lake Sturgeon (*Acipenser fulvescens*) [1]	Mottled Sculpin (*Cottus bairdi*)
Round Whitefish (*Prosopium cylindraceum*) [1]	American Eel (*Lake Champlain pop*) (Anguilla rostrata)[1]
Bridle Shiner (*Notropis bifrenatus*) [1]	American Eel (*CT River population*) (Anguilla rostrata)[1]
Blackchin Shiner (*Notropis heterodon*)	American Shad (*Alosa sapidissima*) [1]
Blacknose Shiner (*Notropis heterolepis*)	Mooneye (*Hiodon tergisus*) [1]
Greater Redhorse (*Moxostoma valenciennesi*)	Cisco or Lake Herring (*Coregonus artedi*)
Stonecat (*Noturus flavus*) [1]	Lake Whitefish (*Coregonus clupeaformis*) [1]
Eastern Sand Darter (*Ammocrypta pellucida*) [1]	Brook Trout (naturally reproducing populations) (*Salvelinus fontinalis*) [1]
Channel Darter (*Percina copelandi*) [1]	Lake Trout (naturally reproducing populations) (*Salvelinus namaycush*) [1]
Sauger (*Sander canadense*)[1]	Redfin Pickerel (*Esox americanus*)
	Northern Pearl Dace (*Margariscus nachtriebi*)
	Silver Redhorse (*Moxostoma anisurum*)
	Shorthead Redhorse (*Moxostoma macrolepidotum*)
	Redbreast Sunfish (*Lepomis auritus*) [1]

[1] Regional Species of Greatest Conservation Need in the Northeastern United States (Terwilliger, 2013)

Species of Greatest Conservation Need status for Blueback Herring is limited to the population residing in the Connecticut River. Similarly, Atlantic Salmon, Lake Trout, Brook Trout and Sea Lamprey are defined with limitations. Two populations of American eel—Connecticut River and Lake Champlain—are recognized individually as the conservation needs of these two runs differ significantly.

Although a disproportionate number of Vermont's SGCN are at the periphery of their range, this should not diminish the importance of these species to the state's biodiversity or in terms of their ecological significance. To illustrate this, of the 80 native Vermont fish species, nearly half of these are here on the eastern edge of each of the species' natural North American range.

Reports on each Fish Species of Greatest Conservation Need are in Appendix A3 of this document. The following is a summary of those reports.

Habitat Needs

Vermont's fish species use a variety of habitats: small ponds, large lakes, rivers, streams, and wetlands. Some habitats are used year-round and others are occupied seasonally, such as for spawning. Within water bodies, SGCN have specific habitat needs for example, riffles or pools in streams or deep, cold areas of lakes. Loss or degradation of any one critical habitat component can threaten the survival of the species in that particular water.

While most of our fishes are completely freshwater dependent, others spend portions of their lives in both freshwater and marine environments. Three SGCN (American Eel, Blueback Herring, and

American Shad. are dependent on both. Herring and shad have anadromous life cycles, that is spawning and at least a portion of the juvenile life occurs in freshwater; to attain maturity the fish must go to sea for a period of years. In contrast, eel is catadromous. Maturity is attained in freshwater and reproduction occurs in the ocean. Consequently, whether anadromous or catadromous, these species not only face problems at the Vermont landscape level, but also those at the regional and international scopes. To conserve our native fishes, and particularly SGCN, it is essential that we protect, enhance and restore habitat not only within Vermont but also, where appropriate, beyond our borders.

Discussion of Threats Impacting Fish SGCN

Factors affecting the security of SGCN are classified as either habitat or non-habitat problems. The most frequently identified habitat related problems impacting aquatic systems are habitat alteration, habitat fragmentation, habitat conversion, invasive non-indigenous species, and climate change. Habitat alteration includes activities, which diminish the quality and/or quantity of habitat features critical to the survival and maintenance of fish populations and other biota on which SGCN are dependent, including stream flows and lake water levels, water temperature regimes, and habitat diversity. Sedimentation is a form of habitat alteration by which the composition of the stream or lake bottoms are altered by greater than normal deposition of fine materials (e.g., silt, sand, organic matter) changing the composition and suitability of substrates to the detriment of their spawning, cover and food production values. Habitat conversion results in the total or near complete loss of function because of extreme habitat alteration. Examples of habitat conversion are loss of active floodplains, wetland draining and stream impoundments. Habitat fragmentation occurs when artificial structures, such as dams, impassable bridge structures, and dewatered stream channels, interfere with the movements of fish preventing their access to critical spawning areas or seasonal refugia. Habitat fragmentation also interferes with the natural dispersal of fish and genetic flow within and between populations. Climate change threatens several SGCN at the regional scale by altering (warming) their required thermal regimes. Invasive species, such as nonnative aquatic plants and zebra mussels, can impact aquatic habitats in a variety of ways. Exotic plants represent a "double edged sword" with respect to the conservation of certain fish species requiring abundant aquatic vegetation. Invasive plant species, such as Eurasian milfoil, may displace native plant communities on which fish are dependent for refugia, food production, and spawning. And, on the other hand, invasive vegetation control programs may eliminate these functions before native plants are restored to desired levels.

While virtually all fishes identified as SGCN are impacted by one or more problems to their habitats, non-habitat related problems are generally more variable from species to species. In some cases, non-habitat problems are a consequence of impacts on habitat. Those affecting SGCN include competition from other species, predation, loss of prey base, water pollution, disease and parasites, and over-harvest. The Sea Lamprey problem in Lake Champlain poses a challenging dilemma. Sea Lamprey has been identified as a known or potential parasite/predator on several SGCN. On the other hand, other SGCN may be threatened by certain control methods needed to control Sea Lamprey abundance and parasitism rates in the lake. Further research and monitoring is required to ensure that successful control measures minimize harm to SGCN.

Research & Monitoring Needs and Conservation Strategies

Priority research and monitoring projects and needs to improve our ability to conserve Vermont's fish SGCN are identified. Conservation strategies to address problems impacting each SGCN were developed. Those cited most frequently and those most effectively applied for multiple fish SGCN include:

Research & Monitoring Needs

1. Better determine the distribution and relative abundance of populations in Vermont.
2. Acquire better information on species' life histories, biology and habitat requirements.
3. Monitor and assess populations and habitats for current condition and future changes.
4. Identify and monitor problems for species and their habitats.
5. Establish a centralized fish database within the Agency of Natural Resources to manage fish and other aquatic data, track permits and management projects that impact aquatic species.

Conservation Strategies

6. Protect and restore aquatic, floodplain and riparian habitats through improved water quality; flow, water level and temperature regimes; sediment reduction; establishment of streamside buffers; floodplain restoration; and suitable aquatic habitat structure, diversity and complexity.
7. Maintain and restore aquatic organism passage and habitat connectivity at barriers (e.g., dams, culverts) to provide access to important habitats and maintain ecological connectivity.
8. Protect riparian and floodplain habitats through acquisition, easements, incentives, technical assistance and education.
9. Participate in existing regulatory processes (e.g., Act 250, stream alteration permits) to protect and restore important habitats.
10. Implement measures and programs to prevent the introduction and expansion of non-indigenous species to Vermont waters; develop and execute appropriate invasive species control programs.
11. Assess, monitor and manage as appropriate potential negative and beneficial effects of the Lake Champlain Sea Lamprey control program on SGCN and other non-target fishes.
12. Support and cooperate with inter-agency programs for the restoration of anadromous and catadromous fishes to the Connecticut River basin.
13. Update Vermont's baitfish rules as necessary and expand to include non-fish invasive bait species.
14. Support efforts to curb global climate change and its negative impacts on SGCN.
15. Support state and regional efforts to require reduction in emissions from coal burning power plants and other sources of acid precipitation.

Conclusion

Over the past decade, since implementation of the 2005 Vermont Wildlife Action Plan, meaningful progress has been made on several fronts to increase our understanding of SGCN and undertake efforts to enhance their conservation in the state. Adult Lake Sturgeon have been documented ascending the Missisquoi, Lamoille and Winooski rivers to spawn and reproduction has been confirmed in these rivers (MacKenzie 2015). A sturgeon restoration plan is now under development.

Technical guidance was developed for the identification of stream crossing structures (e.g., culverts, bridges) where aquatic organism passage problems occur and to assist with the design of passable road-stream crossings. Even though structural improvements emphasize fish passage, other SGCN taxa are also beneficiaries, including numerous amphibian, reptile, mammal and invertebrate species.

Recent surveys of four northeastern Vermont lakes, where there had been historic occurrences of Round Whitefish populations, now appear to be limited to a single population in Lake Willoughby. With this knowledge, actions to conserve this population from potential threats are a critical need and deserve appropriate measures moving forward to secure the species presence in the state.

Other Fish SGCN that are currently receiving attention are Stonecat and Lake Whitefish. Additionally, the ANR continues to adopt and implement programs to minimize the introduction of invasive fish species and diseases to our native fish fauna. Since adoption of the 2005 Wildlife Action Plan four rules have been adopted into statue: (1) a list of prohibited, restricted and unrestricted fish species that may be imported and/or possessed in Vermont; (2) restrictions on the commercial harvest and sale of baitfish, as well as the personal harvest, use and movement of baitfish to minimize the risk of transporting aquatic invasive species, unwanted fish species, and fish diseases and pathogens; (3) a prohibition on the transport of fish in a manner which attempts to keep them alive and represents a risk of introducing unwanted organisms to new waters; and (4) procedures for a Rapid Response General Permit authorizing the ANR to quickly respond to and control an invasive nonnative species. These accomplishments establish a good base from which future conservation initiatives will emerge and continued progress will be made on those already on the ground.

Lastly, climate change represents an emerging threat to several fish species indigenous to the Vermont as well as to the integrity and function of aquatic communities and systems. This will require considerable commitments of agency and stakeholder resources to stem the threats that this global problem poses to our fauna and the ecological and economic values and uses that are so important to the citizens of Vermont.

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Conserving Vermont’s Invertebrates

Invertebrate Team

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Team Charge

The Invertebrate Team was charged with identifying Species of Greatest Conservation Need (SGCN); describing the distribution and habitat usage for each SGCN; evaluating problems impacting SGCN and their habitat; identifying priority research needs to improve our ability to conserve these species; and, developing conservation strategies to address priority problems.

Introduction

The role of invertebrates in our world is mostly unrecognized by humans. But once we get beyond the buzz of mosquitoes and our annoyance with blackflies, our reliance upon these tiny animals slowly unfolds. Within cool forest streams, stonefly and mayfly nymphs consume leaves that fall from forest trees and provide a food source for Brook Trout and other fishes. In the gardener’s corner, bees, flies, wasps, and butterflies pollinate the flowers that will later yield the anticipated fruits and vegetables. Spiders wait to ambush flies in our homes. Dragonflies patrol the stream shores for their insect prey. Beetles, flies, and other invertebrates consume the wastes produced by the human world, leaving fertile soil in exchange. Mostly unnoticed and even avoided, these smallest of creatures provide an amazing array of functions that we depend upon in our everyday life. The diversity of species we are so fortunate to have is, itself, something to marvel.

Of the thousands of species that occur in Vermont, several are rare or threatened enough to be at risk of disappearing from the state in the future. The causes that lead to their predicament vary among species. One of the greatest obstacles to acting to help conserve these “at risk” invertebrates has been the scarcity of information that exists on their distribution, abundance, habitat requirements, life history characteristics, population trends, and threats. It is necessary to assess the status and needs of each species to adequately conserve populations and track the success of these actions. The invertebrate conservation outlined in our first Wildlife Action Plan (2005) therefore focused on obtaining this baseline information.

In the past decade, however, great strides were made in augmenting our knowledge of hundreds of species including bumble bees, butterflies, giant silkmoths, odonates (dragonflies and damselflies), carabid beetles and mussels. While this covers only a fraction of the more than 21,400 invertebrate species believed to be in Vermont, it’s a significant advancement for invertebrate conservation. The 2015 Wildlife Action Plan includes specific conservation actions for several species and species groups that were not possible just a decade ago.

Pollinators: While the 2005 Wildlife Action Plan included 33 species of butterflies and moths, many of them pollinators, their role as pollinators was not critical to their selection as SGCN. Since 2005, concerns over the status of pollinators in general (e.g. flies, wasps, moths, butterflies, beetles, bees, and hummingbirds), and native bees in particular, has become a worldwide concern. Pollination is defined as a mutually beneficial relationship between plants and pollinators wherein the plant provides pollen and/or nectar to the pollinator and the pollinator provides reproductive services for the plant (National Research Council, 2007). Roughly 75 percent of the 240,000 species of flowering plants world-wide rely on pollinators for flower reproduction (NRC, 2007). This includes many plant species that provide browse or forage for larger wildlife, as well as seeds and fruits to support birds and small mammals. These invertebrates also pollinate many commercial crops. In Vermont this includes blueberries, tomatoes, squash, apples, and other produce. The many drivers of pollinator declines include habitat loss and degradation, intensive agricultural practices, use of certain pesticides, diseases and pathogens (Heinz Center, 2013). For this second Wildlife Action Plan nine bumble bee species and 31 species of butterflies and moths—including the Monarch Butterfly—were selected as Species of Greatest Conservation Need.

Implementing the 2005 Wildlife Action Plan

Since the adoption of Vermont's first Wildlife Action Plan in 2005 several significant advances were made in the realm of invertebrate research and conservation, including the following—most of which were funded at least in part by the State Wildlife Grants program:

Vermont Butterfly Survey: The Vermont Butterfly Survey (2002-2007) surveyed the entire state and analyzed historic records and collections to document the distribution of 103 butterfly species, including 12 species new to Vermont, and giant silkworm moths (Saturnids) too. The project was a collaboration between VFWD, the Vermont Center for Ecostudies, and the Vermont Institute of Natural Sciences with more than 125 citizen scientists participating. Assessing the conservation status of each species and establishing a baseline for understanding future changes was the principle goal of the Atlas. Fifteen species were listed as Species of Greatest Conservation Need representing three ecological groups—wetlands, grasslands, and hardwood forests. The vulnerability to climate change was calculated for 14 butterfly SGCN currently found in Vermont. Three species were found to be extremely vulnerable to climate change, five were highly vulnerable, one moderately vulnerable, three presumed stable, and two could likely increase in numbers in Vermont (Table 5.5). We expect to see the Butterfly Survey repeated in ~2027 as a comparison to this baseline.

Peatland and Large River Dragonfly and Damselfly Survey: The first statewide assessment of odonate populations in Vermont, focused on peatlands and large river habitat, was completed in 2009 and provides vital species distribution and occurrence information which has broadened our understanding of rare habitat-specialist dragonfly and damselfly SGCN. Habitat data collected as part of the study provides a comparative baseline for future population trend monitoring. Among the investigation's results were: new encounters with *Gomphus abbreviatus* (S1S2) on two rivers and a moderate gain in the knowledge of *Ophiogomphus* spp. (four species), particularly on the White River; discovery of at least two previously unknown populations of *Neurocordulia yamaskinensis* (S3), a species that had been rarely encountered in Vermont; an expanded knowledge of *Somatochlora* spp. (seven species) distribution in and around peatlands, including *S. albicincta* (S1), *S. cingulata* (S1S2) and *S. franklini* (S1S2), revealing that Silvio Conte National Wildlife Refuge and West Mountain Wildlife Management Area have some of the highest *Somatochlora* diversity in New England; and two new peatland sites for *Williamsonia fletcheri* (S1S2). Future efforts toward odonate SGCN conservation will continue to rely on the information resulting from this and future field studies. For more information see the Vermont Damselfly and Dragonfly Atlas.

Table 5.5. Results of a climate change vulnerability assessment of butterfly SGCN in Vermont (from McFarland, and Zahendra. 2010).

Common Name	Climate Change Vulnerability Index	Confidence	GRank	SRank
West Virginia White	Extremely Vulnerable	Very High	G4	S3S4
Bog Copper	Extremely Vulnerable	Very High	G4	S2
Edwards' Hairstreak	Extremely Vulnerable	Very High	G4	SU
Early Hairstreak	Highly Vulnerable	Very High	G4	S2S3
Hackberry Emperor	Increase Likely	Very High	G5	S2
Tawny Emperor	Increase Likely	Very High	G5	S2
Jutta Arctic	Moderately Vulnerable	Very High	G5	S1
Cobweb Skipper	Presumed Stable	Low	G4	S1
Mulberry Wing	Highly Vulnerable	Very High	G4	S2
Broad-winged Skipper	Presumed Stable	Very High	G5	S2
Black Dash	Highly Vulnerable	Very High	G4	S1S2
Dion Skipper	Highly Vulnerable	Very High	G4	S2
Two-spotted Skipper	Highly Vulnerable	Very High	G4	S2
Dusted Skipper	Presumed Stable	Very High	G4	S1

Vermont Bumble Bee Survey: Growing concerns about the decline of pollinators nationwide and locally prompted this survey. From 2012-2013 biologists and trained citizen scientists led by the Vermont Center for Ecostudies searched more than 1,500 locations across the state and recorded more than 10,000 individual bumble bee encounters. Survey data was then compared with historic data gleaned from public and private collection. The results provided sobering news about the status of Vermont's 15 bumble bee species: more than one-quarter of these species have either vanished or are in serious decline. Harmful parasites accidentally imported from Europe and a class of pesticides toxic to bees are believed to account for North American bumble bee declines (Hatfield et. al. 2012).

Endangered Species Protection for Three Bumble Bee Species: Based on the results of the bumble bee survey, three species—the Rusty-patched Bumble Bee, Yellow-banded Bumble Bee, and Ashton Cuckoo Bumble Bee—were given protection under Vermont's Endangered Species law in 2015. The Rusty-patched Bumble Bee, for example, was common in Vermont until the 1990s. But not a single specimen was found during the 2012-2013 statewide survey. Vermont's bumble bee species appear to be in decline due to parasites imported from Europe and possibly the widespread use of a group of systemic insecticides referred to as 'neonicotinoids' (Hatfield et. al. 2012).

Freshwater Mussel Surveys: Freshwater mussels are recognized as the most endangered group of aquatic organisms in North America, with over two thirds of species considered extinct, endangered, or in need of special protection. In Vermont, 10 of the native eighteen species, or 55%, are listed under the state endangered species law, and several others are considered rare. One species, the dwarf wedgemussel, is federally endangered. Over the past decade surveys were conducted to determine the status of Vermont's freshwater mussel populations to determine habitat needs, fish hosts and to establish appropriate species population goals and conservation strategies with a focus on the Brook Floater (*Alasmidonta varicosa*), Fluted-shell (*Lasmigona costata*), and Creek Heelsplitter (*L. compressa*)—all SGCN.

Tiger Beetle Surveys: Two state-threatened tiger beetle species, the Cobblestone Tiger Beetle and the Hairy-necked Tiger Beetle were the focus of dedicated surveys from 2005-2010 in Vermont. Data gathered in this study was combined with existing information to help inform the drafting of recovery plans for each species. More information can be found at the Vermont Tiger Beetle Atlas.

Development of the Vermont Invertebrate Database: The paucity of basic information such as species presence, geographic distribution, habitat associations, and life history has limited our ability to direct conservation actions for most groups of invertebrates. However, a substantial amount of information exists that could be gleaned from past invertebrate collecting and research in Vermont, although it is scattered among various collections, government offices, research facilities, published works, gray literature, and other sources. In 2006 the Vermont Invertebrate Database project began the task of compiling and organizing information into a format that can easily be accessed so that it could provide a baseline from existing sources for a broad spectrum of invertebrate taxa for future invertebrate conservation and research planning efforts. This ongoing project is accessible to biologists, researchers, conservationists, land-use planners, educators, and other interested parties.

Compilation and Publication of the Ross Bell Carabid Beetle Collection: For more than six decades, Dr. Ross Bell of UVM and dean of Vermont's Entomologists collected carabid beetles in Vermont and across the world. It took a concerted effort by many of the entomologists that followed in his footsteps to catalog and map the thousands of beetles he collected over the years. Carabidae of Vermont and New Hampshire (Bell 2015) was released in 2015.

Restoration of the Carl Parsons Insect Collection: UVM's Zoological Museum includes more than half a million pinned and identified insects emphasizing Vermont species. This wealth of data covering invertebrate diversity over the past two hundred years had fallen into disrepair from neglect and lack of funding. A renewed interest in conserving this collection, led by the Vermont Center for Ecostudies (VCE), over the past decade has led to its near complete restoration.

Selecting Invertebrate SGCN

The task of assessing the conservation needs of Vermont's invertebrates is daunting. The number of species that occur within the state is not known; however, current estimates hover around 21,000 different species. In addition, many of our invertebrates have not yet been scientifically described. Life history, distribution, and abundance information is available for a small minority of Vermont's invertebrates that would be considered as conservation targets, such as freshwater mussels and some tiger beetles. Thus, the Invertebrate Team had to determine how best to assess conservation needs with limited information to draw upon. State and regional experts, as well as entomological hobbyists, have compiled a valuable knowledge base for selected groups of invertebrates over the last century. Although distributional information is often limited, an understanding of the natural history of many of these species enabled the team to move forward. It was the team's decision that identification of SGCN would focus on species and species groups for which adequate information was available.

SGCN selection criteria included: current listing as endangered and threatened; population declines; rarity; vulnerability of habitat; life history traits; vulnerability to collection or take; population limitations; regional status; historic occurrence; disjunct populations; habitat specialization; impacts by exotics; and dispersal capability. A review using these criteria resulted in a SGCN list of 198 species. 139 of these species are ranked High Priority SGCN and 59 are ranked Medium Priority.

These species were organized into 15 taxonomic groups to aid in the development of conservation reports (table 5.6).

Table 5.6. Invertebrate Groups, Vermont Wildlife Action Plan 2015

Group	# Species/ Group
Ant Group	2
Bumble Bee Group	9
Beetles-Carabid Group	67
Beetles-Tiger Beetle Group	7
Butterflies-Grassland Group	4
Butterflies-Hardwood Forest Group	4
Butterflies-Wetland Group	6
Moths Group	17
Mayflies/Stoneflies/Caddisflies Group	14
Odonates-Bog/Fen/Swamp/Marshy Pond Group	15
Odonates-Lakes/Ponds Group	7
Odonates-River/Stream Group	15
Crustaceans Group	3
Freshwater Mussels Group	13
Freshwater Snails Group	15
Total	**198**

The list of species within each of these groups can be found in table 5.7.

Table 5.7. Invertebrate Species of Greatest Conservation Need

MP=Medium Priority SGCN; HP=High Priority SGCN.
[1]Regional Species of Greatest Conservation Need in the Northeastern United States (Terwilliger, 2013)
[2] Regional responsibility species identified in (White et al. 2014).

Ant Group (2)

An ant (*Myrmica lobifrons)* MP
A Slave-making Ant (*Temnothorax pilagens)* HP

Bumble Bee Group (9)

Rusty-patched Bumble Bee (*Bombus affinis)* HP
Ashton Cuckoo Bumble Bee (*Bombus ashtoni)* HP
Lemon Cuckoo Bumble Bee (*Bombus citrinus)* HP
Fernald's Cuckoo Bumble Bee (*Bombus fernaldae)* HP
Yellow Bumble Bee (*Bombus fervidus)* HP
American Bumble Bee (*Bombus pensylvanicus)* HP
Confusing Bumble Bee (*Bombus perplexus)* HP
Red-belted Bumble Bee (*Bombus rufocinctus)* MP
Yellow-banded Bumble Bee (*Bombus terricola)* HP

Beetles-Tiger Beetle Group (7)

Boulder-beach Tiger Beetle (*Cicindela ancocisconensis)* [1] HP
Hairy-necked Tiger Beetle (*Cicindela hirticollis hirticollis)* HP
Boreal Long-lipped Tiger Beetle (*Cicindela longilabris)* HP
Cobblestone Tiger Beetle (*Cicindela marginipennis)* [1] HP
Northern Barrens Tiger Beetle (*Cicindela patruela)* [1] HP
Puritan Tiger Beetle (*Cicindela puritana)* [1] HP
Eastern Red-bellied Tiger Beetle (*Cicindela rufiventris)* HP

Butterflies-Grassland Group (4)

Dusted Skipper (*Atrytonopsis hianna)* MP
Cobweb Skipper (*Hesperia metea)* MP
Monarch (*Danaus plexippus)* HP
Regal Fritillary (*Speyeria idalia)* MP

Butterflies-Hardwood Forest Group (4)

Early Hairstreak (*Erora laeta)* HP
Hackberry Emperor (*Asterocampa celtis)* MP
Tawny Emperor (*Asterocampa clyton)* MP
West Virginia White (*Pieris virginiensis)* HP

Butterflies-Wetland Group (6)

Two-spotted Skipper (*Euphyes bimacula)* HP
Black Dash (*Euphyes conspicua)* HP
Dion Skipper (*Euphyes dion)* MP
Mulberry Wing (*Poanes massasoit)* HP
Bog Copper (*Lycaena epixanthe)* HP
Jutta Arctic (*Oeneis jutta)* HP

Ground Beetles-Carabid Group (67)

Agonum crenistriatum HP
Agonum darlingtoni HP
Agonum moerens MP
Agonum picicornoides HP
Agonum punctiforme MP
Agonum superioris MP
Amara erraticus HP
Amara laevipennis MP
Apristus latens HP
Atranus pubescens MP
Bembidion affine MP
Bembidion cordatum MP
Bembidion grapii HP
Bembidion mutatum HP
Bembidion quadratulum HP
Bembidion robusticolle MP
Bembidion rolandi MP
Bembidion rufotinctum HP
Blethisa hudsonica MP
Blethisa julii HP
Blethisa quadricollis HP
Carabus goryi MP
Carabus maeander MP
Dicaelus dilatatus dilatatus HP
Dicaelus teter HP
Dicheirotrichus cognatus HP
Diplocheila impressicollis MP
Diplocheila striatopunctata HP
Dyschirius brevispinus MP
Dyschirius erythrocerus MP
Dyschirius politus politus HP
Elaphropus dolosus MP
Elaphropus levipes MP
Elaphrus fuliginosus HP
Geopinus incrassatus HP
Harpalus fulvilabris HP
Harpalus indigens MP
Harpalus providens MP
Lophoglossus scrutator HP
Nebria suturalis HP
Notiobia sayi MP
Notiophilus aquaticus MP
Notiophilus borealis HP
Notiophilus nemoralis HP
Notiophilus novemstriatus MP
Olisthopus micans HP
Patrobus foveocollis HP
Pentagonica picticornis MP
Pericompsus ephippiatus MP
Philodes alternans HP
Philodes rectangulus MP
Platynus cincticollis MP
Platypatrobus lacustris MP
Pseudamara arenaria MP
Pterostichus brevicornis brevicornis HP
Pterostichus castor MP
Pterostichus pinguedineus HP
Pterostichus punctatissimus HP
Scaphinotus bilobus MP
Schizogenius ferrugineus MP
Sericoda obsoleta MP
Sericoda quadripunctata MP
Sphaeroderus nitidicollis HP
Tachys oblitus MP
Tachys rhodeanus HP
Tetragonoderus fasciatus MP
Tetraleucus picticornis MP

Moths Group

A Noctuid Moth (*Zale submediana)* HP
Pine Barrens Zanclognatha (*Zanclognatha martha)* HP
Currant Spanworm (*Speranza ribearia)* HP
A Ghost Moth (*Sthenopis thule)* MP
A Noctuid Moth (*Lasionycta taigata)* MP
A Noctuid Moth (*Lemmeria digitalis)* MP
Franclemont's Lithophane (*Lithophane franclemonti)* HP
An Autumnal Noctuid Moth (*Pachypolia atricornis)* HP
Ostrich Fern Borer (*Papaipema sp. 2 nr. Pterisii)* HP
Barrens Moth (*Properigea costa)* MP
A Noctuid Moth (*Xestia fabulosa)* MP
A Noctuid Moth (*Xestia homogena)* HP
Pine Imperial Moth (*Eacles imperialis pini)* HP
New England Buckmoth (*Hemileuca lucina)* MP
Plum Sphinx (*Sphinx drupiferarum)* HP
Clemens' Sphinx (*Sphinx luscitiosa)* HP
A tortricid moth (*Eana georgiella)* MP

Mayflies/Stoneflies/Caddisflies Group (14)

A Caddisfly (*Ceraclea submacula)* HP
A Caddisfly (*Polycentropus glacialis)* HP
A Caddisfly (*Polycentropus iculus)* HP
A Caddisfly (*Rhyacophila amicis)* HP
A Caddisfly (*Rhyacophila brunnea)* HP
A Mayfly (*Ameletus browni)* HP
A Mayfly (*Baetisca rubescens)* HP
A Mayfly (*Eurylophella bicoloroides)* HP
Roaring Brook Mayfly (*Epeorus frisoni)* HP
Tomah Mayfly (*Siphlonisca aerodromia)* HP
A Mayfly (*Siphlonurus demaryi)* HP
Lawrence Sallfly (*Alloperla voinae)* HP
Appalachian Stonefly (*Hansonoperla appalachia)* HP
Spiny Salmonfly (*Pteronarcys comstocki)* HP

Odonates-Bog/Fen/Swamp/Marshy Pond Group (15)

Mottled Darner (*Aeshna clepsydra)* HP
Zigzag Darner (*Aeshna sitchensis)* [2] HP
Subarctic Darner (*Aeshna subarctica)* [2] HP
Comet Darner (*Anax longipes)* HP
Swamp Darner (*Epiaeschna heros)* HP
Cyrano Darner (*Nasiaeschna pentacantha)* HP
Spatterdock Darner (*Rhionaeschna mutata)* HP
Subarctic Bluet (*Coenagrion interrogatum)* HP
Petite Emerald (*Dorocordulia lepida)* HP
Ski-tailed Emerald (*Somatochlora elongata)* [2] HP
Forcipate Emerald (*Somatochlora forcipata)* [2] HP
Delicate Emerald (*Somatochlora franklini)* [2] HP
Kennedy's Emerald (*Somatochlora kennedyi)* [2] HP
Ebony Boghaunter (*Williamsonia fletcheri)* HP
Black Meadowhawk (*Sympetrum danae)* [2] HP

Odonates-Lakes/Ponds Group

New England Bluet (*Enallagma laterale)* [2] HP
Slender Bluet (*Enallagma traviatum)* HP
Lilypad Forktail (*Ischnura kellicotti)* HP
Ringed Emerald (*Somatochlora albicincta)* [2] HP
Lake Emerald (*Somatochlora cingulata)* HP
Banded Pennant (*Celithemis fasciata)* [2] HP
Carolina Saddlebags (*Tramea carolina)* HP

Odonates-River/Stream Group (15)

American Rubyspot (*Hetaerina americana)* HP
Blue-fronted Dancer (*Argia apicalis)* HP
River Bluet (*Enallagma anna)* [2] HP
Rainbow Bluet (*Enallagma antennatum)* [2] HP
Big Bluet (*Enallagma durum)* HP
Stygian Shadowdragon (*Neurocordulia yamaskanensis)* HP
Spine-crowned Clubtail (*Gomphus abbreviatus)* HP
Midland Clubtail (*Gomphus fraternus)* HP
Rapids Clubtail (*Gomphus quadricolor)* HP
Cobra Clubtail (*Gomphus vastus)* HP
Skillet Clubtail (*Gomphus ventricosus)* [2] HP
Maine Snaketail (*Ophiogomphus mainensis)* HP
Rusty Snaketail (*Ophiogomphus rupinsulensis)* HP
Riverine Clubtail (*Stylurus amnicola)* [2] HP
Zebra Clubtail (*Stylurus scudderi)* HP

Crustaceans Group (3)

Appalachian Brook Crayfish (*Cambarus bartonii)* HP
Taconic Cave Amphipod (*Stygobromus borealis)* HP
An Amphipod (*Diporeia hoyi)* HP

Freshwater Mussels Group (13)

Eastern Pearlshell (*Margaritifera margaritifera)*[1] MP
Dwarf Wedgemussel (*Alasmidonta heterodon)*[1] HP
Elktoe (*Alasmidonta marginata)*[1] HP
Brook Floater (*Alasmidonta varicosa)*[1] HP
Alewife Floater (*Anodonta implicata)*[1] MP
Cylindrical Papershell (*Anodontoides ferussacianus)*[1] MP
Pocketbook (*Lampsilis ovata)*[1] HP
Creek Heelsplitter (*Lasmigona compressa)*[1] HP
Fluted-shell (*Lasmigona costata)* HP
Fragile Papershell (*Leptodea fragilis)*[1] HP
Black Sandshell (*Ligumia recta)*[1] HP
Pink Heelsplitter (*Potamilus alatus)* HP
Giant Floater (*Pyganodon grandis)* MP

Freshwater Snails Group (15)

Buffalo Pebblesnail (*Gillia altilis)* HP
Squat Duskysnail (*Lyogyrus granum)* HP
Pupa Duskysnail (*Lyogyrus pupoideus)* HP
Canadian Duskysnail (*Lyogyrus walkeri)* HP
Boreal Marstonia (*Marstonia lustrica)* HP
Spindle Lymnaea (*Acella haldemani)* HP
Mammoth Lymnaea (*Bulimnaea megasoma)* HP
Country Fossaria (*Fossaria rustica)* HP
Star Gyro (*Gyraulus crista)* MP
Dusky Ancylid (*Laevapex fuscus)* MP
Thicklip Rams-horn (*Planorbula armigera)* MP
Liver Elimia (*Goniobasis livescens)* HP
Sharp Hornsnail (*Pleurocera acuta)* MP
Fringed Valvata (*Valvata lewisi)* HP
Mossy Valvata (*Valvata sincera)* HP

Reports on each invertebrate Species Group of Greatest Conservation Need are in Appendix A4 of this document. The following is a summary of those reports.

Habitat Needs

As invertebrates are the most diverse of Vermont's animals, the breadth of habitats they occupy is great. From deep lakes and slow rivers to the alpine peaks of our highest mountains, from the leaf litter of lowland floodplain forests to treetops in upland beech stands, there are invertebrates utilizing an amazing array of niches in every corner of Vermont. Many of these species have general habitat requirements, or live in natural communities that are common and secure within the state. A number of these are so abundant that they are treated as forest and agricultural pests. Such species do not normally require special conservation attention.

In contrast, habitat specialization is also a common strategy among invertebrates. Examples of habitats that host specialized invertebrates include fens, black spruce bogs, river cobble shores, large rivers, and alpine meadows. Certain herbivorous invertebrates feed only on specific plant hosts, exhibiting another form of specialization. While such specialization is often advantageous when the required habitat or plant host is plentiful, it creates a risk to these invertebrates when the habitat or host is rare, widely scattered, or also at risk (e.g., the Monarch Butterfly is suffering from limited winter habitat and loss of milkweed—its host plant for egg laying). In such cases, conservation attention is sometimes needed to ensure that these specialized invertebrates remain a part of Vermont's fauna.

Certain habitats in Vermont support highly diverse wildlife assemblages, including SGCN invertebrates. Good examples include Lake Champlain and its lower tributaries, where many of our freshwater mussel SGCN are located and peatlands for dragonfly and damselfly SGCN. These species-rich areas provide us the opportunity to help conserve many SGCN simultaneously.

Discussion of Threats Impacting Invertebrate SGCN

The greatest problems faced by SGCN invertebrates in Vermont relate to the loss, degradation, and fragmentation of their habitats. Poorly planned construction is ever-increasing on the landscape, often whittling away the wetland and upland habitats available to these creatures when these areas are not protected. As small habitat units disappear from the landscape, those remaining become more distant from one another; this presents an obstacle to those invertebrates that are limited to short-distance movement.

Declines in pollinators from bumble bees to the Monarch Butterfly has been noted nationwide and Vermont is no exception. The drivers of these declines likely vary from region to region and from species to species. In most cases it a combination of threats are probably responsible. One commonly cited threat is of a group of systemic insecticides referred to as 'neonicotinoids'. These pesticides are used on agricultural crops, and are also used in concentrated doses on home gardens, lawns, and ornamental trees. Several types of neonicotinoids are highly toxic to bees, in addition to making them more susceptible to parasites and pathogens.

Surface runoff from developed and agricultural lands can carry pollutant and sediment loads that find their way to rivers and streams, particularly during heavy rain events. The buildup of sediments on river bottoms embeds the natural substrate and can smother the invertebrates that reside there. Other pollutants entering streams and rivers can be detrimental to sensitive aquatic species.

Exotic species and diseases are negatively impacting several invertebrate SGCN, and will likely present increased challenges to conservation in the future as new foreign species invade our lands and waters. Parasites accidentally imported from Europe have ravaged Vermont's bumble bee populations and are particularly deadly to those bees weakened by exposure to the neonicotinoid pesticides mentioned previously. Native freshwater mussels have been eliminated from several large areas of Lake Champlain by the ongoing Zebra Mussel invasion. A small exotic fly (*Tachinid spp*) originally introduced to control gypsy moths instead preys upon many native woodland moth species, including some of our giant silk moths. This may prompt the need for future inclusion as SGCN such species as the Luna, Polyphemus, and Cecropia silkmoths.

Some of the challenges faced by invertebrate SGCN stem from their dwindling numbers and their life history characteristics. Low natural recruitment of offspring into the adult populations can hinder population recovery when numbers are low, such as with freshwater mussels. Other factors shared by several invertebrate SGCN groups that limit or impact populations include trampling/direct impacts, limited localized populations, and the requirement of specialized habitats.

Research & Monitoring Needs and Conservation Strategies

Over the past decade significant efforts have been made to address the lack of knowledge about many invertebrate SGCN. Data has been gathered through both field surveys and through the analysis of existing collections both public and private. Despite these efforts, however, our greatly expanded invertebrate datasets still pale in comparison those of other taxonomic groups and additional research is still needed to better guide conservation efforts. The Invertebrate Team therefore identified priority research and monitoring projects to improve our ability to conserve Vermont's invertebrate SGCN. The Team also developed conservation strategies to address problems impacting each SGCN. Those used most frequently and those best applied to multiple invertebrate SGCN include:

Research & Monitoring Needs

1. Define habitat requirements of SGCN within Vermont, utilizing current knowledge of researchers and field investigations as well as important life history characteristics when such information is lacking.
2. Obtain baseline SGCN distributional and abundance data by conducting surveys throughout the state particularly for additional invertebrate groups, such as spiders, moths, land snails and Orthoptera (grasshoppers, crickets).
3. Freshwater mussels:
   A. Centralize freshwater mussel data currently managed by multiple entities.
   B. Resurvey sites known to support rare mussels in the past that have not been surveyed in at least the past decade.
   C. Determine lampricide impacts on juvenile mussels and the long-term effects on adults.
4. Determine associations between invertebrate SGCN and targeted habitat types and/or natural communities (e.g., wetlands and wetland butterflies) to determine hotspots for conservation planning. Begin with habitat specialists and uncommon/threated habitats.
5. Develop a threat analysis for odonates and coordinate with regional threat analyses.
6. Assess potential and existing impacts of threats to SGCN populations and their habitats.
7. Monitor trends in SGCN population size and structure, and in habitat.
8. Monitor current and potential threats to SCGN species.

Priority Conservation Strategies

1. Conserve high priority SGCN sites through acquisition, easements, technical assistance, and other cooperative means.
2. Protect and restore aquatic habitats on which SGCN are dependent through pollution abatement, riparian buffers (ANR 2005), flow regulation, easements, and other means.
3. Develop mowing plans for state lands (e.g., parks, roadsides (FWHA 2007, rest stops, old fields and rights-of-way) to benefit SGCN pollinators and to limit the spread of invasive plants. Develop similar mowing BMPs for use by partners, municipalities and VTrans.
4. Continue developing recovery plans for listed species including freshwater mussels and tiger beetles. Develop Best Management Practices (BMPs) and management guidelines where appropriate (e.g., for bumble bees).
5. Work with farmers and other landowners to promote the growth and retention of milkweed and other wildflowers in old fields and pastures to benefit bumble bees, Monarch Butterfly and other pollinators.
6. Work with foresters to avoid impacts to SGCN populations and habitats during forest management activities.
7. Work with biologists to minimize impacts and maximize benefits to SGCN invertebrate populations and habitats during and following management activities for sport fish and game wildlife.
8. Participate in existing regulatory processes (e.g., Act 250, stream alteration permits) to protect and restore critical habitats.

Conclusion

The work to conserve our invertebrate SGCN is well underway. We now have statewide data for butterflies and bumble bees, and targeted data for rare dragonflies, damselflies, and freshwater mussels. Efforts to gather and organize invertebrate data from private individuals, museums, and universities are in progress. This expanded base of knowledge can help everyone interested in invertebrate conservation focus on the species, habitats and threats that are most in need of attention and launch new initiatives directed at invertebrate conservation.

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Conserving Vermont's Mammals

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Team Charge

The Mammal Team was charged with identifying mammals of greatest conservation need (SGCN), describing the distribution and habitat usage for each SGCN; evaluating threats impacting SGCN and their habitat; identifying priority research needs to improve our ability to conserve these species; and, developing conservation strategies to address priority threats.

Introduction

For a relatively small state, Vermont is characterized by an impressive diversity of habitat types. This diversity is of course a function of the state's variable climate, geological past and rich human history. The nine distinct biophysical regions that comprise Vermont range in character from that of the low, warm and comparatively dry Champlain Valley where farmers make good use of its productive agricultural soils to that of the cold and largely forested Northeastern Highlands where the underlying granite may be the only thing hardier than the animals that call this remote part of the state home. This landscape diversity provides the underpinnings for a similarly diverse suite of mammals ranging from boreal species such as the Canada Lynx to those that are better known inhabitants of the south such as Gray Fox and Southern Flying Squirrel. In total, sixty-one mammal species presently exist in Vermont or were here just prior to European settlement. While many of these species are abundant and readily recognizable on the landscape such as deer and Woodchuck, other once common species such as wolf and Mountain Lion are now believed to be extirpated and are clearly in need of a concerted conservation strategy if they are to be restored. In between these extremes, however, exist a host of mammals that are either poorly understood, occur in low numbers and/or in specific habitats, are known to be in decline, or are susceptible to any number of identified threats. The updating of Vermont's Wildlife Action Plan was necessary not only to reevaluate the status of these more vulnerable mammals, but also to reassess our current knowledge and understanding of the challenges that lie ahead for all of Vermont's wildlife. It's also an opportunity to measure the progress made to date in addressing these challenges.

While all the threats identified in the 2005 Wildlife Action Plan (e.g., habitat conversion alteration and fragmentation, competition, pollution, loss of prey base, impacts of roads) continue to be of concern today, the knowledge and experience gained over the past 10 years has positioned us to better understand the implications of these threats and the actions we must take to address them. Since 2005, for example, the decimation of bat populations throughout the region because of White-nose Syndrome (WNS) provides a stark demonstration of the vulnerability of Vermont's wildlife to the spread of exotic diseases. It highlights the importance of not only implementing measures to avoid the introduction and spread of such pathogens but the value of a solid foundation of baseline population data for these species as well. Similarly, mounting evidence of resident Canada Lynx in the northeast corner of Vermont since 2005 provides clear indication of the critically important role a connected landscape plays in terms of maintaining wildlife diversity as well as of the importance of conserving and managing the unique habitats upon which such specialized species depend.

Although many of Vermont's mammals are extremely adaptable and resilient such as the ubiquitous Raccoon, Red Fox, and Striped Skunk, others are sensitive to any number of threats and will require continued vigilance in our efforts to better understand these threats and to implement appropriate conservation strategies. While some threats may be relatively simple, readily identifiable and/or reasonably preventable, others will continue to challenge us through the future and will require comprehensive, multifaceted solutions.

Some of the mammal SGCN presently appear to be secure such as Moose and Bobcat, but could be at risk in the foreseeable future due to loss of critical habitats or to population declines resulting from a variety of environmental threats such as climate change, interspecific competition and disease. Several species are facing immediate known threats such as with several of the bat species (disease) and American Marten (climate change) and could easily exist only as a memory on the Vermont landscape in the absence of appropriate and timely action. Others are listed primarily because little is known about their population status and/or distribution in Vermont such as with several of the smaller, more secretive species like the voles and shrews. Despite the specific challenges facing these SGCN, the Mammal Team interpreted the selection criteria for listing broadly in the hopes of preventing further declines in any of Vermont's native mammals.

Implementing the 2005 Wildlife Action Plan

Since its adoption in 2005, Vermont's Wildlife Action Plan has guided the implementation of numerous mammal related initiatives aimed at filling critical knowledge gaps and addressing the challenges they face. While most of this work has been focused primarily in Vermont, the research and monitoring needs identified in the plan, as well as the conservation strategies, have been used to justify the state's participation in several regional and even national initiatives.

Perhaps the best example of such is Vermont's response to White-nose Syndrome. Prior to the availability of State Wildlife Grant funds in 2003, Vermont's efforts to monitor bat populations were limited to periodic hibernacula surveys. But since then, the Vermont Fish &

Wildlife Department developed and implemented what has become one of the more significant state bat conservation initiatives in the region. Major elements of this initiative are:

- Collection of a broad array of statewide bat population data on both summer range and winter hibernacula to determine species composition and relative abundance across the state;
- A study of Indiana Bat maternity colony distribution, size, and habitat use throughout the state;
- Detailed risk assessments to determine wind energy facility impacts to Vermont's bat populations; and,
- A technical assistance and outreach program for land managers and conservation organizations to develop and support the management and protection of important Indiana bat habitat.

Then, in 2008, when White-nose Syndrome was identified in the state, the VFWD was thrown into triage mode to conduct disease surveillance, collect diagnostic samples and coordinate at the state, regional and national levels. However, the experience and knowledge gained by VFWD staff from the original SWG-funded work proved instrumental in positioning the state as a leader in the nation's response to this unprecedented challenge. In the past few years our bat conservation efforts have focused on ongoing surveillance, protection of hibernacula and maternity colony sites, and research into the development of alternative hibernaculum.

Similarly, the work conducted here in Vermont on Canada Lynx has also contributed to the conservation/restoration of this species in the region. Guided by the strategies outlined in the 2005 Wildlife Action Plan, the VFWD continues to partner with other states and organizations in the region, for example, to monitor for its presence (2012 to present – Vermont Trappers Association, US Fish and Wildlife Service, US Forest Service, New Hampshire Fish and Game) in recognition of the critically important role such information plays in the implementation of appropriate conservation strategies. Also, the VFWD remains engaged with its regional partners to identify and conserve critical connective corridors facilitating the continued existence of lynx and many other species across the northern Appalachians (Staying Connected Initiative http://stayingconnectedinitiative.org/). Since 2009, Staying Connected Initiative partners have permanently conserved more than 300,000 forested and wetland acres that include wildlife corridors and road crossings essential to healthy wildlife populations across the region.

Since 2005, the VFWD has also undertaken initiatives to study American Marten and Black Bear. The bear research aims to determine the level of impact that wind power facilities have on bear use of adjacent beech stands, but study's findings have significance for the region in terms of critical habitat protection for the species, the permitting requirements of future energy developments and a better understanding of how bears utilize the landscape and maintain genetic diversity across potential anthropogenic barriers.

Ongoing American Marten research and monitoring was spurred by the discovery of individual marten in southern Vermont near a previously deemed failed reintroduction attempt (1989-1991). Although this work is largely focused on mapping the current distribution and abundance of the species in Vermont, several aspects of this work have regional utility; particularly the testing of a marten occurrence model in collaboration with the New York Department of Environmental Conservation, an assessment of the genetic structure of marten populations across New England, and the evaluation of various measures to minimize the incidental take of marten in traps set for other species. Working in accordance with Vermont's Wildlife Action Plan, the effort to evaluate the status of mammals here in the state and to assess the challenges they face is clearly of regional, and even national, significance.

As noted above, we knew very little about the status and needs of many of our small mammal SGCN, so in 2007 Vermont initiated its Small Mammal Atlas to determine the distribution, relative abundance, and habitat requirements for all small mammal species. Field surveys yielded the capture of 2,844 small mammals representing 20 different species and distribution maps based on historical and current records were constructed for all small mammal species in Vermont.

In addition to the projects highlighted above, the 2005 Wildlife Action Plan was used to justify and develop several key SWG funded research projects designed to fill critical knowledge gaps and address specific threats, including:

- An evaluation of Bobcat habitat uses and movements to identify Bobcat home range requirements and key habitat and resource needs;
- A Beaver Wetland Conservation Technical Assistance program to help landowners and land managers resolve conflicts with Beaver on their properties while allowing Beaver to continue maintaining the wetlands they create for the benefit of beaver and the many SGCN that rely on these incredibly productive habitats; and
- A detailed GIS analysis and prioritization of more than 4,000 forest blocks, the corridors connecting these blocks, and the locations across the state where wildlife crosses roads in significant numbers.

Selecting Mammal Species of Greatest Conservation Need

Of the sixty-one mammal species native to Vermont, the Mammal Team opted to list 34 as Species of Greatest Conservation Need. Those species that were the most vulnerable (faced with immediate threats to survival or showing a significant population decline) were ranked as high. In addition, species that were extirpated locally but were known to exist in adjacent states were included on the high list. In all, 17 species were designated as having high conservation priority (table 5.8). Eighteen additional species were ranked as medium priority.

The Mammal Team was influenced by the Congressional intent of the State Wildlife Grants program of "keeping common species common" so some of the species in the medium category are those that might be well-distributed and even locally abundant now, but that team members felt were at risk in the foreseeable future due to the increasing potential for mortality, habitat loss/fragmentation or other identifiable threat. Mammals may have been included in the medium category either because little was known about their population status, distribution, and/or trends in Vermont or they have been considered extirpated in the region (table 5.8).

Table 5.8. Mammal Species of Greatest Conservation Need

High Priority	Medium Priority
Water Shrew (*Sorex palustris*) [1]	Masked Shrew (*Sorex cinereus*)
Long-tailed or Rock Shrew (*Sorex dispar*) [1]	Smoky Shrew (*Sorex fumeus*) [1]
Pygmy Shrew (*Sorex hoyi*)	Hairy-tailed Mole (*Parascalops breweri*) [1]
Little Brown Bat (*Myotis lucifugus*) [1]	Big Brown Bat (*Eptesicus fuscus*) [1]
Indiana Bat (*Myotis sodalis*) [1]	Snowshoe Hare (*Lepus americanus*)
Small-footed Bat (*Myotis leibii*) [1]	Southern Flying Squirrel (*Glaucomys volans*)
Northern Long-eared Bat (*Myotis septentrionalis*)[1]	Northern Flying Squirrel (*Glaucomys sabrinus*)
Silver-haired Bat (*Lasionycteris noctivagans*)[1]	Muskrat (*Ondatra zibethicus*)
Tri-colored Bat (*Perimyotis subflavus*) [1]	Southern Bog Lemming (*Synaptomys cooperi*)[1]
Eastern Red Bat (*Lasiurus borealis*) [1]	Wolf (*Canis sp?*)
Hoary Bat (*Lasiurus cinereus*) [1]	Gray Fox (*Urocyon cinereoargenteus*)
New England Cottontail (*Sylvilagus transitionalis*)[1]	Long-tailed Weasel (*Mustela frenata*)
Rock Vole (*Microtus chrotorrhinus*)	Northern River Otter (*Lontra canadensis*)
Woodland Vole (*Microtus pinetorum*)	Bobcat (*Lynx rufus*) [1]
Northern Bog Lemming (*Synaptomys borealis*)	Eastern Mountain Lion (*Puma concolor couguar*)
American Marten (*Martes americana*) [1]	Moose (*Alces alces*)
Canada Lynx (*Lynx canadensis*)	

[1] Regional Species of Greatest Conservation Need in the Northeastern United States (Terwilliger, 2013)

Of the 33-species identified as SGCN in Vermont's 2005 Wildlife Action Plan, only Mink was delisted during this revision process. The removal of Mink from the list (from medium in 2005 to low in 2015) was precipitated by the fact that very little evidence could be found in the scientific literature supporting the primary concern regarding their vulnerability to environmental toxins. Therefore, in consideration of this and of the existing framework for monitoring the species (trapper derived harvest, catch per unit effort and pelt sales data), the widespread and abundant nature of the current population, and the continued listing of other indicator species such as the Northern River Otter, team members concluded the species was secure for the foreseeable future and that processes were well established for detecting and reacting to changes in the species' vulnerability to environmental toxins.

In its 2015 revision process, the Mammal Team identified specific threats to two additional species and assigned them both as medium priority SGCN. Since 2005, several threats for Moose have emerged having the potential to impact populations at a regional scale. The most significant is the recently documented, unprecedented mortality resulting from acute winter tick infestations across parts of its range. Much work is currently underway to assess the effects of this tick related mortality as well as to evaluate other potential stressors influencing the population health of this species along the southern edge of its range.

Similar to Moose, Snowshoe Hare also exist in Vermont at the southern periphery of its range which alone makes it vulnerable to certain threats such as a changing climate but, unlike Moose, the species is a habitat specialist reliant upon early successional northern forest habitat types. Although hare populations appear secure at present, forest management trends in recent decades have led to declines in early successional habitat throughout the state creating concern for the species' long-term persistence. To further justify the SGCN status for Snowshoe Hare, team members also acknowledged that the species serves as primary prey for an array of furbearers including other SGCN species (e.g. Canada Lynx and American Marten) and that its security in the state could be jeopardized by shifting carnivore communities responding to climate change.

In addition to removing and adding species to the SGCN list, the Mammal Team also reassigned two previously identified SGCN from medium to high (Little Brown Bat and Northern Long-eared Bat) and two from high to medium (Southern Bog Lemming and Woodland Vole). The former changes were based entirely on the emergence of WNS in 2008 that resulted in the dramatic decimation of these previously healthy bat populations and the latter on the findings of the SWG-funded Small Mammal Atlas which indicated populations of these species to be more secure than was previously believed.

Reports on each of the mammal Species of Greatest Conservation Need are in Appendix A5 of this document.

Habitat Needs

The habitat requirements of the mammals listed as SGCN are as diverse as the species themselves and are reflective of Vermont's varied landscape. While some species are habitat generalists (e.g., Moose) simply requiring undeveloped open space, others are specialists, dependent upon very specific habitat conditions to fulfill their life cycles (e.g., Indiana Bat, and American Marten). Collectively, the habitat needs of the SGCN encompass nearly every identifiable habitat type in the state from the most common and ubiquitous northern hardwood forests to the more scarce and unique alpine meadows. Depending on the species in question, even some of the cultural habitat types can play an important role in the conservation of these species. Thus, in general, maintaining healthy populations of Vermont's native mammals requires the conservation of critical habitats, both specific and broad in nature, and the important connecting corridors linking key habitats across the state and region. It also means conserving large blocks of contiguous forestland with corridors, such as riparian buffers, to provide a network of interconnected habitat blocks suitable for the wide-ranging species such as Canada Lynx, and American Marten as well as for the numerous, less travelled species that make use of the many niches such a conserved landscape provides.

Discussion of Threats to Mammal Species of Greatest Conservation Need

The threats most frequently identified to the 34 SGCN mammals were: Conversion of Habitat (28), Habitat Alteration (28), Loss of Prey Base (16), Competition (14), Disease (12), Genetics (12) and Climate Change (11).

We do not understand all the ramifications, but the pattern seen elsewhere in the US and the world is that increased human population density, higher consumption of land and other resources, and a lack of awareness of impacts to other species can lead to devastating losses of native biota (TWS 2004). Vermont is not immune from these sorts of impacts and our landscape is continuing to be developed (DeVillars 1999). For example, Vermont lost an average of 4,800 acres of wildlife habitat each year to development between 1997 and 2007 (Plumb). Habitat alteration and loss is a near universal challenge to many native mammal SGCN.

Occupying only those limited portions of the state where suitable habitat conditions prevail, some species are found in low numbers and/or in isolated patches making their long-term persistence susceptible to direct habitat impacts and reliant upon functioning connective corridors. Similarly, other species, while abundant to either the north or south of Vermont, exist in the state at the furthest extent of their ranges making them vulnerable to a changing climate and the resulting shifts in biotic communities. Despite our successes at conserving large tracts of land in the state in response to these threats, current trends in the forest products industry and applied forest management practices complicate our ability to manage lands for some species particularly those that rely on early successional habitats. Adequately protecting and managing the landscape to meet the needs of Vermont's SGCN through the future is undoubtedly amongst the greatest challenge we face.

In recent years, the emergence of several pathogens such as WNS, chronic wasting disease (CWD), and Winter Tick (also known as Moose Tick) provide more than ample evidence of the severe consequences such agents can inflict upon whole populations of mammals. In a matter of a few years, for example, we witnessed once thriving populations of bats dwindle to alarming numbers leaving at least one species, the Northern Long-eared Bat, subject to the protections of the federal Endangered Species Act and another, the Little Brown Bat, subject to Vermont's endangered species law. In other states, we watched as biologists scrambled to prevent the further spread of CWD and to minimize the disease's impact on local deer herds. These experiences not only demonstrate the potentially grave consequences such diseases and pathogens have for Vermont's wildlife, but also illustrate the importance of stemming the flow of such agents into the state and implementing sound response protocols should new diseases be discovered within our borders.

Pollution was also identified as a potential threat to several species including bats and otter. Industrial pollutants and heavy metals such as PCBs and mercury can build up in the bodies of animals exposed to these toxins (Novak, 1987). In Vermont, for example, trace amounts of mercury were readily detected in the tissue of several otters sampled during annual necropsy work. Although the ramifications are not clear, it is likely that the biomagnification of these toxins negatively affects reproduction and survival. Bats are particularly susceptible to pesticides and other environmental poisons because they store some lipophilic (fat soluble) pesticides in brown adipose fat tissue. These stores are released as bats use their fat reserves during hibernation. Bats can, therefore, be exposed to both chronic and acute poisoning which can result in death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for several the smaller, insectivorous mammals such as the bats and shrews.

Perhaps the biggest challenge for some species such as bats, wolf, and Mountain Lion is the public's acceptance of and desire to conserve them. Sensational and often inaccurate presentations of public health issues, property damage and potential risk factors involving these species have created an exaggerated fear of these ecologically important animals. The resulting unwarranted negative public perception presents an especially serious threat to the recovery and conservation of these species. For some species, recovery efforts must begin with a public outreach and education effort.

Research and Monitoring Needs and Conservation Strategies

The Mammal Team developed research, monitoring, and conservation strategies for each individual SGCN species. Below is a compilation of the strategies that arose most frequently:

Research and Monitoring

1. Determine the distribution and relative abundance of populations in Vermont.
2. Identify, evaluate and monitor threats.
3. Determine critical habitat needs and connectivity requirements.
4. Determine life history requirements.

Conservation Strategies

1. Develop outreach and education programs that promote the conservation of SGCN and the habitats that they depend on, and increase awareness of the importance of maintaining or restoring these species.
2. Identify the habitat requirements of SGCN and develop strategies for conservation and protection through fee simple purchase, easements, management guidelines, and cooperative agreements with user groups and landowners, etc. (i.e., bat hibernacula and maternity roost trees, Bobcat denning sites, reverting field habitat for New England Cottontail, bear-scarred beech stands, connective corridors, etc.).
3. Initiate an international effort to maintain large blocks of undeveloped forests linked together by habitat corridors to provide a network of interconnected habitats throughout northeastern New England and southeastern Canada.
4. Maintain riparian buffers along streams (see ANR 2005).
5. Maintain and restore habitat connectivity and minimize fragmentation of forest blocks. Identify and prioritize wildlife road crossing locations. Work with the Agency of Transportation and adjacent landowners to reduce wildlife mortality and increase the potential for movement from one side of the road to the other.
6. Work to eliminate pollution that causes acid rain, the deposition of heavy metals, and global climate change.
7. Continue to work cooperatively with landowners, towns, and communities to protect critical habitats and maintain connectivity. Provide *Conserving Vermont's Natural Heritage* to municipal and regional planners (Austin et.al. 2004)
8. Participate in existing regulatory processes (e.g., Act 250, stream alteration permits) to protect and restore critical habitats.

Conclusion

Vermont is at a crossroad. Due primarily to conscious choices made by her citizens in the last 100 years (restoration of White-tailed Deer, Beaver, Wild Turkey, Fisher populations, enactment of Act 250 legislation and wetland regulations, etc.), as well as economic forces that essentially allowed the state to bypass the Industrial Revolution (Bryan, pers com), Vermont has remained predominantly rural throughout the 20th century. Many mammal species, therefore, are at population levels that are likely higher than they were prior to European settlement (Fisher, Red Fox, White-tailed Deer, Raccoon, Bobcat). Today, however, with Vermont's population growing, development pressures increasing and increased roads and traffic the potential for significant habitat destruction in the next 10 years is high. In addition, global climate change is already influencing the potential residency of some native mammal populations in Vermont (Royar, pers com). The decisions made by Vermonters today will chart the course for the future and influence the long-term viability of our native wildlife populations.

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Conserving Vermont's Plants

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Partners

Flora Advisory Group to the Endangered Species Committee (FLAG)
New England Plant Conservation Program Vermont Task Force
Vermont Forest Parks and Recreation
Vermont Department of Environmental Conservation
US Fish & Wildlife Service
US Forest Service
Natural Resource Conservation Service
Vermont Land Trust
St. Michaels College
University of Vermont
Green Mountain College
Vermont Botanical and Bird Club
New England Wildflower Society
Vermont Center for Ecostudies
NatureServe
Network of Natural Heritage Programs and Conservation Data Centers

Team Charge

The Plant Team identified Species of Greatest Conservation Need (SGCN); described the habitats and natural community types they occur in; evaluated impacts to SGCN and their habitat; identified priority research needs to improve our ability to conserve these species; and developed conservation strategies to address priority problems.

Introduction

Vermont is home to approximately 2,000 species of native plants. This includes 1,200 native vascular plants (seed and flowering plants, ferns and fern allies) and 800 non-vascular plants also known as bryophytes (mosses, liverworts, and hornworts). Many species are quite common (e.g., sugar maple, jewelweed) while others are exceedingly rare (e.g., the Green Mountain Quillwort which is found only in Vermont). For a small, northern state such diversity is remarkable.

Plant diversity is an important part of Vermont's biodiversity and they provide food, habitat and shelter for many animal species. Most plant species occur widely enough on the landscape that human activities do not put them at risk. Rare plants, however, often require specialized habitats and occur in relatively few locations. Some species are rare because availability of their habitats has always been limited or they are at the edge of their range in Vermont. Others have recently become rare as land uses have affected their traditional habitat. Rare species may require management or protection to ensure their survival in a working or natural landscape.

Vermont's plant diversity is driven, in part, by the different biomes that inhabit the state.

While most of the state is dominated by Northern Hardwood Forest, there are also extensive areas of boreal forest in the higher elevations and the northern part of the state, and oak-hickory forests in the Champlain and Connecticut River Valleys. There are even remnant alpine tundra and costal beach species.

Plant distribution and diversity is also determined by the following factors: the type of the bedrock; surficial deposits (gravels, sands, silts, and clays) that were laid down during and after the last glaciation; soil chemistry; climate, elevation, topography; and past land use history. Vermont has extensive areas of calcareous (limy) bedrock that is conducive to high plant diversity. While acidic soils or bedrock areas have distinctly less plant species diversity, they still contribute to the overall diversity in the state in that certain species are adapted to these conditions.

Vermont Fish and Wildlife Department's botanists and ecologists met to develop SGCN selection criteria and to cross-walk rare plants with natural community types (Thompson and Sorenson 2005). The Team also benefited by work by field botanists in the last 35 years and the rich documentation in locally and regional herbaria for information going back to the 18th century.

Vascular plants identified as SGCN include gymnosperms (includes conifers), angiosperms (flowering plants), and ferns and allies (seedless vascular plants that disperse by spores). Bryophytes collectively are mosses, hornworts, and liverworts. The emphasis of this report is on vascular plants as there is much greater knowledge of them, in part because they are easier to identify. However, bryophytes can be an important component of many habitats and natural community types and even dominate certain types, such as dwarf shrub bog.

Selecting Plant SGCN

The team selected plants as Species of Greatest Conservation Need from the Vermont Natural Heritage Inventory's (VNHI) list of rare plants. Of the approximately 1,200 vascular and 800 bryophytes native to Vermont, 813 were selected as Species of Greatest Conservation Need, 493 vascular plants and 320 bryophytes.

The 439 vascular plants were further prioritized by means of the New England Plant Conservation Program's Flora Conservanda, which identifies those vascular plants that are rare globally, regionally or are locally disjunct. Those species identified as rare globally and regionally (222) are ranked High Priority and those considered locally rare, 271 species, are ranked Medium Priority. A full list can be found beginning on page 8 of this chapter.

The list of rare VNHI plants include those species that the rarest and often have threats to some or all the populations. These ranks, explained in a following paragraph are based on knowledge of experts, field research over the last 35 years, and more than 125 years of historical records from the literature and specimens documented in regional herbaria. The plant ranks are based on the number of presumed occurrences and the threats to these populations.

A comprehensive review and update of the ranks of vascular plants was completed in the fall of 2014 by the VFWD working with members of the Flora Advisory Group to the Endangered Species Committee and others with knowledge of Vermont's flora. The taxonomy was updated to match the New Flora of Vermont (Gilman, 2015) and Flora Novae Angliae (Haines, 2011).

Dorothy Allard, a member of the Flora Advisory Group and a professional bryologist, ranked all the bryophyte species in the state and maintains a list in conjunction with VNHI that was last updated on April 2, 2011.

The VNHI rarity ranks are defined as: S1– very rare, thought to have 5 or fewer populations with some degree of threat; S2 – rare, thought to have 20 or fewer populations with some degree of threat; and SH – historical, documented from the state, but no currently known populations. VNHI also tracks uncommon species that contain a state rank of S3. These species are generally thought to have 21 to 100 populations. They can be considered watch list species and if their numbers decline substantially they may be considered rare in the future.

Plants and Their Habitat Needs

Vermont's plant SGCN occupy a broad and diverse array of natural habitats and community types found in the state. In some cases, these species take advantage of anthropogenic dominated areas that mimic natural habitats, such as wet agricultural meadows, transmission line rights-of-way, or sandy opening in developed areas.

The New Flora of Vermont (Gilman, 2015) generally describes the habitats for all vascular plants, including SGCN. The habitat for SGCN bryophytes can be found in the literature listed in references.

Vascular plant SGCN were cross-walked to the natural community types where they are commonly found (Appendix I). This crosswalk was only partially completed for bryophyte SGCN because the habitat requirements of some of these species do not align well with natural communities. The natural community approach of conserving rare species conserves representative examples of each natural community type in different physiographic regions of the state. This approach is a more cost-effective way to protect a multitude SGCN, than trying to protect individual species occurrences.

Conserving Vermont's Plant SGCN

The following are highlights of plant conservation work in the state since 2005.

- Monitored hundreds of the rare plant populations state-wide though efforts of VFWD staff, New England Plant Conservation Program Vermont Task Force, New England Plant Conservation volunteers, and our partners.
- Discovered hundreds of new rare plant locations over the past 25 years while conducting natural community inventories, such as the bog-fen and oak-pine, and state lands.
- Added 11 plant species the state Endangered and Threatened Species list providing additional monitoring and protection.

- Re-discovered at least 14 plant species that had not been observed in the state for at least 25 years (listed as state historic).
- Documented plant SGCN in the Natural Heritage Database by entering field data for thousands of new and updated records of rare and uncommon species occurrences.
- Revised the Vermont Natural Heritage Inventory's rare plant ranking list in 2014 to include new species and varieties that are now recognized due to taxonomic revisions and nomenclatural changes. This is the first major revision of the list since 2009. The project entailed several hundred taxonomic and rank changes and standardized the ranking of subspecies, varieties, and exotic sub-taxa.
- Collected seeds from numerous high and medium priority SGCN for storage at New England Wildflower Society seed banking facility.
- Developed a list of plant species that are threatened by collection within the state and regionally to improve data sharing while protecting rare species. This collective solution was completed because herbarium images are now available online through the Consortium of Northeast Herbaria portal and the locations of certain rare species are suppressed.
- Helped protect and mitigate impacts to threatened and endangered plant species from development and facilitated scientific research of these species through state endangered species permitting.
- Discovered a plant species new to science in 2013 a quillwort (*Isoetes viridimontana*), currently known only from one pond site in Vermont.
- Managed invasive plant species that were impacting rare plant populations at multiple sites across the state.
- Supported the 2015 publication of the New Flora of Vermont by Arthur Gilman.

Discussion of Problems Impacting Plant SGCN

The most significant near-term threats to plant SGCN across the state is conversion, alteration, and fragmentation of natural habitats and invasive plants and animals. Other sometime less obvious threats to plant SGCN include pollinator declines; plant diseases; suppression of natural processes; an overabundance of certain animals; air pollution, including acid deposition; and how natural and anthropogenic plant habitats are managed.

Long-term threats are from increasing human population and footprint; and the many issues related to climate change. We can expect that there will be dramatic shifts in plant communities and diversity in the coming decades and centuries from a warming climate. This inevitability is one that we should start planning for, as there is no turning back from much carbon dioxide we have put into the atmosphere.

For decades state plant conservation efforts in Vermont, and nationwide, have been at a significant disadvantage compared with fish and wildlife conservation, due to a dearth of federal funding. Since 1937 states have received federal Wildlife Restoration Program funds (Pittman Robertson) for wildlife conservation (birds and mammals) and since 1950 Sportfish Restoration Program funds (Dingell Johnson). While the State Wildlife Grants program provides funds for fish and wildlife that don't directly benefit from these other programs, plant conservation is not eligible. The short-lived federal Landowner Incentive Program (2002-2005) provided funding for plant conservation, but was cancelled by Congress in 2006. The only federal funds currently available for plant conservation are through the Endangered Species Act for federally endangered plants. In Vermont only three plant species are eligible, the Jesup's Milk-vetch, Barbed-bristle Bulrush and Small Whorled Pogonia.

Research & Monitoring Needs and Conservation Strategies

The research and monitoring needs most frequently identified by the Plant Team and those would benefit multiple plant SGCN are as follows:

Research & Monitoring Needs

1. Document the distribution, abundance, and viability of populations
2. Monitor species
3. Assess condition and viability of associated habitat or natural community
4. Determine life history, such as seedling establishment, pollination needs, threats from invasives, and seed dispersal strategies.
5. Refine the plant/natural community crosswalk, to facilitate using natural communities in conservation planning to protect assemblages of rare plant species.
6. Follow species distribution changes over time, to document changes related to climate shifts.

Conservation Strategies

1. Implement the Vermont Flora Task Force's annual priority Action List of species to inventory and stewardship priorities in coordination with the New England Plant Conservation Program (NEPCoP). Conduct site visits with VFWD staff, NEPCoP trained volunteers and Task Force members.
2. Offer landowners and land managers technical assistance through inventory and stewardship to support private lands stewardship for plant SGCN. Inform landowners how they can manage their forests for rare plant populations when enrolled in the state's Use Value Appraisal Program (Current Use).
3. Work with landowners and partners to develop conservation easements on lands containing plant SGCN. The Vermont Land Trust and The Nature Conservancy in consultation with the VNHI provide opportunities for protection of rare plants through inclusion in easements and with monitoring of populations.
4. Manage information on plant SGCN in the Natural Heritage Database. Update the rarity ranks of plants based on new information. Include documentation of rare plant abundance, location, viability, habitat description, threats, and landowner contact information and permission. Incorporate rare plant data from VFWD field inventories and various partners, researchers, and citizen science.
5. Support species restoration through habitat and natural community management and restoration to restore or mimic natural processes. Carry on restoration work at the Vermont Army National Guard's Camp Johnson with planned burns of the Pine-Oak-Heath

Sandplain community, in part for the benefit of rare sandplain plants. Where necessary, remove competing vegetation to maintain a necessary seral stage. Partner with utility companies and develop and implement annual work plans for habitats with plant SGCN on utility properties and rights-of-way.

6. Manage rare plant populations that are threatened by invasive species. Update the Vermont Flora Task Force Action list with species that have management or stewardship needs. Coordinate with partners who provide stewardship services or manage the land.

7. Share the data with partners. Also, provide generalized information to public through the Agency's Natural Resources Atlas and the Vermont Center for Geographic information to be used in project and conservation planning.

8. Facilitate species restoration through the banking of live plant material by collecting seeds or cuttings that may be used to restore or enhance existing populations threatened with extirpation. NEPCoP in conjunction with the Vermont Task Force prioritizes which plants need to have live material collected. The collection effort is to be coordinated with annual species inventory and stewardship priorities. Plan for species restoration through assisted migration and provide guidance and advice to independent efforts to restore or introduce new populations of SGCN.

9. Educate the public through outreach about Vermont's plants, particularly SGCN. Tell natural history stories about the habitat in which they occur and include their interaction with animal species.

10. Develop conservation strategies for suites of plant species at the natural community formation level or similar higher-level grouping by generalized habitat type.

11. Determine the pollination needs of plant SGCN. Conserve and manage habitat of pollinators that are important to plant SGCN.

12. Develop a long-term funding plan for the VFWD's Plant Program to support conservation of our state's plant diversity. Currently the VFWD's funding for plant inventory, monitoring and stewardship is almost solely from the Department's state funds. Explore funding options from a variety of state, federal and private sources. Create a plant funding committee.

13. Coordinate with state agencies on management, monitoring, and information sharing. Incorporate plant SGCN into the long-range management of Agency of Natural Resources lands. Review annual work plans for potential conflict and where necessary conduct site visits to avoid or mitigate the impacts. Coordinate and share information with ANR's Lakes and Ponds' aquatic plant survey. Coordinate with Vermont Agency of Transportation and Department of Buildings and General Services on SGCN that occur in lands that they manage or own.

14. Share species data with NatureServe, which serves as an umbrella organization for the international network of natural heritage programs. NatureServe creates global datasets with range-wide maps for each species with a corresponding species rarity rank. They also reconcile taxonomic differences between different jurisdictions.

15. Work with our federal, municipal and NGO partners to prioritize management practices and stewardship needs and enhance information sharing. The U.S. Forest Service currently

monitors numerous populations of rare plants on their lands. The U.S. Fish & Wildlife Service monitors rare species on its Wildlife Refuges. Also, VFWD monitors federally listed species through the U.S. Fish and Wildlife Service's Cooperative Endangered Species Conservation Fund (Section 6 of the Endangered Species Act).

16. Develop management plans that include rare plants for landowners with Natural Resource Conservation Service. Coordinate with the Vermont Land Trust who monitors populations of rare plants that are incorporated into their easements. Work with municipal governments who provide protection to rare species and monitor populations.
17. Coordinate and prioritize research with universities and colleges to encourage a focus on high priority conservation needs.
18. Identify, prioritize and maintain existing contiguous forest blocks and associated linkages that allow for movement in response to climate change with consideration to the physical landscape, especially with the makeup of the bedrock. That is, certain plants require a calcareous (limy) bedrock type while others thrive on more acidic conditions.
19. Participate in regulatory processes, such as Acts 250 and Section 248, the Vermont Wetlands Rule, and the endangered species law to protect rare, threatened and endangered plants. Some of these laws only afford protection to those legally listed as threatened or endangered in Vermont. There has been an effort to add protection of habitat to the endangered species law, which would increase the viability of populations in or near developments.
20. List additional species, as warranted, as threatened or endangered to provide additional protection for vulnerable species.

Plant Species of Greatest Conservation Need

MP=Medium Priority SGCN; HP=High Priority SGCN

Conifers and relatives

Creeping Juniper (*Juniperus horizontalis) HP*

Ferns and relatives

Aleutian Maidenhair-fern (*Adiantum aleuticum) HP*
Green Mountain Maidenhair-fern (*Adiantum viridimontanum) HP*
Mountain Spleenwort (*Asplenium montanum) HP*
Green Spleenwort (*Asplenium viride) HP*
Upswept Moonwort (*Botrychium ascendens) HP*
Prairie Moonwort (*Botrychium campestre) HP*
Common Moonwort (*Botrychium lunaria) HP*
Mingan Moonwort (*Botrychium minganense) HP*
Blunt-lobed Grapefern (*Botrychium oneidense) HP*
Rugulose Grape-fern (*Botrychium rugulosum) HP*
Spatulate Moonwort (*Botrychium spathulatum) MP*
Shade Moonwort (*Botrychium tenebrosum) HP*
Weft Fern (*Crepidomanes intricatum) HP*
Laurentian Bladder Fern (*Cystopteris laurentiana) HP*
Northern Ground-cedar (*Diphasiastrum complanatum) MP*
Ground-fir (*Diphasiastrum sabinifolium) MP*
Male Fern (*Dryopteris filix-mas) HP*
Fragrant Fern (*Dryopteris fragrans) MP*
Marsh Horsetail (*Equisetum palustre) MP*
Northern Oak Fern (*Gymnocarpium jessoense ssp. Parvulum*) HP
Mountain Fir Clubmoss (*Huperzia appressa) HP*
Fir Clubmoss (*Huperzia selago) HP*
Engelmann's Quillwort (*Isoetes engelmannii) MP*
Lake Quillwort (*Isoetes lacustris) MP*
River-bank Quillwort (*Isoetes riparia) MP*
Tuckerman's Quillwort (*Isoetes tuckermanii) MP*
Green Mountain Quillwort (*Isoetes viridimontana) MP*
Northern Adder's-tongue (*Ophioglossum pusillum) HP*
Massachusetts Fern (*Parathelypteris simulata) MP*
Stiff Clubmoss (*Spinulum canadense) MP*
Alpine Woodsia (*Woodsia alpina) HP*
Smooth Woodsia (*Woodsia glabella) HP*
Virginia Chain-fern (*Woodwardia virginica) MP*

Flowering Plants

Slender Copperleaf (*Acalypha gracilens) MP*
Yellow Giant Hyssop (*Agastache nepetoides) HP*
Purple Giant Hyssop (*Agastache scrophulariifolia) HP*
Boreal Bentgrass (*Agrostis mertensii) MP*
Wild Garlic (*Allium canadense var. canadense) MP*
Siberian Chives (*Allium schoenoprasum) MP*
Burdick's Wild Leek (*Allium tricoccum var. burdickii*) HP
Water Hemp (*Amaranthus tuberculatus) HP*
Small Round-leaved Orchis (*Amerorchis rotundifolia) HP*
Champlain Beach Grass (*Ammophila breviligulata ssp. champlainensis) HP*
Long-headed Thimbleweed (*Anemone cylindrica) MP*
Early Thimbleweed (*Anemone multifida var. multifida) HP*
Alpine Sweet-grass (*Anthoxanthum monticola ssp. monticola) HP*
White Camas (*Anticlea glauca) HP*
Putty-root (*Aplectrum hyemale) HP*
Lyre-leaved Rock-cress (*Arabidopsis lyrata) MP*
Dwarf Mistletoe (*Arceuthobium pusillum) MP*
Arethusa (*Arethusa bulbosa) HP*
Green Dragon (*Arisaema dracontium) MP*
Spiked Grass (*Aristida longespica var. geniculata) MP*
Boreal Wormwood (*Artemisia campestris ssp. canadensis) HP*
Beach Wormwood (*Artemisia campestris ssp. caudata) HP*
Blunt-leaved Milkweed (*Asclepias amplexicaulis) MP*
Butterfly-weed (*Asclepias tuberosa*) MP
Whorled Milkweed (*Asclepias verticillata) MP*
Canada Milk-vetch (*Astragalus canadensis var. canadensis) HP*
Jesup's Milk-vetch (*Astragalus robbinsii var. jesupii) HP*
Blake's Milk-vetch (*Astragalus robbinsii var. minor) HP*
Smooth False-foxglove (*Aureolaria flava var. flava) MP*
Feverweed (*Aureolaria pedicularia) MP*
Downy False-foxglove (*Aureolaria virginica) MP*
Yellow Bartonia (*Bartonia virginica) MP*
Dwarf Birch (*Betula minor) HP*
Small Bidens (*Bidens discoidea) MP*
Downy Wood-mint (*Blephilia ciliata) HP*
Smooth Wood-mint (*Blephilia hirsuta var. glabrata) HP*
Hairy Wood-mint (*Blephilia hirsuta var. hirsuta) HP*
Strawberry Blite (*Blitum capitatum) MP*
Drummond's Rock-cress (*Boechera stricta) MP*
Green Rock-cress (*Borodinia missouriensis) HP*
Northern Rock-cress (*Braya humilis) HP*
Wild Chess (*Bromus kalmii) MP*
Langsdorf's Bluejoint (*Calamagrostis canadensis var. langsdorfii) HP*
Short-flower Bluejoint (*Calamagrostis canadensis var. macouniana) HP*
Pickering's Reed-grass (*Calamagrostis pickeringii) MP*
Bentgrass (*Calamagrostis stricta ssp. inexpansa) HP*
Northern Water-starwort (*Callitriche hermaphroditica) HP*
Large Water-starwort (*Callitriche heterophylla) MP*
Fairy Slipper (*Calypso bulbosa var. americana) HP*
Twin-flower Hedge Bindweed (*Calystegia silvatica ssp. fraterniflora) HP*
Low Bindweed (*Calystegia spithamaea ssp. spithamaea) HP*
Spring Cress (*Cardamine bulbosa) MP*
Cuckoo Flower (*Cardamine dentata) HP*
Small-flower bittercress (*Cardamine parviflora var. arenicola) MP*
Emmon's Sedge (*Carex albicans var. emmonsii) MP*
Foxtail Sedge (*Carex alopecoidea) HP*
Contracted Sedge (*Carex arcta) MP*
Awned Sedge (*Carex atherodes) HP*
Atlantic Sedge (*Carex atlantica var. atlantica) MP*
Howe's Sedge (*Carex atlantica var. capillacea) MP*
Blackish Sedge (*Carex atratiformis) HP*
Bicknell's Sedge (*Carex bicknellii) HP*
Bigelow's Sedge (*Carex bigelowii ssp. bigelowii) HP*
Bush's Sedge (*Carex bushii) HP*
Buxbaum's Sedge (*Carex buxbaumii) MP*

Capillary Sedge (*Carex capillaris ssp. capillaris) HP*
Creeping Sedge (*Carex chordorrhiza) HP*
Clustered Sedge (*Carex cumulata) MP*
Davis' Sedge (*Carex davisii) HP*
Urchin Sedge (*Carex echinodes) MP*
Bog Sedge (*Carex exilis) MP*
Bronze Sedge (*Carex foenea) MP*
Garber's Sedge (*Carex garberi) HP*
Flaccid Sedge (*Carex glaucodea) HP*
Slender Sedge (*Carex gracilescens) HP*
Pale Sedge (*Carex livida) HP*
False Hop Sedge (*Carex lupuliformis) MP*
Fernald's Sedge (*Carex merritt-fernaldii) MP*
Michaux Sedge (*Carex michauxiana) MP*
Troublesome Sedge (*Carex molesta) HP*
Nerveless Muehlenberg Sedge (*Carex muehlenbergii var. enervis) HP*
Muehlenberg's Sedge (*Carex muehlenbergii var. muehlenbergii) MP*
Few-fruited Sedge (*Carex oligocarpa) HP*
Richardson's Sedge (*Carex richardsonii) HP*
Schweinitz's Sedge (*Carex schweinitzii) HP*
Scirpus-like Sedge (*Carex scirpoidea ssp. scirpoidea) HP*
Hay Sedge (*Carex siccata) MP*
Dioecious Sedge (*Carex sterilis) HP*
Thin-flowered Sedge (*Carex tenuiflora) HP*
Sheathed Sedge (*Carex vaginata) HP*
Wiegand's Sedge (*Carex wiegandii) MP*
Willdenow's Sedge (*Carex willdenowii) HP*
Pignut Hickory (*Carya glabra) MP*
Pale Painted-cup (*Castilleja septentrionalis) HP*
Prairie Redroot (*Ceanothus herbaceus) HP*
Nodding Chickweed (*Cerastium nutans ssp. nutans) HP*
Wild Sensitive Plant (*Chamaecrista nictitans var. nictitans) MP*
Bush's Goosefoot (*Chenopodium berlandieri var. bushianum) HP*
Fogg's Goosefoot (*Chenopodium foggii) HP*
Field Thistle (*Cirsium discolor) MP*
Virginia Spring Beauty (*Claytonia virginica) HP*
Small-flowered Collinsia (*Collinsia parviflora) HP*
Canada Horse-balm (*Collinsonia canadensis) MP*
Autumn Coral-root (*Corallorhiza odontorhiza var. odontorhiza) MP*
Flowering Dogwood (*Cornus florida) MP*
Golden Corydalis (*Corydalis aurea) HP*
Pygmyweed (*Crassula aquatica) MP*
Biltmore Hawthorn (*Crataegus biltmoreana) MP*
Stinking Hawthorn (*Crataegus boyntonii) HP*
Brainerd's Hawthorn (*Crataegus brainerdii*) HP
Precocious Hawthorn (*Crataegus chrysocarpa var. praecox) HP*
Dodge's Hawthorn (*Crataegus dodgei) HP*
Faxon's Hawthorn (*Crataegus faxonii*) HP
Zigzag Hawthorn (*Crataegus irrasa var. irrasa) MP*
Kennedy's Hawthorn (*Crataegus kennedyi) HP*
Western Long-spine Hawthorn (*Crataegus macracantha var. occidentalis*) HP
Oakes' Hawthorn (*Crataegus oakesiana) HP*
Pea Hawthorn (*Crataegus pisifera) HP*
Poplar Hawthorn (*Crataegus populnea) HP*
Fleshy Hawthorn (*Crataegus succulenta var. succulenta) HP*
Plains Frostweed (*Crocanthemum bicknellii) MP*
Rattlebox (*Crotalaria sagittalis) MP*
Buttonbush Dodder (*Cuscuta cephalanthi) MP*
Broad-flower Dodder (*Cuscuta gronovii var. latiflora*) HP
Northern Wild Comfrey (*Cynoglossum virginianum var boreale) HP*
Low Cyperus (*Cyperus diandrus) MP*
Houghton's Cyperus (*Cyperus houghtonii) HP*
Ram's Head Lady's-slipper (*Cypripedium arietinum) HP*
Makasin's Yellow Lady's-slipper (*Cypripedium parviflorum var. makasin) HP*
Tansy Mustard (*Descurainia pinnata var. brachycarpa) HP*
Large-bracted Tick-trefoil (*Desmodium cuspidatum) HP*
Perplexed Tick-trefoil (*Desmodium perplexum) MP*
Prostrate Tick-trefoil (*Desmodium rotundifolium) MP*
Diapensia (*Diapensia lapponica ssp. lapponica) HP*
Few-flowered Panic-grass (*Dichanthelium oligosanthes*) MP
Few-flowered Panc-grass (*Dichanthelium oligosanthes ssp. scribnerianum) MP*
Spherical Panic-grass (*Dichanthelium sphaerocarpon) MP*
Rock Draba (*Draba arabisans) HP*
Hoary Draba (*Draba cana) HP*
Smooth Draba (*Draba glabella) HP*
American Dragonhead (*Dracocephalum parviflorum) HP*
American Waterwort (*Elatine americana) HP*
Small Waterwort (*Elatine minima) MP*
Tidal Spikerush (*Eleocharis aestuum) HP*
Flat-stem Spikerush (*Eleocharis compressa var. compressa) HP*
Wright's Spikerush (*Eleocharis diandra) HP*
Olive Spikerush (*Eleocharis flavescens var. olivacea) MP*
Slender Spikerush (*Eleocharis nitida) HP*
Few-flowered Spikerush (*Eleocharis quinqueflora) MP*
Robbins Spikerush (*Eleocharis robbinsii) MP*
MacGregor's Wild Rye (*Elymus macgregorii) HP*
Southern Wild-rye (*Elymus villosus var. arkansanus) HP*
Hairy Wild-rye (*Elymus villosus var. villosus) MP*
Black Crowberry (*Empetrum nigrum) HP*
Marsh Willow-herb (*Epilobium palustre) MP*
Hyssop-leaved Fleabane (*Erigeron hyssopifolius) HP*
Provancher's Dwarf Fleabane (*Erigeron philadelphicus var. provancheri) HP*
Slender Cotton-grass (*Eriophorum gracile) MP*
Rough Cotton-grass (*Eriophorum tenellum) MP*
Sessile-leaved Boneset (*Eupatorium sessilifolium) MP*
Nodding Spurge (*Euphorbia nutans) HP*
Rough-leaved Aster (*Eurybia radula) MP*
Shortleaf Fescue (*Festuca brachyphylla ssp. brachyphylla) HP*
Autumn Fimbristylis (*Fimbristylis autumnalis) MP*
False Mermaid-weed (*Floerkea proserpinacoides) HP*
Limestone Swamp Bedstraw (*Galium brevipes) HP*
Bog Bedstraw (*Galium labradoricum) HP*
Hairy Bedstraw (*Galium pilosum) MP*
Fringe-top Closed Gentian (*Gentiana andrewsii) HP*
Felwort (*Gentianella amarella) HP*
Stiff Gentian (*Gentianella quinquefolia) MP*
Spring Avens (*Geum vernum) HP*

Sharp Manna-grass (*Glyceria acutiflora) MP*
Eastern Manna-grass (*Glyceria septentrionalis) MP*
Giant Rattlesnake-plantain (*Goodyera oblongifolia) HP*
Nodding Stickseed (*Hackelia deflexa ssp. americana) HP*
Spurred Gentian (*Halenia deflexa) MP*
Alpine Sweet-broom (*Hedysarum alpinum) MP*
Sneezeweed (*Helenium autumnale) MP*
Harsh Sunflower (*Helianthus strumosus*) MP
Umbellate Hawkweed (*Hieracium umbellatum*) HP
Mare's-tail (*Hippuris vulgaris) MP*
Longleaf Bluet (*Houstonia longifolia) MP*
Beach Heather (*Hudsonia tomentosa) HP*
Green Violet (*Hybanthus concolor) HP*
Golden-seal (*Hydrastis canadensis) HP*
Broad-leaved Waterleaf (*Hydrophyllum canadense) HP*
Great St. John's-wort (*Hypericum ascyron) MP*
Orange-grass St. John's-wort (*Hypericum gentianoides) MP*
Red Pine-sap (*Hypopitys lanuginosa*) HP
Smooth Holly (*Ilex laevigata) MP*
Large Whorled Pogonia (*Isotria verticillata) MP*
Tapering Rush (*Juncus acuminatus) MP*
Alpine Rush (*Juncus alpinoarticulatus) MP*
Greater Poverty Rush (*Juncus anthelatus) MP*
Greene's Rush (*Juncus greenei) MP*
Soldier Rush (*Juncus militaris*) MP
Secund Rush (*Juncus secundus) MP*
Woodland Rush (*Juncus subcaudatus) MP*
Torrey's Rush (*Juncus torreyi) HP*
Highland Rush (*Juncus trifidus) HP*
Vasey Rush (*Juncus vaseyi) HP*
Hairy Lettuce (*Lactuca hirsuta) HP*
Beach Pea (*Lathyrus japonicus var. maritimus) MP*
Pale Vetchling (*Lathyrus ochroleucus) HP*
Marsh Vetchling (*Lathyrus palustris) MP*
Lesser Pinweed (*Lechea minor) HP*
Hairy Pinweed (*Lechea mucronata) MP*
Minute Duckweed (*Lemna perpusilla) HP*
Turion Duckweed (*Lemna turionifera) HP*
Violet Bush-clover (*Lespedeza frutescens) MP*
Hairy Bush-clover (*Lespedeza hirta ssp. hirta) MP*
Trailing Bush-clover (*Lespedeza procumbens) MP*
Large White-flowered Ground-cherry (*Leucophysalis grandiflora) HP*
Stiff Yellow Flax (*Linum medium) HP*
Grooved Yellowflax (*Linum sulcatum var. sulcatum) HP*
Lily-leaved Twayblade (*Liparis liliifolia) HP*
Tulip Tree (*Liriodendron tulipifera) MP*
American Shore-grass (*Littorella americana) MP*
Great Blue Lobelia (*Lobelia siphilitica var. siphilitica) HP*
Hairy Spike Lobelia (*Lobelia spicata var. hirtella) HP*
Hairy Honeysuckle (*Lonicera hirsuta) HP*
Swamp Fly-honeysuckle (*Lonicera oblongifolia) MP*
Many-fruited False-loosestrife (*Ludwigia polycarpa) HP*
Wild Lupine (*Lupinus perennis) HP*
Spiked Wood-rush (*Luzula spicata) HP*
Virginia Bugleweed (*Lycopus virginicus) MP*
Lance-leaved Loosestrife (*Lysimachia hybrida) MP*
Winged-loosestrife (*Lythrum alatum ssp. alatum) HP*
White Adder's-mouth (*Malaxis monophyllos var. brachypoda) HP*
Green Adder's-mouth (*Malaxis unifolia) MP*
Mountain Sandwort (*Minuartia groenlandica) HP*
Marcescent Sandwort (*Minuartia marcescens) HP*
Marble Sandwort (*Minuartia rubella) HP*
Large-leaved Sandwort (*Moehringia macrophylla) HP*
Dotted Horsemint (*Monarda punctata) HP*
Red Mulberry (*Morus rubra) HP*
Schreber's Muhly (*Muhlenbergia schreberi) MP*
Sprout Muhly (*Muhlenbergia sobolifera) MP*
Woodland Muhly (*Muhlenbergia sylvatica) MP*
Smaller Forget-me-not (*Myosotis laxa) MP*
Spring Forget-me-not (*Myosotis verna) MP*
Low Water-milfoil (*Myriophyllum humile) MP*
Boott's Rattlesnake-root (*Nabalus boottii) HP*
Glaucous Rattlesnake-root (*Nabalus recemosus) MP*
Slender Naiad (*Najas gracillima) MP*
Guadalupe Naiad (*Najas guadalupensis) MP*
Auricled Twayblade (*Neottia auriculata) HP*
Southern Twayblade (*Neottia bifolia) HP*
Dwarf Water-lily (*Nymphaea leibergii) HP*
Bog Aster (*Oclemena nemoralis) MP*
Nodding Evening-primrose (*Oenothera nutans) HP*
Woodland Cudweed (*Omalotheca sylvatica) MP*
Blunt-fruited Sweet-cicely (*Osmorhiza depauperata) HP*
Violet Wood-sorrel (*Oxalis violacea) HP*
American Ginseng (*Panax quinquefolius*) HP
Stiff Witch-grass (*Panicum flexile) HP*
Philadelphia Panic-grass (*Panicum philadelphicum var. philadelphicum) MP*
Smooth Forked Chickweed (*Paronychia canadensis) HP*
Hairy Forked Chickweed (*Paronychia fastigiata*) HP
Slender Paspalum (*Paspalum setaceum var. muhlenbergii) MP*
Pale Beardtongue (*Penstemon pallidus) MP*
Carey's Smartweed (*Persicaria careyi) MP*
Sweet Coltsfoot (*Petasites frigidus var. palmatus) MP*
American Reed (*Phragmites australis ssp. americanus) HP*
Strawberry-tomato (*Physalis grisea) MP*
Obedient Plant (*Physostegia virginiana) MP*
Black-seeded Clearweed (*Pilea fontana) HP*
Butterwort (*Pinguicula vulgaris) HP*
Jack Pine (*Pinus banksiana*) MP
Slender Mountain-rice (*Piptatheropsis pungens) MP*
White-fringed Orchid (*Platanthera blephariglottis var. blephariglottis) MP*
Tubercled Orchid (*Platanthera flava var. herbiola) MP*
Hooker's Orchid (*Platanthera hookeri) MP*
Large Roundleaf Orchid (*Platanthera macrophylla) MP*
Roundleaf Orchid (*Platanthera orbiculata) MP*
Glaucous Bluegrass (*Poa glauca ssp. glauca) HP*
Inland Bluegrass (*Poa interior) HP*
Wavy Bluegrass (*Poa laxa ssp. fernaldiana) HP*
Agassiz Kentucky Bluegrass (*Poa pratensis ssp. agassizensis*) HP

Lax Bluegrass (*Poa saltuensis ssp. languida) HP*
May-apple (*Podophyllum peltatum) HP*
Riverweed (*Podostemum ceratophyllum) MP*
Eastern Jacob's Ladder (*Polemonium vanbruntiae) HP*
Racemed Milkwort (*Polygala polygama) MP*
Ambiguous Milkwort (*Polygala verticillata var. ambigua) HP*
Whorled Milkwort (*Polygala verticillata var. verticillata) MP*
Common Solomon's-seal (*Polygonatum biflorum) MP*
Douglas' Knotweed (*Polygonum douglasii) MP*
Erect Knotweed (*Polygonum erectum) HP*
Slender Knotweed (*Polygonum tenue) MP*
White-flowered Leafcup (*Polymnia canadensis) HP*
Snail-seed Pondweed (*Potamogeton bicupulatus) MP*
Tuckerman's Pondweed (*Potamogeton confervoides) MP*
Hill's Pondweed (*Potamogeton hillii*) HP
Vasey's Pondweed (*Potamogeton vaseyi) MP*
Ogden's Pondweed (*Potamogeton x ogdenii) HP*
Bird's-eye Primrose (*Primula mistassinica) HP*
Marsh Mermaid-weed (*Proserpinaca palustris*) MP
Wild Plum (*Prunus americana*) MP
Low Sand Cherry (*Prunus pumila var. depressa) MP*
Susquehanna Sand Cherry (*Prunus susquehanae) MP*
Pinedrops (*Pterospora andromedea) HP*
Hoary Mountain-mint (*Pycnanthemum incanum) MP*
Blunt Mountain-mint (*Pycnanthemum muticum) MP*
Bog Wintergreen (*Pyrola asarifolia ssp. asarifolia) MP*
Lesser Pyrola (*Pyrola minor) HP*
Scarlet Oak (*Quercus coccinea) MP*
Scrub Oak (*Quercus ilicifolia) MP*
Dwarf Chinquapin Oak (*Quercus prinoides) MP*
Allegheny Crowfoot (*Ranunculus allegheniensis) MP*
Bristly Buttercup (*Ranunculus hispidus var. hispidus) HP*
Virginia Meadow-beauty (*Rhexia virginica) MP*
Roseroot (*Rhodiola rosea) HP*
Great Laurel (*Rhododendron maximum) HP*
Pinxter-flower (*Rhododendron periclymenoides) MP*
Capillary Beak-rush (*Rhynchospora capillacea) HP*
Lake-cress (*Rorippa aquatica) HP*
Needle-spine Rose (*Rosa acicularis ssp. sayi) HP*
Shining Rose (*Rosa nitida) MP*
Black-eyed Susan (*Rudbeckia hirta var. hirta) HP*
Western Dock (*Rumex occidentalis) HP*
Small Pearlwort (*Sagina decumbens) HP*
Peach-leaf Willow (*Salix amygdaloides) HP*
Bog Willow (*Salix pedicellaris) MP*
Satiny Willow (*Salix pellita) MP*
Tea-leaved Willow (*Salix planifolia) HP*
Bearberry Willow (*Salix uva-ursi) HP*
Water Pimpernel (*Samolus parviflorus) MP*
Canada Burnet (*Sanguisorba canadensis) MP*
Short-styled Snakeroot (*Sanicula canadensis var. canadensis*) HP
Long-styled Snakeroot (*Sanicula canadensis var. grandis) HP*
Yellow Mountain Saxifrage (*Saxifraga aizoides) HP*
Purple Mountain Saxifrage (*Saxifraga oppositifolia oppositifolia) HP*
White Mountain Saxifrage (*Saxifraga paniculata) HP*
Pod-grass (*Scheuchzeria palustris) MP*
Smith's Bulrush (*Schoenoplectiella smithii var. smithii) MP*
Slender Bulrush (*Schoenoplectus heterochaetus) HP*
Torrey's Bulrush (*Schoenoplectus torreyi) MP*
Barbed-bristle Bulrush (*Scirpus ancistrochaetus) HP*
Georgia Bulrush (*Scirpus georgianus) HP*
Whip Nutsedge (*Scleria triglomerata*) HP
Shale Barren Skullcap (*Scutellaria parvula var. missouriensis) HP*
Small Skullcap (*Scutellaria parvula var. parvula) HP*
Wild Senna (*Senna hebecarpa) HP*
Starry Catchfly (*Silene stellata) HP*
Eastern Blue-eyed-grass (*Sisyrinchium atlanticum) MP*
Cutler's Goldenrod (*Solidago leiocarpa) HP*
Sweet Goldenrod (*Solidago odora ssp. odora*) MP
Snowy Aster (*Solidago ptarmicoides) HP*
River-ledge Goldenrod (*Solidago racemosa) HP*
Squarrose Goldenrod (*Solidago squarrosa*) MP
Elm-leaved Goldenrod (*Solidago ulmifolia) MP*
Branching Bur-reed (*Sparganium androcladum) HP*
Lesser Bur-reed (*Sparganium natans*) MP
Shiny Wedgegrass (*Sphenopholis nitida) HP*
Blunt Sphenopholis (*Sphenopholis obtusata) HP*
Case's Ladies'-tresses (*Spiranthes casei var. casei) HP*
Rough Dropseed (*Sporobolus compositus) MP*
Small Dropseed (*Sporobolus neglectus) HP*
Rough Hedge-nettle (*Stachys hispida*) HP
Marsh Woundwort (*Stachys pilosa var. pilosa) MP*
Trailing Stitchwort (*Stellaria alsine) MP*
Slender Pondweed (*Stuckenia filiformis) HP*
Hybrid Thread-leaved Pondweed (*Stuckenia x fennica) MP*
Ontario Aster (*Symphyotrichum ontarionis) HP*
Inland Lance-leaf Aster (*Symphyotrichum lanceolatum var. interior*) HP
Crooked-stem Aster (*Symphyotrichum prenanthoides) HP*
Small White Aster (*Symphyotrichum racemosum) MP*
Tradescant Aster (*Symphyotrichum tradescantii) MP*
White-arrow Aster (*Symphyotrichum urophyllum) HP*
Yellow Pimpernel (*Taenidia integerrima) HP*
Rue-anemone (*Thalictrum thalictroides) MP*
Border Meadow-rue (*Thalictrum venulosum) HP*
Sticky False-asphodel (*Triantha glutinosa) MP*
Deer-hair Sedge (*Trichophorum cespitosum) MP*
Bashful Bulrush (*Trichophorum planifolium) MP*
False Pennyroyal (*Trichostema brachiatum) HP*
Common Arrow-grass (*Triglochin maritima) HP*
Three-bird Orchid (*Triphora trianthophora) MP*
Hairy-glumed False Oats (*Trisetum spicatum var. pilosiglume) MP*
Cork Elm (*Ulmus thomasii) HP*
Inflated Bladderwort (*Utricularia radiata) MP*
Northeastern Bladderwort (*Utricularia resupinata) MP*
Perfoliate Bellwort (*Uvularia perfoliata) MP*
Boreal Blueberry (*Vaccinium boreale) MP*
Dwarf Bilberry (*Vaccinium caespitosum) MP*
Deerberry (*Vaccinium stamineum) MP*
Alpine Bilberry (*Vaccinium uliginosum) HP*
Mountain Cranberry (*Vaccinium vitis-idaea) MP*

Marsh Valerian (*Valeriana uliginosa) HP*
Narrow-leaved Vervain (*Verbena simplex) HP*
Water-speedwell (*Veronica catenata) HP*
Culver's-root (*Veronicastrum virginicum) HP*
Squashberry (*Viburnum edule) MP*
Lance-leaved Violet (*Viola lanceolata ssp. lanceolata) MP*
Early Blue Violet (*Viola palmata) MP*
Lobed Violet (*Viola subsinuata) HP*
Eight-flowered Fescue (*Vulpia octoflora var. tenella) HP*
Northern Yellow-eyed-grass (*Xyris montana) MP*
Horned Pondweed (*Zannichellia palustris) MP*

Hornworts

A Hornwort (*Anthoceros agrestis) MP*

Liverworts

A Liverwort (*Anastrophyllum helleranum) MP*
A Liverwort (*Anastrophyllum michauxii) MP*
A Liverwort (*Anastrophyllum saxicola) MP*
A Liverwort (*Aneura maxima) MP*
A Liverwort (*Athalamia hyalina) MP*
A Liverwort (*Barbilophozia hatcheri) MP*
A Liverwort (*Barbilophozia kunzeana) MP*
A Liverwort (*Calypogeia suecica) MP*
A Liverwort (*Cephalozia connivens) MP*
A Liverwort (*Cephaloziella arctica) MP*
A Liverwort (*Cephaloziella elachista) MP*
A Liverwort (*Cephaloziella massalongi) MP*
A Liverwort (*Cephaloziella rubella var. elegans) MP*
A Liverwort (*Cephaloziella rubella var. rubella) MP*
A Liverwort (*Cephaloziella stellulifera) MP*
A Liverwort (*Chandonanthus setiformis) MP*
A Liverwort (*Chiloscyphus pallescens var. fragilis) MP*
A Liverwort (*Chiloscyphus polyanthos*) MP
A Liverwort (*Fossombronia foveolata) MP*
A Liverwort (*Frullania brittoniae) MP*
A Liverwort (*Frullania inflata) MP*
A Liverwort (*Frullania oakesiana) MP*
A Liverwort (*Frullania plana) MP*
A Liverwort (*Frullania selwyniana) MP*
A Liverwort (*Gymnocolea inflata) MP*
A Liverwort (*Gymnomitrion concinnatum) MP*
A Liverwort (*Harpanthus drummondii) MP*
A Liverwort (*Harpanthus scutatus) MP*
A Liverwort (*Jubula pennsylvanica) MP*
A Liverwort (*Jungermannia caespiticia) MP*
A Liverwort (*Jungermannia evansii) MP*
A Liverwort (*Jungermannia pumila) MP*
A Liverwort (*Jungermannia sphaerocarpa) MP*
A Liverwort (*Kurzia pauciflora) MP*
A Liverwort (*Lejeunea lamacerina ssp. gemminata) MP*
A Liverwort (*Lophocolea cuspidata var. alata) MP*
A Liverwort (*Lophocolea minor) MP*
A Liverwort (*Lophozia alpestris) MP*
A Liverwort (*Lophozia ascendens) MP*
A Liverwort (*Lophozia badensis var. badensis) MP*
A Liverwort (*Lophozia collaris) MP*
A Liverwort (*Lophozia excisa) MP*
A Liverwort (*Lophozia heterocolpos var. heterocolpos) MP*
A Liverwort (*Lophozia laxa) MP*
A Liverwort (*Lophozia sudetica) MP*
A Liverwort (*Marchantia alpestris) MP*
A Liverwort (*Marchantia aquatica) MP*
A Liverwort (*Marsupella sphacelata) MP*
A Liverwort (*Metzgeria crassipilis) MP*
A Liverwort (*Mylia taylorii) MP*
A Liverwort (*Nardia scalaris ssp. scalaris) MP*
A Liverwort (*Pellia megaspora) MP*
A Liverwort (*Plagiochila austinii) MP*
A Liverwort (*Radula obconica) MP*
A Liverwort (*Riccia huebeneriana ssp. sullivantii) MP*
A Liverwort (*Scapania cuspiduligera var. cuspiduligera) MP*
A Liverwort (*Scapania gymnostomophila) MP*
A Liverwort (*Scapania irrigua ssp. irrigua) MP*
A Liverwort (*Scapania lingulata var. lingulata) MP*
A Liverwort (*Scapania mucronata ssp. mucronata) MP*
A Liverwort (*Scapania paludicola var. paludicola) MP*
A Liverwort (*Scapania umbrosa) MP*
A Liverwort (*Tritomaria exsectiformis ssp. exsectiformis) MP*
A Liverwort (*Tritomaria quinquedentata var. quinquedentata) MP*

Mosses

A Moss (*Amphidium lapponicum) MP*
A Moss (*Amphidium mougeotii) MP*
Knothole Moss (*Anacamptodon splachnoides) MP*
A Moss (*Andreaea rothii) MP*
A Moss (*Anomobryum filiforme) MP*
A Moss (*Aphanorrhegma serratum) MP*
Arctoa Moss (*Arctoa fulvella) MP*
A Moss (*Atrichum tenellum) MP*
A Moss (*Aulacomnium androgynum) MP*
A Moss (*Barbula indica var. indica) MP*
A Moss (*Brachythecium acutum) MP*
A Moss (*Brachythecium campestre) MP*
A Moss (*Brachythecium digastrum) MP*
A Moss (*Brachythecium erythrorrhizon) MP*
Falcate Feather Moss (*Brachythecium falcatum) MP*
A Moss (*Brachythecium turgidum) MP*
A Moss (*Bryoandersonia illecebra) MP*
A Moss (*Bryohaplocladium microphyllum) MP*
A Moss (*Bryum pallens) MP*
A Moss (*Bryum pallescens) MP*
A Moss (*Bryum weigelii) MP*
A Moss (*Bucklandiella microcarpa) MP*
Elf Cap Moss (*Buxbaumia aphylla) MP*
Hump-backed Elves (*Buxbaumia minakatae) MP*
A Moss (*Calliergon obtusifolium) MP*
A Moss (*Calliergon trifarium) MP*
A Moss (*Campylium polygamum) MP*
A Moss (*Campylium radicale) MP*
A Moss (*Cinclidium stygium) MP*
A Moss (*Cirriphyllum piliferum) MP*
A Tree Moss (*Climacium kindbergii) MP*
A Moss (*Codriophorus aduncoides) MP*

A Moss (*Codriophorus fascicularis) MP*
A Moss (*Conardia compacta) MP*
A Moss (*Cynodontium alpestre) MP*
A Moss (*Cynodontium strumiferum) MP*
A Moss (*Cynodontium tenellum) MP*
A Moss (*Cyrto-hypnum pygmaeum) MP*
A Moss (*Cyrtomnium hymenophylloides) MP*
A Moss (*Dichelyma capillaceum) MP*
A Moss (*Dichelyma falcatum) MP*
A Moss (*Dichelyma pallescens) MP*
A Moss (*Dicranella cerviculata) MP*
A Moss (*Dicranella schreberiana) MP*
A Moss (*Dicranodontium denudatum) MP*
A Moss (*Dicranum muehlenbeckii) MP*
Ontario Dicranum Moss (*Dicranum ontariense) MP*
A Moss (*Didymodon fallax) MP*
A Moss (*Didymodon ferrugineus) MP*
A Moss (*Didymodon rigidulus var. rigidulus) MP*
A Moss (*Didymodon tophaceus) MP*
A Moss (*Distichium capillaceum) MP*
A Moss (*Ditrichum flexicaule) MP*
A Moss (*Ditrichum tortuloides) MP*
A Moss (*Drepanocladus longifolius) MP*
A Moss (*Drummondia prorepens) MP*
A Moss (*Entodon brevisetus) MP*
An Emerald Dewdrops Moss (*Ephemerum cohaerens) MP*
An Emerald Dewdrops Moss (*Ephemerum spinulosum) MP*
A Moss (*Eurhynchium hians) MP*
Small Pocket Moss (*Fissidens exilis) MP*
A Moss (*Fissidens subbasilaris) MP*
A Moss (*Fontinalis hypnoides var. duriaei) MP*
A Moss (*Forsstroemia trichomitria) MP*
A Moss (*Grimmia hartmanii) MP*
A Moss (*Grimmia longirostris) MP*
A Moss (*Grimmia muehlenbeckii) MP*
A Moss (*Grimmia pilifera) MP*
A Moss (*Grimmia trichophylla) MP*
A Moss (*Grimmia unicolor) MP*
A Moss (*Hamatocaulis vernicosus) MP*
Rock Thread Moss (*Haplohymenium triste) MP*
Blandow's Helodium Moss (*Helodium blandowii var. elodioides) MP*
A Moss (*Helodium paludosum) MP*
A Moss (*Heterocladium dimorphum) MP*
Closter's Brook-hypnum (*Hygrohypnum closteri) MP*
A Moss (*Hygrohypnum duriusculum) MP*
A Moss (*Hygrohypnum luridum) MP*
A Moss (*Hygrohypnum micans) MP*
A Moss (*Hygrohypnum molle) MP*
A Moss (*Hygrohypnum montanum) MP*
A Moss (*Hygrohypnum subeugyrium) MP*
A Moss (*Hylocomiastrum pyrenaicum) MP*
A Moss (*Hyophila involuta) MP*
A Moss (*Hypnum fauriei) MP*
A Moss (*Hypnum plicatulum) MP*
A Moss (*Hypnum recurvatum) MP*
A Moss (*Isopterygiopsis pulchella) MP*
A Moss (*Leptodictyum humile) MP*
A Moss (*Leskea gracilescens) MP*
A Moss (*Leskea obscura) MP*
A Moss (*Leucodon brachypus var. brachypus) MP*
A Moss (*Limprichtia cossonii) MP*
A Moss (*Limprichtia revolvens) MP*
Lindberg's Maple-moss (*Lindbergia brachyptera) MP*
A Moss (*Loeskeobryum brevirostre) MP*
Triangular Swan Moss (*Meesia triquetra) MP*
A Moss (*Microbryum davallianum) MP*
Micromitrium Moss (*Micromitrium tenerum) MP*
A Moss (*Mnium thomsonii) MP*
A Moss (*Myurella julacea) MP*
A Neckera Moss (*Neckera besseri) MP*
A Moss (*Neckera complanata) MP*
A Moss (*Niphotrichum canescens ssp. canescens) MP*
A Moss (*Orthotrichum ohioense) MP*
A Moss (*Orthotrichum pumilum) MP*
A Moss (*Paludella squarrosa) MP*
A Moss (*Palustriella commutata) MP*
A Moss (*Philonotis marchica) MP*
A Moss (*Philonotis muehlenbergii) MP*
A Moss (*Physcomitrium immersum) MP*
A Moss (*Plagiobryum zieri) HP*
A Moss (*Plagiomnium drummondii) MP*
A Moss (*Plagiomnium rostratum) MP*
A Moss (*Platydictya jungermannioides) MP*
A Moss (*Platydictya subtilis) MP*
A Moss (*Pogonatum dentatum) MP*
Andalusian Pohlia Moss (*Pohlia andalusica) MP*
A Moss (*Pohlia annotina) MP*
A Moss (*Pohlia bulbifera) MP*
A Moss (*Pohlia drummondii) MP*
A Moss (*Pohlia elongata var. elongata) MP*
A Moss (*Pohlia proligera) MP*
A Moss (*Pohlia sphagnicola) MP*
A Moss (*Pohlia sphagnicola Bruch & Schimp. Broth.*) MP
A Moss (*Polytrichastrum formosum) MP*
A Moss (*Polytrichastrum longisetum) MP*
A Moss (*Ptychomitrium incurvum) MP*
Felt Round Moss (*Rhizomnium pseudopunctatum) MP*
Blue Dew (*Saelania glaucescens) MP*
A Moss (*Schistidium liliputanum) MP*
A Moss (*Schistidium papillosum) MP*
A Moss (*Schistidium viride) MP*
Luminous Moss (*Schistostega pennata) MP*
A Moss (*Schwetschkeopsis fabronia) MP*
A Moss (*Scorpidium scorpioides) MP*
A Moss (*Sematophyllum adnatum) MP*
A Moss (*Sematophyllum demissum) MP*
A Moss (*Sematophyllum marylandicum) MP*
A Moss (*Sphagnum andersonianum) MP*
A Moss (*Sphagnum angermanicum) MP*
A Moss (*Sphagnum atlanticum) MP*
A Moss (*Sphagnum austinii) MP*
Bartlett's Peatmoss (*Sphagnum bartlettianum) MP*

A Moss (*Sphagnum brevifolium) MP*
Low Peatmoss (*Sphagnum compactum) MP*
A Moss (*Sphagnum contortum) MP*
Henry's Peatmoss (*Sphagnum henryense) MP*
A Moss (*Sphagnum inundatum) MP*
A Moss (*Sphagnum isoviitae) MP*
Lindberg's Sphagnum (*Sphagnum lindbergii) MP*
A Moss (*Sphagnum mcqueenii) MP*
A Moss (*Sphagnum platyphyllum) MP*
Beautiful Peatmoss (*Sphagnum pulchrum) MP*
Five-ranked Bogmoss (*Sphagnum quinquefarium) MP*
Recurved Peatmoss (*Sphagnum recurvum) MP*
A Moss (*Sphagnum riparium) MP*
A Peatmoss (*Sphagnum subfulvum) MP*
Delicate Peatmoss (*Sphagnum tenellum) MP*
Giant Peatmoss (*Sphagnum torreyanum) MP*
A Moss (*Sphagnum viride) MP*
A Moss (*Syntrichia ruralis) MP*
A Moss (*Thelia asprella) MP*
A Moss (*Timmia megapolitana ssp. megapolitana) MP*
A Moss (*Tomenthypnum falcifolium) MP*
A Moss (*Tortella fragilis) MP*
A Moss (*Tortella inclinata var. densa) MP*
A Moss (*Tortella inclinata var. inclinata) MP*
A Moss (*Tortula mucronifolia) MP*
A Moss (*Tortula obtusifolia) MP*
A Moss (*Trichostomum crispulum) MP*
A Moss (*Weissia muhlenbergiana) MP*

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Chapter 6

Landscape Conservation

2015

6. Landscapes and the Conservation of Vermont's Species of Greatest Conservation Need

Introduction

Maintaining and enhancing landscape integrity and ecological function across Vermont is fundamental to conserving our natural heritage and Species of Greatest Conservation Need. Large, connected landscapes are particularly important for wide-ranging species (e.g., Northern Goshawk, Bobcat, Black Bear, Canada Lynx, and American Marten). And because landscape conservation is the most efficient strategy for ensuring the persistence of the many smaller-scale habitats found within a landscape, it is critical to the conservation of many not-so-wide-ranging SGCN as well. Moreover, healthy, intact landscapes enhance the capacity of species and communities to shift and adapt to the changing climate. For these reasons landscape-scale conservation is a fundamental strategy of this Wildlife Action Plan.

Wide-ranging species require large areas encompassing a variety of habitats in order to find sufficient food, shelter and mates. The home range requirements of our wide-ranging SGCN vary greatly from species to species, as do requirements of habitat quality and the number of individuals needed to sustain a population. For example, some area-sensitive birds may require a minimum forest block size of 7,500 acres (Robbins et. al. 1989). Bobcat populations of 250 breeding females require approximately 2,000 square miles, and maintaining Vermont's black bear population may require as much as 6,000 square miles of habitat (Vermont Fish & Wildlife Black Bear Management Plan 1999). Canada Lynx, Wolf, and American Marten range so widely that Vermont alone can meet only a portion of their populations' current or potential habitat needs. Therefore, our landscape conservation efforts cannot stop at the state's borders.

This chapter describes the condition of Vermont's landscapes (historic, current and desired), provides a framework for identifying and prioritizing landscapes important to SGCN and natural heritage conservation based on six key landscape components (Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings), identifies SGCN benefitting from landscape conservation, and identifies significant threats and priority conservation strategies. Additional details and maps of our landscape conservation approach can be found in the report Vermont Conservation Design: Maintaining an Ecologically Functional Landscape (Appendix F).

Landscape Condition

Historical condition: Forests have dominated the Vermont landscape for most of the last 4,500 years—predominantly Northern Hardwood, Spruce-Fir Northern Hardwood and Oak-Pine Northern Hardwood Forests. The forests were continuous, covering mountains and valleys, with intact riparian zones, except in those areas with significant, long-term Native American settlement. Wildlife and plants moved freely, streams and rivers meandered across natural floodplains and natural processes were intact. It has been estimated that 95% of Vermont was forested when Europeans first arrived in the early 1600s. The population of Native Americans in the Champlain Valley and Connecticut River valley in the early 1600s was only 8,000 and only a small amount of forestland was cleared for agriculture, primarily in the river valleys (Klyza and Trombulak 1999). Significant forest clearing began with the arrival of European settlers, however, primarily for lumber, fuelwood, potash, and agriculture. It has been roughly estimated that the percent of forest cover in Vermont was reduced to 82% by 1790, 47% by 1850, and reached a low of 37% by 1880, after which the area of forest began to increase as farms were abandoned (various sources in Klyza and Trombulak 1999). According to Harper (1918), by 1850 more than 60% of the land in New England had been cleared for agriculture.

The impact to Vermont's landscape was not limited to these cleared areas. Forests in the region that were not cleared were typically on steep slopes, stony ground, or poorly drained soils. Many of these were heavily harvested for timber and or used as woodland pastures, with the result that virtually all of our forests have been altered by human activity (Whitney 1994). In general, our forests today are much younger than the presettlement forests. The composition of presettlement forests was also different from our present-day forests, as has been described in several studies of early land survey records that documented witness and boundary line trees (Siccama 1971, Cogbill 1998, Cogbill 2000, Cogbill et al. 2002). These studies indicate that beech was much more abundant in presettlement forests, whereas sugar maple and white pine were less abundant. Red spruce was more abundant in mid-elevation presettlement forests, whereas red maple, white birch, and poplars – species now associated with younger forests and human activity – were much less abundant in the presettlement forests (Cogbill 2000).

Aquatic habitat degradation was another result of the extensive land clearing for forestry and agriculture given that aggressive stream clearing of boulders and coarse woody debris was engaged in for stream log driving and flood control, and by dam construction and railroad and road building. Such activities have resulted in the relocation and straightening of stream and river channels throughout Vermont, resulting in an overall decrease in available riverine habitat. For example, a recent assessment of the upper White River watershed between Granville and Stockbridge shows that 93% (17.8 of 19.1 miles) of the length of the mainstem White River has been channelized in the past, 13 miles of which are still in channelized form (Vermont Department of Environmental Conservation 2004). In addition, the extensive removal of natural substrates, such as boulders and coarse woody debris, has reduced overall stream habitat complexity throughout the Northeast (Verry et al. 2000). The hard armoring of channels combined with the construction of flood control dams means that many of Vermont's river channels have not regained their historic sinuosity. Furthermore, the slow regrowth of the Northeast's forests means that large woody debris contribution to stream and river channels has yet to reach historic levels (Verry 2000).

Prior to European settlement in the northeastern United States, natural disturbance (including wind, fire, and flooding) were the primary forces affecting the region's forests. In Vermont, wind has been the primary source of natural disturbance in upland forests, ranging from frequent local blowdowns of individual trees to infrequent hurricane events that can affect thousands of acres. A recent study, based on the review of many sources of information, provides figures on the expected percentage of the presettlement regional landscape occupied by different age classes (Lorimer and White 2003). For northern hardwood forest, the expected percentage occupied by uneven aged forest over 150 years ranges from 70 to 89 percent, depending on the assumptions and models used. In these forests, from 1.1 to 3.0 percent was occupied by early successional forests (1-15-year age class). For spruce-northern hardwood forest, the expected percentage occupied by uneven aged forest over 150 years ranges from 35 to 78 percent, depending on the assumptions and models used. In these forests, from 2.4 to 7.1 percent was occupied by early successional forests (1-15-year age class).

Current Condition: Currently, Vermont is approximately 8 percent water, 71 percent forest and 21 percent non-forest (including open, agricultural and developed land). These statistics do not, however, express the degree of intactness of these terrestrial and aquatic habitats, nor the barriers in our forest and stream systems.

VFWD conducted an analysis of unfragmented forest blocks in Vermont (Sorenson and Osborne 2014). Each of 4,055 forest blocks was analyzed and ranked for biological and physical diversity factors. Vermont's largest block is 153,000 acres. The average block size statewide is 1,000 acres. But block size is not evenly distributed across the landscape. As seen in figure 1, the largest habitat blocks occur along the spine of the Green Mountains and in the northeastern portion of the State. In the Northeastern Highlands biophysical region, for example, the average block size is its 6,810 acres and 2,694 acres in the Green Mountains. In the Piedmont average block size is 830 acres and in the Champlain Valley it is only 413 acres.

Desired Condition (SGCN Needs): To maintain the full complement of Vermont's Species of Greatest Conservation Need and particularly of wide-ranging species such as American Marten, Canada Lynx and Wolf, Vermont needs landscapes of large, connected habitat blocks with interior forests, surface waters and riparian areas where ecological processes and native species are most likely to persist and adapt to climate change. These areas should represent all natural communities (in all successional stages), habitats and physical landscape diversity. Distributed across all Vermont biophysical regions, these landscapes should be connected locally and regionally, now and in the future as land use and climate change, by way of smaller blocks, riparian areas and rivers to allow for plant and animal movement and migration. Structural and functional connectivity should be maintained and enhanced across and under roads and other transportation structures.

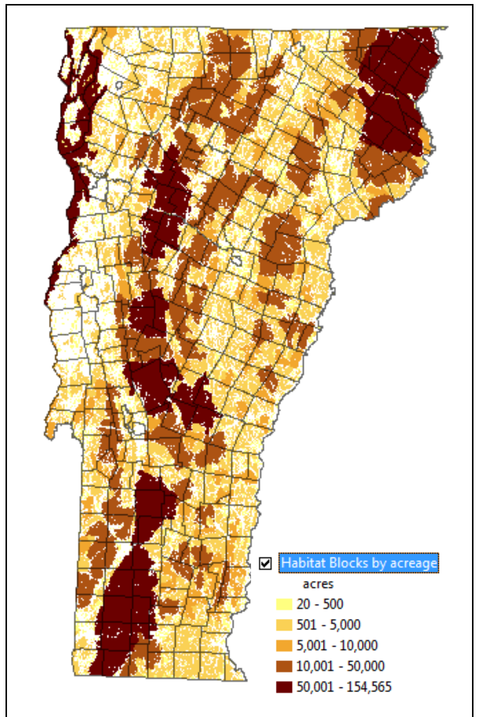


Fig.1. **Habitat Blocks by Size** (acres)
Sorenson & Osborne 2014

Several wide-ranging wildlife species will not persist or re-establish without linkages to other states and Canada. Therefore, regional connectivity (i.e., linkages to New York, New Hampshire, and Canada) must be maintained. Linkages along riparian habitats will also provide connectivity for both semi-aquatic and upland species.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement landscape conservation recommendations of the Wildlife Action Plan since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust, the Forests, Parks & Recreation Department, The Nature Conservancy, Audubon Vermont, and Green Mountain National Forest. The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has acquired in fee and through conservation easements many high priority sites that further landscape conservation and provide critical landscape connectivity. From 2005-2013, the Department acquired 41 separate parcels (excluding fishing access areas) in fee totaling more than 4,100 acres to be added to WMAs or to create new WMAs. VFWD also acquired more than 2,300 acres under conservation easement during the same period. All of these projects either directly or indirectly benefit SGCN. Partner organizations including the Forests, Parks & Recreation Department, The Nature Conservancy, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Use Value Appraisal program (Current Use), and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015) (appendix F). This report identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

The Natural Resources Conservation Service and the Farm Services Agency are both part of the US Dept of Agriculture and both have riparian buffer restoration programs that have partnered with the USFWS and Vermont Agency of Agriculture. While their focus is on water quality, they've produce sizable riparian forest buffers.

The Partners for Fish & Wildlife program of the U.S. Fish & Wildlife Service, which organizes and supports community-based habitat restorations, partnered with more than 600 landowners on more than 550 projects to restore 294 miles of riparian habitat, 5,476 acres of wetland habitat, 976 acres of upland habitat and 1,200 acres of habitats impacted by invasive species. Partners also reopened 1,438 miles of stream to fish passage; and completed 11 miles of in-stream restoration.

Species of Greatest Conservation Need Benefitting from Landscape Conservation

Without landscape-scale conservation, some species are unlikely to remain on our landscape. These are wide-ranging species, including the American Marten, Canada Lynx, Bobcat, Northern River Otter, Bald Eagle, Red-shouldered Hawk and Northern Goshawk. Wolf and Eastern Mountain Lion likely could not return without secure landscapes. Landscape conservation, however, is also expected to benefit most of Vermont's other Species of Greatest Conservation Need as the landscape functions identified here are necessary for either their immediate habitat and movement needs, or for their long-term genetic exchange and climate adaptation needs.

Landscape Characteristics

As part of the Wildlife Action Plan revision, Vermont conducted a broad-based assessment of landscape-level biological and ecological data to identify lands and waters that are of highest priority and value for maintaining Vermont's ecological integrity. The resulting report, Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape (Sorenson et al. 2015) appendix F) identified six landscape elements as most effective at capturing the needs of many Species of Greatest Conservation Need and their habitats. They are Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings and are described below.

The assessment identified the blocks, riparian areas and road crossings that are a parsimonious solution to conserving a functional landscape. High priority areas for each element were mapped and will be made available to conservation practitioners and others via the BioFinder website. The report and maps can also be found in Appendix F.

The goal is to maintain the ecological functions provided by each landscape element. For example, the goal for Interior Forest Blocks is to maintain the unfragmented, interior forest of these areas that provides critical habitat for many species of plants and animals. There is considerable leeway on what can happen within a forest block and still maintain interior forest function. For example, most responsible forest management activities are compatible with maintaining the long-term interior forest functions for these blocks. Each section below provides guidelines on what is needed to maintain ecological functions for that element.

While each landscape element is important on its own, it cannot function in isolation. Maintaining or enhancing an ecologically functional landscape in Vermont depends on both the specific function of the element and the ability of landscape elements to function together. Interactions between elements are what support Vermont's environment and are essential for long-term conservation of Vermont's biological diversity and natural heritage.

By 'conservation' we mean a wide range of activities, from private land stewardship to public ownership and other activities that help maintain ecological function. Many tools can be used to achieve the overall goal. With approximately 80% of Vermont's land privately owned, management and stewardship of private lands will be essential to achieving these goals. Other tools include local planning and zoning, state regulations, conservation easements, and ownership by a state or federal agency or a private conservation organization. This document and these maps do not provide detail as to which of these tools are best suited to specific places, but there are recommendations for further prioritization filters that users can apply to make these decisions.

Interior Forest Blocks: Areas of contiguous forest and other natural communities and habitats (such as wetlands, ponds, and cliffs) that are unfragmented by roads, development, or agriculture.

Forest blocks were identified, mapped, and ranked by Sorenson and Osborne (2014). These forest blocks provide many ecological and biological functions critical for protecting SGCN and the integrity of natural systems (Austin et al. 2004), including:

- Supporting natural ecological processes such as predator-prey interactions and natural disturbance regimes;
- Helping to maintain air and water quality and flood resilience;
- Supporting the biological requirements of many plant and animal species, especially those that require interior forest habitat or require large areas to survive;
- Supporting viable populations of wide-ranging animals by allowing access to important feeding habitat, reproduction, and genetic exchange; and
- Serving as habitat for source populations of dispersing animals for recolonization of nearby habitats that may have lost their original populations of those species.

In addition, large, topographically diverse forest blocks will allow many species of plants and animals to shift to suitable habitat within a forest block in response to climate change within the next century without having to cross developed areas to other forest blocks. (Beier 2012)

Connectivity Blocks: The network of forest blocks that together provide terrestrial connectivity at the regional scale (across Vermont and to adjacent states and Québec) and connectivity between all Vermont biophysical regions.

Landscape connectivity refers to the degree to which blocks of suitable habitat are connected to each other (Noss and Cooperrider 1994). There is a high level of connectivity within individual forest blocks. The proximity of one forest block to another and the characteristics of the intervening roads, agricultural lands, or development determine the effectiveness of the network of Connectivity Blocks in a particular area.

A network of Connectivity Blocks allows wide-ranging animals to move across their range, allows animals to find suitable habitat for their daily and annual life needs, allows young animals to disperse, allows plant and animal species to colonize new and appropriate habitat as climate and land uses change, and contributes to ecological processes, especially genetic exchange between populations (Austin et al. 2004). There is general agreement among conservation biologists that landscape connectivity and wildlife corridors can mitigate some of the adverse effects of habitat fragmentation on wildlife populations and biological diversity (Beier and Noss 1998; Noss and Cooperrider 1994; Haddad et al. 2003; Damschen et al. 2006). Specifically, climate change adaptation is enhanced if the long distance movements of plants and animals is supported by a combination of short movements within large, topographically diverse forest blocks and short corridor movements between forest blocks (Beier 2012).

Surface Waters and Riparian Areas: The network of all lakes, ponds, rivers, and streams, their associated riparian zones and valley bottoms in which geophysical processes occur, and their connections to groundwater.

Vermont's rivers, streams, lakes, and ponds provide vital habitat for a rich assemblage of aquatic species, including fish, amphibians, reptiles, invertebrates (e.g., insects, mussels, snails, worms, freshwater sponges), and plants. This represents an enormous contribution to Vermont's biological diversity. The ecological integrity of an aquatic system is dependent on the condition of the watershed in which it occurs, but is also critically tied to the condition of the riparian area adjacent to the stream or pond. For stability, rivers and streams must have access to their floodplains and freedom to meander within their valley bottoms or river corridors. Naturally vegetated riparian areas provide many critical ecological functions, including stabilizing shorelines against erosion, storage of flood waters, filtration and assimilation of sediments and nutrients, shading of adjacent surface waters to help moderate water temperatures, and direct contribution of organic matter to the surface water as food and habitat structure. Riparian areas are also critical habitat for many species of wildlife that are closely associated with the terrestrial and aquatic interface, including mink, otter, beaver, kingfisher, spotted sandpiper, and wood turtle. Furthermore, the shorelines and riparian areas of rivers and lakes support floodplain forests, several other rare and uncommon natural communities, and many species of rare plants and animals. In addition to these ecological functions that are tied to aquatic systems, the linear network of riparian areas provides a critical element of landscape connectivity for plant and animal movement in response to climate change (Beier 2012). Although many riparian areas and river corridors are highly altered by agriculture, roads, and urbanization, the risk of flooding serves as a natural deterrent for future development. Riparian areas also respond rapidly to restoration efforts (Beier 2012).

Riparian Areas for Connectivity: The connected network of riparian areas in which natural vegetation occurs, providing natural cover for wildlife movement and plant migration.

In addition to supporting the integrity of the lakes, ponds, rivers, and streams that they border, naturally vegetated riparian areas are especially important for providing cover for wildlife movement and other important wildlife habitat, such as nesting habitat for birds. Many wildlife species use riparian corridors for travel to find suitable habitat to meet their life requisites, but certain species are almost entirely restricted to riparian areas, including mink, otter, beaver, and wood turtle. The linear nature of riparian areas contributes to their function as movement corridors for wildlife. Roads, development, and agricultural lands fragment the Vermont landscape. The combination of Riparian Areas for Connectivity and Connectivity Blocks provide the best available paths for connectivity across the landscape.

Physical Landscape Diversity Blocks: Blocks that include physical landscape diversity features that are either rare in Vermont or under-represented in the land and water areas identified as highest priority for Interior Forest Blocks, Connectivity Blocks, and Surface Waters and Riparian Areas.

The Physical Landscape Diversity Blocks complement the other block types and riparian areas to more fully represent the full spectrum of physical landscape diversity that is important for an ecologically functional landscape. Physical landscape diversity is represented in this conservation design by rare Land Type Associations (Ferree and Thompson 2008) and Ecological Land Units stratified by elevation, adapted from Ferree and Anderson (2008).

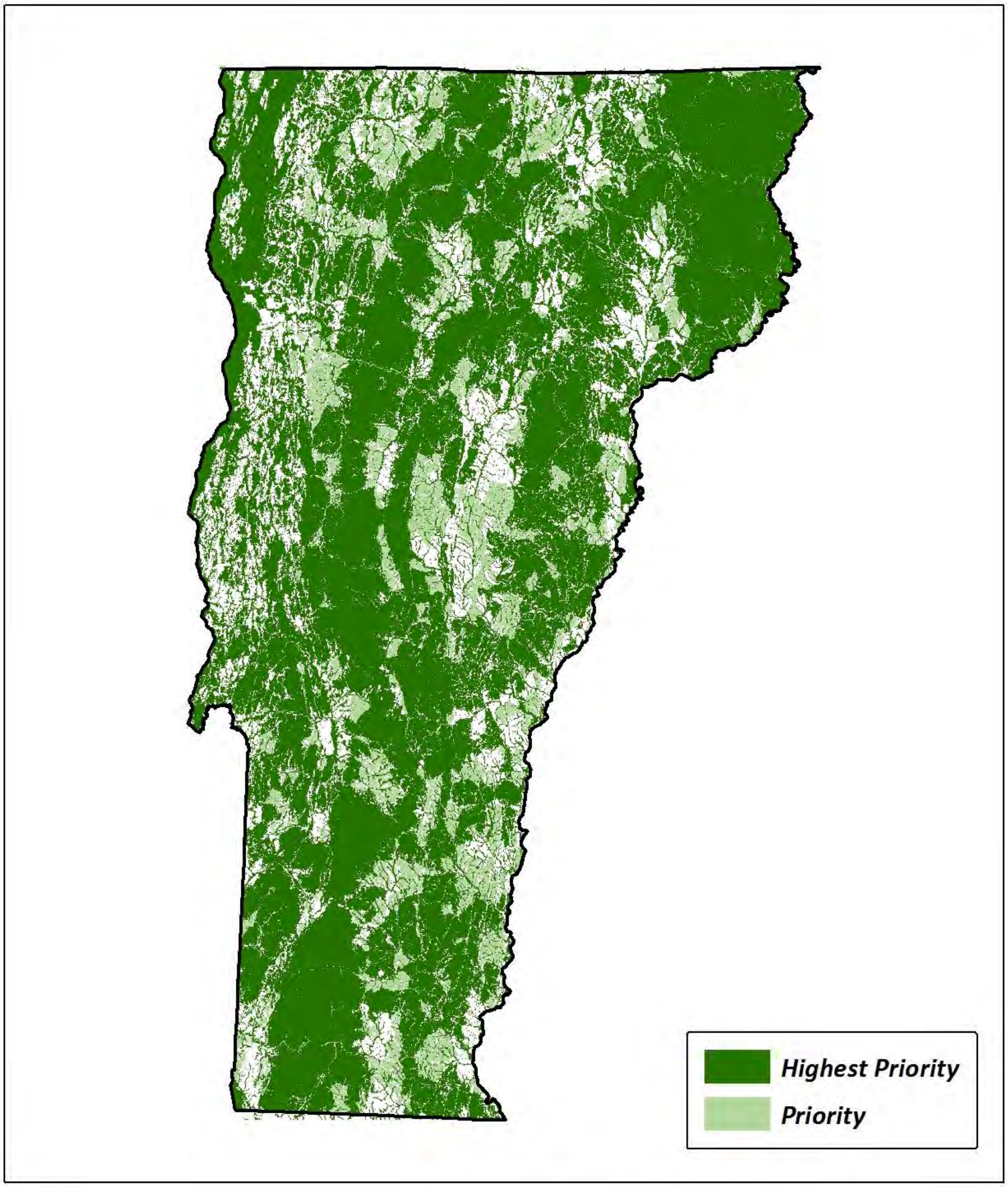
Physical landscapes (often referred to as enduring features) are the parts of the landscape that resist change. They are the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. They remain constant even when changes in land cover and wildlife occur, as plants and animals move, and even as the climate changes. However, these physical landscapes cannot continue to drive ecological processes or support plants, animals, or natural communities if they are developed or otherwise significantly altered by human activities.

Wildlife Road Crossings: Sections of road that cross a wildlife corridor where the adjacent landscape quality and permeability are high, usually because the road is adjacent to a forest block, and the road is the primary impediment to animal movement. Likely wildlife road crossings are identified statewide in VFWD's habitat block project (Sorenson and Osborne 2014).

Wildlife corridors (also referred to as wildlife connecting habitats) are lands and waters that connect larger patches of habitat together within a landscape and allow the movement, migration, and dispersal of animals and plants (Austin et al. 2004). Roads represent a barrier to wildlife movement and dispersal of many other species, including some plants. Sections of roads that have suitable habitat on both sides are more likely to allow wildlife movement and dispersal of other species and, therefore, these sections of roads are critical components of maintaining or enhancing an interconnected, ecologically functional landscape. Wildlife road crossings that provide connectivity over or under roads are critically important between adjacent forest blocks and along linear riparian area networks.

The Ecologically Functional Landscape

Maintaining and enhancing an ecologically functional landscape in Vermont depends on conservation of the five landscape level elements described above. It is the specific functions of each alone and their complementarity functioning together that are critical for long-term conservation of much of Vermont's biological diversity and natural heritage. The following map shows the ecologically functional landscape conservation design developed for this Wildlife Action Plan revision. It excludes the Surface Waters and Riparian Areas elements which are difficult to display at this scale.



Map 1. The Highest Priority and Priority portions of the Ecologically Functional Landscape, including Interior Forest Blocks, Connectivity Blocks, and Physical Landscape Diversity Blocks (excluding the Surface Waters and Riparian Areas which are difficult to interpret at this scale).

Threats & Information Needs

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Determine SGCN Habitat Requirements	Some SGCN and RTE species need to be more confidently captured by landscape and natural community/habitat conservation.	High
Habitat Conversion	Permanent conversion of large blocks of forest to housing development, commercial development, and roads	High
Habitat Fragmentation	Fragmentation of large forest blocks, riparian corridors, and migration paths disrupts animal movement and ecological processes.	High
Impacts of Roads	Roads and road usage disrupt animal movements, alter water quality and stream migration and provide pathways for introduction of invasive species.	High
Climate Change	Species will need to shift their distributions in response to climate-driven habitat and environmental changes. This will be more difficult in a fragmented landscape.	High
Invasive Exotic Species	Invasive species can degrade some landscape scale processes such as species movement and migration. For example, riparian corridors dominated by Japanese knotweed are less suitable for native plant and animal movement.	High
Habitat Conversion	River channel straightening and bank hardening contributes to loss of floodplain connectivity, habitat loss, and downstream erosion and flooding.	High
Habitat Fragmentation	Interruption of movement corridors to and from breeding, feeding, and seasonal habitats via conversion, degradation, and road mortality (i.e., herps).	High

Priority Conservation Actions

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop a system to track habitat loss and conversion statewide.	Change in habitat status. Re-run the statewide habitat block analyses every 5 years	ANR, VTrans, ACCD, UVM, VNRC, NOAA, USGS, VLT, TNC	SWG, PR, ANR
Develop systems to better track habitat quality and protection status	-Apply change metrics (e.g., percent conserved) major landscape components (e.g., blocks, connectivity). -For riparian areas compare acres in restoration vs row crop, hay, developed (using Natl. Landcover dataset every 5-yrs). -FIA forest condition	ANR, VTrans, ACCD, UVM, VNRC, NOAA, USGS, TNC, VLT, Staying Connected, NOAA	SWG, PR, ANR, NOAA (CCAP)
Continue reviewing town plans and bylaws every 10 years to determine municipal level conservation status. Develop spatial component to this assessment.	*Metrics in development*	VFWD, VNRC, ACCD, AVCC	VFWD, ACCD

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Complete the Vermont Conservation Design project by Identifying habitat and species-level conservation goals for SGCN species and make the results widely available.	Identify all habitats and natural communities that are not conserved by landscape-scale features. For each, identify its role as a coarse filter for species, and develop quantitative and/ or spatially explicit conservation targets	FPR, TNC, GMNF, VCE, VLT,	SWG, PR
Refine models of habitat connectivity (e.g., BioFinder's network of Connected land, Local Road Crossings, Staying Connected Linkage Models, Structural pathways)	Number of suitable habitat patches available, miles of riparian corridors & linkages conserved.	TNC, USFWS, USFS, VTrans, NWF	SWG, VHCB, FPR, TNC, VTrans
Support conservation through fee simple purchase and easements on high priority sites	Number of acres conserved	ANR, VLT, TNC, VHCB, other land trusts	VHCB, VLT, USFS, USFWS, LWCF, Forest Legacy
Protect from inappropriate development the highest priority areas identified in the Vermont Conservation Design	Number of acres protected	ANR, VLT, TNC, TPL, VHCB, Towns, RPCs, and other land trusts	VHCB, VLT, USFS, USFWS, LWCF, Forest Legacy
Provide Technical assistance to private landowners, user groups and forest managers to reduce habitat fragmentation and degradation and to restore and enhance degraded habitats.	Number of landowners managing for species of greatest conservation need	NRCS, TNC, VFWD, FPR, Coverts, SAF VWA, NWF	SWG
Restore riparian areas to enhance riparian connectivity at sites identified in Vermont Conservation Design report (appendix F).	Increase in number of acres of riparian habitat restored and/or conserved	ANR, Agency of Agric., VTrans, Rivers Conservancy Municipal Road Managers	
Financial incentives for private landowners to reduce problems and fragmentation to habitats for wide ranging species and to restore and enhance degraded habitats	Number of acres affected/restored	VFWD, NRCS, Coverts	EQIP
Provide technical assistance to towns and Regional Planning Commissions. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004) and Community Strategies for Vermont's Forests and Wildlife (VNRC 2013)	Number of towns incorporating wide-ranging species into planning	VFWD, VNRC, RPCs, VFS, AVCC, SAF, VWA, Coverts, Keeping Track	VFWD
Technical assistance to state and federal land management agencies	Number of state and federal land management plans providing for Lynx and Marten habitat	ANR, USFWS, USFS	ANR
Increase cooperation/ coordination between adjacent states and provinces to support and encourage trans-jurisdictional actions to address issues such as global climate change, acid rain and connectivity.	Implementation of trans-jurisdictional actions.	USFWS, USFS, ANR, other states and provinces, VTrans, USDOT, TNC, Staying Connected,	USFWS, AFWA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor, protect and restore water quality from excessive nutrient sediment loading, other pollutants.	Miles of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, USFS, Lake & Watershed Associations	
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species. Develop plans at landscape-scale.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	DEC, FPR, USFWS, GMNF, NRCS, FSA, Ag, municipal & watershed groups, lake associations foresters,	ANR, NRCS, FSA
Support efforts to reduce the long-range transport of acid rain pollutants to Vermont.	Reduction in acidity levels in monitored high elevation waterbodies	ANR, USFS, AG office, Legislature, Congress.	
Restore aquatic connectivity based on Aquatic Organism Passage recommendations	Miles of passage restored	NRCS, USFWS, VTrans, TU, EBTJV, Watershed Groups	EQIP, CREP, ANR, VTrans
Support efforts to manage flow regulation projects to minimize impacts on SGCN	Decrease in number of river miles with altered flow regimes	ANR, ACOE, VT Dam Task Force, USFWS, watershed orgs	LBCP, USFWS, ACOE, SWG
Provide technical assistance to VTrans, to identify and maintain (or restore) terrestrial & riparian habitat connectivity and improve aquatic organism passage	Number of functional linkages across highways/roads Increase in % or number of road crossings that do not impede aquatic organism movement	ANR, VTrans, Better Back Roads, USFWS, USFS, AVCC, TNC	SWG, USFWS, LCBP, VTrans
Develop road management BMPs for habitat connectivity and vegetation management		VTrans, VFWD, Staying Connected	FHWA
Increase the number of road structures meeting fish and wildlife passage guidelines	Number of improved/upgraded structures	VTrans, VFWD, Staying Connected, USFWS	FHWA,
Fund and support a natural resource planner position at each RPC (use the RPC transportation planner as a model)	Number of Regional Planning Commissions with natural resource planner. Number of Regional Planning Commissions requesting technical assistance	ANR, USFWS, USFS, EPA, RPC, VFWD, VNRC, Staying Connected	ANR, USFWS, USFS, EPA,
Provide more fish, wildlife & natural resource oriented technical assistance to constituent towns for town plan rewrites and bylaw changes	Number of town plans and bylaws with improved language	VNRC, RPCs, VFWD	
Support municipal-scale natural resource inventories and collaborative efforts by towns to identify, prioritize and protect habitat and natural resources.	Number of towns with completed inventories of their natural resources.	VFWD, VNRC, Enviro Consultants	

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Chapter 7

Monitoring, Implementation & Review

2015

Monitoring & Adaptive Management

"However beautiful the strategy, you should occasionally look at the results."
—Winston Churchill

Elements five and six of the Eight Required Elements for Wildlife Action Plans outline Congressional expectations for monitoring and plan review:

5. Proposed plans for monitoring species [of Greatest Conservation Need] and their habitats, the effectiveness of the conservation actions proposed in the 4th element [strategies], and for adapting these conservation actions to respond appropriately to new information or changing conditions.
6. Descriptions of procedures to review the strategy at intervals not to exceed ten years.

Just as a doctor checks a patient's blood pressure at every visit, wildlife monitoring allows biologists to identify changes in the health of wildlife (e.g., population changes, the spread of disease, changes to the landscape). Biologists can also monitor the impact of strategies to determine effectiveness just as doctors assess the efficacy of treatments and compare competing medical practices. The goal is not simply to cure one patient but improve the standard of care for all patients.

Taken together elements five and six speak to the need for a program to track changes in wildlife populations and their habitats, and to hone the effectiveness of actions. Adaptive management is a formalized method for learning from experience where design, management, and monitoring are integrated to test assumptions in order to adapt, learn and improve (Salafsky et. al. 2001). Instead of relying on a fixed conservation goal and an inflexible plan for achieving the goal, adaptive management provides a framework of planning, acting and monitoring for midcourse corrections (Figure 5.1).

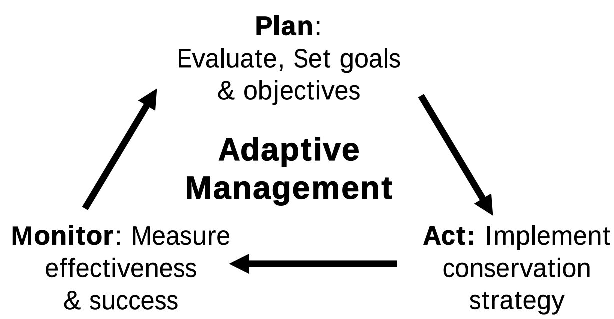

Fig 7.1 Basic steps in an adaptive management process (adapted from Noss & Cooperider 1994)

In the initial **planning** phase for this Wildlife Action Plan teams identified threats and problems limiting SGCN and their habitats and then developed of conservation strategies and research recommendations that the could be implemented during an **action** phase. Measuring the effectiveness and success of the action would occur in the **monitoring** phase. The cycle begins anew with the fine-tuning of goals and objectives before action is renewed.

Current Survey and Monitoring of Vermont's Wildlife and Habitats

The list of current survey and monitoring programs providing relevant data for the conservation and management of SGCN is remarkably long. The Fish & Wildlife Department, sister departments at the Agency of Natural Resources the Department of Environmental Conservation (DEC), the Department of Forests, Parks & Recreation (FPR), and other conservation partners monitor the status of several threatened and endangered species, as well as some rare species, some habitats and some uncommon natural communities. The following is a cursory review of survey and monitoring efforts in that may benefit SGCN conservation and management. It is not meant to be comprehensive.

Species Surveys and Monitoring

Amphibians & Reptiles: The Vermont Reptile and Amphibian Atlas (VtHerpAtlas.org) is an ongoing citizen science research and monitoring project begun in 1995 that tracks the distribution of reptiles and amphibians in Vermont. VFWD monitors threatened and endangered reptiles and amphibians including the Rattlesnake and Spiny Softshell Turtle, and a SWG-funded survey of vernal pools catalogued some 2500 vernal pool amphibian breeding sites statewide.

Birds: Birds are the most studied and best monitored group of wildlife in Vermont—and nationally. A monumental advancement in bird monitoring during the past decade was the completion and publication of Vermont's Second Vermont Breeding Bird Atlas (2013). A collaborative effort, the Atlas was developed with more than 350 citizen scientists contributing more than 50,000 hours over five years to document every bird species breeding across the state. The project was led by the Vermont Center for Ecostudies (VCE), the Fish & Wildlife Department and others, with significant SWG funding. Other important Vermont bird monitoring efforts include: the annual Breeding Bird Surveys, Mountain Birdwatch, Forest Bird Monitoring Project and LoonWatch (VCE); Common Tern and Peregrine Falcon monitoring programs (Audubon and VFWD); Bald Eagle, Wild Turkey, American Woodcock, waterfowl, and Double Crested Cormorants (VFWD). Regional and national monitoring efforts include the Breeding Bird Survey and Atlantic Coast Joint Venture.

Fish: VFWD, the University of Vermont and Vermont Cooperative Fish and Wildlife Research Unit, and other partners have surveyed a broader range of fishes including Lake and Round whitefishes, Lake Trout, Stonecat, Eastern Sand and Channel darters, and Muskellunge. And, a robust, long-term monitoring program for Lake Sturgeon is now underway. *Fishes of Vermont* (Langdon et. al. 2006) is supported by VDEC's 9,000 record fish distribution database. Non-native invasive species, such as alewife, are also the subject regular surveys. Notwithstanding these and other accomplishments executed under the 2005 WAP and looking forward, long-term monitoring of SGCN, more specifically brook lampreys, cyprinids, redhorses and others, require directed attention to obtain baseline population and habitat metrics, as well as development of a long-range plan for species monitoring.

Invertebrates: Significant advances were made in the past decade in assessing the status of Vermont's invertebrates—most projects were SWG funded. The Vermont Butterfly Survey (2002-2007), a statewide survey and analysis of historic records and collections documented the distribution of 103 butterfly species, including 12 species new to Vermont. The first statewide dragonfly and damselfly survey focused on peatlands and large river habitat was completed in 2009 providing species distribution and occurrence information which has broadened our understanding of these rare habitat-specialists (Vermont Damselfly and Dragonfly Atlas). The Cobblestone Tiger Beetle and the Hairy-necked Tiger Beetle were the focus of dedicated surveys from 2005-2010. The Vermont Bumble Bee Atlas (2012-2013) led by VCE had biologists and trained citizen scientists searching more than 1,500 locations across the state and recording more than 10,000 individual bumble bee encounters. And, surveys were conducted to determine the status of Vermont's freshwater mussels, their habitat needs, fish hosts and to establish appropriate species population goals. Virtually all other invertebrate taxa remain largely uninvestigated and unknown in Vermont and basic background surveys to document the presence and distribution of major orders of insects in Vermont are needed.

Mammals: Deer, Moose, Black Bear and furbearing species are closely monitored by VFWD which also monitors the endangered American Marten, Canada Lynx and several bat species in both winter hibernacula and summer maternity colonies. The Small Mammals Atlas (2007-2009) compiled historic documents and museum collections and conducted field surveys documenting 2,844 small mammal captures from 47 sites and created distribution maps for all 23 small mammal species in Vermont. Additionally, Keeping Track, Inc. has citizen monitoring teams in many sections of the state and region collecting long-term data on Black Bear, Bobcat, Moose, Fisher, River Otter, and Mink. Numerous individual localized surveys also occur but most are not ongoing, repeatable monitoring efforts. Since 2013 VFWD and VTrans with help from TNC and NWF have implemented three wildlife camera and road tracking projects to survey wildlife's use of transportation infrastructure.

Habitat and Vegetation Surveys and Monitoring

VFWD conducts ongoing natural community inventory identifies and maps natural community types statewide. A survey and report on the distribution, ecology, classification of hardwood swamps was completed in 2004. VFWD also updates and maintains data on known and mapped significant natural communities, maps natural communities on state land and works with non-governmental organization partners to map or identify significant natural communities on NGO lands. Since 2005 we have completed natural community inventories of Limestone Bluff Cedar-Pine Forest, softwood swamps, Montane Spruce-Fir Forest, are nearly complete with an inventory of Dwarf Shrub Bog and Poor Fen, and are in the last year of oak-pine forest inventory. Cedar bluffs used CARA funds, bogs and fens and softwood swamps used EPA funds, and Montane Spruce-Fir Forest and oak-pine forests used SWG funds. These inventories are a critical part of FWD conservation work at the SGCN level and at the community level.

The Ambient Biomonitoring Program in DEC's Watershed Management Division has been monitoring the biological integrity of Vermont's lakes, wetlands, rivers, and streams for more than 30 years. It tracks long-term trends in water quality through changes over time to fish and macroinvertebrate populations. In 2014 alone the program collected and identified over 100,000 invertebrates from approximately 150 stream collections and usually samples 60-70 stream sites per year for fish.

The Lake Champlain Long-term Water Quality and Biological Monitoring Project began in 1992. A joint effort shared by DEC and the New York State Department of Environmental

Conservation, the primary purpose of the project is to detect long-term environmental change in the lake.

The Forest Inventory and Analysis (FIA) is a recurring inventory conducted by the US Forest Service's FIA Unit of the Northeastern Research Station in conjunction with the Vermont Department of Forests, Parks & Recreation. The inventory provides data for measuring changes and trends in the extent and condition of forest land, associated timber volumes, and rates of timber growth, mortality, and removal (Wharton et. al 2003). Though this information is developed primarily for timber management and does not track old-growth forests it does provide important information to wildlife managers.

The National Resources Inventory program of the National Resource Conservation Service (NRCS) collects and distributes data on a state, regional and national level about the status, condition, and trends of soil, water, and related resources. The focus is primarily on agricultural lands with data includes available land-use types and land-use changes, erosion, and wetlands.

The Forest Ecosystem Monitoring Cooperative (FEMC), previously known as the Vermont Monitoring Cooperative, coordinates numerous monitoring and survey operations in Vermont focusing primarily on forest health issues. The Cooperative's databases house more than two decades of data gathered for five main components of the forested ecosystem: air, water, forest, wildlife and soil resources.

VFWD's ongoing natural community inventories identify and map natural community types statewide and map and monitor state significant natural communities. Since 2005, the following natural community types/Wildlife Action Plan habitat types have been surveyed or inventoried: Significant Limestone Bluff Cedar-Pine Forests of Vermont (2006), Softwood Swamp Inventory (2010), Montane Spruce-Fir Forest Inventory (2010), Bogs and Poor Fens (2013), Oak-Pine Forest Mapping and Inventory (in progress).

Other Monitoring

Technical Assistance Impact: More than 80% of Vermont's land base is privately owned and, land use decision-making is a municipal responsibility (there are 273 municipalities each with separate land use plans and planning authorities). With so much land in private hands guided by local decision making, helping landowners and municipalities make good decisions is critical to protecting and conserving the state's SGCN and their habitats, this is why both the 2005 Wildlife Action Plan and the 2015 revision invest heavily the provision of technical assistance.

Tracking the impact of this technical assistance, and it effectiveness, is both important and difficult. Every 10-years, beginning in 2000, VFWD has reviewed every town plan and bylaw in the state pertaining to fish and wildlife species and habitat protections in order to provide insight into the progress made through municipal planning. The data indicates that protection trends are increasing. VFWD is currently working with UVM researchers and municipal planning partners to develop a conceptual model of community based decision-making processes which can then be used to develop better indicators, measures and success metrics. Technical assistance provided to private landowners is also tracked. For example, from 2003-2013 VFWD and the Natural Resources Conservation Service (NRCS) collaborated on 1,206 new wildlife habitat enhancement projects with as many private landowners. Project funding was through NRCS's Wildlife Habitat Improvement Program (986) and Environmental Quality Incentives Program (220). Follow-up effectiveness monitoring occurs on all projects.

Public Support: VFWD regularly surveys the public, landowners and recreationalists to determine trends in wildlife, conservation, recreation and management policies. This information is critical to effective and responsive long-term management. The most recent survey occurred in July 2015. It found that 83 percent responded, when asked to compare the importance of wildlife with economic development that the use and development of land should be restricted to protect fish and wildlife; and 81 percent responded that wildlife habitat must be protected even if it reduces the land use options of some landowners and developers (Duda et al 2015). The USFWS conducts its National Survey of Fishing, Hunting, and Wildlife Associated Recreation every five years (most recently 2011) and documented that 62 percent of Vermonters went fishing, hunting, or wildlife watching. Vermont ranked second, only two points behind Alaska in participation (U.S. Dept of Interior 2011).

Meeting the Congressional Requirements for Monitoring and Adaptive Management

Monitoring is clearly a linchpin in the adaptive management process. Monitoring is also a complex, demanding and expensive task that never ends. Monitoring was also the weakest link of virtually every Wildlife Action Plan in 2005. The reason is that with the funding and staffing resources available to states, monitoring the status of all SGCN and their habitat and threats was simply not possible. For the 2015-2025 Vermont's Action Plan Monitoring and Adaptive Management Program will focus on the following elements:

1. Landscape Change Monitoring
2. Monitoring of Threatened & Endangered Species and other select SGCN
3. Taxa-wide surveys
4. Development of baseline distribution and abundance estimates:
5. Survey/Monitoring Protocol Development
6. Regional Monitoring of SGCN and Habitats
7. Threat Monitoring
8. Effectiveness Monitoring

Landscape Change Monitoring

The landscape conservation elements of this Wildlife Action Plan (chapter 6) with the accompanying Vermont Conservation Design (appendix F) focuses on the lands and waters of highest priority for maintaining ecological integrity. This connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features on which plant and animal natural communities depend, when conserved or managed appropriately to retain or enhance ecological function, is expected to sustain Vermont's natural legacy into the future.

With this premise in mind, monitoring the status of landscape protection, connectivity and quality will be key to the successful implementation and adaptive management of the

Wildlife Action Plan. Vermont therefore expects to do the following during the coming Action Plan implementation period:

- **Develop and implement systems to track habitat loss and conversion and habitat quality and protection status**: Such tracking could include: Running the statewide habitat block analyses (first completed in 2008) every five years to determine trends; Developing metrics for connectivity blocks, interior forest blocks, diversity blocks and riparian areas (e.g., change in the percentage conserved by GAP status; change in E-911 datasets); Analyzing the Forest Inventory Analysis (FIA) forest conditions datasets and national land-cover datasets every five years to compare acres of restoration in riparian areas to the percentage in row crop, hay and developed;. Working with NOAA, NALCC and other regional partners to develop finer scale satellite data (e.g., increasing the granularity from the current 30m pixel images to 5m pixels would significantly improve our ability to detect change)
- **Municipal Conservation Monitoring:** Continue reviewing town plans and bylaws every 10-years to determine municipal level conservation status (and to assess the effectiveness of technical assistance programs). Research the development of a spatial component to this assessment.
- **Complete the Vermont Conservation Design**: The Design currently identifies only landscape-scale (coarse filter) conservation elements (Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings). While we have confidence that conserving these coarse filter elements will also conserve *most* of the species they contain, Vermont intends to augment the design with finer scale elements in order to meet the needs of all of Vermont's wildlife and wild plants. The next phase, habitats/natural community elements will be in 2016-2017. This will be followed by species-level elements for those SGCN not conserved by the coarser filters.

Monitoring of Threatened & Endangered Species and other select SGCN
Monitoring programs are in effect for many of the state and/or federally listed species in Vermont, including, for example, the Spiny Softshell Turtle, Timber Rattlesnake and Eastern Ratsnake, Bald Eagle and Common Tern, Lake Sturgeon, Canada Lynx, Little Brown Bat, and Jesup's Milk-vetch and Northeastern Bulrush. Monitoring programs remain in effect for Peregrine Falcon and Common Loon which were both removed from Vermont's endangered species list in 2005. The statewide status for all SGCN can be tracked through changes to their State Rank (SRank) which is performed by VFWD's Wildlife Diversity program. This was done for most taxonomic groups in the two years leading up to this Wildlife Action Plan revision.

Many of the surveys described above in the section titled "Current Survey and Monitoring of Vermont's Wildlife and Habitats" will continue, and additional surveys for other SGCN will be initiated as staffing and budgets allow. Regional species assessments will also be supported through a collaboration of the fish and wildlife agencies of the 13 northeastern states (Northeast Association of Fish & Wildlife Agencies) which together fund projects through the Regional Conservation Needs program such as the Wood Turtle Status Assessment and Dragonfly and Damselfly Status Assessment.

Taxa-wide surveys

The Vermont Breeding Bird Atlas is the state's most comprehensive bird survey. The first Atlas (published in 1981) documented the distribution of every bird species breeding in the state. The second Atlas (published 2013) repeated this effort and in doing so documented changes in species distributions. The best data we have for many species. To complete this exhaustive, statewide survey took monumental effort with hundreds of volunteers donating thousands of hours from 2003-2007. The long-standing Vermont Reptile & Amphibian Atlas has been tracking the distribution of Vermont's reptiles and amphibians for years. Newer efforts initiated by the Vermont Center for Ecostudies, with VFWD funding, include: Vermont Butterfly Survey (2007) and the Vermont Bumble Bee Survey (2013) providing our first statewide snapshots of these groups where the data was collected in a rigorous, repeatable manner. The Vermont Damselfly & Dragonfly Atlas covers the distribution of all 142 species known from Vermont. While it may be another 20 years before they are repeated, they can provide vital information regarding species status and trends. Additional statewide surveys may be initiated for other taxonomic groups in the coming years including the Vermont Tiger Beetle Atlas.

Development of baseline distribution and abundance estimates

While great strides were made since 2005 with surveys and inventories for many species and taxonomic groups, little data exists for many other SGCN (lack of data was one criterion for selection as a Species of Greatest Conservation Need). Determining SGCN distribution and abundance is needed in order to establish meaningful baseline data which then can be used to determine measurable goals and objectives that are the foundation of monitoring priorities.

Survey/Monitoring Protocol Development

Rigorous protocols for surveying, monitoring and data analysis for many species do not exist, or are not applied consistently throughout a species' range to provide robust data. VFWD will continue to collaborate with partners on the development of survey protocols through programs such as the Forest Ecosystem Monitoring Cooperative and NEAFWA's Regional Conservation Needs program (e.g., A Framework for Coordinated Bird Monitoring in the Northeast and Development of Regional Analysis for Frog Call Survey Data from the North American Amphibian Monitoring Program). To be successful, any Action Plan monitoring program will need to address these four challenges. It is hoped that the Action Plan and SWG funds will help direct future research and development efforts, facilitate the integration of existing monitoring projects across organizations and improve collaboration.

Regional Monitoring of SGCN and Habitats

The Northeast states collaborated to develop the Northeast Regional Monitoring and Performance Measures Framework (NEAFWA 2008) which identified representative habitats and species groups and proposed indicators of status and trends. States then tasked The Nature Conservancy to test the Framework with a GIS-based evaluation of target habitats conditions, population trends, and land protection status. The final report, Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape (Anderson and Olivero 2011), provides baseline measures at the regional level from which to gauge changes and progress on conservation efforts. Vermont will work with the northeast states to support repeating this evaluation every 5-10 years to provide regional-scale measures of SGCN and habitat status.

Threat Monitoring
Vermont will continue to monitor for diseases such as White-nose Syndrome (bats), Snake Fungal Disease (rattlesnakes), Chronic Wasting Disease (deer), Viral Hemorrhagic Septicemia (fishes), *Batrachochytrium salamandrivorans* (salamanders) and Avian Influenza (birds) and many other diseases affecting SGCN that have been found or could be introduced to the state. Vermont has also programs in effect to monitor for the eventual arrival of forest pests, including the Asian long-horned beetle and emerald ash borer, in order to prevent the establishment and/or limit their spread within the state. Vermont lacks rigorous method for tracking the loss of habitat across the state.

Project and Program Monitoring
In addition to monitoring the status of species, habitat and threats impacting their populations, we also need implementation, effectiveness and validation monitoring (Derr et. al 2005) to ensure that goals and objectives are achieved and funds are spent wisely.

- **Implementation Monitoring:** Assessing the degree to which a conservation strategy was implemented (e.g., were trees planted in a riparian area?).
- **Effectiveness Monitoring:** Measuring the impact or effect of a conservation strategy (e.g., did planting trees in the riparian area stabilize the streambank?—the strategy's objective).
- **Validation Monitoring:** Checking the assumptions upon which the conservation strategy was based (e.g., did stabilizing the streambank actually reduce sedimentation of spawning beds downstream, producing more brook trout fry? —the project's goal). Validation monitoring can help answer questions such as: Is the conservation strategy worth repeating or might another strategy produce results faster, more economically, or meet with better social acceptance?

Together they provide the basis for measuring effectiveness of conservation actions and the adaptive management of fish and wildlife (required element 5). Guidance for effectiveness available in the Northeast Regional Monitoring and Performance Measures Framework (NEAFWA 2008) and Measuring the Effectiveness of State Wildlife Grants Final Report, (AFWA 2011). The foundation these guidelines is the development of conceptual models which explain the causal pathways by which managers believe that a project will achieve its desired results. Both reports recommend using results chains, a graphical diagram that links an action to the desired impact through a series of short, medium, and long-term results in an "if-then" fashion to identify appropriate measures or indicators. AFWA (2011) offers model results chains for many generic actions found in Vermont's Action Plan, including: direct management of natural resources; species restoration; creation of new habitat; land acquisition, easement, lease; conservation area designation; environmental review; management planning; land use planning; training and technical assistance; data collection and analysis; outreach to key resource users; conservation incentives; and stakeholder involvement. AFWA also discusses the potential for applying effectiveness measures to overall of Wildlife Action Plan effectiveness (2011). As VFWD develops indicators and measures for Action Plan implementation projects we will consult this guidance.

Tracking and reporting project effectiveness will occur primarily using Wildlife TRACS (Tracking and Reporting Actions for the Conservation of Species), a database developed by the US Fish & Wildlife Service for tracking and reporting conservation activities funded through its Wildlife and Sport Fish Restoration Program. It will include an effectiveness tracking component intended to track and report project outputs, effectiveness measures, and species and habitat outcomes (based on Measuring the Effectiveness of State Wildlife Grants Final Report, AFWA 2011). It should be noted that though TRACS will provide a consistent system for tracking projects effectiveness, it may take years to determine if a project is indeed effective (e.g., waiting for trees to grow to sufficient height to shade a stream) and validation of a strategy's success may be difficult to tease out from other problems impacting a species or a site (e.g., the strategy did produce more brook trout fry but the results were masked two unseasonably hot summers and an accidental chemical spill).

VFWD annually reports on progress in the implementation of its strategic plan. Where possible, Action Plan indicators will be incorporated in this annual report (e.g., land acquisition, habitat management, status of select species).

Considerations for monitoring program development

Before any new monitoring programs are initiated a review of existing efforts and careful planning are required. Such planning should take into account the following considerations:

Collaboration: Planning to develop and implement a Species of Greatest Conservation Need monitoring program should begin with collaboration. As with the design of actions in this report, successful monitoring of SGCN will require the help and cooperation of many partners. Many current survey and monitoring efforts are conducted by interagency and inter-organizational efforts locally, regionally and nationally. These collaborations share expertise, make the best of limited resources, prevent redundancies of effort, increase the level of expertise of volunteers and improve program quality and effectiveness.

How much collaboration is needed? As many entities as possible should be brought together to develop consistent monitoring protocols and systems for data collection and data sharing, identifying indicators for species and habitats and goals and objectives for SGCN conservation.

The need for collaborative fund raising efforts cannot be overstated. Sufficient funds are imperative for monitoring to be effective. The State Wildlife Grants program currently is not sufficiently funded to finance the monitoring needs outlined here. Even if it was, state-side match is insufficient. A collaborative effort of agencies, conservation partners, local, state and federal elected officials, NGOs and private businesses and individuals is needed to develop adequate funding mechanisms at the state and federal levels.

Coordination: The coordination of monitoring programs, summarizing of results and sharing data with resources managers, researchers, local, state and national decision makers, educators, stakeholders and the general public will be essential to the success of a monitoring collaborative, to Action Plan efforts and to wildlife conservation in general. Solid coordination throughout the implementation phase will also make revisions of the Action Plan report straightforward and uncomplicated.

Indicators: Monitoring every SGCN, their habitats, problems and the effects of conservation actions is too costly and time-consuming to ever complete. Relevant indicators that are measurable, precise, consistent, and sensitive are needed as coarse filters to make monitoring useful and manageable. Indicators should also be of appropriate scale, easily obtained and obvious in meaning so that results can be supported by a broad array of users.

Citizen Science: Successful monitoring projects such as VINS' Bird Atlas, Butterfly Atlas and LoonWatch, the Vermont Reptile and Amphibian Atlas, Keeping Track Inc.'s big mammal monitoring, Audubon's Christmas Bird Counts, and Great Backyard Bird Count and VFWD's Big Game Report Stations provide multiple benefits that should be considered in the development of new monitoring efforts. In addition to the direct benefits—improved wildlife knowledge—citizen-based monitoring also provides wildlife education through active field work on local projects, boosts awareness of and involvement in natural resource protection at the community level, and can be highly cost-effective.

FEMC as a Model for Coordination of Statewide SGCN Monitoring: The Forest Ecosystem Monitoring Cooperative (FEMC), previously known as the Vermont Monitoring Cooperative, is a collaborative partnership that collects and pools information and data on Vermont's forested ecosystems. Participating cooperators from government, academic and private sectors, conduct research projects on a variety of topics including forest health, air quality and meteorology, wildlife and aquatic systems. The Cooperative makes the data and results from these projects available to other scientists, educators, resource managers and the public through its online data library and card catalogue containing the data and metadata from more than 100 projects.

Data storage and data sharing: The volume of government (local, state, federal), NGO, and private sectors data available for plants, animals, ecosystems, climate, geology, hydrology, social and economic that could be used to conserve wildlife is simply huge. The management, storage and accessibility of monitoring data will be a significant issue for any coordinated monitoring efforts. VFWD's Natural Heritage Inventory manages much of the current data for rare wildlife in collected in Vermont but the program is already understaffed. The Natural Heritage Inventory is the Vermont affiliate to NatureServe (www.natureserve.org) an international network of biological inventories—known as natural heritage programs and conservation data centers—operating in all 50 U.S. states, Canada, Latin America and the Caribbean. NatureServe collects and manages data on rare, threatened and endangered plants, animals, and ecosystems, establishes scientific standards for biological inventory and biodiversity data management, and develops data management tools.

Adapting Conservation Actions and the Wildlife Action Plan in Response to New Information or Changing Conditions

The Little Brown and Northern Long-eared Bats underscore the need to adapt management to changing conditions and information. In 2003, VFWD established a Bat Conservation and Management Program determine the distribution and abundance of nine bat species and to identify conservation strategies for these bats. Then in 2008 White-Nose Syndrome (WNS) appeared in the Northeast and monitoring efforts revealed population declines in excess of 90% between 2008 and 2010 for Little Brown and Northern Long-eared Bats at many hibernacula. Several of the high priority conservation strategies identified in 2003 had to set aside as biologist scrambled to identify the cause and extent of WNS and to prevent the total extirpation of these species. Action Plan monitoring and review procedures will be the primary tool to identify new information, changing conditions and the need for adaptation. It will act at three scales—individual conservation projects, ongoing plan-wide adaptations (year-to-year), and 10-year plan review.

The iterative nature of adaptive management (plan→ implement→ monitor→ evaluate→ plan→…) builds opportunities to adapt directly into Action Plan project management activities. Project reporting, monitoring and the increased communication and coordination among conservation partners fostered by Action Plan implementation will feed into overall Action Plan management from year-to-year. The USFWS allows states to incorporate significant "Emerging Issues" into the Wildlife Action Plan without full plan-wide revisions to their Action Plans, as was done with bats and WNS in 2009. All this information will be used to formally review and revise the Action Plan on a 10-year cycle (see also Action Plan Review later in this chapter).

Action Plan: Implementation

Congressional intent for Wildlife Action Plans is for states to identify and address the needs of species that might require help in order to prevent their becoming threatened or endangered. The full import of the word “comprehensive” becomes overwhelmingly clear as numbers in this report are tallied (more than 2,000 threats and 1,000 conservation actions identified for 133 vertebrate species, 200 invertebrates, 645 plants and more than 100 habitat/community/landscape categories). The next steps, conducting the recommended research, setting species and habitat goals and objectives, implementing strategies and designing and implementing the monitoring programs outlined in this report requires the continued help and support of all conservation partners—those that participated in the Action Plan development and new partners as well.

Congress has designated state fish & wildlife agencies as Action Plan and State Wildlife Grants (SWG) custodians because these agencies are mandated by state law to manage and protect wildlife. Custodial responsibilities include not only delivering the completed Action Plan but also for regular review and updating of the Action Plan report and administrating SWG funds. To carry out these responsibilities the VFWD will assign sufficient staff and resources to this program to manage projects, coordinate efforts and monitor overall program operations.

The VFWD will take the lead in coordinating the implementation of the research and monitoring recommendations and conservation strategies described in this report. While the Department may be responsible for implementing much of the research, monitoring and conservation strategies, Conservation partners may be the more logical and appropriate leaders for other research and strategy implementation, due to their skills and expertise, staffing, history, location, available resources and constituencies.

The Action Plan will remain a work in progress for many years, an experiment in long-term multi-species conservation on a broad scale. Much of the work in this document is ground breaking. Many of the species examined here have not received focused attention before. The next few cycles of implementation, review and updating of individual strategies and the Action Plan report overall will be the particularly important for working out kinks, testing methods, and improving aspects of the Action Plan.

Implementation and Participation

As a wildlife conservation plan for the entire state, the Wildlife Action Plan includes some strategies that almost any individual or organization can implement. And, any and all interested partners are encouraged to take part. Though many of these actions will not require the notification of VFWD, tracking the implementation and outcomes of actions will help with the monitoring and adaptive management goals outlined elsewhere in this chapter. All participating partners are encouraged to consult with VFWD prior to taking action.

The Vermont Fish & Wildlife Department will work to keep Conservation Partners and the public informed of Action Plan implementation through communications with partners, partnerships and collaborations, requests for proposals, meetings and conferences as well as through general outreach, education and technical assistance programs.

Impacts on other species, habitats and ecological processes and functions should always be considered when implementing conservation actions to benefit Species of Greatest Conservation Need (SGCN). Implementation may also be subject to changing conditions and regulatory review (where required) and should be conducted in cooperation with land managers, land owners and key stakeholders. Large scale conservation efforts (e.g., broad scale monitoring) should be coordinated through VFWD, interagency workgroups and formal agreements where applicable.

Coordination and Collaboration

As noted throughout this report, coordination of efforts is vital to leveraging available resources to ensure maximum wildlife benefit. VFWD will take the lead in facilitating communications among conservation partners, including local, state and federal agencies. We expect that other partners will also take the initiative to build additional partners just as they did in response to the first Wildlife Action Plan. For example the Vermont Forest Roundtable convened by VNRC in 2006 as a venue for information exchange and policy discussions to address parcelization and forest fragmentation issues regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics; and, the Wildlife Management Institute organized many government and non-government partners in the northeast for implementation of the Woodcock Conservation Plan.

Coordination between the 13 northeast states and Washington D.C. occurs through the Northeast Association of Fish & Wildlife Agencies (NEAFWA) and the regional office of the USFWS Division of Federal Assistance. NEAFWA established the Regional Conservation Needs (RCN) Program in 2008 to formalize a cooperative approach Action Plan implementation across multiple states. The purpose of the RCN program is to develop, coordinate, and implement conservation actions to address issues, threats, and opportunities that are most effectively tackled at a regional scale. More recently, the USFWS's North Atlantic Landscape Conservation Cooperative has been bringing many regional partners together to develop planning, research and monitoring efforts for the Northeastern states.

National coordination will be spearheaded by the Association of Fish & Wildlife Agencies and the US Fish & Wildlife Service.

Prioritizing Conservation Need

During the identification and assessment of SGCN our Action Plan technical teams began the process to prioritize conservation need through the following actions: SGCN were assigned either medium or high priority status (low priority species are deemed relatively secure for now, see Action Plan development), conservation actions, research and monitoring needs and habitat problems were similarly ranked.

We did not prioritize needs and actions beyond this. The Action Plan is a conservation guide for the state—not only VFWD or the Agency of Natural Resources. It is meant to provide guidance to organizations, agencies and individuals who wish to conserve wildlife. The goals and missions of the many and varied partners involved in the project span a broad spectrum of wildlife interests, skills and reach (some are very local, others are state, regional and federal entities). It was clear that there would be no prioritization that would satisfy all partners and that conservation need is so great that there is room for everyone to select the species and habitats they find most important and implement the strategies they are most capable of working on.

When it comes to allocating SWG funds to specific projects, further prioritization is required. Prioritization will take into account the goal of the SWG program—to keep wildlife populations from declining to the point that they require protection under the federal Endangered Species Act (ESA)—and Congressional intent— that SWG funds benefit wildlife that have not historically been the primary beneficiaries of the Federal Aid in Wildlife Restoration Act, Federal Aid in Sport Fish Restoration Program or the federal ESA. Prioritization will also be based on the impact of problems to SGCN and habitats, the project's ability to affect positive change, other conservation and social impacts and the availability of matching funds and project personnel.

Action Plan Review

Element number six of the eight required elements for an Action Plan (see Chapter 1: Congressional Guidelines) requires that states provide "descriptions of procedures to review the strategy at intervals not to exceed ten years."

Vermont will update its Action Plan on a 10-year cycle. Ten years will allow for planning, and implementation of actions and for detecting responses in at least some SGCN populations. Vermont's adaptive management approach to Action Plan implementation, however, means that species and habitat monitoring, formal project reporting and financial tracking will be ongoing and will provide a constant flow of information during the intervening years. Managers, wildlife planners and biologists will use this data to hone strategies, fine tune operations and make mid-course corrections within each ten year cycle. Review activities will include:

- Twice yearly expenditure tracking for individual projects by SWG project managers.
- Annual financial reporting of all in-kind match for individual projects by SWG project managers.
- Full project reports due within 90 days of completion of individual SWG projects by SWG project managers.
- Providing regular Federal Assistance reports to the US Fish & Wildlife Service Division of Federal Assistance.

The process to review and update the Action Plan in 2025 should begin at least two years prior to the deadline. The current thinking is that the review process should mirror the current Action Plan revision process to update each of the eight elements from the original congressional guidelines as follows:

1. Revise the list of SGCN and update information on the distribution and abundance of SGCN. Which species can be removed from the list, which should be added?
2. Update information on the location and condition of key habitats. Describe key habitats of any new SGCN.
3. Describe threats and problems impacting SGCN and their habitats. Update research needs.
4. Review the success of conservation actions implemented to date. Identify conservation actions to conserve SGCN and their habitats.
5. Review Action Plan monitoring efforts to date. Describe plans to monitor species, habitats and conservation actions for the future.
6. Update and describe the process for the next plan review.
7. Review coordination efforts to date. Update plans to coordinate with other plans and planning entities.
8. Revise and describe plans to include the public in the design and implementation of the next Action Plan report.

The Vermont Fish & Wildlife Department will work to keep Conservation Partners and the public informed of Action Plan revision through communications with partners, partnerships and collaborations, meetings and conferences as well as through general outreach, education and technical assistance programs.

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Chapter 8

Revising Vermont's Wildlife Action Plan

2015

Revising Vermont's Wildlife Action Plan

The revision Vermont's Wildlife Action Plan began in earnest January 2013 when a Revision Team of Vermont Fish & Wildlife Department staff met to begin project scoping. Federal guidelines, planning literature and past planning efforts were reviewed and an organizational structure and revision process were subsequently developed. Prior to this, in 2012 VFWD conducted assessments of vulnerability to climate change for 18 species and 44 habitats. The identification of Species of Greatest Conservation Need (SGCN) occurred from July 2014 through January 2015. Habitat delineation for SGCN, problem assessment and strategy development occurred from October 2014 through June 2015. Integration and conservation planning ran from May through August 2015. Review and additional input by the Department, agencies and other stakeholders and the public, occurred between September and November 2015. Final document preparation and editing occurred in December 2015.

The Planning Team reaffirmed five primary goals used to guide its first Wildlife Action Plan as the revision's guiding framework, and added two additional goals:

1. Conserve, enhance and restore Vermont's wildlife and wildlife habitat.
2. Represent good science and conservation planning.
3. Identify conservation priorities yet remain flexible and open to new opportunities.
4. Develop the Action Plan for the entire state; one that all agencies, organizations and individuals can find useful.
5. Build and support advocates for wildlife conservation.
6. Build on the good work of the first Wildlife Action Plan.
7. Develop the Action Plan in a manner that will support regional roll-up of Wildlife Action Plan information among member states of the Northeast Association of Fish & Wildlife Agencies per the Northeast Lexicon (Crisfield 2013) for improved regional conservation.

The Planning Team recognized that meeting these goals required the resources, participation and ingenuity of many conservation-minded individuals, organizations and agencies. This in turn required a development process that included conservation partners to the greatest extent possible. Six teams of taxonomic experts (Species Teams) and a Landscape Team and were created to develop the Wildlife Action Plan. Team members are listed in table 8.1.

Species Teams: (selected Fish and Wildlife staff and other taxonomic experts). Six Species Teams were created: Amphibian & Reptile (Herps), Bird, Fish, Invertebrate, Mammal, and Plant. These teams developed and refined lists of Species of Greatest Conservation Need; assessed species distribution and abundance, identified habitats, communities, threats and actions; developed monitoring and performance measures.

Landscape Team: (selected Fish and Wildlife staff and conservation partners with expertise in GIS, landscape assessment and conservation design). The Landscape Team was charged with developing a landscape-level conservation design for the state, one that would address the needs of most, if not all, Species of Greatest Conservation Need.

Table 8.1: Team and Committee Members, Wildlife Action Plan Revision

*Denotes team/committee chairpersons

Vermont Action Plan Revision Team		**Bird Team**	
Steve Parren*	VT Fish & Wildlife Dept	John Buck*	VT Fish & Wildlife Dept
Ken Cox	VT Fish & Wildlife Dept	Dr. William Barnard	Norwich University
Steve Gomez	VT Fish & Wildlife Dept	Chip Darmstadt	North Branch Nature Center
Jon Kart	VT Fish & Wildlife Dept	Margaret Fowle	Audubon VT
Eric Sorenson	VT Fish & Wildlife Dept	John Gobeille	VT Fish & Wildlife Dept.
Susan Warner	VT Fish & Wildlife Dept	Mark LaBarr	Audubon VT
Lael Will	VT Fish & Wildlife Dept	Sally Laughlin	First VT Bird Atlas
		Dr. Rosalind Renfrew	VT Center for Ecostudies
Planning Team		David Sausville	VT Fish & Wildlife Dept
Steve Parren*	VT Fish & Wildlife Dept	Dr. Allan Strong	University of Vermont
Jon Kart	VT Fish & Wildlife Dept	Erin Talmadge	Birds of VT Museum
Christopher Hilke	National Wildlife Federation		
Municipal Planning Team		**Fish Team**	
Jens Hilke*	VT Fish & Wildlife Dept	Kenneth Cox*	VT Fish & Wildlife Dept
Monica Przyperhart	VT Fish & Wildlife Dept	Dr. William Barnard	Norwich University
Kate McCarthy	VT Natural Resources Council	Dr. Douglas Facey	Saint Michael's College
		Mark Ferguson	VT Fish & Wildlife Dept
Landscape Steering Committee		Eric Howe	Lake Champlain Basin Program
Eric Sorenson*	VT Fish & Wildlife Dept	Richard Langdon	VT Dept of Environmental Conservation
Jens Hilke*	VT Fish & Wildlife Dept	**Invertebrate Team**	
Bob Zaino*	VT Fish & Wildlife Dept	Mark Ferguson*	VT Fish & Wildlife Dept
Liz Thompson	Vermont Land Trust	Steve Fiske	VT Dept of Environmental Conservation
John Austin	VT Fish & Wildlife Dept	Trish Hanson	VT Forest Parks & Recreation Dept
Jayson Benoit	NorthWoods Stewardship Ctr	Kent McFarland	VT Center for Ecostudies
Jeff Briggs	VT Forest Parks & Recreation Dept	Bryan Pfeiffer	Consulting Entomologist
Dan Farrell	The Nature Conservancy		
Jon Kart	VT Fish & Wildlife Dept	**Mammal Team**	
Jane Lazorchak	VT Fish & Wildlife Dept	Chris Bernier*	VT Fish & Wildlife Dept
Paul Marangelo	The Nature Conservancy	Alyssa Bennett	VT Fish & Wildlife Dept
Doug Morin	VT Fish & Wildlife Dept	Dr. William Kilpatrick	University of Vermont
Steve Parren	VT Fish & Wildlife Dept	Dr. James Murdoch	University of Vermont
Nancy Patch	VT Forest Parks & Recreation Dept	Dr. Peter Smith	Green Mountain College
Rose Paul	The Nature Conservancy	Christopher Spatz	Cougar Rewilding Foundation/NE Wolf Coalition
Kim Royar	VT Fish & Wildlife Dept		
Mark Scott	VT Fish & Wildlife Dept	**Plant Team**	
		Bob Popp*	VT Fish & Wildlife Dept
Amphibian & Reptile Team		Everett Marshall*	VT Fish & Wildlife Dept
Doug Blodgett*	VT Fish & Wildlife Dept	Charlie Hohn	VT Fish & Wildlife Dept.
Jim Andrews	VT Herp Atlas	Aaron Marcus	VT Fish & Wildlife Dept
Steve Faccio	VT Center for Ecostudies	Eric Sorenson	VT Fish & Wildlife Dept
Chris Slesar	VT Agency of Transportation	Bob Zaino	VT Fish & Wildlife Dept

Threats, Problems and Species of Greatest Conservation Need

Defining Threats and Problems

Element number three of the eight congressionally required elements of a Wildlife Action Plan requires that states: describe the problems that may adversely affect Species of Greatest Conservation Need or their habitats and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats. Problem and threats are defined as follows:

> **Problem:** Something that is a concern and could cause a negative impact at the species, population, habitat and/or landscape levels (e.g., habitat conversion, pollution, illegal pet trade). A problem can also be the lack of information or a data gap vital to the successful management of a species.
>
> **Threat (direct):** Processes or human activities "that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets" (adapted from Salafsky et al. 2008).
>
> **Threat (indirect):** The factors contributing to or enabling direct threats. Typically, there is a chain of contributing factors behind any given direct threat. Synonyms include contributing factors, underlying factors, drivers, and root causes (adapted from Salafsky et al. 2008).

For the purposes of this report, problem and threat are used in a similar or related manner. For each Species of Greatest Conservation Need in the Action Plan we identified priority problems. Priority research needed to evaluate other potential problems was also identified. They are detailed in SGCN conservation reports (Appendix A) and in habitat/ community summaries (Appendix B).

Each of the threats and problems identified in the Action Plan was assigned to one of 24 categories roughly grouped into habitat-related factors and non-habitat-related factors. These categories make it possible to search our database for similar factors impacting other species. It also makes it easier to roll-up for broad scale conservation planning. The categories were cross-walked (Appendix C) with those developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (Salafsky et al. 2008) to aid in the regional roll-up of Action Plan data as recommended by the Diversity Technical Committee of the Northeast Association of Fish & Wildlife Agencies (Crisfield 2013).

The categories are not mutually exclusive and threats can often logically be placed into more than one category depending on the stress it causes for a species or habitat. For example, a road can fragment the habitat of grassland nesting birds, cars traveling the road can injure or kill amphibians that were crossing the road to mate in an adjacent pool, and salt spread on the road to prevent icing can wash into a stream impacting its population of Brook Trout. In this example, the threats stemming from the road would be recorded in the "Habitat Fragmentation," "Impacts of Roads & Transportation Systems," and "Pollution" categories.

Threats are often species and/or habitat specific. What may negatively impact one species may benefit another. For example, if a cold-water stream with a healthy Brook Trout population was dammed it might no longer support Brook Trout. That impact to the dam would be described as the "conversion of habitat" category. However, the reservoir created by the dam might make it more suitable for a warm water fish species.

Threats/problems to SGCN are described in narratives in each Species Conservation Report (appendices A1-A5). Better known species generally received fuller problem descriptions. For some poorly understood SGCN descriptions of threats/problems were less specific. Species Teams have in some cases provided consensus recommendations of problems as a starting place for future research. Clearly life is too complex to be placed into any one box. Therefore, it is important to read the full description of a factor affecting a species or habitat in the appropriate species or habitat summary.

Threat Categories

See Appendix C for definitions of each category. For context, see Appendix A for SGCN conservation reports and Appendix B for habitat/community summaries.

Habitat-Related Threat/Problem Categories

- Climate Change
- Habitat Alteration/ Degradation
- Habitat Conversion
- Habitat Fragmentation
- Hydrologic Alteration
- Impacts of Roads & Transportation Systems
- Impacts of Energy Infrastructure & Development
- Inadequate Distribution of Successional Stages
- Inadequate Disturbance Regime
- Invasion by Exotic Species
- Parcelization
- Sedimentation

Non-Habitat-Related Threat/Problem Categories

- Competition
- Disease
- Genetics
- Harvest or Collection
- Incompatible Recreation
- Loss of Food Base or Prey Base
- Loss of Relationship with Other Species
- Parasitism
- Pollution
- Predation or Herbivory
- Reproductive Traits
- Trampling & Direct Impacts

Conservation Action Development

Element number four of the eight congressionally required elements of a Wildlife Action Plan requires that states describe "conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions."

We identified actions to address the threats and problems impacting each of Species of Greatest Conservation Need (SGCN) and their habitats. Selected actions are based on the best science available today as well as a strategic assessment of needs and priorities of all wildlife species. In the coming years, as monitoring data on SGCN and conservation actions becomes available, as priorities change, or new threats or opportunities arise, actions may need to be revisited. Not every action in this report will be eligible for State Wildlife Grant funding. Furthermore, it may not be suitable, or feasible, for the Vermont Fish & Wildlife Department to implement some of the actions in this report, however, some conservation partners may find them fitting and practical.

Actions are described in short narratives in each SGCN conservation reports (Appendix A) and in each habitat, community and landscape summary (Appendix B). Actions are intentionally broad and directional to balance the need to guide implementation with the need to maintain relevance and flexibility through the life of the Action Plan (~10 years). For example, an action such as "provide technical assistance to landowners to maintain or improve riparian habitat for Species of Greatest Conservation Need" allows for different approaches to providing that assistance and leaves the door open to a variety of providers to implement. Where action implementation is to be funded by the State Wildlife Grant program the approach should be consistent with the Department's mission and strategic plan, and precise procedures will be detailed in operational plans once the Action Plan is finalized.

Vermont's Action Plan was designed for the state, not just the Fish & Wildlife Department. While the VFWD may be responsible for implementing many of the actions in this report, it could be conservation partners that are the more logical and appropriate leaders for others, due to their skills and expertise, staffing, history, location, available resources and constituencies.

Each of the actions identified in this report were assigned to one of 27 categories in six major classes. The categories were developed by the Conservation Measures Partnership (Salafsky 2005) as a means of standardizing terminology (not practices) among conservation practitioners worldwide. Many states have used these same categories to organize the strategies and actions in their Action Plan. They have also been incorporated into Wildlife TRACS (Tracking and Reporting Actions for the Conservation of Species) the US Fish & Wildlife Services' system for tracking and reporting conservation activities. States, including Vermont, will use TRACS for all work funded through the USFWS once it is fully operational.

The action categories are used solely for organizing and grouping strategies developed by Action Plan teams and committees. It was not our goal to create strategies for every category. A few categories were not applicable to the species or habitats in Vermont whereas others were deemed not as effective. Definitions for each strategy can be found in Appendix C.

Outreach and Public Involvement

The Vermont Fish & Wildlife Department recognized that to meet our Action Plan revision goals that we needed the resources, participation and ingenuity of our conservation partners. More than 30 partners representing 20 different organizations and agencies participated on the landscape team or one of the taxonomic teams.

Additional outreach and public involvement efforts focused on the following groups:

Public: The general public has been kept informed about the State Wildlife Grants and Wildlife Action Plan several ways. These include: ongoing publications of two Department newsletters (*Fish & Wildlife Conservation News* and *Natural Heritage Harmonies*), a website dedicated to Vermont's Action Plan (www.vtfishandwildlife.com/SWG_home.cfm); presentations to conservation and wildlife oriented organizations, lectures at the University of Vermont; postings to listserves such as Vermont's science teacher listserve, and the general news and recreation media. Our public outreach goals were to inform the public that: wildlife may be at risk without our help and without adequate funds to conserve them; that with the financial support of State Wildlife Grants program, the Vermont Fish and Wildlife Department and Conservation Partners are developing strategies to conserve Vermont's wildlife; and; the public could view a draft Action Plan and provide comments in summer 2015.

Endangered Species Committee: The Endangered Species Committee (ESC) is a standing citizens committee of the Agency of Natural Resources. It advises the Agency Secretary on issues concerning the State's listed and potential endangered and threatened species. The committee reviews the endangered and threatened species list and makes recommendations to the Secretary about amendments and ways to protect listed species. The ESC is supported by taxa-specific Scientific Advisory Groups (SAGs). Positions on the ESC and SAGs are filled by experts from local, state and regional organizations, agencies and education/research facilities. The Endangered Species Committee was briefed on the Action Plan early in the process. Several ESC and SAG committee members serve as Species Team members.

Coordination with Other Agencies & Native American Tribes

Congressional guidelines require that each state Action Plan "coordinate the development, implementation, review and revision of the Action Plan with federal, state and local agencies and Indian tribes that manage significant land and water areas within the state or administer programs that significantly affect the conservation of identified species and habitats."

Native American Tribes: There are no federally recognized Native American tribes that manage significant land and water areas within Vermont or administer programs that significantly affect the conservation of Species of Greatest Conservation Need or their habitats. According to information provided by the USFWS, the Stockbridge-Munsee Band of the Mohican Nation, based in Wisconsin, has interests in ancestral in Vermont. We invited the Stockbridge-Munsee Band to participate in Action Plan revision twice (11/24/2014 and 3/20/2015) but our invitations were not accepted.

There are, however, four bands of the Abenaki Tribe recognized by the state of Vermont: the Elnu Abenaki Tribe, the Nulhegan Abenaki Tribe, the Abenaki Nation at Missisquoi and the Koasek Traditional Band of the Koas Abenaki Nation. These tribes were encouraged to take part in the development of the Action Plan as Conservation Partners and through the public input process.

Development: More than 190 representatives of local state and federal agencies and non-governmental organizations concerned with wildlife and land conservation and management (Conservation Partners) were contacted about participation in Wildlife Action Plan revision. Representatives of 21 of these agencies and organizations serve on Action Plan technical teams (Table 8.1). Several provided data used in the Action Plan development. Many reviewed the draft Action Plan and provided comments. Additionally, municipal planners and municipal conservation commissioners were also invited to review drafts of the municipal planning guide (Mapping Vermont's Natural Heritage—appendix G).

Conservation Partners were kept informed of the ongoing developments in the Action Plan through email, meetings and phone calls. Presentations and briefings were made to the Department of Forests, Parks and Recreation, the Department of Environmental Conservation (Divisions of Wetlands, River Management, Lakes & Ponds); the Vermont Agency of Transportation, the Lake Champlain office of the U.S. Fish & Wildlife Service, the U.S. Forest Service's Green Mountain National Forest, the Vermont Forest Roundtable and others.

The public was invited to review and comment on the draft Wildlife Action Plan. Outreach to the public occurred via press releases, news interviews, postings to the VFWD website and Facebook pages and via listserves and newsletters of partner organizations. A Wildlife Action Plan Revision website (http://www.vtfishandwildlife.com/cms/one.aspx?portalid=73163&pageid=480687) was created to provide additional information and direct access to the Action Plan drafts.

Implementation, Review & Revision: All Conservation partners, including federal, state and local agencies will be encouraged to take part in the implementation, review and revision of the Action Plan. Plans for these steps can be found in chapter 7 Vermont's Action Plan: Implementation and Review.

Species & Habitat Conservation

Identifying Species of Greatest Conservation Need

Congress created the State Wildlife Grants program (SWG) in 2001 with the goal of preventing wildlife populations from declining to the point of requiring Endangered Species Act protections. To receive SWG funds, state and tribal fish and wildlife agencies agreed to develop statewide Wildlife Action Plans. Congress directed that the Action Plan identify and be focused on the "Species of Greatest Conservation Need."

Congress left it up to each state to identify their Species of Greatest Conservation Need (SGCN). The State Wildlife Grants program defines wildlife as "any species of wild, free-ranging fauna including aquatic species and invertebrates as well as native fauna in captive breeding programs intended for reintroduction within its previously occupied range." Furthermore, it was Congress' intent that SWG assist wildlife that "have not previously benefited from other federal wildlife conservation and management programs" (e.g., Federal Aid to Wildlife Restoration Act, Federal Aid in Sport Fish Restoration Act, or the Endangered Species Act). In Vermont, SGCN include:

- Species with declining populations;
- Species threatened or potentially threatened; and,
- Species that are so little known in the state that experts cannot yet ascertain status.

Though plants are not eligible for State Wildlife Grants Program funding, Vermont's Action Plan does include plant SGCN. Plant-specific conservation strategies, if and when they are implemented, will be funded through mechanisms other than SWG. Several game and sportfish species are identified here as SGCN. Other established funding programs for the conservation of these species may be used before using SWG.

Vermont began its process of identifying Species of Greatest Conservation Need (SGCN) with a systematic review of all its known wildlife. The review considered both the well-known wildlife species supported by large datasets and poorly understood species.

The six Species Teams (Amphibian & Reptile, Bird, Fish, Invertebrate, Mammal and Plant) conducted the reviews and selected SGCN using the review criteria in table 8.2. They were provided lists of species found in Vermont within their respective taxa (the Invertebrate team received the most up-to-date invertebrate list available, but it is widely accepted that a complete list of the estimated 21,000 invertebrates in Vermont may never be possible. The lists and supporting information were developed by the VFWD's Wildlife Diversity Program using its Natural Heritage Database and augmented with other databases, records and information from NatureServe, universities and research facilities, regional and national monitoring efforts, published literature and the knowledge of technical experts. The following groups had major, taxon-wide State rarity rank reviews: Amphibians & Reptiles (2007), Bumble Bees (2014), Birds (2010), Fishes (2005), Bats (2011), Other small mammals (2008), moths and butterflies (2010), dragonflies and damselflies (2008) and Vascular Plants (2014). Ranks for individual species were updated as needed.

Table 8.2: Review Criteria for Identifying Species of Greatest Conservation Need

Category	Criterion	Allowed Response	Definition/example
Species that are rare or declining	State and/or Federally listed Threatened or Endangered species	Endangered, Threatened, Special Concern [See Appendix J for definitions of T& E status and ranks]	E: Endangered: in immediate danger of becoming extirpated in the state T: Threatened: with high possibility of becoming endangered in the near future. SC: Special Concern: rare; status should be watched
	Rare and very rare species	S-Ranks S1,S2 [See appendix J for definitions of T& E status and ranks]	S1: Critically imperiled (very rare): At very high risk of extinction or extirpation due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors. S2: Imperiled (rare): At high risk of extinction or extirpation due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors
	State Trend	Stable, Fluctuating, Declining, Increasing, Unknown	Based on research data such as BBS routes, other monitoring and best judgment of experts
	Regionally Rare	Yes/No/ Unknown	Based on regional and national research, BBS routes, other monitoring and consensus within technical teams.
	Extirpated in Vermont	Yes/No/ Unknown	
Vulnerable species at risk due to any of the following	Habitat Loss/Conversion/fragmentation	Yes-development, Yes-succession, Yes-natural causes, No, Unknown	Species negatively affected by habitat conversion, degradation, fragmentation or succession
	Life-history traits making the species vulnerable	Yes/No/ Unknown	Species with low fecundity, that take a long time to reach sexual maturity, that take a long time between reproductive events (e.g., sturgeon, wood turtle)
	Species vulnerable to taking	Yes-Regulated, Yes-Unregulated, No, Unknown	Hunting, trapping or collection, legal or otherwise.
	Species vulnerable to other deadly contact with humans	Yes/No/ Unknown	Road kill (bobcat, turtles), wind turbines (birds, bats) contaminates (fish) etc.
	Species w/ limited, localized at-risk populations	Yes/No/ Unknown	Populations that cannot or do not intermix with the meta-population. E.g., non-vagile invertebrates in a sandplain community and perhaps spruce grouse.
	Species significantly impacted by exotics	Yes/No/ Unknown	Impact may lead to elimination of populations, limits to long-term stability, extirpation
Species or species groups w/ unknown status or taxonomy	Unknown status-more data is needed	Yes/No/ Unknown	
	Species w/ taxonomic uncertainties	Yes/No/ Unknown	

Category	Criterion	Allowed Response	Definition/example
Other factors to consider	Keystone species	Yes/No/ Unknown	Species with a disproportionately strong influence on ecosystem functioning and diversity (Power et al.1996).
	Responsibility species	Yes/No/ Unknown	Species for which Vermont has a long-term stewardship responsibility because they are not doing well regionally, even if populations are stable in Vermont (e.g., Bobolink)
	Endemic species	Yes/No/ Unknown	Species found only in Vermont
	Relationship to core population	central peripheral, disjunct, unknown	
	Requires rare or specialized habitats	Yes/No/ Unknown	A species with a very narrow niche, e.g., a species requiring a host plant found only in a handful of serpentine rock outcrops.
	Species with limited dispersal capability	Yes/No/ Unknown	Non-vagile species in dispersed habitats.
	Requires key Vermont migration stopover points	Yes/No/ Unknown	
	Species selected based on expert opinion	Yes/No	Combined opinion of the team.
	Actively managed? (if so list applicable plan(s)	Yes-Mgt plan exists, Yes-regulated, No	Does a management plan exist for the species or species group? (E.g., an osprey plan, waterfowl plan, species recovery plan.)
Secure?	Species Secure	Yes/No/ Unknown	Combined opinion of the team
	Final Assessment	High, Medium, Low Priority	

Once the reviews were complete the Species Team selected SGCN using selection criteria found in Table 8.3. Species were assigned conservation priorities of high, medium or low. Species ranked medium and high constitute Vermont's Species of Greatest Conservation Need. Low priority species were considered secure. There were a few cases where a specific Species Team approached their tasks differently:

Bird Team: An unusually rich collection of data and prior conservation planning efforts are available for bird conservation—far more than is available for other taxa, including the second Vermont Breeding Bird Atlas (2013), the USFWS Breeding Bird Surveys and information from Partners-In-Flight, North American Bird Conservation Initiative, National Audubon Society's Watch List, and the American Bird Conservancy's Green List.

Invertebrate Team: It is estimated that Vermont is home to approximately 21,000 invertebrate species (McFarland, pers comm). The clear majority are un-cataloged, un-studied and just plain unknown. Application of the review criteria to invertebrates on a species-by-species basis would be unproductive. Instead the Invertebrate Team interviewed additional experts within Vermont, regionally and nationally to help in the identification of species and Species Groups of Greatest Conservation Need. The team also took advantage of several significant advances made since (and because of) the adoption of Vermont's first Wildlife Action Plan in 2005, including: the Vermont

Butterfly Atlas, a Peatland and Large River Odonate Survey and the Vermont Bumble Bee Survey.

Plant Team: The Plant Team also had to contend with a huge list of species—more than 1,500 vascular plants (Flora 1993) and 600 bryophytes (Allard 2004). The team took advantage of plant conservation assessments previously conducted by the Agency of Natural Resources' Endangered Species Committee to create its list of Species of Greatest Conservation Need. All species ranked S1 (critically imperiled) and S2 (imperiled) became SGCN. Those SGCN also on the New England Plant Conservation Program list of regionally rare plants were then ranked High Priority. All others were ranked medium priority.

Table 8.3: Criteria for Selecting Vermont's Species of Greatest Conservation Need

Because the circumstances, issues and problems impacting each species differ, teams were given some flexibility in assigning ranks to species.

Species (and Species Groups) of Greatest Conservation Need	**High Priority**	Species that are vulnerable (rarity is an aspect of vulnerability).
		Species with immediate limits to its survivability based on known problems and/or known impacts to the population
		Species exhibit negative population trends.
		Species may be extirpated locally (Vermont) but still exist regionally.
	Medium Priority	Species may be well distributed and even locally abundant, but populations are challenged by factors that increase mortality or habitat loss and therefore threaten the species in Vermont.
		Consider what is known about the species regionally.
		Since this may be the most difficult category to assign species to, there should be a consensus among group members.
Common Species	**Low Priority**	Species is secure for the immediate future.
		Species may be vulnerable to some mortality and/or problems (e.g., habitat degradation) but population is abundant enough to tolerate negative forces

The list of Species of Greatest Conservation Need includes 132 vertebrate species (out of a total of 468), 200 invertebrate species or groups (out of an estimated 21,000) and 645 plant species out of approximately 1,500 vascular and non-vascular species. Table 8.4 provides summary statistics.

Table 8.4: Summary Statistics for Vermont's Species of Greatest Conservation Need

High and medium priority-ranked species constitute Vermont's SGCN.
*21,400 is the estimated number of Vermont invertebrates
** This low percentage reflects the large number of invertebrates whose conservation status is unknown

	Total species in VT	High Priority SGCN	Medium Priority SGCN	Total SGCN	% SGCN of total VT Species
Amphibians & Reptiles	40	12	7	19	47%
Birds	269	29	22	51	19%
Fish	94	13	16	29	31%
Invertebrates*	21,400*	139	59	198	0.93%**
Mammals	61	17	16	33	57%
Plants	1500	238	431	669	45%
Total	**23,364**	**432**	**543**	**977**	**4.29%**

Conservation of Species of Greatest Conservation Need

Fine Filter-Species

Once Species of Greatest Conservation Need were identified, Taxa Teams developed conservation summaries each SGCN. Reports identified species distribution, habitat needs, problems affecting species and their habitats, research and monitoring needs and conservation strategies for each SGCN (Congressionally required elements #1-#5). Invertebrate SGCN were addressed in groups rather than as individual species. Fifteen invertebrate groups were created based on taxonomy (e.g., Bumble Bees, Crustaceans, Tiger Beetles) and habitat use (e.g., freshwater, grasslands, hardwood forests). Individual conservation summaries were not developed for plant SGCN but a taxon-wide summary is provided in chapter 5. All data was entered into the Action Plan database.

Distribution for all SGCN was identified by biophysical region (Girton & Capen 1997) using terminology consistent with VFWD's element occurrence tracking procedures. Distribution of fish SGCN and some additional aquatic SGCN were also identified by 8-digit watershed unit (NRCS 2009). Historic occurrence was noted in a narrative for some of the rarer and extirpated SGCN.

Habitat descriptions for SGCN include a narrative, elevation preferences, migrant status, home range and patch size requirements and landscape requirements (e.g., corridor needs, habitat mosaics or wetland complexes, preference for managed or passively managed forest, large grasslands or developed landscapes).

Research and monitoring were also identified and prioritized for each animal SGCN.

Priority threats and potential risks to Species of Greatest Conservation Need were enumerated for each species. These were not exhaustive lists of all possible problems. Teams identified only those factors posing significant and potentially significant threats for a species. A narrative description was entered into the database. Species teams also assigned each problem to one of 24 habitat related and non-habitat related problem categories (Appendix C). These categories have been cross-walked with those developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (Salafsky et al. 2008) to aid in the regional roll-up of Action Plan data as recommended by the Diversity Technical Committee of the Northeast Association of Fish & Wildlife Agencies (Crisfield 2013).

Species specific conservation actions were also developed by the Species Teams. Actions were designed to address identified threats. Actions were assigned either a "medium" or "high" priority status (low priority actions are not included in the Action Plan) and each strategy was also assigned to a category (Salafsky 2004) to aid in organizing and review of actions (Appendix C).

Actions were not prioritized beyond this step. As a conservation guide for the state, Vermont's Action Plan is meant to provide guidance to organizations, agencies and individuals wishing to conserve wildlife. The varied goals and missions of the partners involved in the Action Plan span a broad spectrum of wildlife interests, skills and reach (some are local; others are state, regional and federal entities). While no prioritization scheme was found that satisfied all partners, the conservation need is deemed so great that there is room for everyone to select the species and habitats they find most important and implement the actions they are most capable of working on.

Coarse Filter-Conservation at Multiple Scales

To aid in the development of community and landscape level conservation actions, each SGCN was assigned to at least one of more than 100 habitat types (natural communities, aquatic habitats, cultural habitats and or landscapes). These habitats were grouped into 24 major categories (Chapter 4. table 4.1) and conservation summaries were developed for each. The summaries include descriptions and general locations; current conditions; desired conditions based on the needs of associated SGCN; prioritized threats and conservation actions, potential conservation partners and funding sources for action implementation; and, a listing of other relevant plans and planning processes.

Threats and problems described in the habitat summaries (and in species summaries) are not comprehensive. Only those problems ranked as medium and high are included in this report. This was a strategic decision to focus attention on those threats and problems determined or perceived to be most important. If additional problem(s) are later identified as significantly impacting a species or habitat it will be incorporated into the Action Plan database during project review and reporting. Actions and actions to address additional problem(s) will also be eligible for SWG funding.

Habitat Classification & Ecological Divisions

"Wetland, Woodland, Wildland - A guide to the natural communities of Vermont" (2000) by Thompson and Sorenson was used as the basis for terrestrial natural communities. Forest cover types (Eyre 1980) and U.S Forest Service Forest Inventory & Analysis types (USDA 2003) were used for early successional and managed forests. "A Classification of the Aquatic Communities of Vermont" by Langdon et al. (1998) was used as the basis for aquatic habitat designations and Reschke (1990) was adapted for cultural habitats.

SGCN distribution was identified to biophysical region (Girton & Capen 1997) and 8-digit watersheds (NRCS 2003). These landscape units were selected in part because they will integrate well with other conservation efforts within the state and regionally. Biophysical regions can be considered a sub-unit of the Bailey's section (Bailey 1995, Bailey 1998) providing finer grain detail. Data can be integrated into Bailey's sections to aide in regional, national and international conservation efforts.

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Chapter 9

Glossary & Acronym Key

2015

Chapter 9: Glossary & Acronym Key

This glossary contains definitions to many of the terms used in this document.

Actively managed: For wildlife this means that a management plan for the species or a suite of species exists. (E.g. an osprey plan, waterfowl plan, spruce grouse plan.)

Anthropogenic: Conditions that result from human activities. "Anthropo-" meaning human and "-genic" meaning produced from.

Comprehensive Wildlife Conservation Strategy (CWCS): the original name for a Wildlife Action Plan. The Action Plan/CWCS sets a plan of action for conserving Vermont's wildlife by addressing conservation issues, management needs, and priorities. It is intended to be used by anyone with an interest in wildlife conservation.

Conservation: Plans and actions that will help restore and/or sustain Vermont's wildlife populations, with a focus on Species of Greatest Conservation Need (SGCN), and utilizing the full array of traditional conservation tools such as management (.e.g. habitat manipulation, restoration (e.g. acquisition, fee-simple easements), landowner education and incentives.

Conservation Opportunity Area: areas of land and water where the likelihood of successful conservation is strongest and the conservation needs of wildlife and their habitats would be best met.

Conservation Partner: The wildlife biologists, ecologists, sportsmen and other conservationists, non-governmental organizations, business leaders, colleges and universities and state and federal agencies representing more than 60 entities (table 1-1) that worked with the Vermont Fish & Wildlife Department to create Vermont's Comprehensive Wildlife Conservation Strategy. When implementation of the Action Plan begins, any and all individuals, organizations, agencies and other entities wishing to participate will be considered conservation partners.

Conservation Reserve Program (CRP): provides annual land rental payments up to 15 years and cost sharing assistance to install water quality enhancement practices on environmentally sensitive land.

Conservation Reserve Enhancement Program (CREP): State and Federal partnership allowing incentive payments to landowners who set aside environmentally sensitive land along streams or field boundaries.

Common Species: "Keeping Common Species Common" is a phrase Congress used to describe its goal for the SWG program and the Action Plan. Common in this situation refers to any species that is not on the federal Endangered Species List (Threaten or Endangered).

Contiguous Forest: An area of forested land with either no roads or low densities of class IV roads, and little or no human development (buildings, parking areas, lawns, gravel pits). Contiguous forest may have various age classes of forest cover and include other habitat types such as wetlands or grasslands that are part of the overall contiguous habitat complex.

Corridor: A route that permits the direct travel or spread of animals or plants from one area or region to another, either by the gradual spread of a species' population along the route or by the movement of individual animals, seeds, pollen, spores, or microbes.

Cultural Habitat: (sometimes referred to as anthropogenic habitat) communities and sites that are either created and/or maintained by human activities or are modified by human influence to such a degree that the physical condition is substantially different from what existed prior to human influence (e.g. old mines, hayfields used by grassland birds, buildings and structures used by bats).

Data Gap: A clear data need identified in the Action Plan as important to the conservation of a species or habitat.

Ecosystem: A complex array of organisms, their natural environment, the interactions between them, and the ecological processes that sustain the system. Ecosystems can be defined at any scale, from rotting logs, to Lake Champlain, to the Green Mountains.

Endangered Species: A species in danger of becoming extinct that is protected by either the federal Endangered Species Act or the Vermont Endangered Species Act.

Endemic species: Found only in a certain place. For the purposes of this document endemic refers to species found *only* in Vermont. There are no known endemic species in Vermont. The most likely possibilities are invertebrates.

Exotic Invasive & Pest Species: An invasive species is defined by the as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Environmental Quality Incentives Program (EQIP): provides cost sharing payments to participants who install enduring conservation practices to help control soil erosion and improve water quality.

Forest Cover Type: A descriptive classification of forestland based on present occupancy of an area by tree species (Society of American Foresters).

Game Species: Wildlife species that are subject to legal hunting, fishing or harvesting.

Habitat: A place where a plant or animal lives. A place where an organism lives. Habitat is generally thought of in terms of single species such as bear or calypso orchid habitat.

Herp: an abbreviation for herptile, which includes both amphibian and reptile species.

Herptile: amphibian and reptile species

Hyporheic Zone: the region beneath and adjacent to streams and rivers where surface and ground water mix. The hyporheic zone: links aquatic and terrestrial systems; serves as transition areas between surface water and groundwater systems; and, can contain species common to both surface and subsurface waters.

Indicator species: A species, or community whose presence in an area indicates the presence of certain environmental conditions.

Indicators: Indicators are measures that track inputs, outputs, and outcomes by stating them in specific and observable terms. They are also used to monitor natural resource conditions and the threats that can degrade natural ecosystems (.e.g. the number lakes infested with Eurasian watermilfoil; the distribution of lakes infested with Eurasian watermilfoil # of boat checks conducted; % of boaters aware of exotic species laws)

Landscape: A heterogeneous area of land containing groups of natural communities and clusters of interacting ecosystems. These can be of widely varying scales, but normally include a range of elevations, bedrock, and soils.

Life-history traits: Examples include be species with low fecundity, that take a long time to reach sexual maturity, that take a long time between reproductive events (sturgeon, wood turtle)

Limiting factor: The factor limiting the growth, abundance, or distribution of a population of organisms or a habitat.

Metadata: Definitional information that provides information about or documentation of other data

Metapopulation: A small number of relatively isolated populations that may occasionally exchange individuals

Mosaic: A pattern of vegetation in which two or more different plant communities are interspersed in patches.

Natural Community: An interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them.

Neotropical Migrants: Birds especially songbirds that summer and breed in North America but migrate to the tropics for the winter. Neotropical refers to the region south of the Tropic of Cancer that includes southern Mexico, Central and South America, and the West Indies

Nongame Wildlife: Wildlife species that are not subject to legal hunting, fishing or harvesting.

Pathogen: Any disease producing microorganism or material

Problem: A force causing a negative impact at the species, population, habitat and landscape levels (e.g., habitat conversion, pollution, illegal pet trade). A problem can also be the lack of information or a data gap vital to the successful management of a species. Because this report addresses an extremely broad range of problems affecting species and their habitats, the term "problem" may not always be the most appropriate term: threat, stress, stressor, issue, concern and limiting factor may at times be more accurate.

Regulated Hunting/Fishing/Trapping: The harvest of wildlife under regulations stipulating setting of seasons, time frame of lawful harvest, open and closed zones, methods of take, bag limits, possession limits, and reporting or tagging of species.

Responsibility Species: Species for which Vermont has a long-term stewardship responsibility because they are not doing well regionally, even if populations are stable in Vermont. E.g. bobolink.

SGCN: see Species of Greatest Conservation Need

Species of Greatest Conservation Need (SGCN): According to federal legislation and guidance from the USFWS on the development of Comprehensive Wildlife Conservation Strategies, "each State will determine these species in the context of developing its [Wildlife Conservation Strategy]. These species must be fauna, and not flora, and may include aquatic species and invertebrates. A State's list of "species of the greatest conservation need" may include currently listed Federal and State wildlife species and other species of concern. We anticipate that the composition of this list will change over time as the status and conservation need of species changes within the State." The term Species of Greatest Conservation Need is not a statutory designation and therefore differs from terms "endangered" or "threatened" which are codified by federal and state Endangered Species Acts.

Take/Taking: "Take" and "Taking" per state statute 10 V.S.A. § 4001(23) means pursuing, shooting, hunting, killing, capturing, trapping, disturbing, harrying, worrying, or wounding snaring and netting fish, birds and quadrupeds and all lesser acts including placing, setting, drawing or using any net or other device commonly used to take fish or wild animals, whether they result in taking or not. It includes every attempt to take and every act of assistance to another person in taking or attempting to take fish or wild animals.

Threatened Species: Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range that is protected by either the federal Endangered Species Act or the Vermont Endangered Species Act

Wildlife: Per State Wildlife Grants legislation, wildlife is any species of wild, free-ranging fauna including fish, and invertebrates and also fauna in captive breeding programs the object of which is to reintroduce individuals of a depleted indigenous species in a previously occupied range.

Wildlife Action Plan (Action Plan) The Action Plan sets a plan of action for conserving Vermont's wildlife by addressing conservation issues, management needs, and priorities. It is intended to be used by anyone with an interest in wildlife conservation.

Acronym Key

This key includes many of the acronyms used in this document. Please let the authors know if additional entries are warranted.

AAFM: Vermont Agency of Agriculture, Food, and Markets

AFS: American Fisheries Society

AFWA: Association of Fish and Wildlife Agencies

AMP: Acceptable Management Practice

ANR: Vermont Agency of Natural Resources (comprised of VFWD, DEC, FPR)

AOT: Vermont Agency of Transportation

AVCC: Association of Vermont Conservation Commissions

BBS: Breeding Bird Survey

BCR: Bird Conservation Region

BMP: Best management practice

CBC: Christmas Bird Count

CITES: Convention on International Trade in Endangered Species of Flora and Fauna

CHC: Cold Hollow-to-Canada

Cons Comms: Conservation Committees of towns

CRASC: Connecticut River Atlantic Salmon Commission

CRJC: Connecticut River Joint Commission

CRP: Conservation Reserve Program (a program of FSA)

CWCS: Comprehensive Wildlife Conservation Strategy, the original name for the Wildlife Action Plan.

DEC: Vermont Department of Environmental Conservation, also VDEC

DHCD: Vermont Department of Housing & Community Development

DJ: Dingell-Johnson Act of 1950, Federal Aid in Sport Fish Restoration Act

EBTJV: Eastern Brook Trout Joint Venture

EO: Element Occurrence

EQIP: Environmental Quality Incentives Program (a program of NRCS)

ESC: Endangered Species Committee of the Agency of Natural Resources

FIA: Forest Inventory Analysis

FIP: Forest Incentives Program (USFS)

FPR: Vermont Department of Forests, Parks & Recreation, also VFPR

FSA: Farm Service Agency (a USDA agency) (www.fsa.usda.gov/vt/)

FWD: Vermont Fish & Wildlife Department

GIS: Geographic Information System

GRP: Grassland Reserve Program

HAT: Hunters, Anglers & Trapper of Vermont

Herp Atlas: Vermont Reptile & Amphibian Atlas

IBA: Important Bird Areas

LCBP: Lake Champlain Basin Program

LCC: Lake Champlain Committee

LCI: Lake Champlain International

LCLT: Lake Champlain Land Trust

MBTA: Migratory Bird Treaty Act of 1940

NABCI: North American Bird Conservation Initiative

NALCC: North Atlantic Landscape Conservation Cooperative

NEPARC: Northeast Partners in Amphibian and Reptile Conservation (the northeast chapter of PARC)

NEPCoP: New England Plant Conservation Program

Nongame Fund: Vermont Nongame Wildlife Fund

NHFGD: New Hampshire Fish & Game Department

NHI: Natural Heritage Inventory of the Vermont Fish & Wildlife Department

NRCS: U.S. Natural Resource Conservation Service (habitat programs include EQIP, CRP)

NWI: National Wetlands Inventory

NWR: National Wildlife Refuge

NWTF: National Wild Turkey Federation

OS: The Orianne Society

PARC: Partners in Amphibian and Reptile Conservation

PIF: Partners in Flight

PR: Pittman-Robertson Act of 1937, the Federal Aid to Wildlife Restoration Act

RGS: Ruffed Grouse Society

RPC: Regional Planning Commissions

SAF: Society of American Foresters

SAG: Scientific Advisory Group (advises the Agency of Natural Resources' Endangered Species Committee)

SCI: Staying Connected Initiative

SGCN: Species of Greatest Conservation Need

SWG: State Wildlife Grants program

TNC: The Nature Conservancy

TU: Trout Unlimited

USACE: United States Army Corps of Engineers

USDA: United States Department of Agriculture

USEPA: United States Environmental Protection Agency

USFS: United States Forest Service

USFWS: United States Fish & Wildlife Service

USGS: United States Geological Service

VASA: Vermont All-Terrain Vehicle Sportsman's Association

VCGI: Vermont Center for Geographic Information

VDHCD: Vermont Department of Housing & Community Development

VCE: Vermont Center for Ecostudies

VFWD: Vermont Fish & Wildlife Department

VFPR: Vermont Forests, Parks & Recreation Department

VHCB: Vermont Housing & Community Board

VINS: Vermont Institute of Natural Sciences

VLCT: Vermont League of Cities & Towns

VLT: Vermont Land Trust

VNRC: Vermont Natural Resources Council

VRC: Vermont River Conservancy

VT Coop: Vermont Cooperative Fish and Wildlife Research Unit (of the US Geological Service)

VTA: Vermont Trappers Association

VTFSC: Vermont Federation of Sportsmen's Clubs

VWA: Vermont Woodlands Association

VTrans: Vermont Agency of Transportation (also AOT)

WCS: Wildlife Conservation Society

WHIP: Wildlife Habitat Improvement Program (a program of NRCS)

WMA: Wildlife Management Area (managed by VFWD)

WDP: Wildlife Diversity Program of the Vermont Fish & Wildlife Department (previously the Nongame & Natural Heritage Program)

WRP: Wetland Reserve Program (NRCS)

Chapter 10

A Reviewer's Guide to Vermont's Wildlife Action Plan

Prepared for the Regional Review Team of the U.S. Fish & Wildlife Service

2015

This Reviewer's Guide to Vermont's Wildlife Action Plan is provided to help Regional Review Teams (RRT) understand how Vermont addressed each of the eight required elements for Wildlife Action Plans and where that information can be found. It begins with an overview of how the report is organized and is followed by the eight elements and specifics as to where information satisfying the element can be found in the Action Plan.

Congress requires that each state revise its Wildlife Action Plan at least every 10 years if it wishes to remain eligible for State Wildlife Grant funds. There are eight congressionally required elements that Action Plans must address to be approved. Congress designated the Director of the U.S. Fish & Wildlife Service (USFWS) to make approval determinations. The USFWS assembled Regional Review Teams in each of eight regions across the country and charged these teams with reviewing each Action Plan, considering how well each plan addressed the required elements, and making approval recommendations to the USFWS Director.

The USFWS "believes it must make an affirmative finding that all of the eight required elements are satisfactorily fulfilled for an "approval" recommendation to be made to the Director of the U. S. Fish and Wildlife Service."

Report Development & Organization

The revision of Vermont's Wildlife Action Plan followed the eight required elements, revision guidance provided by the USFWS and that published in Best Practices for State Wildlife Action Plans (AFWA 2012) and The Northeast Lexicon: Terminology Conventions and Data Framework for State Wildlife Action Plans in the Northeast Region (Crisfield 2014).

The revision began in earnest September 2012 with an assessment of the vulnerability to climate change of species and habitats. In January 2013 a Revision Team of Vermont Fish & Wildlife Department (VFWD) staff met to begin project scoping. The Revision Team has representation from across the VFWD (Wildlife, Fisheries, and Outreach divisions and Business Office) and they have assisted by reviewing strategies, approaches, and our progress. Federal guidelines, planning literature and past planning efforts were reviewed and an organizational structure and revision process were subsequently developed. The identification of Species of Greatest Conservation Need (SGCN) occurred from July 2014 through January 2015. Habitat delineation for SGCN, problem assessment and strategy development occurred from October 2014 through June 2015. Integration and conservation planning ran from May through August 2015. Review and additional input by the VFWD, agencies and other stakeholders and the general public, occurred between September and November 2015. Final document preparation and editing occurred in December 2015. All sections of the Wildlife Action Plan have been revised or updated as needed.

With this revision we take advantage of the many tools, guidance documents and programs developed since 2005 designed to support the conservation and management of wildlife by partners and the general public—several of which were created as a direct result of the first Wildlife Action Plan. These include the Community Wildlife Program, Foresters for the Birds, BioFinder, Vermont Invasives, the Landowners Guide - Wildlife Habitat Management for Lands in Vermont and Community Strategies for Vermont's Forests and Wildlife among many.

Notable changes/additions to the Vermont's Wildlife Action Plan with this revision include:

- An expanded discussion of climate change impacts to SGCN and their habitats and strategies to help wildlife adapt and to improve resiliency (chapter 3).
- A focus on landscape conservation and habitat connectivity (chapter 6) and a design for landscape conservation (appendix F).
- Greater attention to diseases as significant threats to some species.
- Recognition of the important role pollinators play in their ecosystems and the addition of a suite of nine bumble bee species included as SGCN (Appendix A4). The 2005 Action Plan was silent on pollinators.
- A plant conservation summary (chapter 5). The 2005 Action Plan included only a list of plant SGCN.
- Expanded guidance to help municipalities implement the Action Plan (Appendix G).
- Addition of the state's Big Game Management Plan (for Black Bear, Moose, White-tailed Deer, and Wild Turkey) as an appendix (H).
- Revisions to Species of Greatest Conservation Need: SGCN lists have been updated (chapter 5) along with conservation summaries for each SGCN (appendices A1-A5). Table 10.1 summarizes these changes.

Table 10.1 Summary of Changes to SGCN Lists 2005:2015

Taxon	2005 SGCN	2015 SGCN	Change Notes
Amphibians & Reptiles	19	19	No changes
Birds	58	51	Removed: Long-eared Owl, Henslow's Sparrow, Osprey, Cooper's Hawk, Barn Owl, Veery, Blue-winged Teal Added: None
Fishes	33	29	Removed: Arctic Char, Atlantic Salmon (anadromous), Brassy Minnow, Muskellunge and Quillback Added: Northern Pearl Dace
Invertebrates	191	200	Removed: 19 species Added: 28 including 9 bumble bee species
Mammals	33	33	Removed: Black Bear and Mink Added: Moose and Snowshoe Hare
Plants	577	645	Added 68 species

Although development of this Action Plan followed a bottom-up arc from individual species and populations to state and region-wide problems and solutions, its presentation in this report follows a somewhat more user-friendly format. Nine main chapters were selected to first provide readers with context and a big-picture view of wildlife conservation in the state, before diving deep in to the specifics of more 300 SGCN in the appendices. Additionally, because we anticipate that most users of this 1,000-page document will only read sections of it there is some redundancy in the report. Reviewers will find information to help complete their assessment in the locations noted in Table 10.2.

Table 10.2: Organization of Vermont’s Wildlife Action Plan Report

(Locations beginning with a letter (e.g., “B”) refer to appendices. Appendix “A” contains subsections A1 through A5, one each of the five wildlife taxa examined in the Action Plan (e.g. A3:1-6 refers to pages one through six if of appendix A3)

	Chapter : Page
Report Development/Methods	8:1-18
Species of Greatest Conservation Need	
Lists of SGCN	5:13-63
SGCN selection procedures	8:9-12
Overview of SGCN by taxonomic group (amphibians and reptiles, birds, fishes, invertebrates, mammals, plants)	5:2-64
Detailed SGCN information (e.g. status, distribution, habitat, problems, research & monitoring needs and conservation strategies)	A1-A5
Habitat Delineation & Assessment	
Methods	8:13-14
Rationale for habitat classification and organization	4:2-7
Descriptions: desired conditions, problems, research, conservation strategies for Landscapes Habitats	 6:2-14, F B:9-130
Threats Impacting Vermont’s Wildlife	
Threat identification and organization (methods)	8:4-5
Threat definitions	C:2-6
Summary of major threats	2:5-9
Threats impacting each SGCN	A1-A5
Threats impacting SGCN habitat	B:9-130
Climate Change	3:2-23
Conservation Actions	
Action development and organization (methods)	8:6
Definitions of action categories	C:7-9
Statewide goals and objectives	1:7-12
Conservation actions by taxon (birds, fishes, invertebrates, mammals, herpitiles)	5:2-64
Conservation actions for individual SGCN & SGCN Invertebrate Groups	A1-A5
Habitat conservation actions: Landscapes Habitats	 6:2-14 B:9-130
Monitoring & Adaptive Management	7:1-10
Implementation	7:11-12
Review & Revision	7:12-13
Glossary/Acronym Key	9:1-5
Summary of 1st Action Plan Implementation	E:2-23

Element 1. **Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife.**		
RRT Guidance	**Chapter : Page**	**Detail**
1A. The Plan indicates sources of information (e.g., literature, databases, agencies, individuals) on wildlife abundance and distribution consulted during the planning process.	5:all 8:9-13 A1-A5:all	SGCN taxonomic summaries discuss data advancements since 2005. Vermont used the best available science and information on wildlife abundance and distribution including databases and records maintained by VFWD, NatureServe, NEAFWA, NALCC, universities and research facilities, regional and national monitoring efforts and the knowledge of technical experts. Together this represents the Vermont's current state of species knowledge. Each Species Conservation Report includes a bibliography indicating sources.
1B. The Plan includes information about both abundance and distribution for species in all major groups to the extent that data are available. There are plans for acquiring information about species for which adequate abundance and/or distribution information is unavailable.	A1-A5:all A4:all 5:all A1-A5:all	Abundance is noted primarily by State rank as well as in conservation status narratives in Species Conservation Reports. Distribution is noted by biophysical region for terrestrial species and 8-digit watershed (HUC-8) for aquatics as well as in the distribution narrative in the Species Conservation Reports. Abundance and distribution data came from the Natural Heritage Database and was augmented by taxa team experts. Due to the dearth of data on invertebrate species, invertebrate SGCN are treated by taxonomic and habitat groupings rather than individually (e.g., Bumble Bee Group, Odonates-Lakes & Ponds Group). Research needs for each SGCN and SGCN Groups are included in the taxa summaries (chapter 5) and are detailed in the Research & Monitoring section of each Species Conservation Report (appendices A1-A5).
1C. The Plan identifies low and declining populations to the extent data are available.	8:9-10 A1-A5:all A1-A5:all A1-A5:all	VT's Action Plan focused on species with low and declining populations. Our SGCN list includes federal and state threatened and endangered species, species ranked S1 and S2, and species identified by our technical team experts, partners and scientific literature. SGCN with low populations are identified with a State Rank of S1 (very rare) or S2 (rare) in the Conservation Assessment section of each Species Conservation Report. The "Regionally SGCN" field identifies those species selected by NEAFWA states as 'Regional SGCN.' Declining populations are noted in the "State Trend" field of the Species Conservation Reports (see Conservation Assessment section). This field records population trends as "Stable," "Fluctuating," "**Declining**," "Increasing," or "Unknown." In some cases "unknown" was selected because of knowledge gaps. The "Assessment Narrative" field provides details when available. Research and monitoring needs are identified for species whose population trends are unknown or poorly known in the Research & Monitoring section of each Species Conservation Report.

Element 1. Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife.		
RRT Guidance	**Chapter : Page**	**Detail**
1D. All major groups of wildlife have been considered or an explanation is provided as to why they were not. The state may indicate whether these groups are to be included in a future Plan revision.	8:9-10 5:1-3 5:26-36 A4:all	VT's Action Plan process considered all major groups of wildlife including, amphibians and reptiles, birds, fish, 15 groups of invertebrates, mammals. Vermont's Action Plan also includes plants. While our knowledge of VT invertebrate is the most limited of all taxa great advances were made over the past decade. Research designed to further augment our knowledge of invertebrates is included in the Invertebrate Taxon Summary and Species Conservation Reports.
1E. The Plan describes the process used to select the species in greatest need of conservation. The quantity of information in the Plan is determined by the state with input from its partners, based on what is available to the state.	8:9-12 5:1-3 5:all 8:11-12 5:all 8:11, 5:20-23 A3:all	SGCN selection procedures (8:9-12). In general, expert input was incorporated through our Species Teams (a group selected for its expertise in a particular taxon such as mammals). Additional input was solicited from Conservation Partners during Partner meetings and through individual and group correspondence SGCN lists are in each taxon summary. Taxon specific selection procedures: Species Teams selected SGCN based on criteria and guidance developed by our Planning Team (core group planning and organizing the revision). There was some variation between teams in the threshold used for selection as SGCN (e.g. the Herp Team was the most conservative in selecting SGCN whereas the Mammal Team selected some SGCN based primarily on data gaps). Our priority was not to ensure parity in numbers across taxa but rather to ensure that experts within each taxon were in accord regarding the species selected. While great advances were made over the past decade in invertebrate inventories, it was limited to a few groups. The sheer number of invertebrate species in VT (estimated at 21,000) combined with a dearth of expertise limited invertebrate SGCN selection. Whereas SGCN in other taxa are generally those species about which we know the *least*, invertebrate SGCN are generally those we know *best*. Future Action Plan directed research and surveys will further expand our knowledge of this taxon.

Element 2. **Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in the 1st element.**		
RRT Guidance	**Chapter : Page**	**Detail**
2A. The Plan provides a reasonable explanation for the level of detail provided; if insufficient, the Plan identifies the types of future actions that will be taken to obtain the information.	8:13-14 4:2-7 (repeated at B:1-6) A1-A5:all 6:2-14 B:9-130 I:all 1:12	Protocols for describing habitats were developed by our Planning Team in consultation with Species Teams. Because no single habitat classification system satisfactorily integrated the aquatic and terrestrial communities, successional stages, cultural habitats and landscapes used by VT's SGCN, a hybrid of several classification systems with more 120 types organized into 24 major habitat categories was created. Habitat descriptions for each SGCN and Invertebrate SGCN Group are in the Species Conservation Reports. Each includes a narrative, general habitat preferences, landscape requirements and assignment to one or more habitat type. The landscape and habitat summaries each describe characteristics and locations, condition (historical, current and desired) and propose strategies to address data gaps where needed. Plant SGCN are cross-walked with habitat categories where possible. Statewide Goal/Action 3.1.4 identifies the need to continue and enhance habitat monitoring programs to better track the distribution, abundance and status of SGCN habitats.
2B. Key habitats and their relative conditions are described in enough detail such that the state can determine where (i.e., in which regions, watersheds, or landscapes within the state) and what conservation actions need to take place.	A1-A5:all 6:2-14 B:9-130	Key habitats for each SGCN are described in the Species Conservation Reports. Habitat descriptions include a narrative and associations with 120 habitat, community and landscape categories. Detailed assessments of the 24 major habitat categories comprising the 120 habitat types were created. Each contains descriptions, location, **current and desired conditions**, priority problems, research and monitoring needs and priority conservation strategies.

Element 3. Descriptions of problems which may adversely affect species identified in the 1st element or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.		
RRT Guidance	**Chapter : Page**	**Detail**
3A. The Plan indicates sources of information (e.g., literature, databases, agencies, or individuals) used to determine the problems or threats	8:10-14 A1-A5:all	Vermont used the best available science and information to identify priority threats and problems for SGCN and their habitats. Sources include records maintained by VFWD, NatureServe, NEAFWA, NALCC, universities and research facilities, PIF, PARC and the knowledge of our technical experts. Teams identified only those factors posing significant and potentially significant threats for a species or habitat (i.e., not exhaustive lists of all possible problems).
	A1-A5:all 5:4-59	The bibliography in each Species Conservation Report (A1-A5) identifies specific sources. This is also true for taxonomic summaries in chapter 5. Technical team and expert knowledge played a significant role in the identification of problems.
	6:11 B:9-130	The bibliography in each habitat summary identifies specific sources. Technical team and expert knowledge played a significant role in the identification of problems.
3B. Threats/problems are described in sufficient detail to develop focused conservation actions	A1-A5all C:1-6 B9:130	Threats/problems to SGCN are described in narratives in each Species Conservation Report. Each threat/problem was then assigned to one of 22 habitat related and non-habitat related threat categories (described in appendix C). Better known species generally have fuller problem descriptions. For some poorly understood SGCN descriptions of threats/problems were less specific. Species Teams have in some cases provided consensus recommendations of problems as a starting place for future research.
	5:4-59	Taxon-wide threats/problems are described in the taxa summaries.
	6:11 B:9-130	Threats impacting habitats are addressed in the threats section of each habitat summary. As with SGCN, each was assigned to a threat category (appendix C) and priority rank (high, medium, low).
	2:6-9	Major threats, those most frequently or broadly identified as impacting SGCN or their habitats are discussed in greater detail in chapter 2.
3C. The Plan considers threats/ problems, regardless of their origins (local, State, regional, national and international), where relevant to the State's species and habitats.	2:6-9 6:11 B:9-130	Threats, regardless of cause or origin, were considered. For example broad scale problems such as climate change and acid deposition as well as local problems such as the impact of recreational trails were all considered.
	8:13	Technical teams were instructed not to develop exhaustive lists of threats but rather to focus on the significant problems impacting a species or habitat.
3D. If available information is insufficient to describe threats/problems, research and survey efforts are identified to obtain needed information.	A1-A5:all	The Research & Monitoring Needs section of the Species Conservation Reports includes a "threats and their significance" data field. In some cases research is also identified in the conservation strategies section of the Species Conservation Reports.
	5:4-59	Taxa overviews note research needs that came up repeatedly.
	6:11-12 and B:9-130	Habitat summaries contain a "Threat and Information Needs" table where needed identifies 'insufficient information' problems.

Element 3. **Descriptions of problems which may adversely affect species identified in the 1st element or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.**		
RRT Guidance	**Chapter : Page**	**Detail**
3E. The priority research and survey needs, and resulting products, are described sufficiently to allow for the development of research and survey projects after the Plan is approved.	A1-A5:all	Priority research and survey needs are described for each SGCN in the Research and Monitoring section of the Species Conservation Reports. Five research and monitoring categories were selected to help manage data collection (Habitat Requirements, Threats and Their Significance, Habitat Change, Monitor Threats, and Other Monitoring Needs). Technical Teams provided a narrative description of the research or monitoring need, and a priority rank of low, medium and high. As noted earlier teams were directed to focus on significant problems (medium and high). For most SGCN distribution and abundance data is the primary need.
	5:4-59	Priority research and survey needs applicable taxon-wide are broadly described in the taxa overviews
	6:11-12 and B:9-130	Priority research and survey needs are described for each habitat category in the Problem and Information Needs section of each Habitat Summary
	5:1-12	Research and survey needs spanning multiple species and taxa will be addressed in the statewide wildlife monitoring and adaptive management program that will begin with Action Plan implementation.
	1:11-12	The need for a wildlife monitoring and adaptive management program is identified as goal #3 in the statewide goals section.

Element 4 Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.		
RRT Guidance	**Chapter : Page**	**Detail**
4A. The Plan identifies how conservation actions address identified threats to species of greatest conservation need and their habitats.	A1-A5:all 6:11-14 B:9-130 C:7-11	Priority conservation actions were developed for SGCN (strategies section of each Species Conservation Report) and for habitats (strategies sections of the landscape and habitat summaries). Each was then assigned to an action category (appendix C 7-9). Generally, the connection between the problems and conservation actions identified in the Action Plan are intuitive and self-evident (e.g. habitat threatened by encroaching development would be targeted through a suite of strategies including technical assistance to developers and municipal planning authorities, conservation easements and efforts to increase funding for land acquisition). Actions are included to address immediate localized threats as well as broader, diffuse stressors and problems that may cause or exacerbate the localized problems (e.g. riparian habitat restoration to improve stream water temperatures and adaptation strategies in response to climate change).
4B. The Plan describes conservation actions sufficiently to guide implementation of those actions through the development and execution of specific projects and programs.	8:14-16 C:7-11 1:7-12 5:4-59 A1-A5:all 6:11-14 B:9-130	Teams developed conservation action as narrative statements for priority problems to SGCN and their habitats. Each action was then assigned to an action category (appendix C 7-9). Actions balance the need to guide implementation with the need to maintain relevance and flexibility through the life of the Action Plan (~10 years) and therefore are broad and directional. This allows for different approaches to implementation, leaves the door open to a variety of potential implementers and allows for adaptation in response to changing conditions and new information. Where action implementation is to be funded by the State Wildlife Grant program the approach will be consistent with the mission and strategic plan of VFWD, and precise procedures will be detailed in operational plans once the Action Plan is finalized. Conservation strategies are found in the following locations: 1) Statewide Goals/Actions (those that appeared repeatedly across taxa and habitats, and strategies actions address statewide, regional, and national problems). 2) Taxon-wide actions 3) Species and invertebrate group specific strategies 4) Habitat and landscape strategies
4C. The Plan links conservation actions to objectives and indicators that will facilitate monitoring and performance measurement of those conservation actions.	A1-A5:all 6:11-14 B:9-130 1:11 1:11-12	Performance measures are included for conservation actions in the Species Conservation Reports and in the Habitat Summaries. Some measures are very specific, others are general. This Wildlife Action Plan identifies significantly more species, problems and needs than we expect can be addressed in the coming decade assuming current budgets and staffing levels for VFWD and all our partners. Prior to implementing actions identified in this plan, we will develop include indicators and performance measures where appropriate. The need for a wildlife monitoring and adaptive management program is identified as goal #3 in the statewide goals section.

Element 4 **Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.**		
RRT Guidance	**Chapter : Page**	**Detail**
4D. The Plan describes conservation actions (where relevant to the State's species and habitats) that could be addressed by Federal agencies or regional, national or international partners and shared with other States.	1:7-12 A1-A5 all 6:11-14 B9-130 G:all	Vermont's Action Plan was developed as a statewide, all species conservation plan that all partners can take part in which all partners can take part. Indeed, for successful implementation broad partner participation is vital. Moreover, for many actions included in the Action Plan, partners may be the more logical and appropriate project leaders. Each action in Species Conservation Reports and Habitat Summaries includes a list of *potential* partners that could help implement it. No attempt is made to assign specific actions to specific partners, and neither is implementation limited to those listed. Expanded guidance and support to help municipalities implement the Action Plan is provided in Appendix G.
4E. If available information is insufficient to describe needed conservation actions, the Plan identifies research or survey needs for obtaining information to develop specific conservation actions	A1-A5 all 6:11-14 B9-130	Research and survey needs are identified for each SGCN in the Species Conservation Reports (in the Research & Monitoring Needs section and in some cases in the Conservation Strategies section) Research and survey needs for habitats are described in the Priority Conservation Strategy section of each Habitat Summary
4F. The Plan identifies the relative priority of conservation actions.	7:10 8:13 A1-A5:all 6:11-14 B9-130 7:10	All strategies selected for inclusion in VT's Action Plan are deemed "priority" strategies and are ranked "medium" or "high" priority (low priority strategies were dropped from consideration). No further prioritization is included here. The rationale is that no prioritization scheme was identified that satisfied all partners and their varied missions and interests. Detailed discussions with the Conservation Strategy Review team focused prioritization efforts on problems impacting SGCN and habitats rather than on strategies. For species-level conservation, strategy ranks are found in the Species Strategies section of each Species Conservation Report. For habitat level conservation, all strategies found in the Priority Conservation Strategies section of habitat summaries are considered "priorities." Allocation of SWG funds will require additional strategy and action prioritization that will occur at the operational planning level where prioritization will also be based on the impact of threats to SGCN and habitats, a project's ability to affect positive change, other conservation and social impacts and the availability of matching funds and project personnel.

Element 5. Descriptions of the proposed plans for monitoring species identified in the 1st element and their habitats, for monitoring the effectiveness of the conservation actions proposed in the 4th element, and for adapting these conservation actions to respond appropriately to new information or changing conditions		
RRT Guidance	**Chapter : Page**	**Detail**
5A. The Plan describes plans for monitoring species identified in Element #1, and their habitats.	A1-A5:all 6:11-14 B9-130 5:4-59 7:4-8 1:11 7:4-6	Monitoring needs are described for each SGCN in the research and monitoring needs section of each Species Conservation Report. Survey and monitoring recommendations are described for habitats in the Priority Conservation Strategies section Habitat Summaries. Taxonomic summaries include priority monitoring needs and those that frequently cited within the taxon. While monitoring the status of all SGCN, and their habitats, and threats to each is not possible under current funding/staffing constraints (or necessarily wise) a process for meeting the congressional requirements for monitoring and adaptive management is described in chapter 7. Statewide goal #3: "Inventory, monitor, and research SGCN, their habitats and natural communities to provide baselines for conservation and to maintain ecological integrity." Summary of existing broad-based VT monitoring programs addressing SGCN and habitats is at 7:4-6.
5B. The Plan describes how the outcomes of the conservation actions will be monitored.	A1-A5:all 6:11-14 B9-130 7:4, 7:4-8	Performance measures are included for conservation strategies in the Species Conservation Reports and in the Habitat Summaries. Monitoring guidelines in chapter 7 will include implementation, effectiveness and validation monitoring procedures.
5C. If monitoring is not identified for a species or species group, the Plan explains why it is not appropriate, necessary or possible	7:4-8	Not every SGCN or SGCN group will be directly monitored. Attempting to do so would quickly grind VT's Action Plan program to a halt. The monitoring program that will be developed as part of VT's Action Plan implementation will include coarse filter strategies (e.g., landscapes, habitats) that will provide a more effective means of monitoring most SGCN. The monitoring plan to be developed will also identify those SGCN that cannot be served by indicator or habitat monitoring, and those that are extremely rare or threatened. These will be monitored directly where appropriate.
5D. Monitoring is to be accomplished at one of several levels including individual species, guilds, or natural communities.	1:11 7:4-8	The monitoring program to be developed as part of VT's Action Plan implementation will monitor landscapes, habitats, select SGCN, threats and actions at multiple scales.
5E. The monitoring utilizes or builds on existing monitoring and survey systems or explains how information will be obtained to determine the effectiveness of conservation actions.	7:4-6 A1-A5 4:12-34 7:4-8	Existing monitoring and survey systems are reviewed in the monitoring section of chapter 7 and noted in some Species Conservation Reports and Taxon Summaries. Utilizing and where needed, building on effective existing monitoring systems will be stressed in the development of VT's Action Plan monitoring program.

Element 5. **Descriptions of the proposed plans for monitoring species identified in the 1st element and their habitats, for monitoring the effectiveness of the conservation actions proposed in the 4th element, and for adapting these conservation actions to respond appropriately to new information or changing conditions**		
RRT Guidance	**Chapter : Page**	**Detail**
5F. The monitoring considers the appropriate geographic scale to evaluate the status of species or species groups and the effectiveness of conservation actions.	1:11 7:all 7:10	Monitoring of species, habitats, threats and strategies should be at scales appropriate to provide meaningful data for a broad array of users. Regional and sub-regional scale monitoring will be coordinated via NEAWA's Fish and Wildlife Diversity Tech Committee and its RCN program as well as through the NALCC
5G. The Plan is adaptive in that it allows for evaluating conservation actions and implementing new actions accordingly.	7:2 7:8 A1-A5:all 6-11-14 B:9-130	Implementation, effectiveness and validation monitoring will be important components of VT's Action Plan monitoring program and will be used to assess our efforts and to focus future conservation actions. VT's Action Plan encourages adaptive management by including performance measures for strategies in the Species Conservation Reports and Habitat Summaries.

Element 6. **Descriptions of procedures to review the Plan at intervals not to exceed ten years.**		
RRT Guidance	**Chapter : Page**	**Detail**
6A The State describes the process that will be used to review the Plan within the next ten years.	7:4-10 7:11	Vermont's Action Plan will be reviewed on a 10-year cycle. That cycle begins almost immediately as monitoring and reporting described in the Action Plan and new and ongoing collaboration with partners will contribute significantly to the review of the Action Plan. In 2025 we expect to show that we've reviewed and adapted VT's Action Plan accordingly from the outset.

Element 7. **Descriptions of the plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the Plan with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats**		
RRT Guidance	**Chapter : Page**	**Detail**
7A. The State describes the extent of its coordination with and efforts to involve Federal, State and local agencies, and Indian Tribes in the development of its Plan.	8:6-7 8:7 8:1-2, 8:6-7	There are no federally recognized Native American tribes that manage significant land and water areas within Vermont or administer programs that significantly affect the conservation of SGCN or their habitats. According to information provided by the USFWS, the Stockbridge-Munsee Band of the Mohican Nation, based in Wisconsin, has interests in its ancestral lands in Vermont. We invited the Stockbridge-Munsee Band to participate in Action Plan revision twice (11/24/2014 and 3/20/2015). We have not received a response. The four bands of the Abenaki Tribe recognized by the state of Vermont were invited to take part in the development of the Action Plan as Conservation Partners and through the general public input process. Federal, State and local agencies and non-governmental organizations were invited to participate in Action Plan development. Twenty-one groups were represented on Action Plan technical teams (Table 8.1) and many others provided comments on Action Plan drafts.
7B. The State describes its continued coordination with these agencies and tribes in the implementation, review and revision of its Plan.	7:9 A1-A5:all 6:11-14 B:9-130 7:11	Effective implementation of VT's Action Plan will require ongoing collaboration and coordination among partners (including local, state, and federal agencies—as well as with neighboring states and Quebec provinces). This is stressed throughout the document. Implementation of many of the conservation strategies included here will require continued coordination and collaboration with other agencies. The review and revision process will follow the same process used in the development of the Action Plan and will include participation by agencies.

Element 8. Descriptions of the necessary public participation in the development, revision, and implementation of the Plan.		
RRT Guidance	**Chapter : Page**	**Detail**
8A. The State describes the extent of its efforts to involve the public in the development of its Plan.	8:1-2, 8:6-7	The public involvement process is described in chapter 8. Public involvement occurred particularly through non-governmental organizations and citizen committees such as the VT Forest Roundtable and the VT Agency of Natural Resources' Endangered Species Committee. Public involvement began early in the Action Plan development process. Many participated in Action Plan development as Conservation Partners providing review and comments on draft products, and staff representing 21 organizations and agencies served on Action Plan technical teams (Table 8.1). The general public was invited to review and comment on the draft Wildlife Action Plan. Outreach to the general public occurred via press releases, news interviews, postings to the VFWD website and Facebook pages and via listserves and newsletters of partner organizations. A Wildlife Action Plan Revision website (http://www.vtfishandwildlife.com/cms/one.aspx?portalid=73163&pageid=480687) was created to provide additional information and direct access to the Action Plan drafts. The public review period for the draft Wildlife Action Plan was October 9 through November 15, 2015. We accepted all comments that came in after that date and through 12/31/2015.
8B. The State describes its continued public involvement in the implementation and revision of its Plan.	1:3 7:9	It is clear from a variety of surveys that wildlife is very important to the people of Vermont (1:3). Implementation of many of the conservation strategies in this Wildlife Action Plan will require public involvement—particularly through NGOs and municipalities (7:9). Effective implementation of VT's Action Plan requires ongoing collaboration and coordination with the public. This is stressed throughout the document.
	7:9	VFWD will work to keep conservation partners and the public informed of Action Plan implementation through communications with partners, partnerships and collaborations, requests for proposals, meetings and conferences as well as through general outreach and technical assistance programs.
	7:12-13	The review and revision process will follow the same process used in the development of the Action Plan and the public will again be encouraged to participate. VFWD will work to keep Conservation Partners and the public informed of Action Plan revision through communications with partners, partnerships and collaborations, meetings and conferences as well as through general outreach, education and technical assistance programs.

Appendix A1

Amphibian & Reptile SGCN Conservation Reports

Wildlife Action Plan 2015

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S2
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Jefferson Salamander is rare in Vermont (S2, SC), and is considered a species of conservation concern within the region due to evidence of population declines and the fact that a high proportion of the global population occurs within the Northeast (Terres). Jefferson Salamander breeding habitat is limited almost exclusively to temporary woodland pools surrounded by relatively large stands of mature hardwoods. There is evidence that the species may be sensitive to forest fragmentation, and in southern New England, some populations appear to have been outcompeted by its congener, the Blue-spotted Salamander (Klemens, personal communication). In addition, unisexual female hybrid populations exist that introduce uncertainties about the species' taxonomy, population biology, persistence, and long-term viability.

Distribution

The distribution of this rare woodland species is widespread but scattered in Vermont; rare or absent from higher elevations of the Green Mountains.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Middle Connecticut
Lake Champlain
Middle Connecticut
West
Upper Connecticut-Mascoma
Black-Ottauquechee
Hudson-Hoosic
Otter Creek
White
Winooski River

Probable Watersheds
Lamoille River
Waits
Deerfield
Passumpsic

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Habitat mosaics that include breeding pools embedded in closed canopy forest stands is most critical. Maintaining forested corridors connected to other suitable habitat patches with breeding pools is important for juvenile dispersal and to maintain metapopulation dynamics. Requires well-shaded, relatively mature hardwood/hemlock forest stands with abundant course woody debris, leaf litter, and underground refugia (small mammal tunnels, rock crevices, etc.) surrounding temporary woodland (vernal) pools (Faccio 2003). May also use semi-permanent pools. Most commonly found in ridgetop, mid-elevation Northern Hardwood forests in the foothills of the Green Mountains.

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Seeps and Pools

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Any habitat conversion, alteration, or fragmentation that disrupts species' ability to move between breeding and terrestrial sites, disrupts connectivity between breeding sites/metapopulations (Compton et al 2007), changes water/soil chemistry, temperature, pool hydroperiod, humidity, etc, may have negative effects. Road mortality can have major impacts on migrating adults and dispersing juveniles, especially when located between terrestrial and breeding habitats. Climate change that affects hydroperiod and/or water temperature of breeding pools could have significant impacts on productivity (Rowe and Dunson 1995).

Non-Habitat Threats:

Genetics

Competition

Pollution

Reproductive Traits

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

Disease

Trampling or Direct Impacts

Description of non-habitat threat(s): Unisexual, female hybrid populations reproduce via gynogenesis (requires sperm from diploid males which is not incorporated into the genome of embryos; Petranka 1998), resulting in female-biased sex ratios. Since hybrid females require males in the population for successful breeding, but do not produce males to replace those that have been lost, they may have the potential to dilute genetic variability of diploid populations. Competition from the Blue-spotted Salamander, which is more tolerant of disturbed habitats (Klemens 1993), may be a problem in areas where both species are found together (Champlain Valley, southern NE). Two emerging diseases (Ranavirus and Batrachochytrium salamandrivorans (Bs)) could present a threat in the future. Ranavirus was recently shown to be widely distributed in vernal pools in six mid-Atlantic states (Scott A. Smith pers. Comm.), while the fungal disease Bs, which originated in Asia, was recently detected in Europe (Stokstad 2014). Loss of metapopulation structure due to fragmentation of suitable habitats by roads or other non-permeable development is problematic. Jefferson Salamander is more sensitive to acidification of breeding pools compared to other Ambystoma species (Petranka 1998). Complete egg mortality occurs in pools with low pH, and water with a pH <4.5 is often lethal to larvae. Also, widespread treatment of breeding pools to control West Nile Virus would likely have negative effects on amphbians. This is a long-lived amphibian that may not breed every year and produces relatively few eggs per breeding cycle.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Continue to field-verify mapped potential pools and other breeding sites statewide.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) Identify distribution and relative abundance of VT populations 2) Identify significant breeding sites. Large numbers (e.g., >25 egg masses) of breeders or evidence of use by any SGCN. 3) Continue to field-verify mapped potential vernal pools statewide.
Research	Threats and Their Significance	High	1) Conduct sampling to determine if Ranavirus is present in the state, and if so, determine its distribution and which species are affected. 2) Identify sites where road mortality is high annually and evaluate mitigation methods. 3) Identify and evaluate limiting factors.
Research	Population Genetics	Medium	Determine population genetics statewide and monitor populations for changes in sex ratios.
Research	Taxonomy	Medium	
Monitoring	Population Change	High	Implement a statistically robust monitoring protocol to track breeding phenology, population trends, and productivity, as well as changes in breeding site variables (e.g. hydroperiod, water chemistry, etc.).
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	Medium	
Monitoring	Monitor Threats	High	

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Determine presence/absence and distribution of Ranavirus in VT, and which species are most affected.	Number and distribution of sites sampled	VCE, Reptile & Amphibian Atlas, ANR Wetlands Division	SWG, Private Grants
Standards		Timber harvest should be conducted on frozen ground and rutting of ground that could change hydrology of an area or intercept amphibians should be avoided.	Number of operations that did not disturb ground	landowners, FPR, USFS, consulting foresters	State Lands Mgmt, GMNF, EQIP, Current Use
Standards		Maintain 75% mature canopy cover beyond the 30-meter buffer in the terrestrial habitat.	Sites with canopy cover	landowners, consulting foresters	State Lands Mgmt funds, EQIP, Current Use
Standards		Maintain 30-meter water quality buffer around entire perimeter of the pool. Timber harvesting, roads and any ground disturbing activities to be excluded within this buffer.	Number of sites having water quality protected	landowners, consulting foresters	EQIP, Current Use
Compatible Resource Use		Maintain permeable forested habitat matrix between and among breeding populations so that individuals can be exchanged among populations.	Number of pools with forest surrounding	landowners, consulting foresters	EQIP, Current Use
Technical Assistance, Training, Learning Networks		Identify significant road crossings and develop safe road crossings to address roadkill.	Number of sites reported	VTrans, Reptile & Amphibian Atlas, VCE	VTrans, FHWA
Habitat Restoration		When existing road traffic is impacting migration of animals from terrestrial habitat to aquatic pool habitat, identify problem areas and redesign roads with crossing structures when roads are being upgraded.	Number of structures installed	VTrans	VTrans, FHWA
Standards		Maintain habitat mosaic and connectivity between breeding pools. If two large sites are separated beyond the dispersal distance of a species it might be helpful to create or enhance pools that would link the two large sites.	Number of pools within habitat matrix	landowners, consulting foresters	State Lands Mgmt fund, EQIP, Current Use
Compatible Resource Use		Site all permanent roads more than 200 meters from a breeding pool, downslope of the pool if possible.	Number of roads sited to minimize impacts to pools	VTrans, developers	VTrans, development conditions
Habitat Restoration		When feasible restore deciduous or mixed forest surrounding breeding pool.	Number of sites restored	landowners, consulting foresters	Current Use, EQIP

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

Awareness Raising and Communications		Help people understand the essential needs of all life stages, especially upland habitat in proximity to breeding pool.	Number of people exposed to conservation message	VFWD Outreach Division, media, Reptile & Amphibian Atlas, VCE	marketing funds
Compatible Resource Use		Maintain breeding pools and needed terrestrial habitat--usually directly adjacent to pool perimeter out to 200m but could be the equivalent area along a portion of the perimeter while minimizing edge.	Pools with upland habitat.	landowners, consulting foresters	Current Use, EQIP
Compatible Resource Use		Maintain corridor connections between upland and pool habitat.	Number of sites with upland connections	landowners, consulting foresters	Current Use, EQIP
Habitat Restoration		If loss of important sites is likely due to development, consider creating or enhancing other pools that might allow some adults to transfer to the new site if they encounter it or develop a new breeding population from dispersal of colonizers.	Number of utilized pools.	VTrans, Towns	VTrans, development conditions
Technical Assistance, Training, Learning Networks	High	Implement vernal pool management guidelines as described by VFWD.	Number of trainings offered. Number of entities adopting the guidelines.	VFWD, FPR, Coverts, VWA, VT Family Forests, SAF, Land Trusts, Consulting Foresters	SWG

Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

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Common Name: **Jefferson Salamander**
Scientific Name: **Ambystoma jeffersonianum**
Species Group: **Herp**

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Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3
Extirpated in VT?

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Blue-spotted Salamander is rare in Vermont (S3, SC), and is considered a species of conservation concern within the region due to its unknown population status, and taxonomic uncertainty (Terres 1999). The Blue-spotted Salamander is dependent on habitat mosaics consisting of lowland forest adjacent to fishless wetlands suitable for breeding. In addition, unisexual female hybrid populations exist that introduce uncertainties about the species' taxonomy, population biology, persistence, and long-term viability.

Distribution

Well distributed in the Champlain Valley and southern Champlain Hills, with scattered populations elsewhere; rare or absent from higher elevations of the Green Mountains.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Unknown	**Southern Green Mtns**	Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
Metawee River
Passumpsic
West
Hudson-Hoosic
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
St. Francois River
Upper Connecticut
Winooski River

Probable Watersheds
Middle Connecticut
Waits
White

Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Habitat mosaics that include breeding sites embedded in, or adjacent to, closed canopy forest stands are most critical. Maintaining forested corridors connected to other suitable habitat patches with breeding pools is important for juvenile dispersal and to maintain metapopulation dynamics. Requires hardwood/mixed forest stands with abundant course woody debris, leaf litter, and underground refugia (small mammal tunnels, rock crevices, etc.) surrounding a variety of wetland types, including red maple swamps, fens, marshes, temporary woodland (vernal) pools, etc. Most commonly found at lower elevations (<350m), in woodlands adjacent to forested wetlands with sufficient cover for breeding. More tolerant of disturbed habitats and smaller patch size than Jefferson Salamander (Klemens 1993).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Any habitat conversion, alteration, or fragmentation that disrupts species' ability to move between breeding and terrestrial sites, disrupts connectivity between breeding sites/metapopulations (Compton et al 2007), changes water/soil chemistry, temperature, pool hydroperiod, humidity, etc, may have negative effects. Road mortality can have major impacts on migrating adults and dispersing juveniles, especially when located between terrestrial and breeding habitats. Climate change that affects hydroperiod and/or water temperature of breeding pools could have significant impacts on productivity (Rowe and Dunson 1995).

Non-Habitat Threats:

Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

Genetics

Pollution

Reproductive Traits

Disease

Trampling or Direct Impacts

Description of non-habitat threat(s): Unisexual, female hybrid populations reproduce via gynogenesis requiring sperm from diploid males which is not incorporated into the genome of embryos (Petranka 1998), resulting in female-biased sex ratios. Since hybrid females require males in the population for successful breeding, but do not produce males to replace those that have been lost, they may have the potential to dilute genetic variability of diploid populations. Two emerging diseases (Ranavirus and Batrachochytrium salamandrivorans (Bs)) could present a threat in the future. Ranavirus was recently shown to be widely distributed in vernal pools in six mid-Atlantic states (Scott A. Smith pers. Comm.), while the fungal disease Bs, which originated in Asia, was recently detected in Europe (Stokstad 2014). Loss of metapopulation structure leading to genetic isolation due to fragmentation of suitable habitats by roads or other non-permeable development is problematic. Acid precipitation that lowers pH of breeding pools may reduce productivity. Also, widespread treatment of breeding pools to control West Nile Virus would likely have negative effects on amphibians. This is a long-lived amphibian that may not breed every year and produces relatively few eggs per breeding cycle.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Continue to field-verify mapped potential pools and other breeding sites statewide.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) Identify distribution and relative abundance of VT populations. 2) Identify significant breeding sites. Large numbers (e.g., >25 egg masses) of breeders or evidence of use by any SGCN. 3) Continue to field-verify mapped potential vernal pools statewide.
Research	Threats and Their Significance	High	1) Conduct sampling to determine if Ranavirus is present in the state, and if so, determine its distribution and which species are affected. 2) Identify sites where road mortality is high annually and evaluate mitigation methods. 3) Identify and evaluate limiting factors.
Research	Population Genetics	Medium	Determine population genetics statewide and monitor populations for changes in sex ratios.
Research	Taxonomy	Medium	
Monitoring	Population Change	High	Implement a statistically robust monitoring protocol to track breeding phenology, population trends, and productivity, as well as changes in breeding site variables (e.g. hydroperiod, water chemistry, etc.).
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	Medium	
Monitoring	Monitor Threats	High	

Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Identify significant road crossings and develop safe road crossings to reduce roadkill.	Number of reported crossings.	VTrans, VCE, Town highway crews & Cons Comms	Vtrans, FHWA
Standards	Medium	Maintain 30-meter water quality buffer around entire perimeter of the pool. Timber harvesting, roads and any ground disturbing activities to be excluded within this buffer.	Number of pools with protected buffers.	DEC Wetlands	EPA
Habitat Restoration	Medium	If loss of important sites is likely due to development, consider creating or enhancing other pools that might allow some adults to transfer to the new site if they encounter it or develop a new breeding population from dispersal of colonizers.	Connectivity among clusters of pools. No net loss of functional breeding pools.	DEC Wetlands	EPA
Standards	Medium	Maintain habitat mosaic and connectivity between breeding pools. If two large sites are separated beyond the dispersal distance of a species it might be helpful to create or enhance pools that would link the two large sites.	Connectivity among clusters of pools. No net loss of functional breeding pools.	DEC Wetlands	EPA
Technical Assistance, Training, Learning Networks	High	Identify significant road crossings and develop safe road crossings to reduce roadkill.	Numbers of sites identified and addressed.	VTrans, FHWA	VTrans, FHWA
Awareness Raising and Communications	Medium	Help people understand the essential needs of all life stages, especially upland habitat in proximity to breeding pool.	Number of programs and individuals reached with message.	Reptile & Amphibian Atlas, VFWD Outreach Division, VCE	Private Foundation grants
Technical Assistance, Training, Learning Networks	High	Implement vernal pool management guidelines as described by VFWD.	Number of trainings offered. Number of entities adopting the guidelines.	VFWD, FPR, Coverts, VWA, VT Family Forests, SAF, Land Trusts, Consulting Foresters	SWG
Compatible Resource Use	High	Maintain corridor connections between upland and pool habitat.	Number of pools with secure travel paths to and from upland habitat. No net loss.	Consulting Foresters, USFS	Land Mgmt Agency operating budgets

Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

Research	High	Determine presence/absence and distribution of Ranavirus in VT, and which species are most affected.	Number and distribution of sites sampled.	VCE, Reptile & Amphibian Atlas, DEC Wetlands	SWG, Private grants
Habitat Restoration	High	When existing road traffic is impacting migration of animals from terrestrial habitat to aquatic pool habitat, identify problem areas and redesign roads with crossing structures when roads are being upgraded.	Number of structures installed.	VTrans, FHWA, Towns	FHWA
Standards	High	Timber harvest should be conducted on frozen or dry ground to avoid rutting of ground that could change hydrology of an area or intercept amphibians should be avoided.	Number of harvests conducted on frozen ground.	FPR, Consulting Foresters, USFS	timber sale
Standards	High	Maintain 75% mature canopy cover beyond the 30-meter buffer in the terrestrial habitat.	Number and percentage of habitats with adequate canopy.	FPR, Consulting Foresters, USFS	
Compatible Resource Use	High	Maintain breeding pools and needed terrestrial habitat--usually directly adjacent to pool perimeter out to 200m but could be the equivalent area along a portion of the perimeter while minimizing edge).	Number of pools with adjacent upland habitat that is permeable for salamanders moving to and from pool.	Landowners	
Compatible Resource Use	Medium	Site all permanent roads more than 200 meters from a breeding pool, downslope of the pool if possible.	Number/ percentage of roads sited appropriately.	Developers, Act 250 Commissions	Planning grants, development costs
Compatible Resource Use	High	Maintain permeable forested habitat matrix between and among breeding populations so that individuals can be exchanged among populations.	Number of linkages between populations.	Reptile & Amphibian Atlas, Conservation Organizations, USFS	Current Use Program, EQIP
Habitat Restoration	Low	When feasible restore deciduous or mixed forest surrounding breeding pool.	Number of pools restored.	Vermont Family Forests	Current Use

Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

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Common Name: **Blue-spotted Salamander**
Scientific Name: **Ambystoma laterale**
Species Group: **Herp**

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Common Name: **Spotted Salamander**
Scientific Name: **Ambystoma maculatum**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 | **Global Trend:**
State Rank: S5 | **State Trend:**
Extirpated in VT? No | **Regional SGCN?** No

Assessment Narrative:

Spotted Salamander is found in pools adjacent to woodlands. It is widespread and abundant, but is killed in large numbers when it migrates across roads to and from it breeding pools, and is therefore a SGCN. Conservation status could change over time with increased human pressure that impacts the species in Vermont. For now we consider it to be a medium priority species.

Distribution

The Spotted Salamander is distributed widely in the state of Vermont, including the Green Mountains.

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Confident
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

Black - Ottauquechee
Deerfield
Hudson-Hoosic
Lake Champlain
Lamoille River
Metawee River
Middle Connecticut
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut
Upper Connecticut - Mascoma
Waits
West
White
Winooski River

Common Name: **Spotted Salamander**
Scientific Name: **Ambystoma maculatum**
Species Group: **Herp**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Spotted Salamanders must have both ephemeral breeding pools and upland habitat in proximity. They may also breed in semi-permanent or permanent wetlands where there is suitable cover to avoid predation by fish. Upland, non-breeding habitat requirements include hardwood/mixed forest stands with abundant coarse woody debris, leaf litter and underground refugia (e.g., small mammal tunnels, rock crevices) surrounding suitable breeding pools (Faccio 2003).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Habitat problems for the Spotted Salamander include loss of upland and pool habitat, loss of movement between habitats, road mortality and less water as a result of climate change.

Non-Habitat Threats:

Pollution

Reproductive Traits

Trampling or Direct Impacts

Description of non-habitat threat(s): Two emerging diseases (Ranavirus and Batrachochytrium salamandrivorans (Bs)) could present a threat in the future. Ranavirus was recently shown to be widely distributed in vernal pools in six mid-Atlantic states (Scott A. Smith pers. comm.), while the fungal disease Bs, which originated in Asia, was recently detected in Europe (Stokstad 2014). Loss of metapopulation structure leading to genetic isolation due to fragmentation of suitable habitats by roads or other non-permeable development is problematic. Acid precipitation that lowers pH of breeding pools may reduce productivity. Also, widespread treatment of breeding pools to control West Nile Virus would likely have negative effects on amphibians. This is a long-lived amphibian that may not breed every year and produces relatively few eggs per breeding cycle.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Continue to field-verify mapped potential pools and other breeding sites statewide.
Research	Basic Life History	Medium	Need to determine travel distances to pools
Research	Distribution and Abundance	Medium	1) Identify significant breeding sites. Large numbers (e.g., >25 egg masses) of breeders or evidence of use by any SGCN. 2) Continue to field-verify mapped potential vernal pools statewide
Research	Threats and Their Significance	High	1) Conduct sampling to determine if Ranavirus is present in the state, and if so, determine its distribution and which species are affected. 2) Identify sites where road mortality is high annually and evaluate mitigation methods. 3) Identify and evaluate limiting factors.
Monitoring	Population Change	High	Implement a statistically robust monitoring protocol to track breeding phenology, population trends, and productivity, as well as changes in breeding site variables (e.g. hydroperiod, water chemistry, etc.).
Monitoring	Habitat Change	High	It is important to understand the existing habitat base and track trends.
Monitoring	Monitor Threats	High	We should both monitor and manage limiting factors.

Common Name: **Spotted Salamander**
Scientific Name: **Ambystoma maculatum**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Determine presence/absence and distribution of Ranavirus in VT, and which species are most affected.	Number and distribution of sites sampled	VCE, Reptile & Amphibian Atlas, DEC Wetlands	SWG, Private grants
Standards		Maintain 75% mature canopy cover beyond the 30-meter buffer in the terrestrial habitat	Number of sites where canopy cover is retained	landowners state and federal lands managers	state lands Mgmt funds, federal lands Mgmt, EQIP
Technical Assistance, Training, Learning Networks		Identify significant road crossings and develop safe road crossings to address roadkill.	Number of sites identified and crossings developed.	Reptile & Amphibian Atlas, VTrans	VTrans, FHWA
Habitat Restoration		When feasible restore deciduous or mixed forest surrounding breeding pool	Number of sites with restored forest cover	landowners, consulting foresters, EQIP biologists	EQIP, Current Use
Standards		Maintain 30-meter water quality buffer around entire perimeter of the pool. Timber harvesting, roads and any ground disturbing activities to be excluded within this buffer	Number of sites where water quality is protected	DEC Water Quality/Wetlands Office, consulting foresters, EQIP biologists	EQIP
Standards		maintain habitat mosaic and maintain connectivity between breeding pools. If two large sites are separated beyond the dispersal distance of a species it might be helpful to create or enhance pools that would link the two large sites.	Number of areas linked.	FPR and VFWD lands managers, USFS, Federal Refuges, private landowners	State lands Mgmt funds, EQIP
Compatible Resource Use		Site all permanent roads more than 200 meters from a breeding pool, downslope of the pool if possible	Number of roads sited that minimize impacts.	VTrans, developers, Towns	Vtrans
Awareness Raising and Communications		Help people understand the essential needs of all life stages, especially upland habitat in proximity to breeding pool.	Number of people who are exposed to message	Reptile & Amphibian Atlas, VCE, SAG-Herps	private grants
Compatible Resource Use		Maintain corridor connections between upland and pool habitat	Number of sites with connections between pool and upland.	Landowners, consulting foresters, EQIP biologists	EQIP, Current Use

Common Name: **Spotted Salamander**
Scientific Name: **Ambystoma maculatum**
Species Group: **Herp**

Habitat Restoration		When existing road traffic is impacting migration of animals from terrestrial habitat to aquatic pool habitat, identify problem areas and redesign roads with crossing structures when roads are being upgraded.	Number of structures installed	VTrans	VTrans, FHWA
Habitat Restoration		If loss of important sites is likely due to development, consider creating or enhancing other pools that might allow some adults to transfer to the new site if they encounter it or develop a new breeding population from dispersal of colonizers.	Number of sites enhanced.	VTrans	VTrans
Compatible Resource Use		Maintain breeding pools and needed terrestrial habitat--usually directly adjacent to pool perimeter out to 200m but could be the equivalent area along a portion of the perimeter while minimizing edge.	Number of sites with both pools and upland habitat intact.	Landowners, consulting foresters, Reptile & Amphibian Atlas	EQIP, Partners in Wildlife
Standards		Timber harvest should be conducted on frozen ground and rutting of ground that could change hydrology of an area or intercept amphibians should be avoided.	Number of harvest operations that do not disturb ground.	Consulting foresters, FPR	Current Use
Technical Assistance, Training, Learning Networks	High	Implement vernal pool management guidelines as described by VFWD.	Number of trainings offered. Number of entities adopting the guidelines.	VFWD, FPR, Coverts, VWA, VT Family Forests, SAF, Land Trusts, Consulting Foresters	SWG

Common Name: **Spotted Salamander**
Scientific Name: **Ambystoma maculatum**
Species Group: **Herp**

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Species Group: **Herp**

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Common Name: **Four-toed Salamander**
Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

The Four-toed Salamander is rare in Vermont (S2, SC) and the region. Although the species is small and secretive, its distribution appears to be limited to low elevations of the Champlain Valley, Taconics, and probably the lower Connecticut River Valley. The species has specialized breeding requirements and is dependent on habitat mosaics consisting of lowland forest adjacent to suitable wetlands for breeding.

Distribution

The distribution of the Four-toed Salamander appears to be limited to low elevations of the Champlain Valley, Taconics, and probably the lower Connecticut River Valley.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
West	Lamoille River
Upper Connecticut-Mascoma	Missisquoi River
Mettawee River	
Lake Champlain	
Middle Connecticut	
Mettawee River	
Otter Creek	
Winooski River	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Moss or sedge hummocks or moss mats overhanging (often sphagnum) standing water is a critical feature of Four-toed Salamander breeding sites. Eggs are deposited in moss mats and, upon hatching, larvae wiggle through moss and enter pools. Habitat mosaics that include these breeding sites embedded in, or adjacent to, closed canopy forest stands are critical. Maintaining forested corridors connected to other suitable habitat patches with breeding sites is important for juvenile dispersal and to maintain metapopulation dynamics. Eggs have also been reported in the literature in rotting logs or leaf litter. Requires relatively mature, moist hardwood/mixed forest stands with abundant course woody debris, leaf litter, and underground refugia (small mammal tunnels, rock crevices, etc.) in close proximity to suitable breeding sites. Breeding sites include a variety of mossy wetlands, including red maple swamps, bogs, fens, temporary woodland (vernal) pools, etc. Most commonly found in bottomland forests adjacent to shallow, mossy wetlands with pools and sufficient cover for breeding. In surveys in Massachusetts and Maine, species appears to drop-out of suitable sites above 300 m elevation (A. Richmond, pers. Comm.)

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): The Four-toed Salamander has specialized breeding requirements that make it vulnerable to habitat disturbance. Any habitat conversion, alteration, or fragmentation that disrupts species' ability to move between breeding and terrestrial sites, changes water/soil chemistry, temperature, pool hydroperiod, humidity, etc, may have negative effects. Road mortality can negatively impact migrating adults and dispersing juveniles, especially when located between terrestrial and breeding habitats. Climate change that affects hydroperiod and/or water temperature of breeding pools could have significant impacts on productivity.

Non-Habitat Threats:

Genetics

Trampling or Direct Impacts

Disease

Pollution

Common Name: **Four-toed Salamander**
Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

Description of non-habitat threat(s): Loss of metapopulation structure leading to genetic isolation due to fragmentation of suitable habitats by roads or other non-permeable development is problematic. Widespread treatment of breeding pools to control West Nile Virus would likely have negative effects on many amphibians, including Four-toed Salamanders. Two emerging diseases (Ranavirus and Batrachochytrium salamandrivorans (Bs)) could present a threat in the future. Ranavirus was recently shown to be widely distributed in vernal pools in six mid-Atlantic states (Scott A. Smith pers. comm.), while the fungal disease Bs, which originated in Asia, was recently detected in Europe (Stokstad 2014).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Gain better understanding of breeding habitat requirements in Vermont and upper elevational limits.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	1) Identify significant breeding sites. Large numbers (e.g., >25 egg masses) of breeders or evidence of use by any SGCN. 2) Determine distribution and relative abundance of species in southern Connecticut River Valley, Vermont Valley, Champlain Hills, and Taconics. 3) Confirm whether the disjunct population represented by the near-historic record from 1989 in Fairlee is extant.
Research	Threats and Their Significance	High	1) Conduct sampling to determine if Ranavirus is present in the state, and if so, determine its distribution and which species are affected. 2) Identify sites where road mortality is high annually and evaluate mitigation methods. 3) Identify and evaluate limiting factors.
Research	Population Genetics	Low	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	It is important to understand the existing habitat base and track trends.
Monitoring	Range Shifts	Medium	
Monitoring	Monitor Threats	High	We should both monitor and manage limiting factors.

Common Name: **Four-toed Salamander**
Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	When existing road traffic is impacting migration of animals from terrestrial habitat to aquatic pool habitat, identify problem areas and redesign roads with crossing structures when roads are being upgraded.	Number of redesigns of roads.	VTrans	VTrans, FHWA
Technical Assistance, Training, Learning Networks	High	Identify significant road crossings and develop safe road crossings to address roadkill.	Number of crossing identified and structures installed	VTrans	VTrans
Compatible Resource Use	High	Maintain forested habitat matrix around breeding sites.	Number of pools within forested matrix	Landowners	Current Use, EQIP
Standards	Medium	Maintain 30-meter water quality buffer around entire perimeter of the pool. Timber harvesting, roads and any ground disturbing activities to be excluded within this buffer.	Number of pool sites managed for good water quality	Consulting Foresters, private and public landowners	Current Use, EQIP
Standards	High	Maintain 75% mature canopy cover beyond the 30-meter buffer in the terrestrial habitat.	Number of pools with canopy cover retained	Consulting Foresters, private and public landowners	Current Use, EQIP
Compatible Resource Use	High	Maintain corridor connections between upland and pool habitat.	Number of breeding sites with secure upland connection	Landowners, consulting foresters	volunteer compliance, Current Use, EQIP
Technical Assistance, Training, Learning Networks	High	Implement vernal pool management guidelines as described by VFWD.	Number of trainings offered. Number of entities adopting the guidelines.	VFWD, FPR, Coverts, VWA, VT Family Forests, SAF, Land Trusts, Consulting Foresters	SWG
Habitat Restoration	Medium	If loss of important sites is likely due to development, consider creating or enhancing other pools that might allow some adults to transfer to the new site if they encounter it or develop a new breeding population from dispersal of colonizers.	Number of utilized pools created	Landowners, VTrans	VTrans, volunteer effort
Research	High	Determine presence/absence and distribution of Ranavirus in VT, and which species are most affected.	Number and distribution of sites sampled.	VCE, Reptile & Amphibian Atlas, DEC Wetlands	SWG, private grants

Common Name: **Four-toed Salamander**
Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

Standards	High	Maintain habitat mosaic and maintain connectivity between breeding pools. If two large sites are separated beyond the dispersal distance of a species it might be helpful to create or enhance pools that would link the two large sites.	Number of sites enhanced.	Landowners, consulting foresters	Current Use, EQIP
Standards	High	Timber harvest should be conducted on frozen ground and rutting of ground that could change hydrology of an area or intercept amphibians should be avoided.	Number of operations that avoid ground alteration.	FPR, Consulting Foresters	State Lands Mgmt, Current Use
Awareness Raising and Communications	Medium	Help people understand the essential needs of all life stages, especially upland habitat in proximity to breeding pool.	Number of people who receive message.	Reptile & Amphibian Atlas, VCE	private grant
Compatible Resource Use	High	Maintain breeding pools and needed terrestrial habitat--usually directly adjacent to pool perimeter out to 200m but could be the equivalent area along a portion of the perimeter while minimizing edge.	Number of pools with needed upland	landowners, consulting foresters	State Lands Mgmt, Current Use, EQIP
Habitat Restoration	Low	When feasible restore deciduous or mixed forest surrounding breeding pool.	Sites with restored forested habitat.	Landowners	volunteer effort, EQIP
Compatible Resource Use	Medium	Site all permanent roads more than 200 meters from a breeding pool, downslope of the pool if possible.	Number of roads sited so that pool impacts are minimized.	VTrans, Towns	VTrans, FHWA
Technical Assistance, Training, Learning Networks	High	Identify significant road crossings and develop safe road crossings to reduce roadkill.	Number of structures installed.	VTrans, VCE	VTrans

Common Name: **Four-toed Salamander**
Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

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Scientific Name: **Hemidactylium scutatum**
Species Group: **Herp**

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Common Name: **Mudpuppy**
Scientific Name: **Necturus maculosus**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

The Mudpuppy is native to Lake Champlain where it appears to be restricted to shoals and shallows and the lower reaches of lake's tributaries. The Burlington area is the source of the type specimen from the late 1700s. There is also a Connecticut River population that is generally agreed to be from an introduced source. Recent analysis of genetic samples from Lake Champlain and the Connecticut River (Chellman 2011) confirmed the affinities of the Lake Champlain Mudpuppy with populations of the Ohio River drainage, whereas, the affinities of the Mudpuppy in the Connecticut River drainage are not with populations sampled from the Northeast, further supporting the likelihood that the Connecticut River population was introduced. The Mudpuppy is a long-lived species that does not reach reproductive maturity until about six years old. Survival of breeding adults is very important to the maintenance of populations.

Surveying for the Mudpuppy has proven to be difficult and therefore our understanding of abundance, and even distribution, remains uncertain. U.S. Fish & Wildlife Service attempts to survey for Mudpuppy in and near Lake Champlain met with little success. Two recommendations to list this species as threatened were not accepted by the Agency of Natural Resources.

Widespread lampricide applications in many Lake Champlain tributaries is a risk to the Mudpuppy with large losses documented in some treated rivers. Evidence indicates possible losses of some smaller populations. The largest known kill from lampricide applications took place in the Lamoille River during its first treatment (2009) where 528 dead Mudpuppies were found along the shoreline and shallows of the treated area that was searched for non-target mortality. Rescue operations for non-target species affected by lampricide during the second (2013) application of the same river found fewer than 10 Mudpuppies, strongly suggesting a very significant decline in that river. Specimens in some cage studies during lampricide treatments have survived and we do not fully understand why the effects have been so different among treatments. A smaller population in Lewis Creek appears to have declined to the point where the Mudpuppy is no longer detectable. No specimens have been located in Lewis Creek during non-target post-treatment surveys for the last two decades.

Distribution

Primarily the shoals and shallows of Lake Champlain and lower reaches of its tributaries (to the first impassable falls or dam), and the Connecticut River and its tributaries north to Waterford. In addition, it is reported from some waterbodies easily accessed (no barriers) from the Lake Champlain and Connecticut River populations (for e.g., Lake Morey). This species has also been reported from Otter Creek in Brandon but not since 1998. Populations in and near the Connecticut River appear to be introduced from a source other than our native population in Lake Champlain and its tributaries.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Not Probable

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Northeastern Highlands Probable

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Lamoille River	Upper Connecticut
Metawee River	
Upper Connecticut - Mascoma	
Waits	
Winooski River	
Middle Connecticut	
West	
Black-Ottauquechee	
Lake Champlain	
Missisquoi River	
Winooski River	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The Mudpuppy is a generalist, occupying myriad habitats throughout its range including lakes, rivers, small creeks, canals, irrigation ditches and reservoirs (Escleshymer 1906; Hamilton 1932; Bishop 1941; Harris 1959a, b). Waters inhabited may be clear or turbid; still, slow or rapid flowing; cold or warm and may have gravel, cobbled, or muddy bottoms (Harris 1959a). Adults need suitable habitat with cover (for nesting, protection from predators, and shelter from light) such as flat rocks, slabs, logs or planks (Escleshymer 1906; Pearse 1910; Bishop 1941; Harris 1959a). Juveniles are usually found in greater numbers in the substrate of pools where silt and organic debris have accumulated to a minimal thickness of several mm (Matson 1990).

In one study the maximum distance that a Mudpuppy moved was 256m in its aquatic environment (Shoop and Gunning 1967). There is some evidence of short distance seasonal migrations from shallows to pools or river channels.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

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Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): The amount of quality habitat for this species at present is likely less than that of 200 years ago but how much less is unknown. Upstream movement for feeding and spawning has probably been limited by dam building. Pollution and sedimentation of nesting sites have caused declines in populations in Ohio (Pfingsten and White 1989) and is likely to have limited appropriate habitat availability in the Lake Champlain drainage system. Removal of snags and other navigational hazards on rivers and lakeshores may have decreased nesting sites.

Non-Habitat Threats:

Reproductive Traits

Trampling or Direct Impacts

Disease

Pollution

Description of non-habitat threat(s): A large percentage of the area of known distribution for the native Mudpuppy in Vermont coincides with the lampricide-treated spawning habitat for Sea Lamprey. Significant mortality has been documented due to TFM lampricide applications in NY and VT. The Mudpuppy can be negatively affected by chemical pesticides (Bonin et al. 1995; Gendron et al. 1997), especially those used in the control of parasitic Sea Lamprey (Petromyzon marinus) such as 3-trifluromethyl-4-nitrphenol (TFM) and TFM/2', 5-dichloro-4nitrosalicylanide (Niclosamide) mixtures (Matson 1990; Boogaard et al. 2003). Acute toxicity studies of TFM and of TFM/Niclosamide mixtures have been conducted on adult Mudpuppies (Boogaard et al. 2003; Boogaard et al. 2008) and juvenile Mudpuppies (Neuderfer 2002; Neuderfer et al. 2004; Boogaard et al. 2008) including one-year-old Mudpuppies (Durfey and Neuderfer 2009). All of these studies found that TFM and TFM/Niclosamide mixtures caused mortality in Mudpuppies but that the sensitivity to these lampricides was age specific (Neuderfer 2002; Boogaard et al. 2003). Boogaard et al. (2003, 2008) found that adult Mudpuppies were sufficiently more resistant to the lampricides than Sea Lamprey and suggested that there was a sufficient safety margin for selective control of Sea Lamprey in the presence of adult Mudpuppies (i.e., <10% expected mortality). Whereas the information on the acute toxicity of juvenile Mudpuppies between 2 and 5 years of age is limited (Neuderfer 2002), the studies (Neuderfer et al. 2004; Boogaard et al. 2008; Durfey and Neuderfer 2009) on juvenile mudpuppies (young of the year or 1 year of age) has found that this life stage is at risk of substantial treatment related mortality at lampricide concentrations at those needed to control Sea Lampreys. These toxicity studies (Neuderfer 2002; Boogaard et al. 2003; Neuderfer et al. 2004; Boogaard et al. 2008; Durfey and Neuderfer 2009) predict the greatest mortality to young of the year and 1 year old Mudpuppies and little mortality to adult Mudpuppies from exposure to lampricides. The field data from the 2009 Lamoille River lampricide treatment reveal that 19.3% of the dead Mudpuppies detected were adults.

Some individuals are caught on hooks. A large Mudpuppy die off due to botulism was reported in the Great Lakes in 2003.

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Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine how the mudpuppy is using Vermont's lake and river habitat and when. Gather data on egg-laying sites, instream shelter, and seasonal movement patterns.
Research	Basic Life History	Medium	Determine if and when mudpuppies are entering or leaving Vermont rivers would to help us understand the potential impacts of TFM treatments.
Research	Distribution and Abundance	High	1) Develop survey techniques to effectively sample the Mudpuppy. 2) Mudpuppy distribution is not well known in VT and we do not have a good idea of population size or trend. Monitor the size and determine the sustainability of existing populations. eDNA methods are currently being tested to evauate Mudpuppy distribution in the Champlain basin.
Research	Threats and Their Significance	High	We need to better understand the impacts of TFM applications, fragmentation and changed river flows due to dams, and sedimentiaton.
Research	Population Genetics	Medium	Determine the genetic source or at least the most closely related population to our Connecticut River Mudpuppy population.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	High	Range shift may be a useful index of population change.
Monitoring	Monitor Threats	High	

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Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of programs and individuals reached with message.	ECHO, VFWD Outreach Division	Corporate Sponsors, Lake Champlain Basin Program
Habitat Restoration	Medium	Consider removal of stream barriers that restrict upstream movement.	Number of miles of streams reopened.	FERC, Trout Unlimited, VTrans, towns	Power Companies, VTrans, municipalities
Habitat Restoration	High	Maintain adequate stream flows to support mudpuppy populations.	Number of streams	DEC Water Quality, Power Generation companies, FERC	Power Generation companies
Awareness Raising and Communications	High	Encourage reports of sightings to the Vermont Natural Heritage Inventory and the VT Reptile & Amphibian Atlas.	Numbers of reports received	Reptile & Amphibian Atlas, volunteers	Nongame Wildlife Fund, SWG
Invasive Species Control & Prevention	High	Investigate and implement alternative lamprey control methods that have less impacts to mudpuppy populations.	Number of times alternative methods used.	TNC, USFWS, VFWD Fisheries	DJ, USFWS, SWG
Habitat Restoration	Medium	Prevent sedimentation that degrades mudpuppy habitat.	Improvements in water quality. Number of miles of buffer strips established. Turbidity measures	DEC Water Quality, Dam operators, Dept. of Agriculture, VTrans, NRCS	Dam operators, Dept. of Agriculture, VTrans, EQIP
Planning & Zoning	Medium	Implement stream management to promote better water quality in mudpuppy waters.	Streams with improved water quality	USFWS, VFWD Fisheries, DEC Water Quality	DJ, USFWS

Common Name: **Mudpuppy**
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Scientific Name: **Necturus maculosus**
Species Group: **Herp**

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Scientific Name: **Necturus maculosus**
Species Group: **Herp**

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Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:**
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

The Fowler’s Toad is extremely rare in Vermont (S1) and was listed as state-endangered in 2015. The Fowler's Toad has specialized habitat requirements and depends on habitat mosaics consisting of disturbed shorelines and uplands adjacent to shallow breeding sites. Habitat loss due to succession is also a problem for this species. The last documented sighting in Vermont was in 2007 in Vernon. However, recent reports of calling from islands within the Connecticut River of NH suggest that populations may still exist in Vermont.

Distribution

The Fowler's Toad is primarily a species of the Atlantic Coastal Plain, its distribution in Vermont is limited to the lower Connecticut River valley, with populations documented at one site each in Vernon and White River Junction (Andrews 2001, Barker and Caduto 1984).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Middle Connecticut	NA
Black-Ottauquechee	NA
	NA

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The most critical habitat features include dry, sandy woodlands near shallow water for breeding. Breeding sites may include river edges, pond or lake margins, shallow wetlands (forested or emergent), vernal pools, roadside ditches, etc. Fowler’s Toads are tolerant of and dependent upon warmer temperatures than American Toads (Frost and Martin, 1971). Along the north shore of Lake Erie all Fowler’s Toad reports are within ½ kilometer of the shore and the toads require habitat in the early stages of ecological succession. At those sites they require five habitat types in close proximity to sustain a population (COSEWIC, 2010):
--Hibernation habitat (sandy dunes)
--Breeding, egg-laying habitat (sparsely vegetated still-water ponds, sandy bottom pools, shallow rocky shoals, or rocky pools).

--Feeding and hydration habitat (sandy riverside and lakeshore habitats with bare to sparse vegetation cover)
--Daytime retreat and aestivation habitat (sandy beaches and shoreline debris), and
--Dispersal corridor habitat.

Overwintering habitat is mentioned as a potential limiting factor in Canada (COSEWIC, 2010). Burrows must be deep enough for the toads to avoid freezing, close enough to the water table to be damp, but not so deep as to be flooded. Toads are not tolerant of freezing or of long-term submergence while over wintering.

Stille (1952) reported small home ranges with most toads emerging from the ground within 60-210 meters of the water's edge. In Canada (COSEWIC, 2010) Fowler's Toads (nocturnal) spend days buried in soil up to 400 m from the waters edge but they must move to the water as soon as they emerge to replace moisture lost while in the soil.

Along Lake Erie, Fowler's Toads depend upon breeding sites that are continually created or maintained by disturbance.

Breeding habitat in Vermont appears to be the disturbed margins of the Connecticut River and its tributaries in Windham and Windsor Counties, and perhaps shorelines of other water bodies near sandy soils in those floodplains. Terrestrial habitat appears to be largely open areas of adjacent floodplains and lower-elevation uplands within a few hundred meters of those breeding sites, particularly those with sandy or gravelly soils. This includes yard edges and moderately developed residential or agricultural areas. According to Klemens (1993) the species prefers well-drained sand and gravel habitat in Connecticut. Wright and Wright (1949) state "wherever Fowler's Toads are sympatric with American Toads (as they are anywhere in Vermont), Fowler's Toads occur in rivers, streams, or lake beaches" and American Toads in the uplands. This appears to be the case in Vermont. Soil maps show large deposits of sand in the Vernon area.

Habitat Types:

Upland Shores

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Seeps and Pools

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Aquatic: Lower CT River

Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): The Fowler's Toad has specialized habitat requirements that make it vulnerable to disturbance. Any habitat conversion, alteration, or fragmentation that disrupts species' ability to move between breeding and terrestrial sites may have negative effects. Road mortality can negatively impact migrating adults and dispersing juveniles, especially when located between terrestrial and breeding habitats. Climate change that affects hydroperiod and/or water temperature of breeding pools could have significant impacts on productivity.

Early successional habitat in sandy soils within 400 meters of the Connecticut River has probably been reduced significantly with the development of an extensive series of flood control dams in the Connecticut River drainage. In addition, sandy and gravelly soils in the floodplain have been desirable sites for shoreline development and agriculture. Some types of low-density development and agriculture (pasture, some crops, new farm ponds) may have created open early-successional foraging habitat or breeding habitat for this species; however, high-density development with heavy road traffic (toads suffer high road mortality), row crops and intensive pesticide or herbicide use (atrazine) are probably not consistent with continued Fowler's Toad use. Bank stabilization activities would also limit the amount of potential habitat for this species.

This floodplain area has also seen significant road building. Routes 91 and 5 both parallel the river within the floodplain on the Vermont side as well as numerous smaller roads such as 142 in Vernont.

Breeding habitat of this species seems to be concentrated on islands and along the shorelines of the Connecticut River, within the disturbance zone. Regular removal of vegetation, new deposits of sand and gravel, and creation of small pools may be necessary to maintain breeding habitat. Dams along the Connecticut River are built to control flooding. It is possible that they control flooding to an extant that limits the amount of breeding habitat for this species. In addition, subdivision and development within the narrow Connecticut River valley may be limiting useful habitat and increasing mortality on roads and by machinery.

This species regularly undergoes large population changes. The existence of nearby healthy populations to recolonize previously occupied areas is essential. In addition, the colonizers within those populations need to be able to safely traverse the landscape along the river for some distance as populations rebuild. Given distances between populations that may be larger than the dispersal range of juvenile toads, all five required habitat types will need to be located fairly regularly (~every 8 miles) along the shore of the Connecticut

River in order for recolonization to take place from a distant source. Impediments to travel exist in increased road traffic, more intensive or chemical dependent agricultural methods, and intensive development such as in the towns along the river.

Non-Habitat Threats:

Genetics

Pollution

Disease

Trampling or Direct Impacts

Description of non-habitat threat(s): Known populations of this species occur in close proximity to humans, and in a region of the state that continues to see significant development pressure. Fragmentation of suitable habitats by roads or other non-permeable development may result in loss of metapopulation structure and leading to genetic isolation, especially considering the limited and localized populations of this species. Widespread treatment of breeding pools to control West Nile Virus would likely have negative effects on many amphibians, including Fowler's Toad.

According to Freda and Dunson (1986) this species shows decreased larval growth rates with increased acidity (lowered pH) due to acid rain. It is also less tolerant than most amphibians to atrazine (Birge et al., 2000), and is particularly sensitive to the insecticide azinphos-methol (Guthion; Mayer and Ellersieck, 1986). The organochlorides endrin, toxaphene, dieldrin, toxaphene, DDT, and lindane are also highly toxic to larval Fowler's Toads (Sanders, 1970). Adults were also highly sensitive to organochlorides (Ferguson and Gilbert, 1968) as well as pyrethroid insecticides (Bennett et al., 1983) and the metals chromium, gallium, titanium, and aluminum (Birge et al., 2000). In southwestern Ontario, agricultural chemicals were listed as a possible contributing factor to Fowler's Toads declines. The herbicide Trifluralin and the insecticide Endrin were reported to be particularly toxic to toads (COSEWIC, 2010). The disappearance of Fowler's Toads from many of the Massachusetts islands was thought to be the result of DDT use according to Lazell (1976). DDT is also suspected of eliminating populations on Point Pelee in Canada (COSEWIC, 2010). We have not looked at the available data on the level of any of these substances in the Connecticut River or on surrounding lands, although we expect atrazine is widely used on corn crops along the Connecticut River.

Fowler's Toads are susceptible to mycobacterial (Shively et al., 1981) and parasitic infections (Jilek and Wolff, 1978; Ashton and Rabalais, 1978; McAllister et al., 1989; and Vences et al., 2003). Botulism is also considered a potential threat to Fowler's Toads (COSEWIC, 2010). Along the north shore of Lake Erie is was noticed that shoreline mats of algae created the anaerobic conditions that allow Clostridium botulinum to survive.

Toads overwinter and avoid predation and desiccation during the day and during dry periods by digging into sandy or loose soil (Harding and Holman, 1992). By the end of the winter they have burrowed to depths of up to 15-30 cm (R. Latham quoted in Oliver, 1955). Tilling of the soil in late fall or early spring may disturb or kill overwintering Fowler's Toads. Tilling during other times of the year could have the same impact on toads underground for the daytime hours or when aestivating to escape dehydration.

Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Due to the likely spotty distribution of the rare Fowler's Toad in Vermont, it is important that we document and map habitat including connectivity of patches.
Research	Distribution and Abundance	High	1) There is a need to better document the distribution of the Fowler's Toad in Vermont, which will require dedicated searches during the calling period. 2) Continue to document species distribution in Connecticut River Valley with targeted searches of potential sites, and sites where previously reported.
Research	Threats and Their Significance	High	
Monitoring	Population Change	High	Monitor known population annually and attempt to determine population size and demographics.
Monitoring	Habitat Change	High	The habitat of the Fowler's Toad is likely vulnerable to human development and fragmentation of its habitat, including breeding pools. Monitoring the amount and regularity of habitat creation though flooding would provide better insight into the potential impacts of flood control dams.
Monitoring	Monitor Threats	High	

Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Protected Area Management	Medium	Eliminate the use of pesticides and herbicides within protected areas and maintain early successional habitat patches in a way that minimizes direct mortality.	Development and implementation of management plans.	Easement holders, VFWD; VFPR	VHCB, CNWR, Carbon tax revenues
Policy & Regulations	High	Through the FERC dam relicensing process insure adequate water releases to create and maintain breeding habitat.	Increased scouring, vegetation removal, and sand and gravel deposits along Connecticut River.	NH F&W, TNC	
Easements	Medium	1) Purchase land or easements along margin of Connecticut River to the 100 year flood high water line to allow safe flooding and scouring. 2) Purchase land or easements for known terrestrial habitat along Stebbins Road in Vernon.	Change in the acreage of conserved land	VLT, Conte NWR, local and national land trusts, RPCs	VHCB, CNWR, Carbon tax revenues
Awareness Raising and Communications	High	Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received	Reptile & Amphibian Atlas	Nongame Wildlife Fund, private grants
Policy & Regulations	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	ANR, Health Dept, USFWS	
Technical Assistance, Training, Learning Networks	High	Implement vernal pool management guidelines as described by VFWD.	Number of trainings offered. Number of entities adopting the guidelines.	VFWD, FPR, Coverts, VWA, VT Family Forests, SAF, Land Trusts, Consulting Foresters	SWG

Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

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Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

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Common Name: **Fowler's Toad**
Scientific Name: **Anaxyrus fowleri**
Species Group: **Herp**

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Common Name: **Boreal Chorus Frog**
Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

Conservation Assessment

Final Assessment:	High Priority	**Global Rank:**	G5	**Global Trend:**	
		State Rank:	S1	**State Trend:**	Declining
		Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Recent genetic research by Moriarty Lemmon et al. (2007) indicated that the chorus frog of northeastern North America previously considered to be P. triseriata, which includes Vermont's population, is actually P. maculata. This small eastern portion of the species' range is separated from the larger western distribution by a minimum of 200 miles.

The Boreal Chorus Frog previously was considered a western species, present in Ontario and west to the Northwest Territories and eastern British Columbia, and south into the United States from Minnesota to Montana into northern New Mexico. P. triseriata was considered to occur from the Saint Lawrence Valley in Quebec westward to Minnesota and South Dakota, and south to Oklahoma, Indiana, and western New York. Genetic evidence presented by Moriarty Lemmon et al. (2007) redefined the geographic boundaries for several members of this genus, including these two species. According to this work, P. triseriata is more limited, occurring from western Kentucky and southern Illinois, northeastward through Michigan, southern Ontario, and western New York. P. maculata is more widespread, occurring from Illinois north to Ontario and westward, with a disjunct population occurring in southeastern Ontario, and within the Saint Lawrence Valley of Quebec and New York and the northern Lake Champlain Valley.

P. triseriata used to be listed as an SGCN species in Vermont. Based on the study above which is supported by additional anecdotal information (responses to tapes) and gaps in distribution, we feel the best current science suggests that the species we thought was P. triseriata is actually P. maculata. This taxonomy has not been accepted by all authorities, but seems to be the most supported at present. As a result, in 2011 P. triseriata was removed from our list of Vermont endangered species and P. maculata was added. We are now removing P. triseriata from our list of SGCN and replacing it with P. maculata. The supporting information here is an updated version of the same information previously presented but under a corrected name.

This species was located in townships along northern Lake Champlain from Swanton/Alburg to Georgia in the 1970s. Searches in 1988, 1996, and 1997 at the original site and along roads in the northwestern corner of the state were unsuccessful. A novel occurrence of singing male chorus frogs was observed in 1998 and 1999 in Alburg, with only two heard during each visit. This breeding site is located less than one mile from the Quebec border. Annual searches in 2000-2009 have not located chorus frogs at either of the two last known sites or other locations. It has also disappeared from the NY portion of the Lake Champlain Basin (see Corser et al. 2012) and many of its historic locations in Quebec and eastern Ontario. The COSEWIC website states "populations in Quebec are documented to have declined at a rate of 37% over 10 years and are expected to continue to decline. Despite there being some areas where chorus frogs remain evident, surveys of populations in Ontario indicate a significant decline in abundance of 30% over the past decade". In Vermont this species is state-listed as endangered.

Habitat loss due to development, succession, and drainage of pools in agricultural fields are all reported problems for this species. Species may also be vulnerable to taking by mowing of agricultural fields and newer chemicals (herbicides) used in agriculture. Recent studies also show this genus to be sensitive to chemicals produced by the invasive plant species European Buckthorn (Rhamnus cathartica). This plant is currently widespread in the Lake Champlain basin. Habitat in Vermont seems to be flooded or ponded pasture with shrubs. There is evidence to support calling competition between this species and the Spring Peeper (Pseudacris crucifer), so calling times and perhaps localized distribution may need to be isolated from each

Common Name: **Boreal Chorus Frog**
Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

other. There appears to be appropriate habitat remaining within this species historic distribution within Vermont, leading this writer to suspect that changes other than or in addition to habitat loss and fragmentation are causing declines.

Distribution

This species was located in townships along northern Lake Champlain from Swanton/Alburg to Georgia in the 1970s. Searches in 1988, 1996, and 1997 at the original site and along roads in the northwestern corner of the state were unsuccessful. A novel occurrence of singing male chorus frogs was observed in 1998 and 1999 in Alburg, with only two heard during each visit. This breeding site is located less than one mile from the Quebec border. Annual searches in 2000-2009 have not located Chorus Frogs at either of the two last known sites or other locations.

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The Boreal Chorus Frog (P. maculata) is primarily a terrestrial species, occurring in moist, marshy, vegetated environments near breeding sites (NatureServe 2011, IMNH 2000). It may be found in grassy and shrubby areas, meadows, open woodlands, fens, bogs, or similar low habitats (NatureServe 2011, IMNH 2000, Bider and Matte 1996) not far from open ponds, ditches, marshes, temporary pools, or other wetlands (NatureServe 2011, IMNH 2000, HerpNet). The species is generally not found in forested areas (Bider and Matte 1996). P. maculata breeds in temporary to semi-permanent waters of no current, often quite small with no or few fish predators (HerpNet, Lannoo 2005). These are typically open habitats (no canopy) with abundant emergent vegetation which provides both cover and egg attachment sites (IMNH 2000, Lannoo 2005). Boreal chorus frogs are considered poor dispersers, though individual studies have found adults traveling 275 (Quebec) and 685 m (Colorado) from breeding sites (HerpNet, Whiting 2004). Outside the breeding season, this is generally a nocturnal species, being inactive during the day, and is active into September or October (Lannoo 2005, NatureServe 2011). Overwintering occurs under protective cover or underground in the upland areas surrounding a breeding site (NatureServe 2011). Some indirect evidence suggests limited possible hibernation within the breeding pool (Whiting 2004).

In Vermont, the breeding sites observed in 1985 and 1998 were both small, open cattail ponds adjacent to agricultural lands and larger wetland systems. No habitat analyses were undertaken, but the available terrestrial and aquatic habitat types available agreed with those described in literature for P. maculata. The field notes taken by Fred Schueler during his 1975 survey indicate the Vermont chorus frog to be somewhat of a generalist, using a variety of open habitats. He observed breeding in ditches, pools, potholes, and ponds with grasses and cattails, located within or adjacent to meadows, hayfields, woods, pastures, alder swamps, and "cattail swamps."

Habitat Types:

Hardwood Swamps

Seeps and Pools

Marshes and Sedge Meadows

Shrub Swamps

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Shallow wetland habitat appears to be limited and no strong population center known that would provide colonizers. Appears to be limited to NW Vermont. Known distribution retracted from northeastern shore of Lake Champlain (Canadian border to Georgia) to isolated site in Alburg. Also declines in Quebec and eastern Ontario. Needs early successional, open or edge habitat, does not compete well with Wood Frogs, genus has shown sensitivity to a chemical (emodin) released by invacise buckthorn (Rhamnus cathartica). Shallow open seasonal wetlands in the Lake Champlain Basin are particularly likely to be drained for agriculture. These lands are also exposed to regularly chemical use and mechanized cutting.

Non-Habitat Threats:

Genetics

Harvest or Collection

Reproductive Traits

Trampling or Direct Impacts

Competition

Disease

Pollution

Common Name: **Boreal Chorus Frog**
Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

Predation or Herbivory

Description of non-habitat threat(s): Pesticides, herbicides, and runoff. may be inadvertantly collected when Leopard Frogs are collected by sweep net or drift fence. Chytrid fungus or ranavirus may play a role in declines either alone or synergistically. Any remaining populations are likely genetically isolated. Call does not compete well with Spring Peeper (Pseudacris crucifer). More successful if isolated in time or space from their calls. Does not coexist well with Wood Frogs (Lithobates sylvaticus) perhaps as a result of predation. Modern agricultural harvesting equipment is probably too fast and efficient to coexist with populations.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine habitat needs.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Thoroughly survey for this species in Vermont.
Research	Threats and Their Significance	High	Determine the primary limiting factors for this species.
Research	Population Genetics	Medium	Confirm species, Determine if genetically isolated.
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	High	Determine how Vermont fits in with regional population change.
Monitoring	Monitor Threats	High	

Common Name: **Boreal Chorus Frog**
Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Determine which species of Chorus Frog we have/had, how genetically isolated/inbred it is/was and what can be done to address issues if needed.	Genetic assessments	Academic Community, Province of Quebec, NY DEC	SWG, Nongame Fund, private grants
Research	Medium	Determine the presence/absences of amphiban diseases in the historic area of the Chorus Frog and to control their spread and impact.	Disease surveys	Regional Wildlife Healt Lab, Academic community	SWG, Nongame Fund, Private grants
Invasive Species Control & Prevention	Medium	Examine presence/absence of invasives in historic habitat of this species. Conduct lab experiments of impacts of Emodin on this species.		Academic community, TNC	SWG, Nongame Fund, private grants
Protected Area Management	Medium	Manage selected areas for early succession, work with agriculturalists to manage lands in a way that maintains early succesional habitat in a way that is amphibian friendly. Encourage light pasturing rather than harvesting and cultivating near wetlands.	Change in the acres of wetland/grassland mosaics	Sportsmen, Audubon, groups interested in early successiona l bird species	SWG, VHCB, DU,
Policy & Regulations	Medium	Improve agricultural practices that degrade or remove wetlands and surrounding habitat and replace and restore wetlands altered or lost by agriculture.	Wetland Acreage Conserved, Created, or Recreated	DEC, Environment al Organization s, LCI, Lake Champlain protection groups	Private Foundations, water quality grants
Policy & Regulations	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	ANR, Health Dept, USFWS	
Awareness Raising and Communications	Medium	Encourage reports of sightings to the VT Wildlife Diversity Program and the VT Reptile & Amphibian Atlas	Number of training sessions, person-nights surveyed, Number of reports received	Reptile & Amphibian Atlas	SWG, Nongame Wildlife Fund
Easements		Attempt to protect (through easement or purchase) any sites found with breeding populations and adjacent terrestrial habitat.	Acreage and number of sites conserved	Reptile & Amphibian Atlas, Lake Champlain Land Trust, VLT	VHCB

Common Name: **Boreal Chorus Frog**
Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

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Scientific Name: **Pseudacris maculata**
Species Group: **Herp**

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Common Name: **Spotted Turtle**
Scientific Name: **Clemmys guttata**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No
Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

The state-endangered Spotted Turtle is known from three locations in Vermont and is a species of regional conservation concern. It is on Appendix II of CITES, the IUCN lists it as endangered on its Red List, and is a SGCN in Vermont. Two Spotted Turtle sites in Vermont are compromised by surrounding landuse. At one site a RR bisects the wetland. Twenty under rail crossings have been installed to allow safe passage of the turtles. A road parallels much of the other compromised site. Both are believed to have very small populations. The third known site is more robust and found within a large wetland complex, which provides some buffering from surrounding landuse.

Distribution

There are three widely separated known populations in Vermont. The disjunct nature of the three known occurrences means that each needs to maintain itself with little likelihood of rescue from nearby populations. It is possible that some migrants from Massachusetts could reach one of our southern populations. The species is not a migrant but some individuals do wander. Based on limited telemetry work in Vermont it may be young adult males are more prone to dispersal. Because of the vulnerability of this species to illegal collection and the protections of our state law, specific locations are not being shared in this summary.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Hudson-Hoosic	NA
Lake Champlain	
Middle Connecticut	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Based on field inventory and monitoring, the Spotted Turtle uses red maple swamps and other wetland habitats in Vermont. In Massachusetts it has been documented to patch together woodland vernal pools in some localities and can also use ponds. The two smaller Vermont sites are linear riparian wetlands. The third and larger population is part of a large wetland complex. Nesting by this species is reported in the literature to include sphagnum moss and at the larger site a hatchling was documented on a large sphagnum mat. Some sphagnum occurs at one of the smaller sites, but nesting has been documented along a railroad bed. At the other smaller site two female Spotted Turtles have been located near a dirt road during the nesting season.

Potential wetland habitats include Hardwood Swamps, Marshes and Sedge Meadows, Shrub Swamps, Open Peatlands. We have located this species in red maple swamps, shrub swamps, and a bog/fen wetland as well as an adjacent emergent swamp. In Vermont we have found this species at low elevation sites less than 100 m in elevation. Home range is often reported as less than 5ha, but linear movements can be quite long. At one riparian wetland a female Spotted Turlte moved over 300 m. We believe large wetland complexes provide the best habitat by buffering from outside influences and providing options during different moisture regimes. This may become more important with weather patterns linked to climate change. Movement corridors are important in some situations where Spotted Turtles piece together needed resources within a habitat mosaic and this has been documented in Massachusetts with turtles traveling between a large wetland and dispersed vernal pools in surrounding uplands. Long-distance movements are unlikely and assisted migration may need to be considered in the future.

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Habitat threatsfor the Spotted Turtle include loss of wetland overwintering and foraging habitat, loss of nesting areas, fragmentation isolating populations and separating needed seasonal habitats, as well as road and railroad mortality. Climate change could affect the Spotted Turtle if a change in water regime results in wetlands and pools drying.

Common Name: **Spotted Turtle**
Scientific Name: **Clemmys guttata**
Species Group: **Herp**

Non-Habitat Threats:

Genetics

Harvest or Collection

Reproductive Traits

Trampling or Direct Impacts

Predation or Herbivory

Description of non-habitat threat(s): The Spotted Turtle is vulnerable to collection, nest predation, road mortality, and population rescue is unlikely. If close to humans, risks increase.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	1) Given the rarity of this species, examine critical habitat (e.g., wintering sites). 2) Gather data on specific habitat requirements of Vermont populations: denning sites, egg-laying sites, foraging areas, overwintering areas and movement corridors.
Research	Distribution and Abundance	High	Pursue further surveys for Spotted Turtles in Vermont. Need to document all populations and their abundance, as well as the spatial relationship of populations.
Research	Threats and Their Significance	High	Need to identify and resolve potential limiting factors.
Research	Population Genetics	Medium	We don't know if population genetics is a problem or not, but species is isolated in Vermont.
Monitoring	Population Change	High	1) Track population size, age and sex distribution. 2) Monitor the size and determine the sustainability of existing populations through age-class or genetic analysis.
Monitoring	Habitat Change	High	It would be important to track changes in quality and quantity of habitat, as well as connectivity between habitats.
Monitoring	Monitor Threats	High	We need to determine if we are making progress alleviating limiting factors.

Common Name: **Spotted Turtle**
Scientific Name: **Clemmys guttata**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks		With staff turnover try assigning responsibility for species recovery to new VFWD employees to address limited staffing realities.	Recovery plans written and implemented, actions taken, results documented	ESC, Orriane Society	SWG, Nongame Fund, Orriane Society
Compatible Resource Use		Control ATV and other off road usage in known habitat to avoid impacts.	Frequency of ATV use	Railroad, Game Wardens, VASA	operating funds
Compatible Resource Use		Continue to work with landowners and users of area to protect known habitat.	Number of cooperating landowners	local game warden, landowners, country forester	SWG, Nongame Wildlife Fund
Habitat Restoration		Create nesting sites and passages connecting wetland habitats. (e.g. Railroad used American Recovery and Reinvestment Act funds to construct 20 passages in 2012).	Number of enhancements (e.g., 20 passages under rails and 13 nesting pits created at one site).	railroad, local warden	railroad, Nongame Wildlife Fund
Standards		Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of landowners and managers who receive and use guidelines	landowners, consulting foresters, EQIP biologists	SWG, EQIP, Current Use
Awareness Raising and Communications		Encourage reports of sightings to the VT Natural Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received annually	Reptile & Amphibian Atlas	Nongame Wildlife Fund
Species Restoration		Consider reintroduction or augmentation from closest healthy source. Maintaining and enhancing extant populations is always a priority and should be continued.	number of populations.	Bonnyvale Environmental Center	SWG
Species Restoration		Protect nests and adults by predator trapping and removal.	number of raccoons harvested per year.	Trappers Assoc., landowners	Trappers Assoc members
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management.	acres of land conserved.	VHCB	VHCB
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people exposed to message	VFWD Outreach division, Bonnyvale Environmental Center	marketing funds, private grants

Common Name: **Spotted Turtle**
Scientific Name: **Clemmys guttata**
Species Group: **Herp**

Habitat Restoration	Work to maintain connectivity with populations to the south in Massachusetts.	Number of potential connections to populations south of Vermont	Mass Fish and Wildlife, private landowners, VLT	VHCB
Compatible Resource Use	Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects reviewed with spotted turtle planning information	Reptile & Amphibian Atlas, VTrans	VTrans
Awareness Raising and Communications	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of reports.	Reptile & Amphibian Atlas, VTrans	VTrans, SWG

Common Name: **Spotted Turtle**
Scientific Name: **Clemmys guttata**
Species Group: **Herp**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority	**Global Rank:** G4	**Global Trend:**	
	State Rank: S3	**State Trend:** Declining	
	Extirpated in VT? No	**Regional SGCN?** Yes	

Assessment Narrative:

With more than 50% of its distribution in the Northeast the Wood Turtle was selected as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states. Vermont is at the core of its range. The Wood Turtle is listed as an Appendix II species by Convention on International Trade in Endangered Species (CITES), meaning that it not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. It has been petitioned in the past for listing as a federally listed species. The Wood Turtle is believed to still be widely distributed, but potentially declining throughout its range due to its long age to maturity and increasing loses of long-lived adults. It is still encountered over a wide region, which may be masking the conservation peril this species faces. Two populations have been monitored in Vermont (Parren 2013) and Vermont was included in a Northeast range-wide assessment (Jones et al. 2014). This species is getting regional recognition as an RCN species.

The Wood Turtle is found in riparian habitats and upland habitats adjacent to streams, providing it is not heavily developed or intensively used for agriculture. It is vulnerable to mowing of agricultural fields and to road mortality. Habitat loss due to succession is also a challenge for this species, but it seeks out and uses even small suitable patches within woodlands. It is also at risk to collection.

Distribution

The Wood Turtle is well distributed throughout Vermont, but not at very high elevations and rarely encountered at the lowest levels of the Champlain Valley. A suitable medium gradient river or large creek is required.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Middle Connecticut	Waits
West	Upper Connecticut-Mascoma
Upper Connecticut-Mascoma	Passumpsic
Black-Ottauquechee	St. Francois River
Hudson-Hoosic	Upper Connecticut
Mettawee River	

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
White
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

The Wood Turtle is found in a landscape of rolling hills. Upland habitat adjacent to streams needs to be permeable to Wood Turtle terrestrial wanderings. It uses shrub swamps, alder swamps, and can use human-altered landscapes if not too severely changed, but it must have a suitable home stream. Home range can be calculated as less than a hectare if long-distant movements for females to nest or for males to patrol a river or stream to breed females (1.5 km) are not included. Micro Habitat: moderate gradient streams with refuge sites, sand gravel & rock streambeds.

Habitat Types:

Spruce Fir Northern Hardwood
Northern Hardwood
Oak-Pine Northern Hardwood
Floodplain Forests
Hardwood Swamps
Softwood Swamps
Seeps and Pools
Open Peatlands
Marshes and Sedge Meadows
Wet Shores
Shrub Swamps
Early Succession Pine and Hemlock
Early Succession Northern Hardwoods
Early Succession Upland Oak
Early Succession Other Types
Grasslands, Hedgerows, Old Field, Shrub, or Orcharc
Aquatic: Fluvial
Aquatic: Large Lake Champlain Tribs Below Falls
Aquatic: Man-Made Water Bodies

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Incompatible Recreation

Description of habitat threat(s): Loss of upland habitat adjacent to Wood Turtle home stream is real problem. It can tolerate a fair amount of succession providing some suitable patches remain. Although the Wood Turtle can use an agricultural landscape, too intensive a use such as row crops, is unsuitable. Mowing and driving over fields can directly impact Wood Turtles found in agricultural fields (Erb and Jones 2011). Habitat is being broken up by development and roads. Trails can bring more people into contact with Wood Turtles and their populations are often impacted (Graber and Burger 1995). Roads paralleling Wood Turtle streams directly impact Wood Turtle populations and can over time reduce the use of habitat by removal of turtles (Parren 2013). Wood Turtles seem well adapted to finding food resources within a broad habitat matrix, but this requires wandering a large area with associated risks.

Non-Habitat Threats:

Harvest or Collection

Trampling or Direct Impacts

Predation or Herbivory

Description of non-habitat threat(s): Wood Turtles are susceptible to collection as pets and we have detected for profit illegal collection in Vermomt. Nest depredation is a threat all turtles face and Wood Turtles also suffer limb and tail loss to predators. In some cases direct mortality occurs. Road traffic causes Wood Turtle mortality and the roads themselves can be thought of as a landscape feature limiting Wood Turtle habitat (see above). Proximity to human habitatation and our land use is a risk to Wood Turtle survival due to collection, direct mortality from vehicles and other equipment, as well as increased predators such as skunks and raccoons.

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	1) Identification and protection of communal wintering and nesting sites is critical. 2) Gather data on specific habitat requirements of Vermont populations: denning sites, egg-laying sites, foraging areas, and movement corridors.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Identify distribution and relative abundance of populations in Vermont as good knowledge of current distribution and abundance is essential for good monitoring.
Research	Threats and Their Significance	High	It is important to have a solid understanding of limiting factors and how they impact populations of Wood Turtles.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	It is essential to monitor population change for this vulnerable species, consider doing so by monitoring the size and determine the sustainability of existing populations through age-class or genetic analysis.
Monitoring	Habitat Change	High	Since habitat loss/change affects the resilience of Wood Turtle populations, it is important to monitor habitat change.
Monitoring	Range Shifts	High	The VT Reptile & Amphibian Atlas has provided a pretty good baseline of Wood Turtle distribution by township. Failure to detect Wood Turtles in these same townships in the future will be cause for alarm.
Monitoring	Monitor Threats	High	Road mortality, collection, and nest success should be monitored.

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use		Encourage holding off field mowing until October in Wood Turtle habitat or setting mowing bar at 6 inches or higher.	Number of areas adhering to mowing guidance	Corps of Engineers, EQIP biologists	Corps of Engineers, EQIP
Compatible Resource Use		Encourage land-use practices on private lands that continue to allow the Wood Turtle to maintain itself in Vermont.	Number of enrolled landowners	FPR, EQIP, USFWS, private landowners	Current Use Program, EQIP, Partners in Wildlife
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management.	Number of sites protected	VLT, local land trust, towns	VHCB
Compatible Resource Use		Direct trail development away from streams to avoid impacts to Wood Turtle populations.	Number of trails sited in a way to avoid impacts	recreation planners, developers, regulators	private grants, SWG, Nongame Wildlife Fund, Technical Assistance
Habitat Restoration		Develop, implement, and monitor, road crossing structures and barriers for this species.	Effectiveness of crossing structures	VTrans	VTrans, FHWA
Easements		Use conservation easements to protect suitable habitat on privately owned land.	Number of sites protected	VLT, local land trusts	VHCB, private funds
Species Restoration		If populations limited, consider reintroduction or augmentation from closest healthy source. Maintaining and enhancing extant populations is always a priority and should be continued.	Number of reintroduced or augmented populations	Landowners, Corps of Engineers, SAG-Herps	SWG
Compatible Resource Use		Site new roads 1000' away from Wood Turtle streams and avoid parallel roads.	Number of new roads sited away from streams	VTrans	VTrans
Publically-Owned Protected Areas		Protect suitable habitat on publicly owned land.	Number of sites on public land	ANR, TNC, USFS	state lands Mgmt funds, TNC, GMNF
Awareness Raising and Communications		Encourage reports of sightings to the VT Natural Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports	Reptile & Amphibian Atlas Project, Orriane Society	Nongame Wildlife Fund, SWG, Orriane Society

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

Planning & Zoning	Include Wood Turtle habitat in town zoning to limit impacts from development.	Number of towns considering wood turtle habitat in zoning	Cons Comms, VLCT	SWG
Standards	Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of landowners and managers who receive and use guidelines	Reptile & Amphibian Atlas, EQIP biologists	SWG, EQIP
Compatible Resource Use	Manage ATV and other off road usage in known habitat to avoid impacts to Wood Turtles.	Number of sites where ATV use is managed	landowners, state and federal lands managers, VASA	state lands Mgmt funds, landowner decisions
Awareness Raising and Communications	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of reports	VTrans, Reptile & Amphibian Atlas Project	VTrans

Common Name: **Wood Turtle**
Scientific Name: **Glyptemys insculpta**
Species Group: **Herp**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Eastern Musk Turtle**
Scientific Name: **Sternotherus odoratus**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	No

Assessment Narrative:

The Musk Turtle is only recorded from the Champlain Valley of Vermont in about ten townships. It is small with limited dispersal capabilities. Home range is less than 2ha. Water chestnut control harvesting is a potential limiting factor to this species.

This species might be impacted by shoreline development that leads to loss of aquatic vegetation and suitable nesting sites (Harding 1997). In Vermont, ANR staff involved in water chestnut harvesting are aware of the potential to impact Musk Turtles that might be collected with the vegetation, and operate the harvester slowly and are on the lookout for turtles.

It is very easy to overlook Musk Turtles and they can be mistaken for Painted Turtles when observed on a road.

Distribution

Musk turtle reports are clustered in Colchester-Milton-Grand Isle, Ferrisburgh, and West Haven, Benson, Orwell, Castleton, Hubbarton, Sudbury.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Probable
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Lake Champlain	Otter Creek

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Shallow permanent water of lakes and large ponds with aquatic vegetation, and large slow rivers. This species is sometimes referred to as a bottom walker. It nests under logs and at the debris line of shorelines. It is largely restricted to the lowest elevations in Vermont within the Champlain Valley (<60m elevation).

Common Name: **Eastern Musk Turtle**
Scientific Name: **Sternotherus odoratus**
Species Group: **Herp**

Habitat Types:

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Description of habitat threat(s): Development of shoreline that impacts nesting sites and aquatic vegetation.

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Mechanical harvesting of water chestnut. Literature suggests anglers sometimes persecute. Might be subject to some collection as pets but it is not well documented.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Gather data on specific habitat requirements of Vermont populations: nesting sites, foraging areas, over wintering sites.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Conduct statewide survey of Musk Turtle in Vermont. Identify distribution and relative abundance of populations in Vermont.
Research	Threats and Their Significance	Medium	Consider impacts of chestnut harvesting and shoreline development.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	Once baseline is established it would be helpful to monitor population over time.
Monitoring	Habitat Change	High	It would be good to detect habitat change while there is still time to act.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	

Common Name: **Eastern Musk Turtle**
Scientific Name: **Sternotherus odoratus**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks		Encourage observation and rescue of Musk Turtles removed from lakes by mechanical weed harvesting. Develop a training program to train weed harvesters how to do this.	Number of harvest operations that properly screen for turtles.	DEC Water Chestnut Program, Towns that manage aquatic weeds, lake association	
Standards		Develop land and water management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of owners and managers who receive information.	ECHO Leahy Center for Lake Champlain	Lake Champlain Basin Program
Awareness Raising and Communications		Encourage reports of Musk Turtle sightings to the VT Natural Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received.	Reptile & Amphibian Atlas	Nongame Wildlife Fund

Common Name: **Eastern Musk Turtle**
Scientific Name: **Sternotherus odoratus**
Species Group: **Herp**

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Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S1	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

The Spiny Softshell Turtle is restricted to Lake Champlain in VT and Province of Quebec, and is not found elsewhere in New England as wild populations. It is not known from the NY side of Lake Champlain. All other historical locations in Quebec have been lost and the Winooski River population in Vermont has been lost. Shoreline development has limited nesting and basking areas for this species.

The Softshell is a very strong swimmer, but it is restricted to habitats in or near Lake Champlain and is unlikely to gain immigrants from outside Lake Champlain. Habitat loss due to succession is also a problem for this species, but can be corrected with vegetative management and natural processes such as ice scour of nesting beaches. Increasing lake use is limiting this species directly by boat strikes and limiting habitat through lakeshore development, especially sea walls and riprap. Human disturbances limit basking and can chase nesting females away from nesting beaches. Egg predator populations are abnormally high due to lack of larger predators and trapping pressure, and are subsidized by humans in the form of increased food supplies (garbage, pet food, corn).

A sustained nest management effort appears to be reducing nest depredation and many hatchlings have been documented to have emerged from nests and others have been taken into captive care and then released. It is hoped that these efforts will be successful in enhancing the population of this state-threated species in Lake Champlain. A recovery plan has been written and accepted by the Agency of Natural Resources (VFWD 2009). The ongoing nest management actions include monitoring of nest clutch size which should detect recruitment of surviving females as they enter the breeding population at about age 14.

Galois et al. (2002) reported home range size to be 3,200 ha (12.8 sq. miles) for females and 275 ha for the smaller males. Individual adult females are known to travel from the Bay Bridge to the Pike River, a distance of ~19km and some females move upstream to nest. The large home range estimates of adult females is a result of lengthy movements between seasonal habitats.

Distribution

The Softshell is currently restricted to Missisquoi Bay and surrounding areas of shore and lower reaches of rivers and creeks from Pike River to St. Alban's Bay and a smaller subpopulation is associated with the lower Lamoille River and surrounding lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

The following is based on general and regional literature as well as extensive local knowledge. The Spiny Softshell Turtle is a highly aquatic species inhabiting lakes, larger rivers, and associated wetlands. In general, important habitat features include a soft bottom with some aquatic vegetation for foraging and escape cover and fallen trees with underwater limbs, sandbars, and mudflats for basking. Individual or group basking sites such as rocks, logs, mud, sandbanks, or floating debris are also considered important (Ernst et al. 1994). Graham and Graham (1997) found partially submerged dead tree trunks to be the preferred basking substrate in the Lamoille River. Nesting sites are generally free of vegetation, have adequate solar exposure, are well drained throughout the nesting and incubation periods and occur on open sand and gravel/shale pebble deposits. Hatchlings prefer small shallow puddles or shallow waters on the lee end of sandbars that provide warmer and quieter water than surrounding areas (Plummer 1977a). This preference may be attributed to one or a combination of the following: food resources, swimming ability, differences in thermal preferences, social interactions, and predator avoidance (Congdon et al. 1992). Hibernacula must provide well oxygenated water and be free of ice scour, human disturbance, and predators. Turtles during hibernation are particularly vulnerable as they live under the ice for several months with low metabolism and reduced activity. The importance of adequate overwintering sites cannot be overstated, particularly at our latitude.

Habitat Types:

Upland Shores

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): Shoreline development is the biggest habitat threat. Both nesting and basking substrates are lost. Natural processes that create and clear nesting areas along shoreline are now impaired. Dams can cut off upstream populations or even divide populations. Marinas or other deep water development can impact hibernacula.

Non-Habitat Threats:

Pollution

Predation or Herbivory

Trampling or Direct Impacts

Description of non-habitat threat(s): Softshell Turtles are subject to intense nest depredation due to high levels of nest predators and concentrated nesting in a few locations. The nesting sites are impacted by human disturbance during nesting by shoreline and water recreation and nearby camps. Activity on nesting beaches can directly impact eggs and we have documented one case of equipment being driven over nests and causing damage. Human disturbance limits basking opportunities and duration. Polution may have played a role in the decline of the Winooski River population and there remains concern about contaminants in Lake Champlain and possible impacts from toxic blue-green algal booms.

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	1) Determine feasibility of a Winooski River softshell population restoration. 2) Conduct habitat surveys and assessments that provide useful information about distribution, quality, and level of disturbance by humans.
Research	Basic Life History	Low	1) Continue studies monitoring individuals via radio-tagging in an effort to document habitat utilization and movements between those habitats among seasons and years. Movements of radio-tagged individuals will aid in our understanding of the extent of interchange between populations. 2) Develop emergence estimates based on the number of hatchlings produced from each nest, through either direct observation or the counting of eggshell fragments. 3) Nest success can be documented by monitoring nests and calculating the proportion of nests that successfully hatch young by the end of the nesting season.
Research	Distribution and Abundance	Medium	Have a pretty good handle on adults but not on juveniles. Document that recruitment of young into the breeding population is occurring.
Research	Threats and Their Significance	High	1) Assess recovered dead specimens for size, weight, length, age estimate, sex, and the cause of death determined. 2) Employ tracking boards and camera sets to determine what species are predating a nesting site. 3) Investigate sensitivity to environmental contaminants.
Research	Population Genetics	Medium	Investigate if Lake Champlain softshells are genetically distinct as there is interest in the uniqueness of Lake Champlain turtle population. Some work has been conducted by UVM researchers.
Research	Other Research	High	All individuals captured for research should be measured, age estimated, sexed, and possibly marked via pit tags which would provide long-term information.
Monitoring	Population Change	High	Consider the use of genetic methods for investigating populations.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	High	
Monitoring	Monitor Threats	High	

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Alliance Development		Collaborate with other American and Canadian investigators, organizations, and agencies.	Number of interactions with partners.	Société de la faune et des parcs du Québec, Société d'Histoire Naturelle de la Vallée du St-Laurent	
Compliance & Enforcement		Protect high-use basking areas from human disturbance via on and offshore signage and law enforcement.	Number of sites with signage and patrol.	VFWD Outreach Div., game wardens	Nongame Wildlife Funds
Compliance & Enforcement		Protect nesting beaches from human disturbance during nesting season via on and offshore signage, law enforcement, and, if appropriate, visual screens.	Number of sites managed.	USDA Wildlife Service, game wardens	SWG
Technical Assistance, Training, Learning Networks		Encourage softshell habitat landowners to become monitors and land stewards of that habitat for the purpose of softshell conservation.	Numbers of cooperating landowners.	Lake Champlain Land Trust	Lake Champlain Land Trust, Nongame Wildlife Fund
Awareness Raising and Communications		Develop and place signage along important habitat areas.	Number of sites with signage.	USDA Wildlife Service, State Parks staff	SWG, Nongame Wildlife Fund
Species Restoration		Consider recruiting volunteers to monitor potential nesting sites during the nesting season in an effort to identify previously undocumented nesting sites.	Number of trained volunteers and hours expended.	Lake Champlain Land Trust, Audubon VT	volunteer effort
Species Restoration		Create nesting habitat in suitable areas close to water.	Number of created nesting area	Corps of Engineers, Missisquoi National Wildlife Refuge	SWG
Species Restoration		Explore other deterrents such as fencing (chain link/floppy), electric wire, discouraging winter denning near nesting sites, night shooting, and night patrols with a trained dog to lessen predation.	Number of sites where alternative methods employed.	USDA Wildlife Services	SWG

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Awareness Raising and Communications	Develop and place infromational brochures at fishing license agents, marinas, fishing derbies, and State Parks and camping areas.	Brochures distributed	State Parks, VFWD Outreach Div.	Marketing funds, Nongame Wildlife Fund
Species Restoration	Removing debris and large rocks, provide sand-shale substrate, trim or remove shading brush, and dig out encroaching vegetation in old shale deposits at nesting beaches.	Area improved for nesting.	volunteers, Audubon VT, UVM students	volunteer time
Species Restoration	Consider headstarting young if their survival in the nest is compromised.	Number of young salvaged.	ECHO Center for Lake Champlain, Ecomuseum (Montreal)	volunteer effort
Species Restoration	Employ mammalian predator trapping programs at nesting beaches that exhibit a relatively high concentration of nests to reduce the number of nests predated.	Number of predators removed.	USDA Wildlife Services	SWG
Market Forces	Develop an incentives program for diary farmers to halt the access and trampling of sandy shorelines by cows (i.e., provide farmers with large water tanks and electric fencing).	Number of sites were livestock trampling of shoreline controlled.	NRCS, Farm Bureau	NRCS
Species Restoration	Basking habitat could be created via floating platforms or permanent structures.	Number of sites benefiting from basking structures.	Normandeau Inc	VTrans bridge project
Awareness Raising and Communications	A Spiny Softshell Turtle reporting program that encourages the public to document softshell sightings should be part of the overall public outreach effort for this species.	Number of reports received.	Reptile & Amphibian Atlas project	Nongame Wildlife Fund
Awareness Raising and Communications	Incorporate softshells into existing Vermont Agency of Natural Resources fish and wildlife publications (i.e., law digest and fishing guide).	Number of times message is carried in ANR publications.	VFWD outreach division and commissioner	marketing funds
Species Restoration	Protect known habitats from disturbance: nesting, wintering, basking, foraging.	Number of sites protected.	Missisquoi National Wildlife Refuge, Société de la Faune et Des Parcs du Québec, TNC of Canada, FPR, VFWD	Lake Champlain Mgmt funds, Lake Champlain Basin Program funds, SWG
Awareness Raising and Communications	Recruit local volunteers for the purpose of monitoring nesting beaches and increasing the general public's awareness of Lake Champlain Spiny Softshells.	Number of volunteers and effort expended	Audubon VT	Nongame Fund, Audubon VT

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Species Restoration		When feasible, protect nests with ½" x ½" hardware cloth or vinyl-coated wire mesh cages by state and federal biologists in an effort to reduce the number of depredated nests.	Number of successful nests protected,	USDA Wildlife Services	SWG
Awareness Raising and Communications		Organize workshops at boat-ramps to educate anglers on turtle identification and fishing hook removal.	Number of workshops held and numbers of people who attend.	angler organization s, Lake Champlain Committee, LCI	LCI
Compliance & Enforcement		Identify areas that provide critical foraging habitat, particularly for juveniles, and protect vulnerable areas from human disturbance via on and offshore signage and law enforcement if the areas are reasonably small and identifiable.	Number of areas documented.	TNC of Canada, Normandea u Associates	VTrans bridge monitoring
Compliance & Enforcement		Develop and maintain internal communications with law enforcement and biologists to build awareness and support for turtle protection.	Number/frequency of exchanges of information.	Game wardens, fisheries biologists	SWG, Nongame Wildlife Fund
Habitat Restoration		When feasible, basking areas will be enhanced via natural (e.g., tree limbs and trunks) structures in an effort to increase basking surface area.	Number of basking areas	Missisquoi National Wildlife Refuge	refuge operating budget
Habitat Restoration		Improve water quality in Lake Champlain by reducing sources of existing pollution and prevent future pollution impacts.	Improvements in water quality	DEC, Farmers, Towns	Clean and Clear Program
Technical Assistance, Training, Learning Networks	Low	Identify significant road crossings and develop safe road crossings to reduce the potential for roadkill. Softshells rarely venture far from water so are less vulnerable to road mortality than other turtles.	Number of sites identified and crossings developed.	Reptile & Amphibian Atlas,	VTrans, FHWA
Species Restoration		Trap nesting areas that exhibit a relatively high concentration of nests in an effort to reduce the number of predated nests.	Number of areas trapped	USDA Wildlife Services	SWG
Compliance & Enforcement		Further develop program by which softshell sightings and/or harassment can be reported to Vermont's Wildlife Diversity Program.	Number of reports received	Reptile & Amphibian Atlas	Nongame Wildlife Fund
Policy & Regulations		Explore and implement legal protection to benefit the Spiny Softshell Turtle, including the establishment of a legal means of designating and protecting habitats critical for softshells, both on land and water.	Number of legal tools provided.	Game wardens	state general

Common Name: **Spiny Softshell Turtle**
Scientific Name: **Apalone spinifera**
Species Group: **Herp**

Publically-Owned Protected Areas	Pursue acquisition of those areas identified as important for maintaining and enhancing Spiny Softshell Turtles.	Number of sites and acreage conserved.	Lake Champlain Land Trust, Nature Conservanc y of Canada	VHCB funds
Awareness Raising and Communications	Develop and distribute information to landowners of current and potential riverine and lakeside softshell habitat.	Numbers of landowners/camp owners contacted.	Lake Champlain Land Trust	Lake Champlain Land Trust, Nongame Wildlife Fund
Compliance & Enforcement	Monitor hibernacula when Spiny Softshells have congregated (September – May) to ensure disturbance is minimal.	Frequency of monitoring	Société de la faune et des parcs du Québec	Québec grant
Technical Assistance, Training, Learning Networks	Inform state biologists of potential problem for hibernacula (e.g., potential marina development) and take appropriate actions when a hibernaculum's physical characteristics and/or hibernating individuals are limited.	Number of actions taken to protect turtles and their habitat.	Act 250 coordinator, game warden, Missisquoi National Wildlife Refuge	

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Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

The Five-lined Skink is an S1, state-endangered species, that is known from only three locations in West Haven, VT. All Five-lined Skink sites in Vermont feature talus and exposed rock within a mile of Lake Champlain. Total records of individual sightings number approximately 40. We have almost no data on their abundance and natural history in VT. We would benefit from data on distribution, behavior, seasonal movements, egg-laying sites, predators, food, population size, genetic heterozygosity and microhabitat requirements.

Distribution

The Five-lined Skink is known from three locations in West Haven, VT.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Mettawee River
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The Five-lined Skink is known currently only on talus slopes and nearby cliff faces, exposed rocky ridges, and rocky shorelines. The ridges are composed off a mixture of ledge, broken rock, and scattered juniper or hardwoods. All known sites have a south or southwestern exposure, low elevation, nearby water, and relatively warm climates for Vermont. Anecdotal historic reports mention the use of exposed faces of old buildings near the above habitat and old mining areas. A skink sighting of this nature was recently documented in an abandoned shanty.

Known in Vermont only from West Haven/Benson along Lake Champlain where talus slopes and exposed cliff faces and ridges of low elevation are close to water. Critical habitat includes leaf litter and coarse woody debris mixed with exposed broken rock/ledge seems to be preferred.

Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Northern Hardwood

Oak-Pine Northern Hardwood

Subterranean

Building or Structure

Mine

Other Cultural

Current Threats

Habitat Threats:

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Five-lined Skinks need solar exposure, rock slides and fire may play a roll in keeping talus and ledges exposed. Development of lake-shore areas where the skink is found, removal of coarse woody debris, and introduction of cats could prove to eliminate local populations. Skinks may move from denning sites on talus to feeding areas nearby. Short-distance seasonal movements seem likely. They do not seem to move across open field but rather short distances from talus to cliff, ridge, field edge, or lake-shore. Moderate traffic, wide roads and large agricultural fields could limit movements. Future sources of coarse woody debris need to be maintained (old snags, large dead trees, etc.).

Non-Habitat Threats:

Genetics

Trampling or Direct Impacts

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Genetic isolation of very localized populations are potentially a problem. Predation by cats or other introduced or subsidized predators could be a problem. Insecticide use could impact their prey base. When cold, lizards move slowly. Excessive trampling (intensive agricultural, residential, or recreational use could be a problem). Sites may have become isolated by large agricultural fields. Continuous sunny and rocky edge habitat may connect one large meta-population (Bald Mountain, Austin Hill, and adjacent rocky shorelines and talus slopes). Two other known locations (Dresden Narrows, Benson) may be isolated.

Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	1) Gather data on specific habitat requirements of Vermont populations: denning sites, egg-laying sites, foraging areas, and movement corridors. 2) Identify critical habitat that includes basking sites.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	1) Determine distribution and abundance in Vermont. 2) Survey anthropogenic sites such as old mines and talus piles in western Rutland County for this species. 3) Identify appropriate habitat in Western Rutland and Addison Counties from maps and photos.
Research	Threats and Their Significance	High	Recover any dead specimens or use other means to obtain genetic tissue samples as the basis for genetic assessment/demographic info.
Research	Population Genetics	High	Recover any dead specimens or use other means to obtain genetic tissue samples as the basis for genetic assessment/demographic info.
Monitoring	Population Change	High	Monitor the size and determine the sustainability of existing populations through age-class and/or genetic analysis.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	Medium	
Monitoring	Monitor Threats	High	

Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks		Train Rattlesnake researchers and game wardens to keep data on the sightings and habits of this species.	Number of cooperators who gather information on skinks.	game wardens, volunteers	SWG, TNC
Standards		Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of landowners and mangers who receive and use guidelines	VFWD district biologists, consulting foresters	SWG
Technical Assistance, Training, Learning Networks	Medium	Train Rattlesnake "Responders" to collect and submit data on the sightings and habits of the five-lined skink.	Number of cooperators who gather information on skinks. Number of skink tissue samples collected.	Game Wardens, volunteers, VFWD district biologists	SWG, TNC
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people who receive message.	VFWD Outreach Division, TNC	Outreach marketing funds
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements and education of private landowners and managers regarding appropriate management.	Number of sites and acreage conserved.	TNC, VLT	VHCB funds
Awareness Raising and Communications		Encourage reports of sightings to the VFWD Wildlife Diversity Program and the Vermont Reptile and Amphibian Atlas.	Number of reports received	Reptile & Amphibian Atlas, TNC	Private grants, Nongame Wildlife Fund, SWG
Species Restoration		Work to maintain connectivity with populations to the west in New York State and between the two known populations. Collect tissue sample when/where possible for genetic assessment.	Quality and quantity of connecting habitat.	New York DEC, TNC, VLT	VHCB, TNC, SWG
Habitat Restoration		Experiment with habitat enhancement such as creating small openings in heavily shaded areas along the top of cliffs and talus slopes, dropping logs onto the talus, maintaining coarse woody debris and scattered cover.	Number of sites with active management that have been monitored.	TNC	TNC, SWG
Alliance Development		Continue to work cooperatively with important landowners such as the Nature Conservancy. Develop and maintain allies in local government and private citizens.	Number of joint meetings with partners.	TNC, landowners	various

Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

Compatible Resource Use	Manage ATV and other off road usage in known habitat to avoid impacts.	Number of sites where ATV use is controlled.	Landowners, TNC, Game Wardens, VASA	Land Mgmt funds
Awareness Raising and Communications	Keep cats away from known habitat. Discourage or re-direct residences away from known habitats.	Number of areas fenced or otherwise protected	Landowners, TNC	TNC
Awareness Raising and Communications	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of sites reported	VTrans, Reptile & Amphibian Atlas, volunteers TNC	Vtrans, TNC
Species Restoration	If local populations are determined to be unsustainable, consider reintroduction or augmentation from closest healthy source. Maintaining and enhancing extant populations is always a priority and should be continued.	Number of extant sites	TNC, NYDEC	Private grant, SWG

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Common Five-lined Skink**
Scientific Name: **Plestiodon fasciatus**
Species Group: **Herp**

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Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend:
Regional SGCN? Yes

Assessment Narrative:

The North American Racer is currently known from only one site in Vermont. It had not been documented in Vermont since 1985 and had been feared extirpated until relocated in 2003. It is a very rare species in Vermont (S1) a was listed as threatened in 2005. Anecdotal historic reports in the southern Connecticut River Valley and on nearby ridges repeatedly speak of a North American Racer that was commonly seen in this area twenty-five or more years ago. Recent Reptile & Amphibian Atlas records include racer reports in a six-town area in this region although the species is currently known from only site in VT. Focused Racer research from 2004-2007 identified eight individuals in Vernon/Gilford which were PIT-tagged and monitored. Subsequent survey efforts occurred annually but no animals were seen between 2008 - 2014 sparking added fears of extirpation. Two sightings were most recently documented in 2104 in Gilford. Habitat loss due to succession is likely negatively affecting this species. Since 2007, habitat improvement efforts directed specifically towards Racers have occurred at the Gilford I-91 weigh-station site.

Historically, this species probably expanded in numbers as Vermont's forests were cleared. Open pasture, fields mowed by hand or horse, or fields not mechanically baled probably provided expanded habitat. Currently, with farm loss/abandonment over the past several decades, habitat favorable to Races has declined significantly.

Distribution

The only known population of the North American Racer in Vermont uses early successional open ledge, grass, fern, and other herbaceous cover exclusively during the summer. It does move through short (30m) sections of woodlands between patches. It may move larger distances through woodlands to denning sites. Telemetry research on this species in 2004-2007 identified long, narrow home range movements covering some three miles, tightly associated with a major powerline and grass margins of the Interstate right-of-way. The animal is known to den along ledges with talus slopes and exposed rock in other northern locations. One former denning site in Vermont has been located. Recent racer habitat improvement efforts have focused on creating early successional (grass/shrub) habitat, creation of experimental hibernacula, egg-laying substrate and basking habitat at the animal's last known occurrence site in Gilford.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Middle Connecticut	West
	Black-Ottauquechee

Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Otter Creek

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The North American Racer is currently known only from a very limited portion of a two-town area in the Connecticut River Valley. The species primarily uses early successional and sunny habitat along low rocky ridges in warm portions of the state. It probably moves from ridges to adjacent open areas at lower elevations to feed during the summer months. It needs to get below frost line for denning. Overwintering mortality has been documented for this species. Connected mosaics of early successional habitat and rocky exposed ledges is probably required.

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Oak-Pine Northern Hardwood

Early Succession Pine and Hemlock

Early Succession Upland Oak

Subterranean

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): This species probably expanded in numbers as early Vermont was cleared. Open pasture, fields mowed by hand or horse, or fields not mechanically baled probably provided expanded habitat. Loss of early successional habitat including small farms, increased row cropping, increasing speed and mechanization of mowing and bailing and increased parcelization are believed to have limited appropriate habitat.

Non-Habitat Threats:

Genetics

Reproductive Traits

Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

Trampling or Direct Impacts

Disease

Description of non-habitat threat(s): Isolation of appropriate habitat patches and small population size may have led to genetic isolation. Snake Fungal Disease is a potential threat but as yet unknown in VT racers. Increasing mechanization and speed of mowing and bailing causes direct mortality. Increasing ATV use in rural areas is a direct problem. Direct persecution from encounters with humans and possibly dogs needs to be addressed.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	While the Racers' general requirements are known from literature, we lack full understanding of VT habitat utilization. Gather specific habitat requirement data for VT populations: denning sites, egg-laying sites, foraging areas, and movement corridors.
Research	Distribution and Abundance	High	1) Continue racer surveys at known sites and for additional populations. Identify distribution and relative abundance of populations. Look for/examine evidence of Rutland/Bennington county populations. 2) Identify appropriate southeastern VT habitat from maps, photos, aerial surveys, and ground survey and interviews in likely areas.
Research	Threats and Their Significance	High	Opportunistically capture racers and recover any dead specimens to assess health status, obtain demographic information and genetic tissue samples for analysis.
Monitoring	Population Change	High	1) Monitor the size and determine the sustainability of existing populations through age-class or genetic analysis. 2) Review petenient literature to investigate/inform the possibility of augmentation from closest, healthy source population.
Monitoring	Habitat Change	High	Continue on-going habitat improvement/maintanence schedules and monitor weigh station sites for evidence of racer use/occupation.
Monitoring	Monitor Threats	High	Watch for Snake Fungal Disease in Racer populations.

Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration		Contiune to maintain and create early successional habitat. Create/enhance denning, basking, egg-laying habitat if limited. Monitor existing improvemnts for evidence of use. Educate private landowners about maintaining habitat in a snake friendly manner.	Number of acres and specific sites maintained or enhanced.	VELCO, local landowners, VFWD district biologists, VTrans	VELCO, VFWD, VTrans, SWG
Alliance Development	Medium	Continue to work cooperatively with organizations and individuals in southeastern Vermont. Develop and maintain allies.	Number of partners.	Bonnyvale Environment al Center, local conservation commission, landowners, consulting foresters, VTrans, Reptile & Amphibian Atlas	SWG
Awareness Raising and Communications		Educate landowners in area about snakes in general and encourage coexistence with snakes. Inform them about the identification, natural history, and conservation problems and needs of this species.	Number of people who receive message.	VFWD Outreach Division	marketing funds, SWG
Species Restoration		If local populations are determined to be unsustainable, consider augmentation from closest healthy source. Maintaining and enhancing extant populations is always a priority and should be continued.	Number of extant populations.	Mass F&W, NH F&W	SWG
Planning & Zoning		Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects that utilize racer information.	VTrans, Reptile & Amphibian Atlas	FHWA, SWG
Awareness Raising and Communications	Medium	Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received.	Reptile & Amphibian Atlas	Nongame Wildlife Fund
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people who received message.	VFWD Outreach Division	Nongame Wildlife Fund, SWG

Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

Standards	Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of managers and landowners who receive message.	Consulting foresters, VELCO, VTrans	SWG
Technical Assistance, Training, Learning Networks	Establish a web site with conservation information on this species and trained local contacts who can relocate snakes.	Establishment of web site containing information on racer.	VFWD Outreach Division, VTrans, Bonnyvale Environmental Center, Reptile & Amphibian Atlas	VTrans, VFWD marketing funds
Habitat Restoration	Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed.	VTrans	FHWA
Easements	Conserve know habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management.	Number of areas conserved.	consulting foresters, landowners, VLT, Vtrans, local land trusts	VHCB, FHWA
Species Restoration	Work to maintain connectivity with populations to the south in Massachusetts.	Maintenance of connectivity.	VTrans, VFWD, Mass Highway Dept. Town Planning Commissions	FHWA, Vtrans
Awareness Raising and Communications	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of reports received.	VTrans, Reptile & Amphibian Atlas	Nongame Wildlife Fund
Compatible Resource Use	Manage ATV and other off road usage in know habitat to avoid impacts.	Number of areas where ATV use is controlled.	Landowners, VELCO, VTrans, VASA	VELCO, VTrans
Awareness Raising and Communications	Quickly and thoroughly, counter myths and misinformation appearing in the press that may limit this species.	Number of press articles. Numbers of individuals who received message	Bonnyvale Environmental Center, Reptile & Amphibian Atlas	Private funds and grants

Common Name: **North American Racer**
Scientific Name: **Coluber constrictor**
Species Group: **Herp**

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Common Name: **Eastern Ratsnake**
Scientific Name: **Pantherophis alleghaniensis**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	No

Assessment Narrative:

The Eastern Ratsnake is a S2 species that is listed as state-threatened. Development, habitat fragmentation, road mortality, and direct persecution limit both Ratsnake populations in Vermont. The northern population appears to be entirely isolated. Anecdotal reports strongly suggest that both populations are declining.

Distribution

The Eastern Ratsnake is known from only two regions of VT. One meta-population can be found in western Rutland County and extending into southwestern Addison County. The second population is very localized on the border of Monkton, Bristol, and New Haven. The southern population is essentially bounded on the south by Route 4, on the west by Route 30, and on the north by Route 73 with an extension on Bald Hill in Sudbury reaching across Otter Creek into Leicester. The northern population is essentially bordered on the south by Plank Road, on the west by North Street (and the adjoining wooded swamp) on the north by Piney Hill Road and on the East by the Monkton-Bristol Road. Recent work in Vermont (Andrews 2012) has shown that individual snakes migrate at least 1.5 miles to and from hibernacula. Many, but not all, of these dens are on or immediately below south or southwest facing cliffs along the shore of Lake Champlain or similar but more interior cliffs and talus slopes. At least one population must use less-exposed ledges due to an apparent lack of cliffs within known migration distances.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Probable Watersheds
Lake Champlain
Metawee River
Otter Creek

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

This species dens in cracks and caves on cliff faces, in rocky talus slopes often at the base of cliffs, and possibly in rocky woodlands and along ledges at low elevation (<400m) with a southern or southwestern exposure. Many of these dens are along the shore of Lake Champlain or similar but more interior cliffs and talus slopes are also used. At least one population must use less-exposed but deeply eroded ledges due to an apparent lack of cliffs within known migration distances.

From these dens individuals travel distances of 1.5 miles or more to summer foraging areas that consist primarily of cliff tops, field edges, old fields, old orchards, abandoned or seldom used buildings and barns, or wetland margins. Large exposed dead or partly dead hollow trees along field edges, cliff tops, on talus slopes, or along margins or wetlands and water bodies are often used as refuges, as well as basking and feeding areas. Habitat mosaics including rocky slopes, cliffs, large dead and hollow trees, old fields, wetlands, and old buildings are ideal. Areas that also include abundant amphibians such as Northern Leopard Frogs seem to be most frequented. Along Lake Champlain while traveling between dens and foraging areas, ratsnakes spend most of their travel time within the thickly-vegetated shoreline margin of the lake. In other areas they appear to use densely vegetated corridors and hedgerows as their travel corridors. They also return to favored barns and protected refugia year after year.

Appropriate denning areas (talus, rock crevices) with spring basking opportunities, low elevation warm rocky woodlands, and safe connectivity to woodland or edge foraging areas with low human and road density appear to be important. Standing hollow snags with good sun exposure provide feeding, protection, and basking.

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Oak-Pine Northern Hardwood

Hardwood Swamps

Marshes and Sedge Meadows

Early Succession Upland Oak

Building or Structure

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Other Cultural

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): This species often travels relatively long distances from den sites for foraging areas. As development continues, this travel may require movement through increasingly mechanized agricultural areas, and across increasingly busy roads. This movement in combination with their affinity for edge habitat, old buildings, barns, and outbuildings often brings them into contact with humans. Increasing development brings snakes into contact with more humans, and their machines.

Non-Habitat Threats:

Genetics

Reproductive Traits

Trampling or Direct Impacts

Disease

Description of non-habitat threat(s): Some populations appear to be completely isolated, others may become so. This is a long-lived species, consequently direct persecution from humans and increased road mortality of adult breeders can outpace production. Roads attract and hold cold snakes as basking areas. Increasing road density and traffic are a problems. Increased ATV use in and near woodland fragments is known to cause mortality to snakes basking in trails. Increasing efficiency and speed of farm equipment for the planting and harvest of crop lands increases mortality from this source. Snake fungal disease has recently been identified in this area and is known to cause mortality in ratsnakes. It may have impacts on our populations but the extant of and impacts from the disease in Vermont are currently unknown.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine food requirements, denning sites, nesting locations, foraging areas, movement corridors, annual range, and other important natural history information that can be used to better protect and/or enhance habitat.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	1) Identify distribution and relative abundance (population sizes) of populations in Vermont. 2) Survey all areas from which reports have originated in the last ten years.
Research	Threats and Their Significance	High	Is this species susceptible to or carrying Snake Fungal Disease or other diseases in Vermont? Are there specific locations where snake fencing and underpasses would benefit this species?
Research	Population Genetics	Medium	Is the northern population in danger due too limited genetic diversity?
Monitoring	Population Change	High	Are populations associated with any of the dens declining? If so, at what rate?
Monitoring	Habitat Change	High	How and at what rate is habitat changing? Is traffic increasing?
Monitoring	Range Shifts	High	Has this species disappeared from any historic range. Is it moving into any previously uninhabited range?
Monitoring	Monitor Threats	High	

Common Name: **Eastern Ratsnake**
Scientific Name: **Pantherophis alleghaniensis**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Educate landowners and residents within the snake's range to encourage coexistence with snakes.	Number of programs and number of people who receive message.	landowners, Cons Comms	SWG, Private grants
Technical Assistance, Training, Learning Networks	High	Work with VTrans crew and other land managers to raise awareness of conservation need and implement conservation actions that benefit snakes.	Number of crew members who receive training	VTrans	VTrans training funding
Alliance Development	High	Continue working cooperatively with important landowners such as The Nature Conservancy. Develop and maintain allies in local government and private citizens.	Number of joint meetings held with partners.	TNC, landowners, towns	SWG, Nongame Wildlife Fund
Natural Processes Restoration	Medium	Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed	VTrans, Academic community	SWG, VTrans, FHWA
Species Restoration	Medium	Work to maintain connectivity with populations to the west in New York State and between known populations.	Quantity (acerage) and quality of connective habitat.	NY DEC, VLT, Champlain Land Trust	VHCB
Standards	Medium	Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects where ratsnake information was used for planning	VTrans, Reptile & Amphibian Atlas	VTrans, FHWA
Compatible Resource Use		Manage selected areas for early succession, work with agriculturalists to manage lands to maintain early succesional habitat does not cause direct mortality (e.g., light pasturing rather than harvesting/cultivation near wetlans and denning habitat.	Acres of wetland/grassland mosaics within safe travel distanct of known denning habitat.	Sportsmen, Audubon VT	SWG, VHCB
Planning & Zoning	High	Identify important denning areas and movement corridors and minimize development, clearing, road building and increased traffic in these areas. Maintain low density human use in mosaics in known areas.	Number of specific sites identified. Number of sites with compatible land use.	TNC, landowners, land managers, VTrans, town government s, Town/ Regional Planners	SWG, TNC, VTrans
Compatible Resource Use	Medium	Manage ATV and other off road usage in known habitat to avoid impacts.	Number of sites where ATV use is controlled	Landowners, Game Wardens, TNC, VASA	ATV License fees, SWG

Common Name: **Eastern Ratsnake**
Scientific Name: **Pantherophis alleghaniensis**
Species Group: **Herp**

Research	Medium	Determine the presence/absences of reptile diseases in the historic area of the Chorus frog and to control their spread and impact.	Disease surveys	Regional Wildlife Healt Lab, Academic community	SWG, Nongame Fund, Private grants
Awareness Raising and Communications	High	Quickly and thoroughly, counter myths and misinformation appearing in the press that may limit this species.	Number of press responses carried by media.	SAG-Herps, Reptile & Amphibian Atlas, VFWD Outreach Division	SWG, Marketing funds
Technical Assistance, Training, Learning Networks		Maintain and support the network of trained snake relocators for this species as well as Rattlesnakes. Put information about Ratsnakes and this service on the same materials and website as for rattlesnake.	Number of requests for assistance.	Volunteers, Reptile & Amphibian Atlas, TNC, Orianne Society	TNC, Orianne Society
Awareness Raising and Communications	Medium	Encourage reports of sightings to the VT Wildlife Diversity Program and the VT Reptile & Amphibian Atlas.	Number of reports received	Reptile & Amphibian Atlas	Nongame Wildlife Fund, SWG
Standards	Medium	Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Numbers of landowners and managers who become aware and use guidelines	VFWD district biologists, consulting foresters	SWG
Awareness Raising and Communications	Medium	Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people who receive information	ECHO Center for Lake Champlain, VFWD Outreach Division	Corporate Sponsors, Lake Champlain Basin Program, Marketing funds
Awareness Raising and Communications	Medium	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTrans, and the VT Reptile & Amphibian Atlas.	Number of sites reported	VTrans, Reptile & Amphibian Atlas.	VTrans, FHWA, SWG
Publically-Owned Protected Areas	High	Protect through easement or purchase or collaboration, denning sites, travel corridors and foraging areas.	Acreage and number of sites conserved	Reptile & Amphibian Atlas, Lake Champlain Land Trust, VLT	VHCB

Common Name: **Eastern Ratsnake**
Scientific Name: **Pantherophis alleghaniensis**
Species Group: **Herp**

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Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

The Common Watersnake (previously known as the Northern Watersnake) is mainly a Champlain Valley species in Vermont, but also found in SE Vermont. This species is relatively large and aggressive, so is sometimes killed by humans. This species does suffer some road mortality and is purposely killed by some. It is usually associated with large wetlands of the Champlain Valley. Shoreline development may increase negative impacts from humans. Literature suggests pollution may be a problem (Harding 1997; Hunter, Calhoun, McCollough 1999). In some locations, the Northern Water Snake can be found in large numbers (e.g., Bristol Pond).

Distribution

The Common Watersnake is known from the Champlain Valley, Shaftsbury, and Vernon.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Certain
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Middle Connecticut	West
Hudson-Hoosic	Lamoille River
Mettawee River	Missisquoi River
Lake Champlain	
Missisquoi River	
Otter Creek	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Wetlands associated with permanent water bodies. Also used flooded meadows. Avoids deeply shaded areas (Hunter et al. 1999). Uses overwintering sites in upland rock outcrops with cracks. Basking sites near water.

Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Habitat Types:

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Loss and conversion of wetlands, and shoreline development

Non-Habitat Threats:

Trampling or Direct Impacts

Disease

Pollution

Description of non-habitat threat(s): Northern Water Snakes may be impacted by pollution of their aquatic habitat. They are sometimes persecuted by people and are run over when crossing roads. Northern Water Snakes have become entangled in plastic erosion control/landscape netting. Snake fungal disease has recently been identified in this area and may potentially cause mortality in this species. Ranavirus may also impact population.

Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	1) Identification of wintering sites would be important. 2) Gather data on specific habitat requirements of Vermont populations: denning sites, birthing sites, foraging areas, and movement corridors.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) Need to develop a good baseline for this species. Identify distribution and relative abundance of populations in Vermont. 2) Target some surveys along the Connecticut River Valley.
Research	Threats and Their Significance	High	1) It would be helpful to know the level of mortality due to human activity. 2) Investigate water quality and human impacts to snakes.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	Need to monitor population and distribution change in order to take action while there is still time.
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	High	Monitor for changes in Vermont distribution and manage accordingly.
Monitoring	Monitor Threats	High	1) Monitor for snake fungal disease. 2) It is important to monitor limiting factors to gauge impacts to the species.

Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use		Maintain or regain water quality in known use areas.	Maintenance or improvement in water quality.	Wetlands managers, farmers, Towns	Clean and Clear funding
Compatible Resource Use		Manage ATV and other off road usage in known habitat to lessen impacts.	Number of areas where ATV use is controlled.	Missisquoi National Wildlife Refuge, landowners, state lands managers, VASA	Refuge Mgmt funds, State Lands Mgmt
Awareness Raising and Communications		Quickly and thoroughly, counter myths and misinformation appearing in the press that may limit this species.	Number of media outlets that carry rebuttal of myths.	Reptile & Amphibian Atlas, SAG-Herps, media, VFWD Outreach Division	Marketing funds, volunteer efforts
Species Restoration		Reexamine species status at regular intervals (no longer than every 10 years) to determine if listing is appropriate.	Frequency of reviews.	SAG-Herps	volunteer effort
Species Restoration		Protect denning areas.	Number of sites protected.	landowners, managers	EQIP
Policy & Regulations		Establish and maintain 100-foot buffers of natural vegetation along water bodies in known habitat.	Number of sites with protected buffer habitat.	landowners, wetland managers	state lands Mgmt funds, EQIP, Partners in Wildlife
Planning & Zoning		Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects that use watersnake information for planning.	VTrans	VTrans FHWA
Standards		Develop management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Numbers of landowners and managers who receive and use guidelines.	Wetlands Managers, landowners	SWG
Habitat Restoration		Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed.	VTrans	VTrans, FHWA

Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Standards	Medium	Encourage compliance with ANR Stormwater Guidelines regarding erosion control matting, in both regulated and non-regulated contexts.	Number of contractors and homeowners who use non-plastic EC and landscape matting. Number of retailers stocking and selling non-plastic matting.	VT Stormwater Office, VT Association of General Contractors. Product manufacturers and distributors.	SWG
Awareness Raising and Communications		Put information about watersnakes on the web.	Number of sites with posting.	Lake Champlain Committee, ECHO Leahy Center for Lake Champlain, Lake Champlain Basin Program	Lake Champlain Basin Program funds
Awareness Raising and Communications		Place informational posters at access areas where this species is known (Button Bay, Shelburne Pond, Bristol Pond, Vernon Pond).	Number of sites with signage.	game wardens	Nongame Wildlife Fund
Awareness Raising and Communications		Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received.	Reptile & Amphibian Atlas	private grants, Nongame Wildlife Fund
Awareness Raising and Communications		Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of sites reported.	VTrans, Reptile & Amphibian Atlas	VTrans
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements and education of private landowners and managers regarding appropriate management.	Number of sites and acreage conserved	VLT, Missisquoi National Wildlife Refuge	VHCB funds, refuge acquisition
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people exposed to message.	Reptile & Amphibian Atlas, VFWD Outreach Division	marketing funds
Awareness Raising and Communications		Educate anglers regarding the conservation needs, habits of this species, and inform them of the protected status of this species.	Number of anglers exposed to message.	VFWD Outreach Division, angler groups, refuge staff	Marketing funds

Common Name: **Common Watersnake**
Scientific Name: **Nerodia sipedon**
Species Group: **Herp**

Easements	Consider creation of basking, denning, and refuge areas (rock piles) near appropriate foraging habitat.	Number of sites created and used.	Wetland managers, refuge staff	state land Mgmt funds, refuge operating budget

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Common Name: **DeKay's Brownsnake**
Scientific Name: **Storeria dekayi**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

The Dekay's Brownsnake is an S4 species in Vermont, but populations are small and highly localized. The Brown Snake reaches its ecological limit across northern New England (Hunter et al. 1999), where it is less tolerant of disturbed sites and dependent upon habitat mosaics consisting of wetlands or riparian margins adjacent to upland forest overwintering sites.

Distribution

The Brown Snake is primarily found in the Champlain Valley, Taconics, and a few scattered records from the southern CT River Valley. It is widespread and more common in southern New England (Klemens 1993).

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Probable
Champlain Hills	Probable	Vermont Valley	Confident
Northern Green Mtns	Probable	Southern Green Mtns	Probable
Northern VT Piedmont	Probable	Taconic Mtns	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Known Watersheds
Middle Connecticut
West
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Lake Champlain
Lamoille River
Otter Creek
Winooski River

Probable Watersheds
Hudson-Hoosic
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Dekay's Brown Snake primarily occupies wet woods and fields, sedge meadows, seeps, and wetland or stream margins adjacent to upland forest. They are typically found under a variety of cover objects, including logs, stones, brush piles, leaf litter, etc. Critical habitat for this snake includes lowland wetlands or riparian margins adjacent to upland forest where it overwinters.

Common Name: **DeKay's Brownsnake**
Scientific Name: **Storeria dekayi**
Species Group: **Herp**

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Early Succession Northern Hardwoods

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Any habitat conversion, alteration, or fragmentation that disrupts species' ability to move between foraging and overwintering sites may have negative effects. Road mortality can negatively impact migrating adults and dispersing juveniles, especially when located between hibernaculum and foraging habitats. In Vermont this species appears less tolerant of disturbed habitats than in southern New England near the core of its range.

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): This species often occurs in close proximity to humans, and its distribution is primarily in a region of the state that continues to see significant development pressure. Fragmentation of suitable habitats by roads or other non-permeable development may result in loss of metapopulation structure leading to genetic isolation and prevention of recolonization, especially considering the limited and localized populations of this species.

Common Name: **DeKay's Brownsnake**
Scientific Name: **Storeria dekayi**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	1) Gather data on specific habitat requirements of Vermont populations: denning sites, birthing sites, foraging areas, and movement corridors. 2) Determine if and how habitat differs in Vermont compared to the core of the Brown Snake range.
Research	Distribution and Abundance	High	Determine species statewide distribution and relative abundance with emphasis in Taconics and southern CT River Valley.
Research	Threats and Their Significance	High	
Research	Other Research	Medium	Develop enhancement techniques for birthing and overwintering habitat.
Monitoring	Population Change	High	Monitor population sizes and distribution changes.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	High	Range distribution monitoring may be how we are able to track population change in Vermont (maintenance or loss of populations).
Monitoring	Monitor Threats	High	

Common Name: **DeKay's Brownsnake**
Scientific Name: **Storeria dekayi**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received. Geographic coverage of reports.	Reptile & Amphibian Atlas	Nongame Wildlife Fund
Compatible Resource Use		Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of sites where information on crossing areas	VTrans, Reptile & Amphibian Atlas	VTrans planning funds
Compatible Resource Use		Manage ATV and other off road usage in known habitat to lessen impacts.	Number of brownsnake areas with restricted or managed ATV use.	Land managers, private landowners, VASA	
Awareness Raising and Communications		Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of areas reported.	VTrans, Reptile & Amphibian Atlas	VTrans funds
Habitat Restoration		Maintain habitat mosaic and connectivity necessary for this species, particularly in Champlain Valley.	Number of intact habitats and connections	Consulting Foresters, landowners, Cons Comms	Current Use, EQIP
Standards		Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.			
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements and education of private landowners and managers regarding appropriate management.	Number of known sites conserved.	Consulting foresters, local Cons Comms	VHCB funds
Species Restoration	High	Reexamine species status at regular intervals (no longer than every 10 years) to determine if Endangered Species Act listing is appropriate.	Frequency of review	SAG-Herps	donated time
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people exposed to message.	VFWD Outreach Division	Marketing funds
Species Restoration		Develop, install, and monitor, road crossing structures and barriers for this species.	Number of structures installed.	VTrans	FHWA

Common Name: **DeKay's Brownsnake**
Scientific Name: **Storeria dekayi**
Species Group: **Herp**

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Common Name: **Eastern Ribbonsnake**
Scientific Name: **Thamnophis sauritus**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S2
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

The Eastern Ribbonsnake is a rare species in Vermont (S2) and is considered a species of special concern in Vermont. The Eastern Ribbonsnake is one of the rarest of snakes in Vermont based on the number of known current sites. It seems to depend on a combination of a relatively warm, undeveloped lowland site and wetlands.

Distribution

It is currently documented from only six locations in Vermont: five in western Rutland County and one along the southern Connecticut River valley. A handful of historic records and sightings come from further north in the Lake Champlain basin and the Connecticut River Valley.

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
West	Middle Connecticut
Mettawee River	Hudson-Hoosic
Lake Champlain	Otter Creek
	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

This species requires wetland edges with sunny exposed basking sites in warm, low-elevation, largely undeveloped, areas. The presence of nearby rocky woodlands and talus seems to increase the chances of finding this species.

Common Name: **Eastern Ribbonsnake**
Scientific Name: **Thamnophis sauritus**
Species Group: **Herp**

Habitat Types:

Cliffs and Talus

Oak-Pine Northern Hardwood

Seeps and Pools

Marshes and Sedge Meadows

Shrub Swamps

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Conversion or drainage of wetlands, shoreline development, and fragmentation due to road density could all be problems.

Non-Habitat Threats:

Genetics

Trampling or Direct Impacts

Loss of Prey Base

Description of non-habitat threat(s): Some populations may be genetically isolated and others are becoming more so as a result of development. This species may be dependent on local amphibian populations that are known to vary annually. ATV use, increased traffic, cutting and bailing, and lawn mowing could all increase mortality significantly. It has not been located in moderately or heavily developed areas.

Common Name: **Eastern Ribbonsnake**
Scientific Name: **Thamnophis sauritus**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	This species may use a wider variety of habitats in Vermont than is currently known. 1) Gather data on specific habitat requirements of Vermont populations: denning sites, birthing sites, foraging areas, overwintering sites and movement corridors.
Research	Distribution and Abundance	High	Identify distribution and relative abundance of populations in Vermont. Search for ribbonsnakes in areas of open talus in the Champlain, Connecticut River valley, and other relatively warm valleys, especially if adjacent to wetland foraging areas.
Research	Threats and Their Significance	High	Monitor for signs of Snake Fungal Disease in this species.
Research	Other Research	Medium	Develop enhancement techniques to improve for birthing and overwintering habitat.
Monitoring	Population Change	High	Monitor population sizes and distribution changes.
Monitoring	Habitat Change	High	
Monitoring	Monitor Threats	High	

Common Name: **Eastern Ribbonsnake**
Scientific Name: **Thamnophis sauritus**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Quickly and thoroughly, counter myths and misinformation appearing in the press that may limit this species.	Number of response carried by media.	Media, SAG-Herps, Reptile & Amphibian Atlas, VFWD Outreach Division	volunteer, marketing funds
Publically-Owned Protected Areas		Locate populations on public lands and manage some specifically for this species.	Number of sites managed for ribbonsnake	FPR, USFS, VFWD	State Lands Mgmt funds, GMNF funds
Awareness Raising and Communications	Medium	Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received.	Reptile & Amphibian Atlas	Nongame Wildlife Fund, private grants
Awareness Raising and Communications		Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTrans, and the VT Reptile & Amphibian Atlas.	Number of sites reported.	VTrans, volunteers	VTrans
Compatible Resource Use		Review all roadway projects in appropriate habitat, check against known crossing areas VTrans, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects reviewed with planning information on snakes.	VTrans, Reptile & Amphibian Atlas	VTrans
Compatible Resource Use		Manage ATV and other off road usage in known habitat to lessen impacts.	Number of sites where ATV use is controlled.	Land managers, landowners, VASA	
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements and education of private landowners and managers regarding appropriate management.	Number of sites conserved.	Vermont Land Trust	VHCB funds
Awareness Raising and Communications		Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people who receive message.	VFWD Outreach Division	Marketing funds
Standards		Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.	Number of landowners and managers who receive and use guidelines.	VFWD district biologists, consulting foresters	SWG
Habitat Restoration	Medium	Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed.	VTrans	FHWA

Common Name: **Eastern Ribbonsnake**
Scientific Name: **Thamnophis sauritus**
Species Group: **Herp**

Species Restoration	High	Reexamine species status at regular intervals (no longer than every 10 years) to determine if ESA listing is appropriate.	Number of years since last review.	SAG-Herps	volunteer

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Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S4 **State Trend:**
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Few people encounter the Smooth Greensnake and it is thought to be found less frequently than in the past. Little is known about its distribution in Vermont and its considered uncommon in Vermont (S3). It's conservation status is uncertain and its considered a medium-priority SGCN.

Habitat loss due to development is also a problem for this species, especially in the lowlands. In past large beaver meadows may have been connected. Mechanization of agriculture, lawn mowing, and roads all are likely impacts. In the southern Great Lakes Basin it is reported to be decreasing due to intensive conversion of its habitat to agricultural uses and pesticides (Harding 1997. The Amphibians and Reptiles of the Great Lakes Region).

Distribution

Primarily at mid-elevational levels. Missing from Northeastern Vermont

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills		**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Known Watersheds
Middle Connecticut
West
Waits
Upper Connecticut-Mascoma
Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
White
Winooski River

Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

Black-Ottauquechee

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Greensnakes use sedge meadows, marsh borders, pastures, powerlines, shrub areas, and early successional habitat not mowed regularly. Micro Habitat: dense annual vegetation. Critical habitat includes overwintering habitat (ant mounds), early successional foraging habitat, and areas for egg laying.

Habitat Types:

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Mowing and pesticides are limiting factors for this species. Baling also does impact snakes.

Non-Habitat Threats:

Trampling or Direct Impacts

Disease

Pollution

Description of non-habitat threat(s): Mowing of habitat, road traffic, and pesticide use. Snakes have become entangled in plastic erosion control/landscape netting. Snake fungal disease has recently been identified in this area and may potentially cause mortality in this species. Ranavirus may also impact populations.

Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Gather data on specific habitat requirements of Vermont populations: denning sites, egg-laying sites, foraging areas, overwintering sites and movement corridors.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Identify distribution and relative abundance of populations in Vermont.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Other Research	Medium	Gather data from known habitat on how it is kept in early succession and apply this knowledge.
Monitoring	Population Change	High	Monitor population sizes and distribution changes.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Monitor for Snake Fungal Disease.

Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Encourage compliance with ANR Stormwater Guidelines regarding erosion control matting, in both regulated and non-regulated contexts.	Number of contractors and homeowners who use non-plastic EC and landscape matting. Number of retailers stocking and selling non-plastic matting.	VT Stormwater Office, VT Association of General Contractors.	SWG
Compatible Resource Use		Maintain connectivity between areas of appropriate early successional habitat.	Number of acres linked through connectivity	landowners	EQIP, Current Use
Habitat Restoration		Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed	VTrans	VTrans, FHWA
Awareness Raising and Communications		Encourage reports of sightings to the VT Heritage Inventory and the VT Reptile & Amphibian Atlas.	Number of reports received	Reptile & Amphibian Atlas	private grant, Nongame Wildlife Fund
Easements		Conserve known habitat through fee simple purchase, development rights or easements, management agreements and education of private landowners and managers regarding appropriate management.	Number of sites and acreage conserved	VLT, local land trusts	VHCB funds
Compatible Resource Use		Manage ATV and other off road usage in known habitat to lessen impacts.	Number of sites where ATV use is controlled	landowners, land managers, VASA	EQIP, state lands Mgmt funds
Standards		Develop land management guidelines for owners and managers of appropriate habitat and make them readily available through multiple media, including print and the web.			
Awareness Raising and Communications		Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of reports received	VTrans	VTrans
Planning & Zoning		Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects reviewed using green snake information	VTrans, Reptile & Amphibian Atlas	VTrans, FHWA
Species Restoration		Reexamine species status at regular intervals (no longer than every 10 years) to determine if listing is appropriate.	Frequency of reviews	SAG-Herps	volunteer effort

Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

Awareness Raising and Communications	Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people exposed to message.	Reptile & Amphibian Atlas, VFWD Outreach Div	Marketing funds
Publically-Owned Protected Areas	Locate populations on public lands and manage some specifically for this species.	Number of sites managed for green snake.	district foresters and wildlife managers	state lands Mgmt funds
Standards	Work with power companies, airports, horse farmers, and other landowners that provide large areas of early successional habitat to maintain it in a manner safe for this species.	Number of sites maintained in a safe manner.	Managers of powerlines, airport staff, landowners	VELCO, VTrans, EQIP

Common Name: **Smooth Greensnake**
Scientific Name: **Opheodrys vernalis**
Species Group: **Herp**

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Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend:
Regional SGCN? Yes

Assessment Narrative:

The Timber Rattlesnake is a state-endangered S1 species that was historically known from a much wider range in VT and the region. Current estimates of population and species distribution hover near some 75-85% loss and range contraction from historic levels. Recent telemetry research in Vermont further refined local home ranges by sex and range distribution of one population and concomitantly highlighted strategic rattlesnake habitats for future conservation efforts. Genetic analysis indicated relatively low heterozygosity in this cohort although random mating still appears to be occurring. Roads with high traffic levels appeared to present significant barriers to movement and dispersal. (Spear et.al. 2013).

Extant rattlesnake populations are known only from two denning areas in Vermont. Since it is a venomous species, it is more widely feared and persecuted—a significant threat to the species in Vermont. The species had a bounty on it until 1971. The bounty was lifted in 1987, but direct persecution and occasional takings still occur. Its habit of denning communally at sites which are now quite widely known make it unusually vulnerable to takings. This behavior also provides opportunities for geographically targeted protection. In 2012, a novel and lethal snake fungal disease, Ophidiomyces ophidicola, was isolated and identified in Vermont's Timber Rattlesnake populations and has since been found in various snake species in a dozen eastern states. This finding has prompted an in-depth, regional investigation of this disease in which Vermont is participating. Known as Snake Fungal Disease (SFD) it imposes an unknown but potentially devastating threat to the species. As the animals' name implies, the Timber Rattlesnake depends on warm low-elevation woodlands that are sparsely populated. Habitat fragmentation and concomitant increases in roads/traffic, human interactions present an increasing threat of mortalities.

Distribution

Two isolated populations of the Timber Rattlesnake are restricted to areas near the southern portion of Lake Champlain in western Rutland County below 1000 ft. in elevation Research conducted in 2011-2012 indicates that genetic exchange between the two poulations is likely non-existant. Populations in other parts of the state have been lost.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Mettawee River

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

The Timber Rattlesnake in Vermont is documented only from western Rutland County at elevations below 1000 feet. In this region snakes den communally on south or southwest facing talus slopes which are near rocky ridges with exposed ledge and large undeveloped or sparsely developed areas of oak-hickory and maple-ash-hickory-oak vegetative communities. Males range annually about 2.5 miles from the natal den with females ranging up to 1.5 miles and gravid females utilizing still smaller ranges. Small, scattered canopy openings and forest wetlands along with their buffers are readily utilized and enhance habitat for foraging rattlesnakes. In Vermont, forested lands of approximately 5500 acres adjacent to the dens, sparsely developed and largely unfragmented by roads, support Vermont's discrete rattlesnake populations.(Spear et. al. 2013) Habitual movement corridors between dens and summer range are utilized annually. Roads present significant barriers and are deleterious to seasonal movement and dispersing snakes. Successful long distance movements between extant dens are now highly unlikely and may require human intervention/assistance in the future. Rattlesnakes maintain strict annual fidelity to their traditional, communal den sites. In Vermont's harsh climate, overwintering, frost-free den site requirements are exacting and thus, extremely limiting.

Critical habitat features are the rocky talus slopes with traditional dens, nearby ridges with exposed ledges, and extensive associated woodlands of oak-hickory and Pennsylvania sedge.

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Oak-Pine Northern Hardwood

Hardwood Swamps

Shrub Swamps

Early Succession Northern Hardwoods

Early Succession Upland Oak

Subterranean

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Impacts of Roads or Transportation Systems

Description of habitat threat(s): The most immediate threat to Timber Rattlesnakes with potential population consequences is the documented presence of Snake Fungal Disease (SFD) in extant populations. The lethality and severity of SFD has the potential to overwhelm other efforts on behalf of the species. The rattlesnake uses large contiguous woodland areas adjacent to their dens. Heavy agricultural or residential use, or conversion to open land are all problems. Direct loss of habitat, increased habitat fragmentation and road-density with higher traffic levels result higher road mortality , population isolation and increased snake/ human interactions. Roads present a highly fragmenting landscape feature, heightened chances of direct mortality and formidable barriers to successful snake movement, dispersal and genetic exchange. Lowland wooded patches are popular building sites and thus are becoming increasingly fragmented. The resultant direct persecution stemming from human fear and intolerance especially towards adult rattlesnakes can profoundly impact a population.

Non-Habitat Threats:

Genetics

Harvest or Collection

Reproductive Traits

Trampling or Direct Impacts

Disease

Description of non-habitat threat(s): Snake Fungal Disease is an immediate and potentially overwhelming threat to Vermont's population. Genetic exchange between Vermont’s two populations is likely non-existent. Exchange with New York’s nearest rattlesnake population is unknown. Although protected, this venomous species is still illegally collected for various purposes and snakes that have been killed are occasionally discovered. Known traditional den sites and predictable patterns of behavior make the species very vulnerable to collection and persecution. Birthing sites also appear to be limited and traditional. This is a long-lived, K- selected species that can successfully reproduce only every 4-5 years. Consequently, loss of breeding adults, particularly adult females is a problem to the sustainability of the species. Heavy ATV use, increased traffic, and heavy recreational use along ridges during key time-periods is also a problem. Since this species is venomous, it is often feared and killed when found near residences.

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Better determine range and habitat usage and protect critical areas.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Determine Population Status: continue monitoring during ingress/egrees periods.Focus on adult females/reproductive status/litters as an index.
Research	Threats and Their Significance	High	Monitor Snake Fungal Disease Status (SFD), continue surveillance, disease testing in cooperation with Regional SFD Investigation.
Research	Population Genetics	Medium	Conduct periodic genetic assessment to inform genetic exchange/variability. Consider techniques to facilitate gene flow (translocation/captive rearing/headstarting).
Monitoring	Population Change	High	Monitor the size and determine the sustainability of existing populations through age-class and/or genetic analysis.
Monitoring	Habitat Change	Medium	Continue vigilance with regulatory habitat protections (Act 250, CPG's).
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Continue the Rattlesnake Responder Program which 1) protects both snakes and residents and provides opportunity for outreach/education. 2) continue law enforcement efforts. Also See Threats research regarding SFD.

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Alliance Development	Medium	Continue to work cooperatively with important landowners such as the Nature Conservancy. Develop and maintain allies in local government and private citizens.	Number of partner contacts made annually.	TNC, towns, landowners	SWG
Technical Assistance, Training, Learning Networks	High	Maintain and support the network of trained Maintain and support the network of trained Snake Responders. Put information about Rattlesnakes and this service on the web. Educate local landowners. Distribute Responder Team refridgerator magnets.	Number of times public receives technical assistance.	Volunteers, local warden, town officials, TNC, Reptile & Amphibian Atlas	TNC
Awareness Raising and Communications	High	Continue the Rattlesnake Responder Program to protect people and animals and take advantage of "teachable moments." Patrol denning and birthing areas during necessary times to protect all life stages and send an important message to the public.	Number of animals safely moved. Number of sites that are patrolled.	Rattlesnake responder team, Game Wardens	SWG
Habitat Restoration	Medium	Develop, implement, and monitor, road crossing structures and barriers for this species.	Number of structures installed.	VTrans, Consulting herpetologis ts	VTrans
Species Restoration	Medium	Work to maintain connectivity with populations to the west in New York State and between the two known populations.	Quantity and quality of landscape connections.	New York DEC, TNC, VLT	VHCB
Awareness Raising and Communications	Medium	Quickly and thoroughly, counter myths and misinformation appearing in the press that may limit this species.	Number of press responses carried by media.	SAG-Herps, Reptile & Amphibian Atlas, VFWD Outreach Div., TNC	SWG, volunteer efforts, marketing funds
Easements	Medium	Conserve known habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and mangers regarding appropriate management.	Number of sites conserved.	landowners, TNC, VLT, TPL, Orianne Society	VHCB, Orianne Society
Standards	Medium	Develop land management guidelines for owners and managers regarding appropriate management and make them readily available through multiple media, including print and the web.	Number of landowners and mangers who receive and use the guidelines.	landowners and land managers, TNC, Towns	SWG, TNC

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

Planning & Zoning	Medium	Review all roadway projects in appropriate habitat, check against known crossing areas VTRANS, VFWD, VT Reptile & Amphibian Atlas, survey appropriate habitat when unknown.	Number of projects reviewed using rattlesnake planning information.	VTrans, Reptile & Amphibian Atlas, Towns	VTrans,
Research	High	Monitor Snake Fungal Disease status, continue surveillance, disease testing in cooperation with Regional SFD Investigation.	Relative prevelance of SFD in populations.	TNC, Orianne Society, Veterinarians, Castleton State College	SWG, other research grants
Species Restoration	High	If local populations are determined to be unsustainable, consider augmentation from closest healthy source. Maintaining and enhancing extant populations is always a priority and should be continued.	Number of successful reintroductions or augmentations.	New York DEC	SWG
Technical Assistance, Training, Learning Networks	Medium	Work with District 3 VTrans crew and other land managers to raise awareness of conservation need and implement conservation actions that benefit snakes.	Number of VTrans and others managers cooperating.	VTrans	VTrans
Compatible Resource Use	High	Protect known denning areas and adjacent ledges and woodlands from incompatible development and heavy use during critical time periods. Protect foraging land from development.	Number of sites conserved.	TNC, landowners, VLT, Act 250 Staff	VHCB
Awareness Raising and Communications	Medium	Encourage reports of road-killed specimens, road crossing, and road basking areas to VFWD, VTRANS, and the VT Reptile & Amphibian Atlas.	Number of sites reported.	VTrans, Reptile & Amphibian Atlas, TNC	VTrans, Nongame Wildlife Fund
Compatible Resource Use	Medium	Manage ATV and other off road usage in known habitat to avoid impacts, including foraging habitat.	Number of sites where ATV use is controlled.	Landowners, land mangers, VASA, other ATV user groups	land Mgmt funds/decisions
Awareness Raising and Communications	Medium	Encourage reports of sightings to the Vermont Wildlife Diversity Program and the VT Reptile & Amphibian Atlas.	Number of reports received.	Reptile & Amphibian Atlas	SWG, Nongame Wildlife Fund
Awareness Raising and Communications	Medium	Help Vermonters assign value to this species through educational programs, printed material, web site information, field trips, TV and video information.	Number of people exposed to message	VFWD outreach division, Reptile & Amphibian Atlas	marketing funds

Common Name: **Timber Rattlesnake**
Scientific Name: **Crotalus horridus**
Species Group: **Herp**

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Appendix A2

Bird SGCN Conservation Reports

Wildlife Action Plan 2015

Common Name: **Common Loon**
Scientific Name: **Gavia immer**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2B,S4N
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

Officially designated as Endangered in VT in 1978, statewide population has steadily rebounded from a low of 8 nesting pairs in 1983 and 1984 to 43 pairs in 2004.

Common Loon was designated as Endangered in VT in 1978, and removed from the list in 2005. The statewide population has steadily rebounded from a low of 8 nesting pairs in 1983 and 1984, to 301 adults and 66 chicks in 2014. Sustained management and monitoring has continued due to the Vermont Loon Conservation Project: a partnership with Vermont Center for Ecostudies and the Vermont Fish and Wildlife Department.

Distribution

Breeding is concentrated in northeastern and north-central VT, with confirmed nests found in the southern Green Mountains. Breeding probable in Champlain Valley. Loons are a medium –distance migrant. After leaving Vermont Loons head to coastal marine wintering locations along the entire eastern seaboard of the United States

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Unknown
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Territories range from 9 to 161 ha, prefers freshwater lakes larger than 24 ha, particularly those containing small islands and coves. Lakes with undisturbed islands or marshy shorelines, adequate fish and crayfish prey base, and clear water to a depth of at least 3 m.

Habitat Types:

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Common Name: **Common Loon**
Scientific Name: **Gavia immer**
Species Group: **Bird**

Current Threats

Habitat Threats:

Habitat Alteration

Climate Change

Incompatible Recreation

Description of habitat threat(s): Lakeshore development and subsequent loss of shoreline habitat is a threat to the breeding population at this time. Effects of climate change may impact this species.

Non-Habitat Threats:

Competition

Pollution

Trampling or Direct Impacts

Description of non-habitat threat(s): Interference competition from extraterritorial loons has caused some territory and nest abandonments, as well as direct killing of chicks and adults, in recent years. Vermont Loon Conservation Program participated in a study looking at mercury in Loons. They found that mercury bioaccumulates, resulting in a negative effect on adult behavior and chick productivity. Recreational activities and direct human disturbance of nesting or nursery sites also a serious problem on more heavily used lakes. Lead fishing gear likely killed three adult Loons in 2014 in Vermont. Maine and New Hampshire have also reported deaths due to lead poisoning

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	Low	This is well known overall, due to sustained annual monitoring since 1978, and the Vermont Breeding Bird Atlas, but changes due to loss of nesting areas should be documented quickly.
Research	Threats and Their Significance	High	) Collaborative research on extent and possible effects of mercury contamination in VT loons should be continued. 2) Patterns of shoreline development and ownership of current and recent nest sites needs to be documented.3) Effects of climate change may impact population and should be documented.
Monitoring	Population Change	High	Sustained monitoring is crucial to documenting population trends
Monitoring	Habitat Change	Low	Changes of suitable nesting habitats, and use of rafts.
Monitoring	Monitor Threats	Medium	Monitoring of all limiting factors goes hand-in-hand with population monitoring and is critical to evaluate long-term viability and management needs of statewide population. Sick, weak, and dead loons should be collected and sent to wildlife health facilities for determination of cause of death, including interference competition from other loons (trauma), lead, and other contaminants. Annual summaries of known causes of deaths should be completed and disseminated. Results should be evaluated for management applications.

Common Name: **Common Loon**
Scientific Name: **Gavia immer**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Continue concerted public education effort targeting landowners and lake users. Volunteers should continue to receive training, toward long-term goal of having loon monitoring and management be largely volunteer-based.	Public presentations, informational signs at VFWD lake access areas, media articles, and informal meetings with lakeshore residents and recreationists are all crucial to continued public awareness. Platforms and sign buoys must be used as necessary.	VFWD, VCE	Nongame Fund, SWG
Easements	High	Long-term protection of all current and recent (within past 5 years) loon nest sites should be secured through conservation easements and land acquisition.	Ownership of all current and recent nest sites should be documented. For those nest sites not currently protected, landowners should be contacted and protocols for securing protection should be developed.	VFWD, VCE, TNC, Lake Associations, power companies	SWG, PR
Species Restoration	High	Monitoring and management should be continued and supported.	Annual management should be continued as necessary. Annual LoonWatch should be continued indefinitely.	VFWD,VCE	VFWD, USFWS

Common Name: **Common Loon**
Scientific Name: **Gavia immer**
Species Group: **Bird**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Pied-billed Grebe**
Scientific Name: **Podilymbus podiceps**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2B,S3N	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

A sporadic breeder in Vermont, but believed to have been much more common historically. Loss of suitable wetlands since European settlement may have greatly reduced population. Development of wetland buffers and increased disturbance of nesting sites by recreationists and boat wakes may have helped continue the population decline. The second Atlas of Breeding Birds of Vermont showed little change of statewide distribution, but a slight decrease in occurrences was seen. The Breeding Bird Survey of Vermont showed a long term trend (1966 - 2012) of -8.6%. The 10-year trend from 2003-2012 (-7.99%) mirrors the long term loss.

Distribution

Most breeding was documented within wetlands located in the Champlain Valley and Lake Memphremagog regions. During the second Atlas breeding documentation was lost from the Green Mountains, Vermont Valley and Southern Piedmont biophysical regions.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Lakes, ponds, marshes, swamps, and slow-moving streams and rivers. Prefers shallow, permanent marshlands with stable water levels.

Common Name: **Pied-billed Grebe**
Scientific Name: **Podilymbus podiceps**
Species Group: **Bird**

Habitat Types:

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Invasion by Exotic Species

Incompatible Recreation

Description of habitat threat(s): Conversion of Habitat - loss of wetlands due to draining, filling for development and agriculture. Habitat Degradation - outdoor recreational activities disturb nesting. Invasion by exotic species - common reed and purple loosestrife compete with native vegetation for nesting and feeding sites.

Non-Habitat Threats:

Harvest or Collection

Trampling or Direct Impacts

Description of non-habitat threat(s): Harvest or Collection - sometimes mistakenly shot as waterfowl. Trampling or Direct Impacts; nests susceptible to damage by boating and associated wakes. Mercury accumulation. Human disturbance of nest sites. Disturbance by recreational water users

Common Name: **Pied-billed Grebe**
Scientific Name: **Podilymbus podiceps**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	More surveys needed to determine distribution and abundance.
Research	Threats and Their Significance	Medium	Impact of recreational activities at known nest sites.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Protect nesting areas from destructive recreational activities through enforcement, signing, press releases, educational materials, television/radio commercials.	Presence/absence of nesting grebes, number of chicks surviving to fledgling stage.	Audubon-VT, VINS, lake associations, angler groups, boating organizations.	SWG, Nongame fund, USFWS
Publically-Owned Protected Areas	High	Protect large wetlands (>20 ac.) suitable as grebe nesting habitat, acquired in fee through purchase.	Number of acres conserved in fee.	USFWS,DU, TNC	PR, DU, VHCB, VLT, Lake Champlain Land Trust, VT Waterfowl Stamp Funds
Policy & Regulations	High	Protect potential nesting habitat (large wetlands) through regulatory process.	Number of wetland acres protected from development.	VT-DEC	PR, EPA

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Common Name: **American Bittern**
Scientific Name: **Botaurus lentiginosus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4
State Rank: S3B,S3N
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

The distribution and population status of this species of regional conservation concern are not well documented in VT. The Breeding Bird Survey indicates a 0.22% increase over the long term trend (1966-2012) and a 0.38% increase over the last 10-years, but this is based on a small sample of routes and low abundance, so cannot be considered reliable. The Second VT Breeding Bird Atlas showed an increase of presence in all biophysical regions, except the Southern Green Mountains and Southern Vermont Piedmont regions. Vermont recently delisted the species from the status of species of special concern.

Distribution

From first VT Breeding Bird Atlas, confirmed breeding in large wetland complexes in Champlain Valley, also in West Rutland Marsh, sites in lower Connecticut River Valley, and two sites in north-central VT. Probably breeds in other larger wetland complexes (e.g., Memphremagog) and scattered smaller wetlands throughout the state. The second VT Breeding Bird Atlas confirmed breeding in marsh systems located in the northern portions of the state. The southern portions showed a stable or slightly decreasing presence.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Primarily freshwater wetlands with tall, emergent vegetation. Inhabits wetlands of all sizes (0.1-1,000 ha), but more abundant on larger than smaller wetlands. Prefers impoundments and beaver-created wetlands to those of glacial origin. Also found in wet swale of poorly drained fields.

Habitat Types:

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Common Name: **American Bittern**
Scientific Name: **Botaurus lentiginosus**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Invasion by Exotic Species

Description of habitat threat(s):): Loss or degradation of wetland habitats the primary problem to this species throughout its range. Changes in wetland isolation and water stabilization may erode habitat quality. Invasion of Phragmites and purple loosestrife a further problem to native wetland vegetation.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Chemical contamination and human disturbance are identified problems.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	Medium	1) More robust data are needed on the statewide distribution and abundance of this species in wetlands of different sizes and vegetative composition. 2) A standardized, coordinated statewide survey of this and other wetland birds is needed to establish baseline information on distribution and abundance. An extensive, single-season survey could be followed by annual monitoring at a core number of wetlands. A volunteer-based survey that uses standardized, repeatable protocols could collect presence/absence and relative abundance data at a large number of wetland sites statewide. A core number (12-15) of sites could be annually monitored for long-term trends.
Research	Threats and Their Significance	Medium	
Monitoring	Population Change	High	A standardized monitoring program is needed for this and other wetland birds, Extensive sampling needs to coordinated periodically, while a core sample of wetlands should be monitored annually.
Monitoring	Habitat Change	Medium	Important to monitor habitat quality and changes that may be occurring, e.g. from invasive plants like Phragmites and purple loosestrife.
Monitoring	Monitor Threats	Medium	

Common Name: **American Bittern**
Scientific Name: **Botaurus lentiginosus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	Medium	Assess whether wetland habitat quality is compromised by invasive species like Phragmites and purple loosestrife; implement control measures at selected sites to eliminate or minimize these species; evaluate success of measures for AMBI and other birds.	Correlate presence/absence and changes in relative abundance of AMBI and other wetland species, in relation to natural and manipulated changes in vegetation composition caused by increase or elimination of invasives.	VFWD, USFWS, TNC, VTDEC	Wetland Reserve Program, NFWF, SWG
Policy & Regulations	Medium	Ensure that wetlands inhabited by this species are well-protected, including a representative sample of smaller wetlands. Ensure that further wetland loss or degradation in VT is minimized.	Conduct a spatially explicit inventory and evaluation of wetlands in VT, and assess local regulations for protecting them. Involve local conservation commissions in wetlands inventories and protection, also monitoring.	VFWD, USFWS, TNC, local Cons Comms	Wetland Reserve Program
Compatible Resource Use	Medium	Monitor wetland habitat quality (sedimentation rates, nutrient fluxes, water quality, chemical contamination) and correlate with changes in AMBI relative abundance or presence/absence.	Correlate habitat parameters with standardized AMBI survey data, and changes in both over time.	VFWD, USFWS, TNC, local Cons Comms	Wetland Reserve program

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Common Name: **Least Bittern**
Scientific Name: **Ixobrychus exilis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:**
State Rank: S2B,S2N **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

No state BBS data. BBS routes are not well-sited for monitoring marsh species. Status of species unknown in state; the species is regularly found in relatively few marshes in VT (Kibbe 1985).

Distribution

Primarily found in the deep water marshes of Lake Champlain Valley and more sparsely in other favorable habitats in other parts of the state.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Found in freshwater and brackish marshes with dense, tall growths of emergent vegetation interspersed with woody vegetation and open water. Most abundant in hemi-marsh conditions with stable water levels, rarely found in areas without standing water. In freshwater marshes, generally prefers cattails (Typha spp.; Poole et al. 2009).

Habitat Types:

Marshes and Sedge Meadows

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Invasion by Exotic Species

Description of habitat threat(s): Loss of wetlands will continue to limit the species. Invasion of wetlands by loosestrife and phragmites will degrade habitat quality. Agricultural and urban runoff could reduce water quality and prey populations. Greater frequency of storm events could lead to variation in water levels in wetlands, particularly along Lake Champlain, leading to decreased nesting success.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Information about the distribution of LEBI in VT is lacking. A state-wide (perhaps one-time) survey of all potential wetlands would also yield valuable information for other wetland-dependent species (SORA, VIRA, COGA, PBGR, AMBI, BLTE). Marshbird monitoring programs are limited in their spatial extent in VT. An extensive initial survey would provide baseline data for a long-term monitoring program that would lay the foundation for a more representative marshbird monitoring program.
Monitoring	Population Change	High	Improving the standardization and spatial extent of marsh monitoring programs for wetland birds would greatly help our understanding of the species' distribution and population status.
Monitoring	Habitat Change	Medium	Most wetlands on which LEBI are found are protected, but more information about wetland loss and degradation would be useful as loss of wetlands will continue to limit LEBI. Although regulations currently in place will likely protect most nesting sites, some research indicates that LEBI is not area-sensitive (Gibbs and Melvin 1990) and may be found on wetlands <=0.4 ha.

Common Name: **Least Bittern**
Scientific Name: **Ixobrychus exilis**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	Medium	Prevent wetland invasions by Phragmites and Purple Loosestrife and remove these species where they have already invaded in order to maintain/improve habitat quality for LEBI.	Presence/absence of LEBI in relation to changes in vegetation composition.	VFWD, TNC, USFWS.	NFWF, Marsh bird monitoring groups, TNC, Wetland Reserve Program (NRCS).
Compatible Resource Use	Medium	Decrease sedimentation rates and nutrient influxes into marshes currently containing LEBI to maintain habitat quality.	Ideally, annual variation in abundance of LEBI could be correlated with changes in habitat quality. More realistically, survey results will need to be based on presence/absence in relation to changes in water quantity, quality and vegetation.	VFWD, TNC, USFWS.	NFWF, Marsh bird monitoring groups, TNC, Wetland Reserve Program (NRCS).

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Common Name: **Great Blue Heron**
Scientific Name: **Ardea herodias**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2S3B,S5N
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? No

Assessment Narrative:

Population currently stable with numbers increasing at largest colony site, Missisquoi National Wildlife Refuge.

Largest breeding colony (350 pairs) currently located at Missisquoi National Wildlife Refuge, second largest at Porters Bay on Lake Champlain (~100 pairs). Smaller colonies located throughout the state. Missisquoi colony stable until 2000 when 600 pair colony failed due to disturbance early in the season. Has recovered to approx. 350 pairs.

Distribution

Widely distributed with the largest colonies located in Champlain Valley. Smaller colonies located throughout state.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills		**Vermont Valley**	Unknown
Northern Green Mtns	Probable	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☐

Colony nester, nesting in tall trees, usually in wooded swamps. Colony size ranges from a couple of pairs to more than 500 pairs. Inhabits marshes, swamps, streams and lakeshores.

Habitat Types:

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Common Name: **Great Blue Heron**
Scientific Name: **Ardea herodias**
Species Group: **Bird**

Current Threats

Habitat Threats:

Habitat Alteration

Incompatible Recreation

Description of habitat threat(s): Loss or degradation of nesting habitat at colony sites, especially larger colony sites directly impacts population

Non-Habitat Threats:

Competition

Predation or Herbivory

Description of non-habitat threat(s): Disturbance of nesting colony early in the season has lead to abandonment of nesting colonies. Increasing numbers of nesting Double-crested Cormorants at large colony sites results in competition for nesting space and habitat degredation

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine specific habitat requirements for nesting locations.
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Document know nesting locations in the state, primarily smaller nesting colonies.
Research	Threats and Their Significance	High	Continue research efforts into competititon with cormorants in breeding colonies unknown. More research is needed to better understand dynamics between these 2 species and effects on heron breeding colonies. Determine impacts of Double-crested Cormorants
Research	Population Genetics	Low	
Monitoring	Population Change	High	Annually monitor known nesting colonies.
Monitoring	Habitat Change	High	Monitor habitat changes at colony sites especially degredation of nesting trees due to the presence of Double-crested Cormorants.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Monitor disturbance and nest site competition at colony sites.

Common Name: **Great Blue Heron**
Scientific Name: **Ardea herodias**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Protected Area Management	High	Reduce competition at nesting locations by Double-crested Cormorants	Minimize impacts of cormorants on nesting herons by limiting the number nesting cormorants at the colony site	USFWS, VTFWS, UVM, TNC	USFWS, TNC
Compatible Resource Use	Medium	Attempted predation by Bald Eagles is suspected of causing colony abandonment. Potential eagle nesting near colony sites could result in the loss of the colony	Maintain largest two colonies (Missisquoi and Porters Bay) in Vermont	USFWS,VT FWS, UVM, TNC	USFWS, SWG
Protected Area Management	High	Protect colony sites from human disturbance early in the nesting season to decrease chances of abandonment.	Increased education and awareness of individuals using the area (primarily boaters) through outreach efforts and signage.	USFWS, VTFWS, Audubon VT, TNC	USFWS, SWG
Habitat Restoration	High	Stop or reverse loss of vegetation used for nesting (trees) due to impacts of expanding Double-crested Cormorant colonies and maintain suitable nesting structure.	Maintenance of current nesting structure and identification of other suitable habitat.	UFWS, UVM, Audubon	UFWS

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Common Name: **Black-crowned Night-heron**
Scientific Name: **Nycticorax nycticorax**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S1B,S2N **State Trend:**
Extirpated in VT? **Regional SGCN?** Yes

Assessment Narrative:

Currently no documented nesting in Vermont.

Black-crowned Night-herons have been documented nesting on Lake Champlain, Vermont with the largest colony (30-50 pairs) having been on Young Island in Lake Champlain. Competition for nest sites and degradation of habitat by Double-crested Cormorants on Young Island resulted in the abandonment of that colony in the mid 1990's.

Distribution

Has nested at 2 sites along Lake Champlain with the largest being Young Island on the northern part of the lake. Nesting has not been documented in the state since the mid 1990's.

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills		**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☐

Prefers islands and wooded swamps for nesting locations. Feeds along shoreline and within marshes and swamps

Habitat Types:

Floodplain Forests

Hardwood Swamps

Marshes and Sedge Meadows

Shrub Swamps

Common Name: **Black-crowned Night-heron**
Scientific Name: **Nycticorax nycticorax**
Species Group: **Bird**

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Degradation of habitat as a result of nesting Double-crested Cormorants

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition for nest sites with Double-crested Cormorants

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine specific nesting habitat requirments
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Currently there is no documented breeding of this species in Vermont although breeding suspected. Surveys for breeding pairs and colonies should be undertaken to better assess status in Vermont
Research	Threats and Their Significance	Medium	Determine limiting factors to potential breeding locations.
Monitoring	Population Change	High	Determine presence/absence of species in the state.
Monitoring	Habitat Change	Medium	
Monitoring	Monitor Threats	Medium	If nesting sites located determine and monitor potential limiting factors.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Protected Area Management	Medium	Rapid increase in cormorant population of Young Island has displaced BCNH. Efforts to reduce cormorant numbers and restore areas of the island for BCNH nesting may result in BCNH nesting here in the future.	BCNH nesting on Young Island	VTWD, Wildlife Services	US government, USDA
Habitat Restoration	Medium	Restore nesting structure (trees and shrubs) on Young Island to enhance nesting opportunities.	BCNH nesting on Young Island	VTFW, UVM	USDA Wildlife Services, USFWS

Common Name: **Black-crowned Night-heron**
Scientific Name: **Nycticorax nycticorax**
Species Group: **Bird**

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Laughlin, S. B. and D.P. Kibbe, editors. 1985. The Atlas of Breeding Birds of Vermont. University Press of New England, Hanover, New Hampshire, USA.

Common Name: **American Black Duck**
Scientific Name: **Anas rubripes**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S5B,S5N
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Population decline is readily apparent, but likely due to a number of factors including habitat loss, hybridization with mallard, and marine pollution that affects molluscs, an important winter food source. The second Atlas of Breeding Birds of Vermont showed a 32% decrease in distribution. The Breeding Bird Survey of Vermont showed a 5.9% decrease in occurrence in the long term trend, (1966-2012) and a 5.44% decrease during the 10- year period form 2003-2012. The Atlantic Flyway Breeding Waterfowl Plot Survey showed the 2014 breeding population 11.19% below the long term average, (1993-2014). The downward slope of the long term trends for the traditional and eastern survey areas mirror the decreasing population estimates of the Atlantic Flyway Breeding Waterfowl Plot Survey.

Distribution

Widespread across Vermont. Highest occurrences are found in the Champlain Valley, the Northern and Southern Vermont piedmonts and Southern Green Mountain biophysical regions.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Uses a variety of wetland habitats along the coast, in woodlands, boreal forest, mixed conifer-hardwoods, wherever there is water nearby. Nests in dense shrub vegetation usually near water but sometimes up to a mile or more away. Preferred wintering habitat includes brackish marshes bordering bays, estuaries, and agricultural areas, but also found on inland lakes, reservoirs, and marshes wherever ice-free conditions exist.

Common Name: **American Black Duck**
Scientific Name: **Anas rubripes**
Species Group: **Bird**

Habitat Types:

Floodplain Forests

Hardwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Description of habitat threat(s):): Habitat conversion and degradation- conversion of wetlands to agriculture, and loss due to development including shoreline construction, ditching and other drainage methods; road building, alteration of wetland hydrology; invasive species such as purple loosestrife, common reed. On the wintering areas coastal erosion and filling of wetlands for development are a concern.

Description of non-habitat threat(s):

Common Name: **American Black Duck**
Scientific Name: **Anas rubripes**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	A breeding black duck survey is needed to determine where birds are breeding, by wetland or woodland type.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution and abundance of breeding black ducks are not well known in Vermont.
Research	Threats and Their Significance	High	The main limiting factor includes the loss of shrub wetlands from agriculture and residential and commercial development, including alteration and degradation of habitats over time. This duck is more susceptible to human disturbances than other duck species due to its shy nature and tendency to abandon nests when disturbed.
Research	Population Genetics	Low	This species hybridizes with the mallard but it is not believed to be a long term threat.
Research	Taxonomy	Low	
Monitoring	Population Change	High	Regional trends show a declining population in the St. Lawrence River Valley and northern New England.
Monitoring	Habitat Change	High	Wetland inventories should be updated periodically and analyzed for changes in wetland abundance by wetland type (i.e. scrub-shrub wetlands as potential black duck nesting). habitat.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Same as Habitat change.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Payments/Financial Incentives	High	Work with farmers and provide incentives for protection of wetlands from agricultural conversion.	Number of acres protected from conversion.	USFWS, USDA-NRCS, Ducks Unlimited	EQIP,NAWCA, PR, DU
Compliance & Enforcement	High	Better enforce state and federal wetland laws, including buffer zones.	Number of wetland acres and wetland buffer acres protected under state Conditional Use Determination regulatory process and federal Clean Water Act.	VT-DEC, EPA, US Army COE	EPA, PR

Common Name: **American Black Duck**
Scientific Name: **Anas rubripes**
Species Group: **Bird**

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Common Name: **Bald Eagle**
Scientific Name: **Haliaeetus leucocephalus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 | **Global Trend:**
State Rank: S1B,S2N | **State Trend:** Increasing
Extirpated in VT? No | **Regional SGCN?** No

Assessment Narrative:

State listed as endangered. Removed from the federal list of endangered and threatened species in 2007. 2014 population of 18 territorial pairs within Vermont's borders. The Vermont eagle population has seen a steady increase since the first pair nested successfully in 2008. The first Atlas in 1982 had only one record of a possible nesting; the second Atlas showed an 800% increase from the first to the second atlas (Renfrew 2013). Breeds in all adjacent states and Quebec. See: VT Bald Eagle Recovery Plan (VFWD 2010). Currently close to meeting downlisting goals of 19 pairs, 50% of which nest successfully in VT (VFWD, unpublished data).

Distribution

Breeding and wintering concentrated in the CT River and Lake Champlain watersheds. Numerous incidental sightings throughout the year on additional waterbodies throughout the state.

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Unknown
Northern Green Mtns	Unknown	Southern Green Mtns	Unknown
Northern VT Piedmont	Confident	Taconic Mtns	Unknown
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Breeding: Lakes & rivers with large trees for nesting, perching and roosting. Prefers minimal human. Disturbance (USFWS 1999, DeGraaf & Yamasaki 2001). Wintering: Large waterbodies with open water or good supply of carion (USFWS 1999).

Common Name: **Bald Eagle**
Scientific Name: **Haliaeetus leucocephalus**
Species Group: **Bird**

Habitat Types:

Floodplain Forests

Hardwood Swamps

Marshes and Sedge Meadows

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Habitat loss and human disturbance considered significant problems to breeding eagles. Roads and/or trails near nest site can be detrimental if human activity is not restricted. (Buehler 2000). Climate change has the potential to reduce food supply.

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Disease

Loss of Prey Base

Description of non-habitat threat(s): Eagles are most vulnerable to toxic substances - lead, mercury, pesticides, and other toxic chemicals (DeSorbo and Evers 2007). Also vulnerable to collisions with vehicles and power lines and possibly to disease (USFWS 1999, Buehler 2000). Potentially threatened by wind turbines (Pagel et al. 2013)

Common Name: **Bald Eagle**
Scientific Name: **Haliaeetus leucocephalus**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Follow up on reports of nesting pairs
Research	Threats and Their Significance	Medium	Monitor potential effects of climate change and wind turbines
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	High	Effects of chemical threats such as mercury not well-known in Vermont.
Monitoring	Population Change	High	Monitor population and productivity.
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Monitor potential threats of habitat loss, human disturbance,

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Protect nesting habitat of nesting pairs using predator guards, signage, and long-term protection as necessary.	Monitoring productivity at active breeding sites	VFWD, Audubon VT, VINS, MNWR	PR, SWG, private grants
Awareness Raising and Communications	Medium	Educate the public about eagle ecology and the importance of minimizing disturbance	Public presentations, informational signs, media articles are all necessary for increased public awareness.	VFWD, Audubon VT, VINS	PR, SWG, private grants
Species Restoration	High	Implement the VT Bald Eagle Recovery Plan, including breeding season monitoring, winter surveys, etc.	Monitoring population's distribution and productivity	VFWD, Audubon VT, VINS, NH Audubon, USFWS, MNWR, NY DEC	PR, SWG, private grants
Research	Medium	Send any deceased eagles for necropsies and toxic chemical testing	Determine any mortality caused by toxic chemicals – mercury, lead, etc.	VFWD, USFWS, NY DEC, Tufts Univ	USFWS

Common Name: **Bald Eagle**
Scientific Name: **Haliaeetus leucocephalus**
Species Group: **Bird**

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Common Name: **Northern Harrier**
Scientific Name: **Circus cyaneus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2B,S3S4N	**State Trend:**	Increasing
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Recent positive population trends in Atlas (Renfrew 2013) and stable BBS data for VT, NH, and NY (Sauer et al. 2011). There is a documented decline of this species in some eastern states (PA), and there may be the suggestion of a decreasing range but increasing population density in appropriate habitat (Renfrew 2013). Listed as VT Species of Special Concern, and listed as endangered in CT and NH. Recent population increases may be due to the fact that harriers can nest in wetter grasslands that cannot be mowed early in the season. Abandoned farmland in the past 20 years may have increased the number of unused wet agricultural fields. Primary threats are incompatible agricultural management, wetland destruction, development grasslands, and succession.

Distribution

Distributed in all biophysical regions of the state, but most concentrated in the Champlain Valley (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Open wetlands, marshy meadows, wet, lightly grazed pastures, old fields, marshes, upland prairies, mesic grasslands, drained marshlands, croplands, cold desert shrub-steppe, and riparian woodland. Densest populations typically associated with large tracts of undisturbed habitats dominated by thick vegetation (MacWhirter and Bildstein 1996).

Habitat Types:

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Common Name: **Northern Harrier**
Scientific Name: **Circus cyaneus**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Fragmentation

Description of habitat threat(s): Major problem is likely early mowing of hayfields. Other problems include heavy grazing rotations in pastures, especially wet pastures and wetland drainage or destruction. Additionally, hayfield abandonment (succession) and urban/suburban development are also problems (Renfrew 2013).

Non-Habitat Threats:

Trampling or Direct Impacts

Loss of Prey Base

Description of non-habitat threat(s): Early mowing can destroy nests and decreases rodent populations.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Wetlands are likely a safer nesting habitat for this species in VT. Proportion of birds nesting in wetlands versus hayfields would be helpful from a management standpoint.
Research	Basic Life History	Medium	Many studies on home range size, little on territory size. The disparity between the two (240 ha mean hr size versus 0.8 to 10 ha territory size) creates major variation in potential recommendations for habitat requirements for 500 pairs. Additionally, determining the causes of breeding failure and mortality are important.
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	Medium	Better information of timing of nesting in relation to hay harvest. Data from first breeding bird atlas suggests nestling dates are much later than necessary to fledge young prior to a Memorial Day cutting.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	Population would be relatively easy to monitor through roadside counts. Demographics would be more difficult to assess.
Monitoring	Habitat Change	Medium	It would be useful to know the proportion of grasslands lost to forest succession versus urban/suburban development.
Monitoring	Monitor Threats	High	Better information about the timing of hayfield cutting.

Common Name: **Northern Harrier**
Scientific Name: **Circus cyaneus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Education and outreach program that provides information about grassland dependent species and management options to enhance their populations in Vermont.	Number of landowners reached. Number of cooperating landowners who are maintaining grasslands by periodic late-summer mowing. Periodically assess (5yrs) grassland acreage in Vermont, through GIS analysis.	UVM, Audubon VT, VCE, NRCS.	NRCS, USDA, PR, SWG
Technical Assistance, Training, Learning Networks	High	Provide technical assistance to town and regional planning commissions to help conserve grassland habitats from development.	Number of town and regional planning commissions reached. # of cooperating landowners maintaining grasslands by periodic late-summer mowing. Periodically assess (5yrs) grassland acreage in Vermont, through GIS analyses.	UVM, NRCS.	USDA, NRCS.
Conservation Payments/Financial Incentives	High	Enroll farmers in NRCS funding programs (EQIP) for early/late or delayed mowing regimes	Number of cooperating farmers who are enrolled in EQIP. Additionally, estimates of foraging success rates of birds before and after hay harvest would help assess questions of abundance vs. availability of prey.	UVM, Audubon VT, VCE, NRCS.	NRCS, USDA.
Protected Area Management	High	Maintain nesting habitat throughout breeding season by following site specific conservation plans which include restricting mowing after July 15 on publicly owned lands (WMAs and state airports).	Maintain and increase current acreage under management on state lands	VFWD, NRCS, VTrans	VFWD
Habitat Restoration	High	Maintain grassland habitat in suitable locations through active management of woody vegetation within Grassland Bird Focus Areas.	Increase and maintain available habitat in suitable locations	VFWD, Audubon VT, NRCS, USFWS	PR

Common Name: **Northern Harrier**
Scientific Name: **Circus cyaneus**
Species Group: **Bird**

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Common Name: **Northern Goshawk**
Scientific Name: **Accipiter gentilis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3S4B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Relatively abundant and widespread, Holarctic; population trends are difficult to determine; no hard evidence of a significant decline in recent decades, but probably declining in some areas primarily as a result of habitat alteration (natureserve.org). Formerly nested principally in Canada, but expanded breeding range south into northeastern North America beginning around 1950 (Laughlin & Kibbe 1985). In Vermont regions show a declining trend (21% statewide) in populations since the first Breeding Bird Atlas in 1985 (Renfrew 2013).

Distribution

Distribution info from VT Breeding Bird Atlas (Laughlin & Kibbe 1985, Renfrew 2013). NOGOs found in all regions of the state, with 22 confirmed breeding pairs mainly in the Green Mountain region of the state, and 1 in the lower Champlain Valley. Most sightings were in areas of medium - high elevation, with all but 1 in the Champlain Valley in the hilly areas on the periphery of the region. Most regions in VT show a declining trend (21% statewide) in populations since the first atlas (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Breeding: Forest interior habitats prefers mature forests with large trees and open understories. Found in all elevations up to treeline (DeGraaf & Yamasaki 2001). Nests usually in bottom of the canopy of a large hardwood tree in the East (Laughlin & Kibbe 1985). In Minnesota, 81% of 46 goshawks nests were in aspen trees, generally located in mature (>50 years) early successional upland hardwood stands (aspen and paper birch forest types) (Boal et al. 2001). Prey is primarily small to medium birds, but will also feed on small mammals. Preferred feeding habitats are openings in forests (DeGraaf & Yamasaki 2001).

Breeding: nest site must be away from human disturbance. Occupancy of nest sites positively correlated with stand size. Nests usually in bottom of the canopy of a large tree - goshawks tend to prefer hardwoods for nest trees in the East (Laughlin & Kibbe 1985). In Minnesota, 81% of 46 goshawks nests were in aspen trees,

Common Name: **Northern Goshawk**
Scientific Name: **Accipiter gentilis**
Species Group: **Bird**

generally located in mature (>50 years) early successional upland hardwood stands (aspen and paper birch forest types). Remaining nests were in paper birch, white pine or red oak (Boal et al. 2001).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Loss of interior mature forest caused decline when Europeans settled New England. Does not nest in small forest tracks bounded by roads (DeGraaf & Yamasaki 2001).

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Highly sensitive to human presence (DeGraaf & Yamasaki 2001). Some sensitivity to pesticides/toxic checmicals.

Common Name: **Northern Goshawk**
Scientific Name: **Accipiter gentilis**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Basic Life History	Low	Estimate productivity of nesting pairs.
Research	Distribution and Abundance	Medium	Determine population status and trends in VT (locate nesting pairs).
Research	Threats and Their Significance	Medium	Need to determine significance of limiting factors to habitat in Vermont and whether active management/protection of this species is needed.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	Monitor trends in Vermont population
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	Monitor limiting factors to VT population

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Publically-Owned Protected Areas	High	Manage a portion of Vermont public lands with long rotations or as no-cut reserves.	Number of productive nests on conserved public lands.	VFWD, USFS, USFWS, USFS	SWG, PR
Habitat Restoration	Medium	Identify contiguous forests blocks w/mature components & encourage their conservation via easements or other financial incentives on private lands. Conserve contiguous forest blocks on public lands via appropriate long-range management plan designations.	Number and distribution of core forest blocks conserved on private and public lands	ANR, USFS, USFWS, VHCB, VLT, TNC	SWG, PR, VHCB

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Common Name: **Red-shouldered Hawk**
Scientific Name: **Buteo lineatus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3S4B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Declined by 37% from first atlas to second atlas (Renfrew 2013). Appears to be stable or increasing in surrounding states and Ontario, as well as North America as a whole. BBS data shows increasing trend in the East, but current populations are thought to be far below historic levels (early 1900's).

Distribution

Reported in all biophysical regions (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Mature forested wetlands near natural openings for foraging and upland forests adjacent to wetlands (DeGraaf & Yamasaki 2001). Requires riparian woodlands with tall trees for nesting. Nest sites are often in the largest deciduous trees and always near water, such as river, pond or swamp. Prey upon herptiles, crustaceans, insects, and small mammals (Laughlin & Kibbe 1985, DeGraaf & Yamasaki 2001).

Common Name: **Red-shouldered Hawk**
Scientific Name: **Buteo lineatus**
Species Group: **Bird**

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Description of habitat threat(s): Declines in early 1900s due to loss of wetland habitat (DeGraaf & Yamasaki 2001). Shown to be vulnerable to habitat conversion, including deforestation, development, and draining of wetlands (Dykstra et al. 2008).

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Description of non-habitat threat(s): RSHAs have been shown to accumulate pesticides such as PCBs (Laughlin & Kibbe 1985). May also be out-competed by more aggressive species such as Red-tailed Hawks and Great-horned Owls (Renfrew 2013).

Common Name: **Red-shouldered Hawk**
Scientific Name: **Buteo lineatus**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Determine population size and productivity in VT.
Research	Threats and Their Significance	High	Evaluate limiting factors to population in VT
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	Monitor population changes.
Monitoring	Habitat Change	High	Monitor loss of habitat
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	Medium	Develop and implement protocols to monitor and manage population so as to minimize impacts.		VFWD, Audubon VT, VCE	
Habitat Restoration	High	Identify remaining blocks of contiguous forests w/mature components & encourage their conservation via easements or other financial incentives on private lands. Conserve these blocks on public lands via appropriate long-range management plan designations	Number and distribution of core forest blocks conserved on private and public lands	ANR, USFS, USFWS, VHCB, VLT, TNC	SWG, PR, VHCB

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Common Name: **American Kestrel**
Scientific Name: **Falco sparverius**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Recent negative population trends in Atlas (Renfrew 2013) and BBS data for VT (NS) and survey-wide (Sauer et al. 2011). Listed as Species of Special Concern in 2009. Concern about population in the Northeast as a whole. Development of farmland, habitat succession, West Nile virus, and changes in farming practices are issues in the northeastern US.

Distribution

Distributed in all biophysical regions of the state, but most concentrated in the Champlain Valley and Northern Vermont Piedmont (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Minimum area requirements appear to be ~25 ha grassland. Reports of home range size are variable. "Typical" densities are 0.11 to 1.74/100 ha (assuming peripatric home ranges, 57 to 909 ha). However, greater densities have been reported of 5.4 and 27.4/100 ha (3 -18 ha home range sizes). Kestrels are cavity nesters and use woodpecker holes, farm building crevices, or human-made nest boxes (Smallwood and Bird 2002).

Habitat Types:

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Common Name: **American Kestrel**
Scientific Name: **Falco sparverius**
Species Group: **Bird**

Habitat Fragmentation

Description of habitat threat(s): Loss of grassland habitat to forest succession, conversion of agricultural areas to urban/suburban development, or changes in farming practices to eliminate hedgerows and trees for nesting (Renfrew 2013).

Non-Habitat Threats:

Trampling or Direct Impacts

Disease

Predation or Herbivory

Description of non-habitat threat(s): Automobile collisions are a concern where nest boxes have been placed on interstate highway signs (Smallwood and Bird 2002). There are also concerns with mortality from West Nile virus (Medica et al. 2007) and predation from increasing Cooper's Hawk populations (Farmer et al. 2006).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Research should focus on relative importance of grassland habitat and cavity availability. If cavity availability is limiting, species could benefit from an active nest box placement program.
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	This species is relatively conspicuous and roadside counts could provide an excellent index of statewide population trends.
Research	Threats and Their Significance	High	Species is a useful model for environmental contaminants and climate change. May be a useful indicator species as they feed on herbivorous insects in agricultural habitats.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	
Monitoring	Population Change	High	Nest monitoring in MA cranberry bogs shows 4 consecutive years of population declines. Peterson (2003) suggests the species is "quietly slipping away in New England."
Monitoring	Habitat Change	High	It would be helpful to know whether development or forest succession is more important to habitat loss.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	

Common Name: **American Kestrel**
Scientific Name: **Falco sparverius**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Payments/Financial Incentives	High	Conserve grassland/shrubland habitats on private lands.	Number and total area of sites conserved.	USDA, NRCS, USFWS, VHCB	EQIP, SWG, PR, VHCB
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and general public about grassland birds and management options to protect habitat	Enroll landowners into USDA habitat incentive programs	VFWD, Audubon VT, NRCS, UVM	PR, SWG, private funding sources
Habitat Restoration	High	Maintain grassland habitat in suitable locations through active management of woody vegetation within Grassland Bird Focus Areas.	Increase and maintain available habitat in suitable locations	VFWD, Audubon VT, NRCS, USFWS	USFWS, NRCS
Technical Assistance, Training, Learning Networks	Medium	Develop a nest box program for interested landowners.	Nest box occupancy rates as reported by landowners.	Audubon VT, VFWD	EQIP

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Common Name: **Peregrine Falcon**
Scientific Name: **Falco peregrinus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4 **Global Trend:**
State Rank: S2B,S2N **State Trend:** Stable
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Officially designated as Endangered in VT in 1972, statewide population has steadily recovered and surpassed recovery goals.
See: VT Peregrine Falcon Recovery Plan (Fowle et al. 2001) and Post-delisting Monitoring and Management Plan. Removed from VT Endangered Species List in 2005. Increases due in large part to concerted monitoring and management efforts; population continues to require monitoring and site protection to ensure successful nesting (Renfrew 2013).

Distribution

Breeding well distributed throughout the state. Nest sites known in all biophysical regions except the Vermont Valley.

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Unknown
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Open areas for hunting, adequate food supply and steep rocky cliffs for nesting (Ratcliffe, 1993). Cliffs must be high enough (at least 30 m) to protect from terrestrial predators, have adequate horizontal nesting ledges (loose substrate for nest, protection from weather and predators), and have adequate perches and good views of the surrounding area for territorial defense and hunting (Hickey 1942, Ratcliffe 1993). Human disturbance on or above the nesting cliff must be minimal and limited to more than 1/4 mile from the nest site, but activity such as a road below the nesting cliff will not negatively affect the nesting birds (USFWS 1991, Ratcliffe 1993).

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Species Conservation Report

Common Name: **Peregrine Falcon**
Scientific Name: **Falco peregrinus**
Species Group: **Bird**

Habitat Types:

Upland Shores

Cliffs and Talus

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Description of habitat threat(s):): Inappropriate development, poorly planned forest management and habitat changes on or near a cliff during the breeding season may disturb nesting peregrines and cause them to abandon their nest site. Any development on or near a cliff may be enough to cause a pair to abandon that nest site (USFWS 1991, Fowle et al. 2001).

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Pesticides and other toxic chemicals have shown negative effects in the past, and some of these chemicals persist today (Fowle et al. 2001, USFWS, unpublished data). Fire retardant chemicals have been found in elevated levels in Vermont and northeastern peregrine populations (Eriksson et al. 2004, Da Chen et al. 2008). Human disturbance on or near nesting cliffs is the greatest known problem to peregrines nesting in VT. Predation of young on the nest site has been an occasional problem in the past, as has adverse weather (Fowle et al. 2001, Ratcliffe 1993).

Common Name: **Peregrine Falcon**
Scientific Name: **Falco peregrinus**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	
Research	Threats and Their Significance	Medium	Potential effects of toxic chemicals and ridgeline wind development
Research	Population Genetics	Low	
Monitoring	Population Change	High	Monitor breeding population and productivity annually
Monitoring	Habitat Change	Medium	Protect breeding habitat from human disturbance and development
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	Monitor human disturbance effects and protect nesting cliffs from disturbance. Where possible, monitor other potential threats on productivity such as predation and adverse weather

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Monitor site occupancy and productivity, as well as monitor threats	Continue to evaluate the health of the breeding population annually	VFWD, Audubon VT, VINS, landowners, volunteers	PR, SWG, Private grants
Compatible Resource Use	High	Reduce/minimize human disturbance at nesting cliffs through access closures during the breeding season.		VFWD, Audubon VT, CRAG-VT	PR, SWG, Private grants
Awareness Raising and Communications	High	Continue concerted public education effort targeting climbers and recreational hikers to inform public of cliff closures. Continue volunteer-based monitoring efforts.	Public presentations, informational signs at climbing and hiking areas, and media articles and posts are all critical to maintaining public awareness.	VFWD, Audubon VT, CRAG-VT	PR, SWG, private grants

Common Name: **Peregrine Falcon**
Scientific Name: **Falco peregrinus**
Species Group: **Bird**

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Common Name: **Spruce Grouse**
Scientific Name: **Falcipennis canadensis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S1B	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

The Spruce Grouse is a state listed endangered species. The species is not listed in the Breeding Bird Survey data likely due to its interior forest nature and limited vocalizations render it difficult to detect. Draft Recovery Plan for Vermont. Spruce grouse inhabit the boreal forests of North America. Although considered common in Canada and in a few northern states, in Vermont the species is near the southern edge of its range. Historical accounts indicate the species was present in the northeastern counties of Orleans and Essex (Thompson 1853, Cutting 1884). Currently, breeding spruce grouse are restricted to a 62 km2 (25 mi2) area of spruce-fir forest in northern Essex County (Royar and Alexander 1987). This breeding habitat is principally owned by the U.S. Fish and Wildlife Service (Nulhegan Division of the Silvio Conte Refuge) and the State of Vermont, Department of Fish and Wildlife (Wenlock Wildlife Management Area).

It is estimated that between 150 and 300 adult birds occur in this population, and periodic surveys since 1990 indicate a stable population. Although the future of this population would seem secure given the interest of the two public owners in conserving wildlife (assuming that vegetation management will continue to maintain and improve habitat and that disturbance from the potential increase in recreationists to this area can be controlled) a stochastic event such as a widespread fire or disease outbreak could prove disastrous.

Full recovery of Vermont spruce grouse, outlined in its recovery plan, will require the establishment of 2 additional sub-populations, most likely on the State Lands located in the southern Essex County towns of Victory and Granby, and in the northern Essex County town of Norton. During 2008 and 2009 a total of 136 spruce grouse (males, females, and chicks) from Maine and Quebec were translocated to the Victory Basin Wildlife Management Area. This was an effort to establish a second viable population as per goals of the recovery plan. Subsequent surveys from 2009 through 2014 indicate the translocated birds are not successfully reproducing and declining in number due to inherent mortality factors.

Distribution

Spruce grouse inhabit the boreal forests of North America and are considered common in much of Canada. PIF reports a continental estimate of 11,000,000 birds. In Vermont, Maine, and New Hampshire the species is at the southern edge of its range. Historical accounts indicate the species was present in the northeastern Vermont counties of Orleans and Essex (Thompson 1853, Cutting 1884). Currently, breeding spruce grouse are restricted to a 62 km2 (25 mi2) area of spruce-fir forest in northern Essex County (Royar and Alexander 1987). This breeding habitat is principally owned by the U.S. Fish and Wildlife Service (Nulhegan Division of the Silvio Conte Refuge) and the State of Vermont, Department of Fish and Wildlife (Wenlock Wildlife Management Area).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable

Common Name: **Spruce Grouse**
Scientific Name: **Falcipennis canadensis**
Species Group: **Bird**

Northeastern Highlands Confident

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

The spruce grouse is a bird of the boreal forest. Highest grouse densities (40-80 adults in summer/100 ha) are found in young dense jack pine (Pinus banksiana) stands, where live branches occur from 4-8 meters (13-26 ft.) above ground (Szuba and Bendell 1983; Keppie 1995). Jack pine forests do not occur in Vermont, however, spruce-fir forests of similar structure provide suitable habitat throughout much of the species range. Keppie (1987) documented breeding densities of 9.8 - 21.9 adults/100 ha (0.25-0.55/ac) in a New Brunswick spruce-fir pine forest. Spruce (Picea spp.) is preferred over fir (Abies balsamea) because it develops and maintains better vertical stratification. A shrub layer of Vaccinium spp. or regenerating spruce-fir in low densities enhances habitat for spruce grouse (Robinson 1969). Larch (Larix laricina) in the overstory may provide a preferred fall food resource. Forest openings are important to female spruce grouse and their broods, as they provide greater abundance of accessible food resources for chicks than the dense forest (Allan 1985).

Habitat Types:

Spruce Fir Northern Hardwood

Softwood Swamps

Open Peatlands

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Two main causes of historic spruce grouse decline are habitat loss and human encroachment. As colonial settlements expanded from southern Vermont into northeastern Vermont forests, spruce fir forests were cleared and the relatively tame spruce grouse was undoubtedly taken for human consumption whenever the opportunity arose. As industrial timber companies were formed, vast areas of virgin spruce fir forest were cut, and 19th century loggers may have taken spruce grouse to supplement their daily fare. By 1980 spruce grouse apparently remained only in the Nulhegan Basin, which at the time was experiencing heavy cutting of its mostly mature forests.

With the dawn of the new millennium, much of Essex County forests are publicly owned or subject to conservation easements held by the State and/or private conservation organizations. As a result, Conservation and sustained forestry goals across much of Essex County forestland will likely maintain if not increase available spruce grouse habitat. Increasing human development, however, will no doubt continue to encroach on some peripheral habitats, and the forecast increases in outdoor recreationists to Essex County could disrupt breeding activities and/or increase susceptibility to predation or adverse weather conditions (especially if pets accompany their owners on excursions through grouse habitats)

Non-Habitat Threats:

Harvest or Collection

Predation or Herbivory

Description of non-habitat threat(s): Predation is likely the most common cause of spruce grouse mortality (Boag and Schroeder 1992) although no predator seems to depend on spruce grouse as a large part of its diet (Robinson 1980). A major predator of spruce grouse eggs is the red squirrel (Tamiasciurus hudsonicus) (Boag et al 1984, Naylor and Bendell 1987). Other potential predators in Vermont are the northern goshawk (Accipiter gentilis), barred owl (Strix varia), northern raven (Corvus corax), red fox (Vulpes vulpes), coyote (Canis latrans) , bobcat (Lynx rufus), black bear (Ursus americanus), striped skunk (Mephitis mephitis), fisher (Martes americana) and ermine (Mustela erminea). On Mount Desert Island, 7 of 19 radio transmitter-carrying adult females (37%) were predated between April and late August (Whitcomb et.al.1996). Predators identified were a Red-tailed Hawk (Buteo jamaicensis), red fox and an unidentified raptor. A study in Ontario of 67 spruce grouse nests found 55% were depredated by red squirrels, red fox, black bear and striped skunk (D'Eon 1997).

Another potential problem, especially in small patches that might hold dispersing grouse, is accidental shootings by ruffed grouse hunters. A limited number of accidental shootings were documented during the 1980's in Ferdinand and Norton. The continuation of educational efforts aimed at grouse hunters in Essex County should help prevent this source of mortality from actually limiting the population.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Vermont's triennial census within the Nulhegan Basin should be continued, and reported sighting from elsewhere during the breeding season should be investigated
Research	Threats and Their Significance	Low	
Research	Population Genetics	Low	Genetic comparisons between Vermont birds and potential sources for reintroduction should occur.
Monitoring	Population Change	Medium	Vermont's trienniel census within the Nulhegan Basin should be continued, and reported sighting from elsewhere during the breeding season should be investigated
Monitoring	Habitat Change	Medium	Extent of spruce-fir forests in Northeastern Vermont should be peridocally assessed (eg USFS Forest Survey).
Monitoring	Monitor Threats	Low	

Common Name: **Spruce Grouse**
Scientific Name: **Falcipennis canadensis**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Implement the habitat management guidelines as detailed in VFWD's Spruce Grouse Recovery Plan.	Number of public land management plans which incorporate Spruce Grouse habitat management.	VFWD, USFWS	SWG, PR
Species Restoration	High	Establish a 2nd sub-population in Victory Basin to reduce likelihood of serious impact to the overall population. Enhance genetic exchange with NH s grouse with establishment of another population within dispersal distance of the Connecticut River.	Number of sub-populations established and maintained.	ANR	SWG
Awareness Raising and Communications	Medium	Continue with educational campaign to reduce accidental harvest by ruffed grouse hunters.	Number of accidentally-shot spruce grouse	VFWD, USFWS	SWG, PR

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Common Name: **Ruffed Grouse**
Scientific Name: **Bonasa umbellus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S5B	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

While no trend data is collected in Vermont, habitat declines and trends reported from other states (MA drumming survey, NH regional biologist information, ME hunter reports) indicate a general decline in ruffed grouse populations across New England. the potential exists for some of these declines to be related to ruffed grouse "cycles", these cycles have been shown to be less prevalent in the NE than in midwest and northern/subarctic regions.

Early successional habitat components required by ruffed grouse are declining on both a statewide and regional basis. Losses of acceptable habitat continue due to conversion to non-forest use. On areas which remain forested, stand maturation due to reductions in active forest management have substantially reduced habitat quality and grouse population density has decreased significantly. Conservation efforts should focus on implementing a comprehensive program of habitat improvements on both public land and private land.

Distribution

Distributed statewide where acceptable habitat components are present.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Prefers mosaic of young and mid-aged hardwood and hardwood/conifer forests. Typically utilizes maturing forest habitats for nesting, sapling/pole stage hardwood forest habitats for breeding, and very young hardwood forest regeneration habitats for brood rearing. While species can utilize and survive within edge and other suboptimal habitats, larger patch sizes of required habitat components adjacent to one another usually result in greater productivity and survival.

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Common Name: **Ruffed Grouse**
Scientific Name: **Bonasa umbellus**
Species Group: **Bird**

Habitat Types:

Upland Shores

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Inadequate Disturbance Regime

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): - permanent loss of forest habitat to non-forest uses; - regional forest maturation resulting in suboptimal brood survival due to lack of protective cover and resulting increased predation; - fragmentation of dense regeneration habitats by mature forest resulting in substantially declining species productivity and significant mortality in localized, and sometimes large areas. Coupled with habitat loss to conversion of non-forest habitats, some ruffed grouse sub-populations have been extirpated in areas of former population abundance.

Non-Habitat Threats:

Parasites

Common Name: **Ruffed Grouse**
Scientific Name: **Bonasa umbellus**
Species Group: **Bird**

Predation or Herbivory

Description of non-habitat threat(s): Herbivory by white-tailed deer can substantially limit necessary brood habitats in areas of high deer abundance, although this is essentially a manifestation of an early-succession habitat volume-related problem.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Information on optimal habitat component patch size in various landscapes and forest cover types would be helpful.
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	Institute a ruffed grouse drumming survey and small-game hunter survey to establish ruffed grouse breeding population trends and harvest levels.
Research	Threats and Their Significance	Medium	Information on mortality due to parasites or nest predation in northern hardwood forest would be helpful.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	Little monitoring has been done on either productivity or mortality. This has compromised efforts to adequately measure changes due to habitat loss and respond to these population changes with corrective actions.
Monitoring	Habitat Change	High	See above.

Common Name: **Ruffed Grouse**
Scientific Name: **Bonasa umbellus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Reverse VT ruffed grouse population trend delcine to support an annual average hunting harvest of 150,000 birds over 10 years through improvement of grouse breeding and rearing habitat Use CSWA habitat target of 82,000ha (Rosenberg 2004).	Population response to management, BBS surveys.	Ruffed Grouse Society, FWD	PR, EQIP
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.		
Habitat Restoration	Medium	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, VT Loggers	PR, EQIP
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative. Fund for > $50,000/yr with revenues from state lands forest management.	Level of funds raised.	FWD	ANR, PR

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Common Name: **Sora**
Scientific Name: **Porzana carolina**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2S3B,S3N
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Currently listed as a species of special concern in Vermont. Known as a breeder in the state but distribution and abundance unknown. Although uncommon in the state, the species increased by 50% between the first and second breeding bird atlas, perhaps as a result of more concerted use of playbacks.

Distribution

In the second Vermont Breeding Bird Atlas, 60% of records were from the Champlain Valley, with the remainder scattered across the state, generally at lower elevations.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Unknown
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Found primarily in seasonal or semi-permanent freshwater wetlands with shallow and intermediate water depths (~0.33 m), dominated by emergent vegetation, especially cattails (Typha spp.), sedges (Carex spp., Cyperus spp.), burreeds (Sparganium spp.) and bulrushes (Scirpus spp.; Melvin and Gibbs 2012). Some suggestion that the species is area sensitive, but data are inconclusive.

Habitat Types:

Marshes and Sedge Meadows

Current Threats

Habitat Threats:

Conversion of Habitat

Invasion by Exotic Species

Climate Change

Common Name: **Sora**
Scientific Name: **Porzana carolina**
Species Group: **Bird**

Description of habitat threat(s): Habitat Threats: Loss of wetlands will continue to limit the species. Invasion of wetlands by loosestrife and phragmites will degrade habitat quality. Greater frequency of storm events could lead to variation in water levels in wetlands, particularly along Lake Champlain, leading to decreased nesting success.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Agricultural and urban runoff could reduce water quality and prey populations.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Determine habitat requirements specific to Vermont
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Information about the distribution of Sora in VT is lacking. A state-wide (perhaps one-time) survey of all potential wetlands would also yield valuable information for other wetland-dependent species (VIRA, COGA, PBGR, AMBI, LEBI, BLTE). Marshbird monitoring programs are limited in their spatial extent in VT. An extensive initial survey would provide baseline data for a long-term monitoring program that would lay the foundation for a more representative marshbird monitoring program.
Research	Threats and Their Significance	Medium	Determine potential limiting factors
Monitoring	Population Change	High	Improving the standardization and spatial extent of marsh monitoring programs for wetland birds would greatly help our understanding of the species' distribution and population status.
Monitoring	Habitat Change	Medium	1) Most wetlands on which Sora are found are protected, but more information about wetland loss and degradation would be useful as loss of wetlands will continue to limit Sora. 2) Monitor habitat changes at known nesting locations
Monitoring	Monitor Threats	Low	

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Common Name: **Lesser Yellowlegs**
Scientific Name: **Tringa flavipes**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S4S5N **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** No

Assessment Narrative:

There is limited information on the population size of Lesser Yellowlegs. The best estimate is 400,000 birds worldwide. The species has been experiencing long-term (> 30 year) population declines (Andres et al. 2012). Impacts to breeding areas (Canadian tundra, muskeg) include commercial development, extraction of earth resources, and oil and gas development. Wetlands along migration routes in VT may be jeopardized by development also. Pollutants and un-regulated hunting may be concerns on wintering grounds (S. America)

Distribution

Found in all biophysical regions of Vermont

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Nests in open forest and forest-tundra transitional habitat, the vast majority of which (over 90%) occurs in the boreal forest of Alaska and Canada. Typical nesting habitat is open to semi-open forest mixed with marshes, bogs, sedge meadows, and ponds (Clay et al. 2012), using shallow wetlands and muskeg areas with abundant aquatic invertebrates. Migratory habitats include lake shores, river banks, and wetlands near agricultural area and early successional forests and shrub patches.

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Common Name: **Lesser Yellowlegs**
Scientific Name: **Tringa flavipes**
Species Group: **Bird**

Habitat Types:

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Description of habitat threat(s): Conversion of wetlands to agriculture and residential development along shorelines, oil and gas development, logging, and mining activities. As a boreal forest-breeding species it is susceptible to climate change as higher temperatures may lead to drought and habitat changes.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Agrochemicals are used throughout the species' migration corridors and nonbreeding grounds, the effects of which are unknown. Hunting pressure has presumably declined, but unregulated hunting during fall migration is a concern in the Caribbean and the Guianas.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Water level management to attract shorebirds. Timing and duration of drawdowns is critical to providing stopover areas along migration routes in VT..
Research	Distribution and Abundance	Medium	More shorebird surveys are needed around Lake Champlain and during drawdowns at state wildlife management areas.

Common Name: **Lesser Yellowlegs**
Scientific Name: **Tringa flavipes**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	Medium	Protect shorelines through ACT 250 and other regulatory processes.	Number of shoreline acres or feet impacted by development.	Audubon-VT, VT-DEC, USFWS	EPA, Nongame fund, Partners for Fish and Wildlife, EQIP
Awareness Raising and Communications	Medium	Continue to provide training to waterfowl hunters to minimize inadvertent take.	Number of trainings and training materials offered	VFWD, DU	PR, SWG

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Common Name: **Upland Sandpiper**
Scientific Name: **Bartramia longicauda**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S2S3B,S3N
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Breeding population possibly extirpated in Vermont, no confirmed breeding records in at least 5 years. Currently listed as endangered in Vermont.
Upland Sandpiper numbers have dropped sharply in Vermont since the early 1990's, with population losses from 1966-2003 estimated at -9.6 per year (Sauer et al. 2014), and the breeding has population has disappeared from the state since the first SWAP. The small numbers reported during the second Breeding Bird Atlas (2003-2007) in the Champlain Valley and at the Berlin airport are no longer present. Habitat loss due to direct loss and agricultural intensification possible causes, as well as range contraction in the northeastern US. Broadcast methods designed to encourage establishment of a breeding population have been unsuccessful.

Distribution

In recent years, only 1-2 individuals reported during breeding season, from same location in northern Franklin County.

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Unknown
Champlain Hills	Probable	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

A migrant that winters in South America, Upland Sandpiper prefers large grassland areas (50-100 acres) with a mosaic of grassland vegetation structures (short, medium, and taller grasses for foraging, nesting, and brood rearing, primarily pastures and hayfields in Vermont. Will use airports with suitable mowing regime.

Habitat Types:

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Other Cultural

Common Name: **Upland Sandpiper**
Scientific Name: **Bartramia longicauda**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Loss of habitat due to development and succession of abandoned farmland, fragmentation of large agricultural grasslands, and agricultural intensification (conversion to row crops, early haying regimes).

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Destruction of nest site from mowing.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Monitoring	Population Change	Medium	Track, verify, and monitor any observations recorded during breeding period. Note habitat structure and landscape characteristics at any site where there is evidence of breeding.

Species Strategies

Strategy Type	*Strategy Priority*	*Strategy Description*	*Performance Measure*	*Potential Partners*	*Potential Funding Sources*
Compatible Resource Use	High	Implement Vermont grassland bird management and recovery plan (LaBarr et al. 2013)			
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and general public about grassland birds and management options to protect habitat	Continue grassland bird outreach programs and initiation of landowner information-sharing network	VFWD, Audubon-VT, VCE, UVM	PR, SWG
Habitat Restoration	High	Maintain grassland habitat in focal areas through active management of woody vegetation.	Increase and maintain available habitat in focal habitat	VFWD, Audubon-VT, NRCS	SWG, EQIP
Conservation Payments/Financial Incentives	High	Protect potential breeding habitat in grassland bird focal areas (see LaBarr et al. 2013, Vermont Grassland Bird Management Plan) by focusing EQIP payments on provate lands in thee areas.	Protection of acreage through enrollment in EQIP	VFWD, Audubon-VT, NRCS	EQIP

Common Name: **Upland Sandpiper**
Scientific Name: **Bartramia longicauda**
Species Group: **Bird**

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Common Name: **American Woodcock**
Scientific Name: **Scolopax minor**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

PIF Tier IIA -- high regional concern. Annual singing-ground survey trends for the Eastern Region and Vermont for the period 1968-2004 = -2.1 (P<0.01) and -1.1%, respectively (Kelly 2004). Range wide declines in American woodcock have been tied to similar declines in habitat area and quality, and losses of these habitats appears to be accelerating. Existing, moist-soil early-successional hardwood habitat (especially alder and aspen-dominated sites), and open field components required by woodcock should be identified on both public and some conserved private land, and these habitats should be actively managed to prevent further losses or qualitative declines. Additional work should focus on identifying areas where active habitat management would re-establish quality regeneration and open field habitat components across all biophysical regions.

Distribution

American woodcock are present statewide where acceptable habitat exists. During migration, woodcock numbers increase and birds can often be found less optimal habitat. While distributed across all Vermont biophysical regions, the relative scarcity of critical habitat components w/in these polygons makes this distribution map somewhat a misleading gauge of habitat security.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Prefers young hardwood, hardwood/conifer and alder forests proximate to open-field habitats in moist soil areas. Typically utilizes dense alder or aspen regeneration forest habitats for nesting, brood rearing and adult feeding, open field or forest openings > 1 ac. for breeding and roosting. While species can utilize and survive within moist soil forest edge and other suboptimal habitats, larger patch sizes of required habitat components adjacent to one another usually result in greater productivity and survival.

Common Name: **American Woodcock**
Scientific Name: **Scolopax minor**
Species Group: **Bird**

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Seeps and Pools

Open Peatlands

Wet Shores

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): Losses of moist-soil regeneration/successional habitats has been implicated in 30-yr population decline in both eastern and central flyways. Additional concerns regardingconversion to agriculture and non-forest cover of overwintering habitat in southern U.S. Fragmentation of both field habitats by reforestation and feeding/brood cover by succession has likely increased brood mortality during post-hatch brood movements to adequate rearing habitat.

Non-Habitat Threats:

Pollution

Predation or Herbivory

Description of non-habitat threat(s): Some anecdotal and emerging scientific data concerns regarding soil contaminants (primarily heavy metals) inducing adult mortality and compromising

Common Name: **American Woodcock**
Scientific Name: **Scolopax minor**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Habitat/breeding success interrelationship information would help to formulate range-wide recovery strategies.
Research	Basic Life History	Medium	AOU recommends studies to investigate large-scale population dymamics as related to habitat.
Research	Distribution and Abundance	Low	AOU recommends studies to investigate potential range expansions, however these likely would not be warranted in Vermont or established , central portions of range.
Research	Threats and Their Significance	Medium	As related to Habitat requirements, IAFWA has conducted work on habitat v. hunting mortality. Additional work could expand on this type of comparative mortality assessment, including such elements as soil contamination, losses by domestic predators and potential breeding losses due to various statutory restrictions on vegetation management in riparian and other "buffer" areas.
Monitoring	Population Change	High	Ongoing singing ground surveys should be enhanced and updated to consider historic habitat changes and other factors such as degree of development, etc.
Monitoring	Habitat Change	High	Habitat losses have largely been "tracked" by USFS Forest statistics in terms of age class/cover type composition. A more focused approach to estimation of historic, current and projected "woodcock habitat" across the region is certainly warranted.
Monitoring	Range Shifts	Medium	See above research needs re: distribution.

Common Name: **American Woodcock**
Scientific Name: **Scolopax minor**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Reverse declining woodcock breeding populations to BPOP of 3.0-3.2 males/singing ground route. Maintain population w/ breeding habitat enhancement and creation/maintenance of suitable migration/feeding habitat.Use CSWA habitat target (Rosenberg 2004)	Population response to management, BBS surveys.	Ruffed Grouse Society, FWD	PR, EQIP
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.		
Habitat Restoration	Medium	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, VT Loggers	PR, EQIP
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative (modeled on NH's Small Landowner Grant program). Fund for > $50,000/yr with revenues from state lands forest management. This could offset landowner EQIP obligations.	Level of funds raised.	FWD	EQIP
Species Restoration	Medium	Continue and increase efforts at singing ground survey participation and observer recruitment.			
Habitat Restoration	Medium	Increase the size and number of well distributed roosting/display field habitats in proximity to feeding and brood habitat on public land.	Number and distribution of roosting/display fields		

Common Name: **American Woodcock**
Scientific Name: **Scolopax minor**
Species Group: **Bird**

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Common Name: **Common Tern**
Scientific Name: **Sterna hirundo**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
Global Trend:
State Rank: S1S2B,S2N
State Trend: Stable
Extirpated in VT? No
Regional SGCN? Yes

Assessment Narrative:

VT state endangered since 1988. Common Tern populations in Vermont declined during the 1970's and 80's from about 300-400 breeding pairs to approx. 50 breeding pairs in 1988. Since then numbers have increased steadily due to monitoring and management efforts and protection of nesting islands. Breeding numbers have recently exceeded the levels recommended for down-listing to Threatened in Vermont but continuing low productivity has prevented down-listing. Monitoring and management efforts will need to continue to avoid a population decline in the future.

Distribution

Nests only on 4-5 small rocky islands (<0.5 ha) in the NE arm of Lake Champlain. Has not been documented nesting elsewhere in VT. Popasquash and Rock island primary nesting sites. Both are small islands in the NE arm of Lake Champlain. Has nested in the past on 3 other island. A social attraction (decoys and sound) project in 2006-2008 was successful in bringing terns to Grammas Island but heavy owl predation at this site resulted in the discontinuation of this work. Can be observed throughout the northern part of the lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☐

Nests on isolated islands, beaches, dredge spoils and human made structures in areas with little to no vegetation.

Habitat Types:

Aquatic: Lake Champlain

Common Name: **Common Tern**
Scientific Name: **Sterna hirundo**
Species Group: **Bird**

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Traditional nesting islands are currently protected for this species. No direct habitat problems documented although habitat degradation due to nesting and roosting Double-crested Cormorants possible. Current management actions have limited cormorant related degradation in recent years.

Non-Habitat Threats:

Trampling or Direct Impacts

Competition

Predation or Herbivory

Description of non-habitat threat(s): Predation by avian predators and ants, competition for nesting sites with Ring-billed gulls and human disturbance are primary problems to this species.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Well documented.
Research	Basic Life History	Low	Well documented.
Research	Distribution and Abundance	Low	Well documented.
Research	Threats and Their Significance	Low	Well documented.
Research	Population Genetics	Low	Well documented.
Monitoring	Population Change	High	Annual monitoring needed to determine population size and reproductive success.
Monitoring	Habitat Change	Medium	Annual monitoring of impacts of Ring-billed Gull and Double-crested Cormorants and impacts on island vegetation.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	Annual monitoring required to determine impacts of predation, nest-site competition, and human disturbance on breeding population

Common Name: **Common Tern**
Scientific Name: **Sterna hirundo**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Protected Area Management	High	Provide adequate nesting space by managing gull and cormorant populations as competition for nesting space on tern nesting islands by Ring-billed Gulls and Double-crested Cormorants may result in limited nesting space for terns	breeding success, number of nests per island.	VFWD, Audubon-VT	PR, private grants
Protected Area Management	High	Limit predation by owls, night herons and ants at nesting islands through active management (fencing, trapping owls, eradicating ants).	Sustained increase in reproductive success to 1 fledgling/pair	VFWD, Audubon-VT	PR, private grants
Species Restoration	High	Continue to prevent Double-crested Cormorants from nesting as nesting islands could be negatively impacted by Double-crested Cormorants resulting in alteration of current vegetative cover	Number of islands free of double-crested cormorants.	VFWD, Audubon-VT, Lake Champlain Land Trust	PR, private grants
Protected Area Management	High	Continue to restrict access to tern nesting islands during the breeding season.	No documented nest failure due to human disturbance	VFWD, Audubon-VT, VT State Police	PR, private grants

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Black Tern**
Scientific Name: **Chlidonias niger**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S2B,S2N
Extirpated in VT?

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

Listed as Endangered in Vermont. Black Tern populations have remained low and fluctuated during the past decade with a high count of 157 breeding pairs in both 2010 and 2015 and a low of 65 pairs in 2007. Totals for 2014 were 95 breeding pairs but this was considered an underestimate (J. Sefchick-Edwards, pers. com.). These numbers represent an overall increase from estimates between 1990 and 2005 (44-103 pairs). Missisquoi National Wildlife Refuge remains the only nesting location for Black Tern in Vermont. They are, however, found in 6 separate locations within the 6000+ acre refuge.

Distribution

Black Terns are currently only found at one location, Missisquoi National Wildlife Refuge on northern Lake Champlain. Nesting occurred regularly in Lake Memphremagog South Bay throughout the 1990's.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Probable	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Nests in wetlands consisting of both emergent (cattails) and shrub (buttonbush) vegetation with adequate floating vegetation to build nests on.

Habitat Types:

Marshes and Sedge Meadows

Shrub Swamps

Current Threats

Habitat Threats:

Invasion by Exotic Species

Common Name: **Black Tern**
Scientific Name: **Chlidonias niger**
Species Group: **Bird**

Description of habitat threat(s): Sufficient habitat seems available both at its known nesting site (MNWR) and at sites it has nested at in the past. High water levels on Lake Champlain seem to influence nesting numbers at MNWR by limiting available nesting habitat. A water chestnut infestation at MNWR is being actively controlled. It could limit nesting and feeding habitat without control.

Non-Habitat Threats:

Unknown Non-Habitat Threats

Trampling or Direct Impacts

Description of non-habitat threat(s): Direct problems to this species have been difficult to determine, however Vermont is on the periphery of this species range and declines in the core of its range may be causing peripheral populations to decline at a faster rate. Human disturbance is suspected as at the Missisquoi National Wildlife Refuge Black Terns have only nested in areas closed to public use.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine if changes in habitat structure at nesting locations has resulted in abandonment of sites used in the past.. Evaluate the significance of Vermont's habitat for migration/staging.
Research	Basic Life History	Low	Well documented
Research	Distribution and Abundance	Medium	Annually monitor current and past nesting locations
Research	Threats and Their Significance	High	Increased understanding of limiting factors to this species in Vermont
Research	Population Genetics	Medium	Relationship to core population
Research	Taxonomy	Low	
Research	Other Research	Low	
Monitoring	Population Change	High	Annually monitor breeding population at current and past nesting locations.
Monitoring	Habitat Change	Medium	Monitor changes in habitat structure, especially those due to invasive species.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	Annually monitor known limiting factors
Monitoring	Other Monitoring Needs	Medium	Continue to manage protected wetlands to provide suitable habitat. Determine appropriate management actions (e.g. vegetation management, artificial nesting structures) that will enhance breeding success.

Common Name: **Black Tern**
Scientific Name: **Chlidonias niger**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Determine appropriate management strategies which will increase population size and the number of breeding locations.	Increase in population size and number of colony sites at different geographic locations.	USFWS, VFWD, Audubon-VT	SWG, PR

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Shambaugh, Nathanial. 2003. 2003 Black Tern Population Survey and Other Marshbird Monitoring Activities in Vermont. Unpubl. report. VT Fish and Wildlife Department, Waterbury. Vermont

Common Name: **Black-billed Cuckoo**
Scientific Name: **Coccyzus erythropthalmus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Bird Conservation Regions 13 & 14 High Regional Concern. Not on Audubon/ABC's Watch Lists. BBS shows a significant long-term (1966-2013) annual decline for Vermont (-4.62 %). Shorter-term (2003-2013) decline is higher (-6.28%), but not judged significant.

Distribution

Distributed statewide, although less common in northeastern quarter of the state. The Second Atlas of Breeding Birds of Vermont (Renfrew 2013) results show biggest losses from southern Green Mountains.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Brushy pastures, shrubby hedgerows at edges of fields, dry, open woods and groves (DeGraaf and Rudis 1986). Prefers groves of trees, forest edges, and thickets; frequently associated with water. In NE. U.S.; usually found in edges and clearings of young deciduous-coniferous woods; abandoned farmland...brushy hillsides and pastures hawthorn thickets " (Hughes 2001).

Common Name: **Black-billed Cuckoo**
Scientific Name: **Coccyzus erythropthalmus**
Species Group: **Bird**

Habitat Types:

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Fragmentation

Description of habitat threat(s): "Declines in some regions could be due in part to reversion of abandoned farmland to forests that are unsuitable (Erskine 1992). Other problems responsible for declines could be modification of habitat on wintering grounds, hazards during migration, and pesticide use." (Hughes 2001).

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Black-billed cuckoos may be highly vulnerable to pesticides used on insect outbreaks, perhaps especially on winter range in South America.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	The nature of breeding range habitat changes relatively well understood, however the magnitude of these changes should be documented.
Research	Distribution and Abundance	Medium	Continued monitoring of changes in distribution and abundance should be tied to tracking changes in habitat (succession of abandoned farmland).
Monitoring	Population Change	Medium	Continued monitoring of changes in distribution and abundance should be tied to tracking changes in habitat (succession of abandoned farmland).
Monitoring	Habitat Change	Medium	The nature of breeding range habitat changes relatively well understood, however the magnitude of these changes should be documented.

Common Name: **Black-billed Cuckoo**
Scientific Name: **Coccyzus erythropthalmus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	Medium	Better control use of pesticides harming this species and its food sources.	Number of regulations restricting use of harmful pesticides. Reduction in contaminates present in cuckoo habitat.	ANR, Vt. Dept of Agriculture, USDA	USDA, FDA
Conservation Payments/Financial Incentives	Medium	Conservation of hedgerows could be incorporated into EQIP program goals.	Number of sites designated for hedgerow conservation and protection from development.	ANR, USFS, USFWS	SWG, PR,EQIP
Habitat Restoration	High	Early- successional habitat (shrubland) goals should be developed for public and private land to support 4,200 individuals (Rosenberg 2004).	Total area managed for ESH.	ANR, USFS, USFWS	SWG, PR,EQIP

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Rosenberg, K. V. 2004. Partners in Flight continental priorities and objectives defined at the state and bird conservation region levels, Vermont. Cornell Lab of Ornithology, Ithaca, NY. 26 p.

Common Name: **Short-eared Owl**
Scientific Name: **Asio flammeus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S1B,S2N	**State Trend:**	Unknown
Extirpated in VT?	Unknown	**Regional SGCN?**	Yes

Assessment Narrative:

Unknown breeding status in VT - regular winter sightings in Champlain Valley.

BBS data indicate significant long-term overall decline, although trend unknown for many areas. Decline likely attributed to habitat conversion of marshes, grasslands, and low-use pastures.

Distribution

Distribution info from VT Breeding Bird Atlas (Laughlin & Kibbe 1985). Two confirmed nestings found in Champlain Valley. Other sightings in Northern Green Mts, and Southern & Northern VT Piedmont - all single sightings. Significant wintering concentrations have been seen in the Champlain Valley.

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Probable
Champlain Hills		**Vermont Valley**	Unknown
Northern Green Mtns	Probable	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Probable	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Breeding: Open land (marshlands & grasslands preferred), but will also use agricultural land and other open habitat.

Wintering: same as above with little/no snow cover (DeGraaf & Yamasaki 2001).

Habitat Types:

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Common Name: **Short-eared Owl**
Scientific Name: **Asio flammeus**
Species Group: **Bird**

Habitat Succession

Habitat Alteration

No Habitat Threats

Description of habitat threat(s): Loss of marshes and grasslands since 1930s has caused declines in population (DeGraaf & Yamasaki 2001).

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Farming practices may impact nesting owls.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Determine if there is a breeding population in VT
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	

Common Name: **Short-eared Owl**
Scientific Name: **Asio flammeus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Payments/Financial Incentives	High	Protect suitable grassland habitat from development and agricultural intensification by creating Grassland Bird Focus Areas to concentrate management efforts (see Vermont Grassland Bird Management Plan)	Development of Grassland bird focus Areas and increased protection of habitat through enrollment in EQIP and CRP Grassland	VFWD, Audubon VT, NRCS	USDA
Protected Area Management	High	Maintain nesting habitat throughout breeding season by developing site specific conservation plans which include restricting mowing after July 15 on publicly owned lands (WMAs and state airports).	Maintain and increase current acreage under management on state lands	VFWD, NRCS, VTrans	VFWD
Habitat Restoration	High	Maintain grassland habitat in suitable locations through active management of woody vegetation within Grassland Bird Focus Areas.	Increase and maintain available habitat in suitable locations	VFWD, Audubon VT, NRCS, USFWS	US government
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and general public about grassland birds and management options to protect habitat	Develop a grassland bird outreach program	VFWD, Audubon VT, VCE, UVM	SWG, VFWD

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Laughlin, S. B., and D. P. Kibbe. 1985. The atlas of breeding birds of Vermont. University Press of New England, Hanover, NH. 456 pp.

Common Name: **Common Nighthawk**
Scientific Name: **Chordeiles minor**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

The Common Nighthawk was listed as an endangered species in Vermont in 2012. In Vermont's first breeding bird atlas (1985) there were three confirmations in priority blocks and the bird occupied 35 blocks. During the second Breeding Bird Atlas (2013) in Vermont the bird was not confirmed in any survey blocks, and only occupied nine survey blocks. The species is declining due to lack of breeding habitat. Additional evidence that non-selective pest control for mosquitoes has resulted in declining food resource availability (largely moths).

Distribution

Confirmed breeding records are few, and decreased between the first and second Atlas surveys (1985-2013). Two probable breeding records were from southern Orange County and Brattleboro. The bird has been recorded via ebirders throughout the state over the past 10 years, but those sightings include birds that are migrating.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Prefers nesting/breeding habitats including dunes, beaches, logged or clearcut areas, open forests, rock outcrops, gravel outwashes and gravel on flat roofed buildings. Utilizes virtually all open habitats, above water and open woodlands, including urban and suburban areas, during crepuscular feeding and migration.

Common Name: **Common Nighthawk**
Scientific Name: **Chordeiles minor**
Species Group: **Bird**

Habitat Types:

Upland Shores

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): Losses of upland openings, reductions of clearcut timber harvest, conversion of natural openings to non-suitable habitat (residential, etc.), conversion of flat, gravel-covered roofs to metal/rubberized coating/sheeting.

Non-Habitat Threats:

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Reductions of preferred prey due to non-selective pesticide use. Loss of suitable wintering ground habitats due to changes in agricultural practices.

Common Name: **Common Nighthawk**
Scientific Name: **Chordeiles minor**
Species Group: **Bird**

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Factor accounting for decreased nesting on available gravel roofs and effects of deforestation; nest/roost site characteristics. Continue study on effectiveness of creating artificial gravel patches on rooftops
Research	Basic Life History	Medium	Longevity of breeders, reproductive output; male fidelity
Research	Distribution and Abundance	Low	Continued monitoring to determine if population is increasing or decreasing. Support for gathering data from citizen scientists, including Vermont ebird.
Research	Threats and Their Significance	High	Population status as related to pesticide use on breeding grounds, wintering grounds, and migration routes.
Monitoring	Population Change	High	Sustained monitoring is crucial to maintaining the existing population
Monitoring	Habitat Change	High	Changes of suitable nesting habitats, and use of rafts.
Monitoring	Monitor Threats	Medium	Monitoring of all limiting factors goes hand-in-hand with population monitoring and is critical to evaluate long-term viability and management needs of statewide population. death, including interference competition from others.

Common Name: **Common Nighthawk**
Scientific Name: **Chordeiles minor**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Conduct complete vegetation removal on select areas of existing upland openings, and provide for even-age timber management on public lands to increase suitable common nighthawk nesting habitat.	Number of acres positively affected by management. Population response to management.	FWD, FPR, Audubon, Forest Products Association, VT Loggers	PR, EQIP
Habitat Restoration	High	Identify specific threats, and agricultural practices that negatively impact birds		FWD	PR
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even-age forest management and the need for mineral soil outcrops (gravel, ledge) on public and private lands to create suitable habitat complexes.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	ANR, USFS, USFWS	SWG, PR
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative. Fund for > $50,000/yr with revenues from state lands forest management. Allow the installation of gravel pads on flat roofed buildings as a conservation practice.	Level of funds raised.	FWD	PR
Habitat Restoration	Medium	Identify and enlarge/enhance suitable lakeshore and riparian gravel depositions to create additional nesting habitat.	Number of sites identified and positively affected by management. Population response to management.	VA, VCE	SWG, NRCS, FSA

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Common Name: **Whip-poor-will**
Scientific Name: **Caprimulgus vociferus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 | **Global Trend:**
State Rank: S2B | **State Trend:** Declining
Extirpated in VT? No | **Regional SGCN?** Yes

Assessment Narrative:

Whip-poor-will has been declining throughout much of its range, particularly in the northeastern US and eastern Canada, based on data from breeding bird atlases. In Vermont this species was found in 77% fewer blocks between the first (1979-85) and second (2003-2007) breeding bird atlases (Renfrew 2013). Based on expert knowledge, atlas data, and standardized whip-poor-will survey routes conducted since 2005, the statewide population was estimated at <200 breeding pairs in 2012 by the Scientific Advisory Group on Birds (an advisory group for the State's Endangered Species Committee of the Agency of Natural Resources). Based on this estimate and declining trends, the species was listed as threatened in 2013. There are ongoing efforts to determine a more precise estimate of the state's population, and standardized monitoring continues. Causes of declines unknown, possibly succession of farmland, prey, and/or invasive plant and other understory growth in otherwise suitable forests.

Distribution

Statewide, but primarily in Champlain and Connecticut River valleys, rare and disjunct in northern and southern thirds of the state. Highest densities appear to be in West Haven area.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

In Vermont, dry open deciduous or open mixed lowland forest with little or no underbrush or ground cover, near or adjacent to open areas for foraging (Cink 2002), such as pastures. Occupied territories often consist of areas where forested mountainsides abut lowland open areas such as pastures, e.g. in the lower Champlain Valley (VFWD/VCE, unpubl. data). Open areas also may be forest clearings, meadows, water, or gravel pits. May occur along power line rights-of-way and pine-oak forests along major rivers.

Common Name: **Whip-poor-will**
Scientific Name: **Caprimulgus vociferus**
Species Group: **Bird**

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Invasion by Exotic Species

Description of habitat threat(s): Habitat alteration due to forestry practices or conversion of grassland to crops. Habitat conversion due to rural/suburban development of fields and forest. Habitat succession via closure of forest openings and regrowth of understory. Roads present potential threat of direct impact on whip-poor-wills that forage along roads at night, particularly secondary and tertiary roads. Solar infrastructure can result in loss of open habitat, wind turbines present strike hazard. Late successional forest stands with little undergrowth needed for nesting. Exotic plants such as Buckthorn and Mountain Holly compromise nesting habitat. .

Non-Habitat Threats:

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Pesticide/bio control for agricultural pests may have reduced prey base. Ground nests vulnerable to predators.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Habitat preference, ultimately to guide development of management recommendations. Seemingly suitable habitat is unoccupied, although this could be due to limitations other than breeding habitat.
Research	Basic Life History	High	Many unknowns in this species that are difficult to study, including: demography, including seasonal and year-round survival, site fidelity, inter- and intra-seasonal movements, and migratory connectivity.
Research	Threats and Their Significance	High	Reasons for population declines still not well understood. Whether food is limited still unknown. Vulnerability to wind turbines, especially during migration, not known for Vermont. Survival during non-breeding season, including post-fledgling survival, could be a limiting factor. Potential effects of climate change not known.
Monitoring	Population Change	High	Standardized survey to detect regional population changes inadequate for detecting population trends at state level. Need more intensive, standardized survey method to better monitor Vermont’s population, to determine local detection probabilities, and to derive a more accurate population estimate.

Common Name: **Whip-poor-will**
Scientific Name: **Caprimulgus vociferus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Investigate and implement, where possible, understory prescribed burning to create open-forest habitat w/ little underbrush suitable for whip-poor-will nesting.	Number of sites identified and positively affected by management. Population response to management.		
Habitat Restoration	Medium	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, VT Loggers	PR, EQIP
Habitat Restoration	High	Stabilize or reverse declining population trend for whip-poor-wills to realize and maintain a population of >400 breeding pairs.	Standardized survey routes, occasional statewide counts with public participation	VFWD, VCE, Audubon	PR, EQIP
Conservation Finance	Medium	Investigate and implement, where possible and where suitable habitat mosaic exists, understory prescribed burning to create open-forest habitat w/ little underbrush suitable for whip-poor-will nesting.	Number of acres identified and positively affected by management. Population response to management.		
Awareness Raising and Communications	Medium	Initiate public education campaigns on the need for active, even-age forest management on public and private lands and to eliminate undergrowth in prime potential forest habitat adjoining open habitat, especially removal of invasive plants (e.g. buckthorn	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs, number of acres treated		

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Common Name: **Chimney Swift**
Scientific Name: **Chaetura pelagica**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S4B	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Vermont's second Breeding Bird Atlas found a 26% loss in the number of occupied blocks. These losses were primarily from the Champlain Valley, Northern Green Mountains, and Northern Vermont Piedmont. Declines for this species throughout its range have been shown with BBS surveys and Breeding Bird Atlas surveys. Once nested in old growth forests with scattered large hollow trees for roosting. Since settlement and industrialization, the species has shifted its habitat to mostly urban areas with large chimneys used for roosting and nesting, and agricultural areas where barns and silos provide similar roosting and nesting habitat. Reductions in sizes of chimneys due to change from coal burning to oil and electricity use have now further reduced this species population. Threats on migration pathways and wintering grounds are also a factor.

Distribution

Chimney Swifts breed in almost every region of Vermont; although the second Breeding Bird Atlas found a 26% loss in the number of occupied blocks. They travel miles to feed and are documented through ebird throughout Vermont. Chimney Swifts winter in the Amazon Basin.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Chimney Swifts formerly nested and roosted in caves and large dead trees. As European settlement and development increased, the birds nested mainly in large, tall chimneys in urban and suburban areas. The conversion from heating with coal to oil and electricity in residential homes and industrial plants has reduced the size of chimneys making them less suitable as nest sites for chimney swifts. Some experts believe the birds may still nest in large snags in rural areas. Chimney Swifts forage in a variety of habitats, but seem to prefer open areas over densely forested habitats.

Common Name: **Chimney Swift**
Scientific Name: **Chaetura pelagica**
Species Group: **Bird**

Habitat Types:

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Lawns, Gardens, and Row Crops

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Description of habitat threat(s): Originally, loss of old growth habitat with large trees used for roosting and nesting. After habitat shift, loss of large chimneys in urban areas.

Non-Habitat Threats:

Unknown Non-Habitat Threats

Description of non-habitat threat(s): Threats across their range include pesticides, collisions, catastrophic weather events, threats to wintering grounds

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Snag requirements for nesting. Determine if artifical nest structures can reverse declining population.
Research	Distribution and Abundance	Medium	Support of for gathering data from citizen scientists important, including Vermont ebird
Monitoring	Population Change	Medium	Continued monitoring needed to assess if declining trend in population is significant and warrants listing. Use of radio telemetry to determine specific habitat requirements.
Monitoring	Habitat Change	Medium	Assess forest succession conditions throughout state and determine if chimney swifts are re-occupying original forest habitats. Nest and roost trees identified and preserved.
Monitoring	Monitor Threats	Medium	Monitoring of all limiting factors goes hand-in-hand with population monitoring and is critical to evaluate long-term viability and management needs of statewide population.

Common Name: **Chimney Swift**
Scientific Name: **Chaetura pelagica**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Restoration of old growth habitats should be monitored to determine if chimney swifts are re-occupying these areas.	Presence/absence of chimney swifts on breeding bird surveys, bird atlas; location of roost or nest trees.	USFS,USFWS,VFPR, private landowners.	PR, Nongame Fund, SWG
Habitat Restoration	High	Implement artificial nest structure program, especially on existing and new commercial buildings, to restore nesting opportunities for chimney swifts.	Number of artificial nest structures erected and utilized.	VFWD, VA, VCE, TWF, VLCT, VT Home Builders Association, Cons Comms	SWG

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Common Name: **Black-backed Woodpecker**
Scientific Name: **Picoides arcticus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2B,S2N	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	No

Assessment Narrative:

Uncommon resident in northeastern Vermont. Thirty successful nesting pairs documented by Weinhagen (1998) in northeastern Vermont in 1996-97. Black-backed woodpeckers in Vermont are habitat specialists that depend on mature/over mature spruce-fir- tamarack forests for nesting and foraging. Trends in amount of required habitat are unknown. Conversion of substantial amount of potential habitat from intensively managed industrial forest land to public or private land w/easements over the past decade may lead to increased and/or stable amount of preferred habitats. Habitat losses may be caused by seasonal and/or permanent residential development, especially at shoreline sites, which may experience increase frequency in the coming decade in northeastern Vermont.

Distribution

Most nesting records concentrated in Northeast Highlands. Thirty successful nests were documented by Weinhagen (1998) in 1996-97. The Second Atlas of Breeding Birds of Vermont (Renfrew 2013) reports that 35% of the Northeast Highlands biophysical region was occupied by Black-backs and that 93% of all records of this species were found here as well.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

The Black-backed woodpecker inhabits mature and decadent coniferous forests where it utilizes these older stands for both nesting and foraging habitat. Lowland spruce-fir forests and bogs and swamps supporting tamarack, red and black spruce, and balsam fir typify the natural community preferred by black-backed woodpeckers. Black-backed woodpeckers feed primarily on wood-boring beetle (cerambycids) larvae (Dixon and Saab 2000). In Vermont, Weinhagen (1998) found a mean stand diameter of 11.5 to 26.7 cm within a 900 meter radius of 62% of nest trees. Average dbh of nest trees was 27 cm (range 19-55). Natural mortality due to senescence or reduced tree vigor brought on by fire, windstorm, flooding, spruce budworm outbreak or residual stand damage from logging can all lead to cerambycid infestations followed by nesting black-backs (Dixon and Saab 2000).

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Black-backed Woodpecker**
Scientific Name: **Picoides arcticus**
Species Group: **Bird**

Habitat Types:

Spruce Fir Northern Hardwood

Softwood Swamps

Open Peatlands

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Black-backed woodpeckers in Vermont are habitat specialists that depend on mature/over-mature spruce-fir-tamarack forests for nesting and foraging. Trends in amount of required habitat are unknown. Conversion of substantial amount of potential habitat from intensively managed industrial forest land to public or private land w/easements over the past decade may lead to increased and/or stable amount of preferred habitats. Habitat losses may be caused by seasonal and/or permanent residential development, however, especially at shoreline sites. Some predictions are that lakeshore development may experience increased frequency in the coming decade in northeastern Vermont.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Minimum and optimum patch size and degree of home range overlap should be determined. Effects of selective or shelterwood silvicultural practices on nesting success should be investigated
Research	Distribution and Abundance	Medium	Periodic surveys of known woodpecker occupancy throughout the Northeast Highland biophysical region to determine extent of distribution and abundance.
Research	Threats and Their Significance	Medium	Known nest sites should be monitored periodically for limiting factors.
Monitoring	Population Change	Medium	Periodically monitor occupancy of known & potential nesting habitats
Monitoring	Habitat Change	Medium	Known nest sites should be monitored periodically for limiting factors.

Common Name: **Black-backed Woodpecker**
Scientific Name: **Picoides arcticus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Increase rotation age in some managed forests.	Number or sites and total area with increased rotation ages.	ANR	SWG,PR
Publically-Owned Protected Areas	Medium	Identify potential areas on public lands for designation as reserve or no-cut status (including some areas where wildfires and insect outbreaks would not be controlled).	Number of sites and total area of designated reserves.	ANR, UVM, TNC	SWG, PR
Protected Area Management	High	Area of suitable breeding habitat (mature spruce-fir patches > 100 ha) should be mapped. A subset of this data that is in reserve or no-cut status should be determined. Use research findings to inform whether additional acreage is necessary.	Number of sites inventoried. Number of these sites occupied by breeding black-backed woodpeckers.	ANR, UVM	SWG, PR

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Common Name: **Olive-sided Flycatcher**
Scientific Name: **Contopus cooperi**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S4B
Extirpated in VT? No
Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Strong NS negative trends on VT BBS routes (Sauer et al. 2004).

Population declines throughout North America (Sauer et al. 2004). VT populations widespread but local (Fichtel 1985).

Distribution

Based on Fichtel (1985).

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Confident
Champlain Hills		**Vermont Valley**	Confident
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Montane and northern coniferous forests. Frequently associated with forest openings, forest edges near natural openings, or open to semi-open forest stands (Altman and Sallabanks 2000]).

Habitat Types:

Spruce Fir Northern Hardwood

Other Cultural

Current Threats

Habitat Threats:

Conversion of Habitat

Inadequate Disturbance Regime

Description of habitat threat(s): Species seems to require disturbances in coniferous forests. Beaver ponds, burns, clearcuts, or wind throws all appear to be appropriate. The species has a large territory size (10-20 ha), therefore there seems to be wide spacing between territories. Other problems are conversion to nonforest habitat, loss of wintering habitat, and decrease in prey species (summarized from Altman and Sallabanks 2000).

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Range-wide, a better understanding of habitat associations is a research priority.
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Habitat-specific demographic data would be useful to understanding population ecology.
Research	Threats and Their Significance	High	The relative importance of breeding versus wintering habitat loss and degradation would help target effective conservation strategies.
Monitoring	Population Change	High	Distribution in Vermont and areas of high abundance to target habitat management activities.
Monitoring	Habitat Change	High	Determine effects of disturbance regimes on habitat quality.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Create more early successional habitat, particularly in the northeast kingdom of VT.	Number of acres positively affected by management. Population response to management.	ANR, USFWS	PR, SWG

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Common Name: **Purple Martin**
Scientific Name: **Progne subis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3S4B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? No

Assessment Narrative:

Populations have shown a nation-wide decline, especially since 1980. The Purple Martin once lived along riparian, lake shoreline, and swamp edges. It is now almost completely found inhabiting areas close to human settlement. It originally nested in tree cavities but almost all nesting now occurs in bird houses erected by humans, except in western U.S. where some natural nesting still occurs.

Distribution

Breeding in Vermont is almost exclusively the Champlain Valley, although the bird is recorded from other places within the state. In 2012 the Scientific Advisory Group on Birds and many volunteers surveyed the state to try to record all Purple Martins breeding. This is possible with this species, as they are completely dependent upon human-provided nest sites. At that time 421 nesting pairs were counted and documented on ebird. Purple Martins migrate outside of the US to central south America. Recent research suggests that some fly across the Gulf of Mexico.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Historically found along riparian areas, lake and pond shorelines, and edges of forest openings. Currently found almost exclusively around human settlements. All confirmed breeding records in the second Breeding Bird Atlas were in the Champlain Valley, with the majority of records less than 10 kilometers from the Lake. Colonies were clustered in Grand Isle County and Addison County. In Vermont a survey was completed in 2012 to find all Purple Martin nests. Birds will nest as one pair or in larger colonies. The 2012 survey ranged from 1 occupied compartment to 53 occupied compartments. Some limitations may be due to competition with non-native species such as the House Sparrow and the European Starling.

Common Name: **Purple Martin**
Scientific Name: **Progne subis**
Species Group: **Bird**

Habitat Types:

Wet Shores

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Aquatic: Fluvial

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Alteration

Invasion by Exotic Species

No Habitat Threats

Climate Change

Description of habitat threat(s): Change in rainfall resulting wet springs impact food supplies for adults returning form wintering grounds and adults feeding young. Competes for nest sites with introduced House Sparrow and European starling. Habitat requires maintenance of nest boxes by humans. Inadequate number of nest boxes erected to attract martins and support population viability.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competes with introduced house sparrow and European starling for nest sites. Inadequate number of nest boxes erected to attract martins and support population viability. Nest boxes may not be maintained adequately by owners.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Distribution and Abundance	Medium	Support for gathering data from citizen scientists important, including Vermont ebird. Support education to ensure new martin houses are built and maintained.
Research	Threats and Their Significance	Medium	Maintain existing boxes in a manner to attract martins, reduce exotic species, and prevent disease.
Monitoring	Population Change	Medium	Continued monitoring needed to assess if declining trend in population is significant and warrants listing. Use of radio telemetry to determine specific habitat requirements.
Monitoring	Habitat Change	Low	Support citizens if needed, to ensure martin houses are constructed and maintained.
Monitoring	Monitor Threats	Medium	Monitoring of all limiting factors goes hand-in-hand with population monitoring and is critical to evaluate long-term viability and management needs of statewide population.

Common Name: **Purple Martin**
Scientific Name: **Progne subis**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Establish artificial nest box program on public and private lands.	Presence/absence of breeding martins, number of young fledged, number of nests abandoned due to house sparrows and starlings.	Audubon-VT, VCE, BOVM, Cornell Lab of Ornithology, USFWS, NRCS	Nongame Fund, SWG, Neotropical Bird Conservation Act grants, National Fish and Wildlife Foundation grants, USFWS, NRCS
Awareness Raising and Communications	Medium	Educate public about nest box program, nest box maintenance, and Purple Martin Society	Number of cooperating homeowners who erect martin boxes	VFWD, VA, VCE	SWG, PR

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Gray Jay**
Scientific Name: **Perisoreus canadensis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
Global Trend:
State Rank: S1S2B,S1S2N
State Trend: Unknown
Extirpated in VT? No
Regional SGCN? No

Assessment Narrative:

Partners In Flight (PIF) reports a continental population estimate of 20,000 birds based on Breeding Bird Survey (BBS) estimates. The Canadian estimate of 17,000 individuals is categorized as of medium quality while the American estimate of 3.4 million (sic) birds is categorized as high quality. Breeding Bird Survey (BBS) data for Vermont is nonexistent but survey data for Quebec report increases in population size (<1.5% annual increases since 1966). However, the same indices suggest a greater than 1.5% annual decrease for grey jay in the Maritime Provinces and northern New England states. The Second Breeding Bird Atlas (2003-07) reports a 14% decrease in breeding blocks (7 blocks to 6) since the first atlas (1982). Increased softwood harvest in northeastern Vermont between 1978 and 1984 heightened concerns for the Gray Jay's continued existence. The Scientific Advisory Group on Birds (SAG) proposed it be listed as threatened, but the proposal was rejected. Public lands and conservation easements acquired over the last 2 decades in prime gray jay range, along with higher than expected densities found by Barnard in his ongoing field studies (begun in 1991) have reduced this concern. However, concerns for the species are again increased due to projected effects of long-term climate change influences potentially decreasing the abundances and distribution of the already limited boreal habitat (southern edge of range). For this reason SAG recommends this species be reclassified from medium to a high priority assessment.

Distribution

Distribution limited to largest boreal forest patches of northeastern Vermont. Strongholds include the Victory, Nulhegan and Coaticook River Basins. Also occurs at high elevation coniferous forest.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Coniferous forests and nearby deciduous or mixed woodlands.

Common Name: **Gray Jay**
Scientific Name: **Perisoreus canadensis**
Species Group: **Bird**

Habitat Types:

Spruce Fir Northern Hardwood

Softwood Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Gray jays utilize all seral stages of coniferous forests, readily occupy managed landscapes, and readily visit bird feeders or take handouts directly from humans. Conversion of coniferous forests in Vermont strongholds unlikely, however, smaller occupied patches (if they exist) could be degraded by residential or commercial development.

Non-Habitat Threats:

Harvest or Collection

Description of non-habitat threat(s): Accidental capture by trappers has been reported in Ontario. Susceptibility to land trap losses depends on types of baits used (Strickland and Ouellet 1993).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	1) Investigate minimum patch size required for successful breeding and map all potential breeding habitat. 2) Determine total minimum area of suitable coniferous forest patches necessary to support 500 breeding pairs of gray jays in northeastern Vermont.
Monitoring	Population Change	Medium	Monitor population trends via surveys in targeted habitats and track the number of sites inventoried for breeding gray jays.
Monitoring	Habitat Change	Medium	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	Low	Investigate the occurrence of gray jays accidentally caught in furbearer traps in Vermont and, if needed, educate trappers on baiting techniques to minimize losses.	Number of accidental losses.	ANR, VT Trappers Association	SWG, PR

Common Name: **Gray Jay**
Scientific Name: **Perisoreus canadensis**
Species Group: **Bird**

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Common Name: **Sedge Wren**
Scientific Name: **Cistothorus platensis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1B
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Rangewide BBS population trends have been stable long-term and in the last ten years, although northeast populations have shown non-significant declines in recent years (Sauer et al. 2014), and the species' persistence as a breeding species in the Northeast is considered to be in jeopardy. In nearly all the states where it occurs, it is state-listed as endangered or threatened. Populations have evidently undergone dramatic declines in the latter part of 20th century after a northern expansion in range which was probably due to the clearing of forests in the 1800s. Land conversion in recent decades from old fields and pasturelands to forests or development has reduced nesting habitat. However, it appears that sedge wren populations today remain well below the level that available habitats could support, and the species is rare and local in Vermont (Renfrew 2013). Breeding pairs that are present in one year are not necessarily present in subsequent years (A. Strong, pers. obs.).

Distribution

Occasionally appear in June somewhere in Champlain Valley, location not consistent. Records during the second Breeding Bird Atlas were limited to the southern half of the Champlain Valley (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Dense, tall growths of sedges and grasses in wet meadows, hayfields, retired croplands, upland margins of ponds and marshes, coastal marshes, and sphagnum bogs. Avoids short, sparse, or open vegetative cover, flooded areas, and wetlands dominated by cattails (Herkert et al. 2001). In Vermont, Sedge Wrens have been observed in June on older hayfields (both well-drained and wet), in a ditch, and on ungrazed pasture (Perlut 2013).

Common Name: **Sedge Wren**
Scientific Name: **Cistothorus platensis**
Species Group: **Bird**

Habitat Types:

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): Early haying of grasslands perhaps not as critical as SEWR in VT may be second nesting attempts of birds breeding further north earlier in summer. Consequently, drainage ditches in wet hayfields and meadows may reduce habitat availability. Succession of grassland habitats and conversion of agricultural habitats to urban/suburban developments problematic. Habitat conversion is likely not as severe a problem as for other grassland species, as SEWR requires wet meadow habitat and at least to some degree protected through regulatory measures.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine habitat requirements, including preferred soil moisture regimes, vegetation height/density/composition, specific nesting cover requirements, minimum effective habitat area.
Research	Basic Life History	High	Determine where VT birds are coming from.
Research	Other Research	High	Habitat Requirements: Define relationships between habitat use, invertebrate prey abundance and soil moisture, rainfall, wetland proximity, grassland type. There is potential to evaluate through landsat imagery, although substantial ground-truthing would be necessary.

Common Name: **Sedge Wren**
Scientific Name: **Cistothorus platensis**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and general public about grassland birds and management options to protect habitat	Continue grassland bird outreach and landowner networking programs	VFWD, Audubon-VT, VCE, UVM	SWG, PR
Protected Area Management	High	Maintain nesting habitat throughout breeding season by developing site specific conservation plans which include restricting mowing after July 15 on publicly owned lands (WMAs and state airports).	Maintain and increase current acreage under management on state lands	VFWD, NRCS, VTrans	SWG, PR
Compatible Resource Use	Medium	Maintain consistency of timing of cutting for potential habitat, as early season mowing of potential habitat is a problem in dry springs.		UVM, NRCS	NRCS (EQIP, CRP Grassland), USDA.
Habitat Restoration	Medium	Late season mowing of potential habitat would reduce problem of succession.	Long-term maintenance of wet meadow habitat.	UVM, NRCS.	NRCS (EQIP, CRP Grassland), USDA.

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Bicknell's Thrush**
Scientific Name: **Catharus bicknelli**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S3B
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Species extensively studied by VINS since 1992, but no baseline data before that, so population trends still poorly known. Recent data from Mountain Birdwatch project indicate that species experienced an annual regionwide decline of 9.1% from 2001-2004. A habitat specialist whose overall population trends and abundance are not well known. Conservation limiting factors on both breeding and wintering grounds, combined with rarity and occupancy of naturally fragmented habitats, place the species at conservation risk. A high priority for attention in VT.

Distribution

Distributed throughout high elevation montane forests of VT

Distribution by Biophysical Region:

Champlain Valley	Not Probable	Southern VT Piedmont	Not Probable
Champlain Hills	Not Probable	Vermont Valley	Not Probable
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Not Probable	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Montane forests dominated by balsam fir with lesser amounts of red spruce, heart-leafed white birch, and mountain ash. Often associated with recently disturbed areas undergoing vigorous succession, characterized by standing dead conifers and dense regrowth of balsam fir. Highest densities typically found in chronically disturbed stands of dense, stunted fir on exposed ridgelines or along human-created openings (e.g. ski trails) or in regenerating fir waves.

Habitat Types:

Spruce Fir Northern Hardwood

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Bicknell's Thrush**
Scientific Name: **Catharus bicknelli**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): The primary problems in Vermont and the Northeast (there are other, likely more significant problems on the species' Caribbean wintering grounds) are degradation and fragmentation of montane forests. Atmospheric pollution may be affecting forest health, and climate change could profoundly impact long-term viability of montane balsam fir forests. Immediate problems include loss and fragmentation of habitat from ski area development, communications tower development, and wind turbine development.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Mercury contamination may be a problem, as research has shown significantly higher atmospheric deposition rates in montane forests than in surrounding low elevation habitats. Recent research has indicated that Hg levels in adult BITH increase with age.

Common Name: **Bicknell's Thrush**
Scientific Name: **Catharus bicknelli**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Habitat requirements are reasonably well known, though responses to human-created developments need study.
Research	Basic Life History	Medium	Much basic life history is known, but some aspects of ecology and demography need further study.
Research	Distribution and Abundance	Medium	Distribution is well-documented, but better information is needed on abundance and population ecology in different subhabitat types.
Research	Threats and Their Significance	Medium	1) Expand studies of mercury contamination in BITH and synergistic effects with other environmental stressors (such as calcium depletion); evaluate effects on reproductive success, behavior, survivorship. Design and implement expanded research program on multiple peaks (at least Stratton, Mansfield, and East Mt) 2) It is not known how developments affect local breeding populations.
Research	Population Genetics	High	Knowledge of natal dispersal and migratory connectivity could help elucidate population structure and guide conservation planning.
Research	Taxonomy	Low	Taxonomy, while still debatable to some, has been resolved and is not crucial to conservation.
Research	Other Research	High	1) Conduct research that will enable robust predictions of breeding densities in different sub-habitat types, which can be extrapolated across VT and entire breeding range to derive population estimates. Design specific studies that will quantify BITH breeding densities, correlate density measures with GIS habitat data to estimate overall population numbers in different montane forest subhabitat types. Use data to generate overall population estimates. 2) There are needs for additional research on the species' wintering grounds.
Monitoring	Population Change	High	Mountain Birdwatch is a critical, ongoing program to monitor population trends.
Monitoring	Habitat Change	High	Mountain Birdwatch will collect habitat information with bird population data, as a means to evaluate local changes that may be occurring. Landscape level monitoring of montane forest habitats is essential.
Monitoring	Range Shifts	High	Ongoing monitoring through Mountain Birdwatch will help assess distributional changes, as will programs underway in Quebec and Canadian Maritime provinces, where the species also breeds.
Monitoring	Monitor Threats	High	Landscape level studies of the impacts of development on montane forest species will be the onnly means to document changes that occur. The current strategy of reacting to site-specific projects (e.g. East Mountain wind farm) is unlikely to provide rigor rigorous information that can be applied across the species' range.
Monitoring	Other Monitoring Needs	High	Monitoring must be continued on the species' winter range.

Common Name: **Bicknell's Thrush**
Scientific Name: **Catharus bicknelli**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Identify the 15 core monitoring sites, ensure that funding is available to monitor them annually and indefinitely	Coordinate with Mountain Birdwatch program to ensure annual coverage of sites	VCE, VFWD, GMC, USFS	SWG, USFWS, GMNF
Compatible Resource Use	High	Evaluate impacts of human development (ski area expansion/construction, wind power, telecommunications facility) on Bicknell's Thrush and montane forest habitat, and use results to guide future development	Evaluate published results of past studies, implement new studies as appropriate to investigate development impacts, develop and periodically revise as necessary guidelines to minimize and mitigate impacts, monitor post-construction response of BITH	ANR, USFS, TNC, VCE	SWG, GMNF, USFWS
Habitat Restoration	Medium	Implement experimental habitat manipulation measures to evaluate the possibility of creating suitable habitat for BITH through artificial disturbance	Conduct controlled habitat manipulations of montane forest to mimic natural disturbance events (e.g., fir waves, catastrophic storm events); carefully monitor BITH and vegetation responses over time	VFWD, VFPR, GMNF, VCE	SWG, GMNF, NFWF
Planning & Zoning	High	Develop a planning process whereby explicit mitigation and management guidelines are specified. Further develop a means to ensure that these are followed and monitored, both in short- and long-term.	Formalize as policy existing recommendations for ski areas and develop new recommendations as research findings warrant. Establish accountability by land owners/managers to adopt specified measures.	ANR, USFS, VCE	SWG, PR
Publically-Owned Protected Areas	High	Identify top 15 breeding sites (those with largest habitat blocks and/or largest known breeding concentrations), specify these as highest priority for long-term protection/ conservation/monitoring. Ensure minimal or no further habitat loss at these sites	Use GIS to identify 15 largest montane forest habitat patches, review current protected status of each, assess further needs for long-term protection, develop site-specific plans for each site.	VFWD, USFS, TNC, VCE	State Wildlife Grants, GMNF, USFWS

Common Name: **Bicknell's Thrush**
Scientific Name: **Catharus bicknelli**
Species Group: **Bird**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Wood Thrush**
Scientific Name: **Hylocichla mustelina**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

The USGS Breeding Bird Survey (BBS) reports for the period 1966-2012 the Vermont Wood Thrush population experienced an estimated 3.5% annual decline. The same BBS reported annual Wood Thrush declines of 4.8% in New Hampshire and 2.8% in the New England/Atlantic Coast Region. Partners In Flight (PIF) estimates the continental population of 11,000,000 birds. The species is declining at similar rates in NH, ME, MA, and NY and throughout USFWS Region 5. A common but declining breeding species of northern hardwoods forests, in many ways an "umbrella" species that merits focused conservation attention in VT. Its decline may be due in part to maturation of northern hardwoods forests and the fragmentation of existing forests for human development. Certain forest management practices that encourage younger aged stands and conservation of forest blocks may help stabilize Wood Thrush declines. Factors on the species' Central American wintering grounds may also be involved in its declining populations. As a forest health umbrella species the Wood Thrush's re-catagorization to High Priority represents concerns for the future of the northern hardwood forest in the face of ever expanding human development.

Distribution

Distributed widely throughout state in n. hardwood forests

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Upland, mesic northern hardwood forests, Interior and edges of deciduous and mixed forests, especially well-developed, upland, mesic sites. Key elements for suitability include: trees > 16 in height, high variety of deciduous tree species, moderate subcanopy and shrub density, shade, fairly open forest floor, moist soil, and decaying leaf litter

Habitat Types:

Northern Hardwood

Common Name: **Wood Thrush**
Scientific Name: **Hylocichla mustelina**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Fragmentation

Description of habitat threat(s): Forest fragmentation may introduce nest predators and cowbirds that lower reproductive success, especially in smaller, isolated patches

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Acidification of northern hardwoods forests and consequent calcium depletion may affect population ecology of this species

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Habitat-specific data needed in relation to assess area sensitivity in VT
Research	Basic Life History	Medium	Age- and sex-specific survivorship and reproductive success in different forest subhabitats and patch sizes needed.
Research	Distribution and Abundance	Medium	Age- and sex-specific partitioning (relative abundance and density) in different forest subhabitats and patch sizes needed
Research	Threats and Their Significance	High	1) Need to understand relative importance of differing fragmentation effects on demography, productivity, and site persistence; also how species responds to different forestry practices. Conduct field studies in different forest types (successional stage, patch size and configuration, proximity to edge habitat), use results to guide conservation planning that incorporates forestry and sustainable development. 2) Investigate environmental stressors like mercury and calcium depletion in Wood Thrush, as a means to understand their synergistic role in avian population and forest health; use results to guide regulatory planning for Hg and acidic ion emissions. Conduct studies to measure levels of Hg and Ca in WOTH and in ecosystem food chain; correlate measures to WOTH demographics and reproductive success.
Monitoring	Population Change	High	Need continued, habitat-specific monitoring in core no. hardwoods habitats, both managed and unmanaged landscapes
Monitoring	Habitat Change	High	Need to document and understand impacts of landscape-level forestry practices and atmospheric pollution on species' population biology
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	

Common Name: **Wood Thrush**
Scientific Name: **Hylocichla mustelina**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	Medium	Educate landowners, private foresters, local conservation and planning commissions about habitat conservation needs of Wood Thrush, as a means to guide sustainable land use practices and local regulations	Develop educational materials based on known information about Wood Thrush ecology, habitat needs and conservation in VT. Provide planning expertise to local planners, landowners, foresters.	VFWD, VFPR, USFS, TNC	Municipal planning grants, NFWF
Standards	High	Evaluate and refine current forestry practices as a means to promote optimal habitat suitability for this species, and to reverse population declines	Synthesize management studies from other parts of species' breeding range and evaluate applications to VT; conduct focused studies to assess species' response to differing forestry regimes	VFPR, VFWD, USFS, VT Assoc Loggers, private foresters, VWA, Coverts	NFWF, USFWS, SWG

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Brown Thrasher**
Scientific Name: **Toxostoma rufum**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

BBS trend 1966-2012 for VT was –4.5 and for 2002-2012 was -3.77 ($p = 0.25$). The Second Vermont Breeding Bird Atlas showed a 47% decrease in breeding block occupation from the first atlas. These trends suggest recent declines remain similar to long-term declines and as such Brown Thrasher has been moved from Medium to High Priority. Species declining along with shrub dominated and successional habitats throughout the East as forests mature and suitable habitat is converted to non-forest/non-habitat use.

Distribution

Statewide

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Thicket/shrub complexes; hedgerows and early successional habitat w/ high stem densities coupled with low (10%-30%) canopy coverage.

Common Name: **Brown Thrasher**
Scientific Name: **Toxostoma rufum**
Species Group: **Bird**

Habitat Types:

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Incompatible Recreation

Description of habitat threat(s): Losses of shrub dominated and early successional woody regeneration habitats due to conversion and forest maturation.

Non-Habitat Threats:

Trampling or Direct Impacts

Pollution

Description of non-habitat threat(s): Evidence exists that nest discovery/disturbance evokes high rate of abandonment; evidence exists that pesticide use in feeding areas resulted in substantial declines.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Effects of land management practices on nest site selection and productivity/mortality.
Research	Basic Life History	Medium	More comprehensive breeding ecology information.

Common Name: **Brown Thrasher**
Scientific Name: **Toxostoma rufum**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Determine appropriate old field habitat targets for state and private lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, Power companies, VT Loggers Association	PR, EQIP, private grants
Awareness Raising and Communications	High	Initiate public education campaigns to highlight the need for active, management on public and private lands to create and maintain early successional shrubland habitat for the suite of shrubland birds.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	VFWD, Audubon, VCE, power companies	PR, EQIP, private grants

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Hunt, P. 2013. The Second Atlas of Breeding Birds of Vermont. R. Renfrew, ed. University Press of New England, Hanover and London. 548pp.

Common Name: **Blue-winged Warbler**
Scientific Name: **Vermivora pinus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2S3B	**State Trend:**	Increasing
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

National Breeding Bird Survey data indicate a 2.44% long term population decline in the New England/Mid-Atlantic region for Blue-winged Warbler (Sauer 2011). But, results of the Second Vermont Breeding Bird Atlas (Renfrew 2013) indicate a 125% increase in Blue-winged Warblers between this publication and the First Vermont Breeding Bird Atlas (Laughlin and Kibbe 1985). Species distribution has shifted since the early 1980s, and appears to be moving north. PA and MD observed declines in their recent atlases, while Ontario and NY had increases (Renfrew 2013). Species is listed as Special Concern due to small population size and declining habitat.

Distribution

The Second Vermont Breeding Bird Atlas (Renfrew 2013) reports Blue-winged Warbler distribution to be largely in the western biophysical regions that border New York State where 81% of the species records are found. The Northern Green Mountain and Southern Vermont Piedmont regions hold the remaining 5% and 14%, of the distribution respectively. The species likely occurs in other regions of the state during migration.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Unknown
Northern Green Mtns	Probable	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Nests in brushy growth near the borders of swamps or streams, forest edges, abandoned fields and pastures, thickets, and second-growth woods. Prefers brushy old pastures and old fields with saplings < 3 m tall" (DeGraaf and Yamasaki 2001).

Common Name: **Blue-winged Warbler**
Scientific Name: **Vermivora pinus**
Species Group: **Bird**

Habitat Types:

Shrub Swamps

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): Succession of old field to forest, loss of habitat to development, and fragmentation are major problems.

Non-Habitat Threats:

Genetics

Predation or Herbivory

Description of non-habitat threat(s): Hybridization with Golden-winged Warbler. Although hybridizes extensively with Golden-winged Warbler, introgressive hybridization appears to be asymmetric with Blue-winged Warbler gene pool remaining largely "pure" (Gill et al. 2001). Competition between Blue-winged Warbler and Golden-winged Warbler appears to be leading to continual northward shift in the range of Golden-winged Warbler. Colonization of Golden-winged Warbler breeding sites by Blue-winged Warbler may have negative impacts on Golden-winged Warbler populations. Brown-headed Cowbird parasitism is also a signficant problem,

Common Name: **Blue-winged Warbler**
Scientific Name: **Vermivora pinus**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Develop a better understanding of the characteristics of high quality habitat would be valuable, as are optimal management activities. Audubon VT and NRCS are working together to answer these questions.
Research	Distribution and Abundance	High	Likely more common in Vermont than Breeding Bird Atlas data suggest. Because habitat is transitory and song is not necessarily a good indicator of presence (because of hybridization) there is a need to characterize the species' distribution in the State. Audubon VT is currently doing some of this work.
Research	Threats and Their Significance	High	Understanding effects of Brown-headed Cowbirds, Golden-winged Warbler, development, and succession are necessary to manage and conserve the species in VT.
Monitoring	Population Change	Medium	Knowing how long a patch remains suitable would be useful, as is knowing how long after management Blue-winged Warbler will return to a site. Additionally, understanding how species interacts with Golden-winged Warbler presence and Brown-headed Cowbird parasitism would also be helpful.
Monitoring	Habitat Change	High	Quantify the relative importance of succession and development.
Monitoring	Range Shifts	Medium	Determine if the species is moving northward in VT and if there are areas that are "pure" Blue-winged Warbler sites.
Monitoring	Monitor Threats	Medium	Get better information about current limiting factors to habitat (development versus habitat succession). Implement periodic assessment (5 year?) of grassland/shrubland acreage in Vermont, likely through GIS analysis.

Common Name: **Blue-winged Warbler**
Scientific Name: **Vermivora pinus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Initiate education campaigns highlighting the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes. Use demonstration sites to educate public and professionals about BMPs	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	Audubon VT, NRCS, VFWD, Towns, land trusts, etc.	Private grants
Easements	High	Create at least one large (>1000 ha) management area dedicated to early successional species.	Acres of land purchase or conservation easements with dedicated management plan acquired.	UVM, NRCS, VFWD.	NRCS, USDA.
Habitat Restoration	High	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, NRCS, USFS, Audubon VT, Forest Products Association, VT Loggers	PR, EQIP,

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Common Name: **Golden-winged Warbler**
Scientific Name: **Vermivora chrysoptera**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S2S3B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

National Breeding Bird Survey data show a long term Golden-winged Warbler population decline of 10.8% in the Northeast/Mid-Atlantic regions (Sauer 2011). Results of the Second Vermont Breeding Bird Atlas (Renfrew 2013) indicate a 7% decline between this effort and the First Vermont Atlas (Laughlin 1985). It is suspected the species has been negatively affected by Brown-headed Cowbird parasitism and hybridization with Blue-winged Warblers (Confer 1992), as well as forest succession (Renfrew 2013). Audubon Vermont surveys conducted in 2013 and 2014 found approximately 60 Golden-winged Warblers in the southern Champlain Valley, which is significantly more than the previously estimated population of 20 pairs (Audubon VT, unpubl. data). Partners in Flight report Golden-winged Warblers to be a Tier 2 species (Rosenberg and Wells 2005). It is likely that forest succession and development of abandoned agricultural habitat will continue to limit this species.

Distribution

The Second Vermont Breeding Bird Atlas indicates 100% of the confirmed nesting distribution of the species is found among the Champlain Valley, Vermont Valley, and Taconic Mountain biophysical regions (Renfrew 2013). The species may occur in other regions as migrant.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Preferred habitat in Vermont is a mosaic of shrub thickets, forbs, grasses, scattered trees or saplings, and forest edges (Confer 1992, and C. Smalling, pers. comm.). Also uses power line rights-of-way (ROWs) (Golden-winged Warbler Working Group 2013). The Golden-winged Warbler Working group (2013) recommends the following for optimal Golden-winged Warbler habitat, as long as the area is next to a primarily deciduous forest patch and non-active agriculture (such as row crops):
-- 30-70% tall shrubs and saplings (3–13 ft.) distributed unevenly
-- Herbaceous openings (mostly forbs and some grasses)
-- Deciduous trees (5–15/acre), creating 10–30% canopy cover

Common Name: **Golden-winged Warbler**
Scientific Name: **Vermivora chrysoptera**
Species Group: **Bird**

Habitat Types:

Early Succession Northern Hardwoods

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): Loss of habitat through development and succession. Habitat quality may decline with presence of Brown-headed Cowbird and Blue-winged Warbler.

Non-Habitat Threats:

Genetics

Description of non-habitat threat(s): Hybridization with Blue-winged Warbler may be causing range shifts and contribute to overall decline of the Golden-winged Warbler.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	A better understanding of the characteristics of high quality habitat would be valuable, as are optimal management activities. Audubon VT and NRCS are working together to answer these questions.
Research	Distribution and Abundance	High	Because habitat is transitory and song is not necessarily a good indicator of presence (because of hybridization) there is a need to characterize the species' distribution in the State. Audubon VT is currently doing some of this work.
Research	Threats and Their Significance	High	Understanding effects of cowbirds, BWWA, development, and succession are necessary to manage and conserve the species in VT.
Research	Population Genetics	Medium	Quantifying the genetic "pureness" of the VT population would be valuable, especially understanding N-S variation. Hybridization likely a factor.
Monitoring	Population Change	High	Knowing how long a patch remains suitable would be useful, as is knowing how long after management GWWA will return to a site. Additionally, understanding how species reacts to BWWA presence and BHCO parasitism would also be helpful.
Monitoring	Habitat Change	Medium	Quantify the relative importance of succession and development.
Monitoring	Range Shifts	Medium	Determine if the species being pushed northward in VT as a result of hybridization and genetic swamping by Blue-winged Warbler
Monitoring	Monitor Threats	Medium	Monitor the effects of Blue-winged Warbler, development, succession, and Brown-headed Cowbird . In particular better information about current limiting factors to habitat (development versus succession). Periodic assessment (5 year?) of early successional acreage in Vermont, possibly through GIS analysis.

Common Name: **Golden-winged Warbler**
Scientific Name: **Vermivora chrysoptera**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Stabilize or reverse declining population trend for GWWA through habitat management via NRCS, USFWS funds, and private and corporate landowners	Population response to management, targeted surveys.	VFWD, NRCS, Audubon VT, VELCO, private & corporate landowners	NRCS, private and other public funding sources (NFWF)
Research	Medium	Determine if there are any habitats that are used solely by GWWA and prioritize for conservation. Research genetics of VT GWWA/BWWA population to determine the level of genetic swamping.	Stable population of GWWA in the presence of BWWA.	UVM, Audubon VT, VFWD.	NFWF. PR, SWG
Awareness Raising and Communications	Medium	Initiate education campaigns highlighting the need for active, even-age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes. Use demonstration sites to educate public and professionals about BMPs.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs	Audubon VT, NRCS, VFWD, Towns, land trusts	Private foundations
Habitat Restoration	High	Establish at least one large (>1000 ha) management area dedicated to early successional species.	Land purchase or conservation easements and dedicated management plan.	VFWD, NRCS, TNC.	SWG, NRCS

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Common Name: **Chestnut-sided Warbler**
Scientific Name: **Dendroica pensylvanica**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? No

Assessment Narrative:

This species is slowly declining in Vermont according to Breeding Bird Survey data. However, it was found widely distributed throughout the state in both breeding bird atlases. Most gains from the first atlas occurred in the Champlain Valley, including the Lake Champlain islands (Renfrew2013) .Shrub habitats are a necessary component for nesting either through succession of agricultural fields or periodic active forest management.

Distribution

Found in all regions of the state with increases noted mainly in the northern part of the Champlain Valley. Distribution has remained consistent between the two breeding bird atlases.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Forested or shrubby habitats during migration. The species requires shrubs for nesting mostly in early successional hardwood forests that are 1-3m in height (DeGraaf et. al. 2006). Highly specialized habitat for breeding, confined to early-successional deciduous forest ranging from wet to dry sites. This habitat can be provided using even-aged management, or uneven-aged forest management using group selection tree cutting that promotes shrub development. Not known to use coniferous forest habitats.

Common Name: **Chestnut-sided Warbler**
Scientific Name: **Dendroica pensylvanica**
Species Group: **Bird**

Habitat Types:

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): Loss of successional habitats due to conversion to non-forested uses and suppression of natural disturbance (flood, fire), and reductions in active forest management.

Non-Habitat Threats:

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Some indications that Lepidoptera larvae reductions due to pesticides and biological controls can decrease productivity.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Basic Life History	Medium	Basic research on breeding activities is needed, particularly to determine trends in re-nesting and lifetime broods/reproductive success

Common Name: **Chestnut-sided Warbler**
Scientific Name: **Dendroica pensylvanica**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative (modeled on NH's Small Landowner Grant program). Fund for > $50,000/yr with revenues from state lands forest management. This could offset landowner EQIP obligations.	Level of funds raised.	FWD	SWG
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	VFWD, USFS, USFWS	SWG, PR
Habitat Restoration	High	Stabilize or reverse declining population trend for Chestnut-sided warblers to realize and maintain a survey value of 14-15 per BBS route or between 120,000 to 180,000 individuals (Rosenberg 2004).	Population response to management, BBS surveys.	Audubon, VFWD	PR, EQIP
Habitat Restoration	Medium	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, VT Loggers	PR, EQIP

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Common Name: **Black-throated Blue Warbler**
Scientific Name: **Dendroica caerulescens**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

BBS survey trends variable by time period. Survey-wide, significant positive long- (1966-2012, +2.26%) and short-term trends (2002-2012; +3.77%). Vermont shows non-significant increases in both long- and short-term periods. Slight (3%) increase in number of blocks with breeding evidence between first and second breeding bird atlases. Population likely secure. Primary breeding ground limiting factors result from consequences of fragmentation (by permanent land use changes) on reproductive success. Because winter range is restricted to the Caribbean, there is some concern over the effects of deforestation on these islands, particularly the Greater Antilles.

Distribution

From Kibbe (1985).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Large, continuous tracts of undisturbed deciduous or mixed deciduous/coniferous forests, often in hilly or mountainous terrain (Holmes 1994). " Uneven aged timber harvest methods such as selection or group cuts can effectively mimic the natural disturbance regime and seem to be compatible with Black-throated Blue Warbler conservation" (Burdett and Niemi 2003).

Habitat Types:

Northern Hardwood

Current Threats

Habitat Threats:

Conversion of Habitat

Common Name: **Black-throated Blue Warbler**
Scientific Name: **Dendroica caerulescens**
Species Group: **Bird**

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Productivity and density decrease in forest fragments. Susceptible to parasitism by Brown-headed Cowbirds in these forests when located in predominately agricultural landscapes. Habitat conversion through development or habitat alteration from clearcutting can limit species. Conversely, as forest regenerates from abandonment of agricultural lands, additional habitat will become available through succession.

Species susceptible to decreased overwinter survival rates with El Niño cycle droughts in the Caribbean (Sillett et al. 2000). Some evidence that ENSO cycles are becoming more extreme. Simulations of range shift in response to climate change suggests extirpation from Vermont by 2080 (National Audubon Society 2014).

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	Medium	1) Compare changes in population trends across BBS routes in areas with different land use patterns. 2) More information is neede on distribution and overwinter survival in disturbed habitats on wintering grounds.
Research	Threats and Their Significance	High	Effects of fragmentation on breeding season productivity, particularly the effects of predation and cowbird parasitism should be further researched. Landscapes dominated by contigous forests have not consistently shown increased predation trends associated with relatively temporary disturbances, such as timber harvests; "It is critical to better comprehend the complex relationships that exist between nest predation, habitat fragmentation, and landscape context." (Burdett and Niemi 2003).
Monitoring	Population Change	Medium	A better assessment of population trends across a variety of landscape types is needed.
Monitoring	Habitat Change	High	1) Better information on land use change in Vermont would help concentrate development in areas that would be less likely to affect forest interior species. Trends in rate of forest loss and fragmentation across range should be investigated. 2) Continue to monitor populations at Hubbard Brook Experimental Forest (unfragmented), unevenaged-managed forests, and forest fragments in Vermont to better assess the effect of patch size and management on population trends using a source-sink framework

Common Name: **Black-throated Blue Warbler**
Scientific Name: **Dendroica caerulescens**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	Medium	Where timber resource extraction and/or other habitat management goals requiring timber cutting are desired, uneven aged management, using selection harvests, should be employed on a portion of public lands	Amount of public forests designated for unevenaged management.	ANR, USFS, USFWS	SWG, PR
Habitat Restoration	Medium	Identify contiguous forests blocks w/mature components & encourage their conservation via easements or other financial incentives on private lands. Conserve contiguous forest blocks on public lands via appropriate long-range management plan designations.	Number and distribution of core forest blocks conserved on private and public lands.		

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Strong, A. 2013. The Second Atlas of Breeding Birds of Vermont. R. Renfrew, ed. University Press of New England, Hanover and London. 548pp.

Common Name: **Prairie Warbler**
Scientific Name: **Dendroica discolor**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3B
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

BBS trend for eastern region, 1966-2012 = -2.04 and 2002-2012= -1.07. Significant declines in the US per BBS data 1966 -2012; less significant decline 2002-2012. Distribution during first Vermont Bird Atlas was limited to the eastern foothills but shifted in large part to the southern Champlain Valley during the second Vermont Breeding Bird Atlas. Second Breeding Bird Atlas showed a 66% increase in priority block occupancy (4 blocks to 7).

Distribution

Rare breeder in southern Champlain Valley and northern CT River drainage.

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Probable
Champlain Hills	Probable	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Breeding habitat of early successional hardwood forest regeneration, old field, shrub/dune, upland shrub habitats; prefers open canopy (however uses closed canopy palustrine forest in Mid-Atlantic breeding areas). Utilizes, powerline corridors, Christmas tree farms and gravel pit/mine shrub habitats.

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Prairie Warbler**
Scientific Name: **Dendroica discolor**
Species Group: **Bird**

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s): Succession of old field habitats and forest maturation have caused habitat decline in parts of Vermont.

Non-Habitat Threats:

Parasites

Description of non-habitat threat(s): Parasitized by brown-headed cowbird.

Common Name: **Prairie Warbler**
Scientific Name: **Dendroica discolor**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Effects of land management practices on nest site selection and productivity/mortality
Research	Basic Life History	Medium	More comprehensive breeding ecology information.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Determine appropriate old field habitat targets for state and private lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	Audubon, VFWD, NRCS, Ruffed Grouse Society, Wild Turkey Federation	PR, EQIP, private grants, power companies
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, management on public and private lands to create and maintain early successional shrubland habitat for the suite of shrubland birds.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	VFWD, Audubon, NRCS, VCE, power companies	PR, EQIP, Private grants, Power companies

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Bay-breasted Warbler**
Scientific Name: **Dendroica castanea**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S1B
Extirpated in VT? No
Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Breeding evidence documented in three priority blocks during the first breeding bird atlas and four blocks during the second atlas, none of which were the same between atlases. Only three confirmed breeding records for the state. Breeding Bird Survey results are not available for Vermont. The species' trends are variable across regions. However, analyses of population trends from Canada (which supports 98% of the breeding population) suggests 3-5%/year declines depending on the time period analyzed (Venier et al. 2011).

Distribution

First breeding confirmation was near Sable Mountain, Granby (1980). Subsequently confirmed nesting at Wenlock Wildlife Management Area, Ferdinand (1987) and Brighton State Park, Brighton (1995) and four blocks during the second atlas.

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Unknown
Northern Green Mtns	Confident	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Mainly breeds in dense, boreal forests of mature spruce and fir; also inhabits old mixed-wood stands and prefers moist, swampy areas to dry, upland locations. (Mayasich and Niemi 2002). Dramatic increases reported in response to outbreaks of spruce budworm (Choristoneaura fumiferana)."Foraging microhabitat preferences are the inner portions of mid-level branches that are among the large lichen-covered (scant foliage) limbs of conifers; also the inner portions of conifer branches among the dead limbs at lower heights." (Mayasich and Niemi 2002).

Common Name: **Bay-breasted Warbler**
Scientific Name: **Dendroica castanea**
Species Group: **Bird**

Habitat Types:

Spruce Fir Northern Hardwood

Softwood Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Fragmentation

Description of habitat threat(s): Some suggestion that Bay-breasted Warblers are susceptible to habitat conversion of wintering ground habitat. Additionally, conversion of natural forests to plantations of black spruce (Picea mariana) and jack pine (Pinus banksiana) plantations decrease habitat quality as these species are less susceptible to spruce-budworm (a key food resources for the Bay-breasted Warbler) outbreaks. Loss and fragmentation of late successional, lowland spruce-fir forest; management practices that favor short-cutting cycles preventing establishment of late successional habitat.

Description of non-habitat threat(s): Possible impacts from aerial spraying for spruce budworm (declines following application of organophosphate insecticides documented in New Brunswick in 1970s)

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Specific habitat association in VT needs better documentation
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Not well documented in VT. A targeted survey of this and other late successional, lowland boreal forest birds is needed. Virtually no information exists now.
Research	Threats and Their Significance	High	Need to understand landscape level limiting factors (primarily via timber harvesting) to persistence of late successional, lowland boreal forests and population biology of this species
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	Traditional monitoring methods (BBS, VT Forest Bird Monitoring Program) do not adequately cover this species. Need to document trends in VT via a targeted survey of lowland boreal forests.
Monitoring	Habitat Change	High	Need to understand landscape level changes and limiting factors (primarily via poorly-planned timber harvesting) to persistence of late successional, lowland boreal forests. Quantify extent of current suitable breeding habitat.
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	Medium	

Common Name: **Bay-breasted Warbler**
Scientific Name: **Dendroica castanea**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Publically-Owned Protected Areas	Medium	Identify potential areas on public lands for designation as reserve or no-cut status (including some areas where wildfires and insect outbreaks would not be controlled).	Number of sites and total area of designated reserves.	ANR, USFS, USFWS, UVM, TNC	SWG, PR
Habitat Restoration	Medium	Apply increased rotation ages to some managed spruce-fir forests on public lands.	Number of sites and total area with increased rotation ages.	ANR, USFS, USFWS	SWG, PR
Species Restoration	Medium	Determine current management regimes, and ensure that overall management is compatible with goal of maintaining or increasing current population levels. No PIF target was set for VT as "Population numbers are unavailable at this time" (Rosenberg 2004).			

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Common Name: **Blackpoll Warbler**
Scientific Name: **Dendroica striata**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 | **Global Trend:**
State Rank: S4S5B | **State Trend:** Declining
Extirpated in VT? No | **Regional SGCN?** No

Assessment Narrative:

The breeding distribution for Blackpoll Warbler appears to not have changed much in last 25 years. However, data indicates significant changes within the distribution have occurred. This is also the case in Vermont. The species occupied 33 priority 1 blocks during the first Vermont atlas (1982) and 28 priority 1 blocks during the second atlas (2013). But during that interval, priority block gains numbered 8 while losses numbered 13. Blackpolls are found largely among the high elevation spruce-fir forests of the Green Mountains. Elevations greater than 2800 feet most often provide the greatest area of montane forest, the blackpoll's preferred habitat. Although the population appears to have been static during the last 30 years threats such as habitat loss to human development and accumulated environmental toxins such as mercury are likely an important factor in the species' long-term status. Current climate change models project the warbler's preferred montane forest habitat will decrease in size as it recedes northward. This suggests a seriously imperiled future for the species.

Distribution

This species is a high elevation species that breeds above 2800 feet in Vermont. It is detected throughout Vermont during spring and fall migration. Recent work by VCE biologists and biologists in Nova Scotia used geotrackers to show these birds fly non-stop over the Atlantic Ocean an average of 2540 km to the Greater Antilles or the northeastern coast of South America.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

In Vermont Blackpoll Warblers breed in dense thickets within montane forests dominated by balsam fir, with lesser amounts of spruce, white birch, and mountain ash.

Habitat Types:

Spruce Fir Northern Hardwood

Early Succession Spruce-Fir

Common Name: **Blackpoll Warbler**
Scientific Name: **Dendroica striata**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Audubon's climate model suggest that this species will be effected by climate change as the spruce-fir habitat is shifting upslope, requiring the and the species breeding range to contract or shift north. Other potential problems include loss and fragmentation of montane forests from ski area, wind power and telecommunications development. Collision mortalities have been documented with wind energy facilities and telecommunication towers.

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Description of non-habitat threat(s): Atmospheric pollution, including airborne mercury, could impact the species directly, as well as damage its habitat. Collision mortalities have been documented with buildings.

Common Name: **Blackpoll Warbler**
Scientific Name: **Dendroica striata**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Habitat needs reasonably well known, although population structure in different sub habitat types (krummholz, regenerating chronically disturbed forests, taller stature and more open forests, transitional spruce-fir-birch forests) not well known.
Research	Basic Life History	High	Demographics and breeding success need more study, especially in different sub habitat types.
Research	Distribution and Abundance	Medium	Fairly well known, although relative abundance in different sub habitat types needs to be better quantified. Conduct research that will enable robust predictions of breeding densities in different sub-habitat types, which can be extrapolated across breeding range to derive population estimates. Documenting shift range may be necessary if climate change has a big impact on Vermont's high elevation habitat.
Research	Threats and Their Significance	High	1) Species' susceptibility and response to habitat fragmentation and conversion from development (ski area, wind turbines, telecommunications facilities) needs to be better understood. Evaluate impacts of human development (ski area expansion/construction, wind power, telecommunications facility) on montane forest habitat, and use results to guide future development. 2) Impacts of atmospheric pollutants (e.g. mercury) and possible role of calcium depletion should be studied.
Research	Population Genetics	Low	Genetic structure of breeding populations in Northeast, and relation to core breeding populations in Canada interesting, but probably not crucial for conservation.
Research	Taxonomy	Low	Genetic structure of breeding populations in Northeast, and relation to core breeding populations in Canada interesting, but probably not crucial for conservation.
Monitoring	Population Change	High	Species poorly monitored by traditional methods like BBS. VCE Mountain Birdwatch program monitors adequately, but must be maintained for long-term. Very important to monitor this species as an avian indicator of montane forests. Continue long-term monitoring at a minimum of 15-20 sites in VT to document population trends. Support for gathering data form citizen scientists important.
Monitoring	Habitat Change	High	Important to document habitat changes in concert with population changes.
Monitoring	Range Shifts	Medium	This should be covered by a regional monitoring program (i.e. Mountain Birdwatch).
Monitoring	Monitor Threats	Medium	Important to monitor limiting factors like development, atmospheric pollution, mercury burdens, climate change, impacts of collisions.

Common Name: **Blackpoll Warbler**
Scientific Name: **Dendroica striata**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Planning & Zoning	Medium	Develop a planning process whereby explicit mitigation and management guidelines are specified. Further develop a means to ensure that these are followed, and results monitored, both in short- and long-term.			
Research	High	Monitor development, atmospheric pollution, mercury burdens, climate change, impacts of collisions.		VCE, Audubon, BOVM, FWS	SWG
Habitat Restoration	High	Identify 10-15 core breeding sites and ensure that a long-term protection plan exists for each.	The number of sites protected		

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Common Name: **Cerulean Warbler**
Scientific Name: **Dendroica cerulea**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4
Global Trend:
State Rank: S1B
State Trend: Declining
Extirpated in VT? No
Regional SGCN? Yes

Assessment Narrative:

Strong significant long-term decline (-4.2%) based on survey-wide BBS data. No data from Vermont.

Historic population at the mouth of the Lamoille River appears to be extirpated. In 2002-2004, singing males have been located in Niquette Bay State Park, Highgate, and near Colchester Pond. More populations may be discovered as Vermont's forests continue to mature (and the second breeding bird atlas is completed), however declines throughout its range suggest that this species will never be common in Vermont. Preliminary survey data from the wintering range suggest that it can be found in a diversity of forest types in Columbia, Venezuela, Ecuador, and Peru (Hamel 2000).

Distribution

Data from Ellison (1985).

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Unknown
Champlain Hills		Vermont Valley	Unknown
Northern Green Mtns	Unknown	Southern Green Mtns	Unknown
Northern VT Piedmont	Unknown	Taconic Mtns	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

As summarized by Hamel (2000), this species requires a closed canopy, presence of scattered tall, old growth canopy trees, and distinct layering of foliage from ground cover to canopy. Area sensitivity varies by area with minimum patch size 20-30 ha in Ohio to 700 ha in Middle Atlantic States to 1,600 ha in the Mississippi Alluvial Valley, but breeding occurs in 10 ha patches in Ontario (summarized by Hamel 2000).

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Common Name: **Cerulean Warbler**
Scientific Name: **Dendroica cerulea**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Fragmentation

Description of habitat threat(s): Area sensitive in parts of its range, suggesting fragmentation a problem to population. Development or harvest of mature upland forests will decrease available habitat.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Species has been relatively well-studied on its breeding range, including recent studies from Ontario. However, better summaries of this information may lead to directed searches for new populations in Vermont. Better information about habitat requireme
Research	Basic Life History	Medium	Also relatively well-studied, however more information about non-breeding social system, particularly as to whether or not they are an obligate flock follower.
Research	Distribution and Abundance	High	1) Directed surveys in Vermont are necessary to better understand their present status in the state. 2) Better information on distribution in Vermont will be critical to conserving the species and predicting future distribution. Intensively monitor (as le
Research	Threats and Their Significance	Low	Presumably habitat quality in Vermont will increase as forests mature. However, some information on minimum patch size would help in understanding the effects of development.
Monitoring	Population Change	High	Population trends in Vermont will be difficult to assess without more information on distribution. But all known local populations should be carefully monitored.
Monitoring	Habitat Change	Low	As forest regenerates from abandonment of agricultural lands, habitat will become available through succession. Population response of CERW will be difficult to assess. Forest growth models might be useful in helping to predict future occurrences in the s

Common Name: **Cerulean Warbler**
Scientific Name: **Dendroica cerulea**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Identify contiguous forests blocks w/mature components & encourage their conservation via easements or other financial incentives on private lands. Conserve contiguous forest blocks on public lands via appropriate long-range management plan designations.	Number and distribution of core forest blocks conserved on private and public lands	ANR, USFS, USFWS, VHCB, VLT, TNC	SWG, PR, VHCB
Easements	Medium	Maintain of large forest tracts, particularly in Champlain Valley and Taconic regions.	Maintenance of large forest tracts, particularly in Champlain Valley and Taconic regions.	TNC, VFWD, Forest Legacy program	TNC

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Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S4B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

In Vermont the results from the second Breeding Bird Atlas indicate this bird is declining in Vermont. Block occupancy dropped 31% between the Atlases. Regional atlases and breeding bird surveys have also demonstrated a decline throughout the region over the past 30 years. As the climate and the forests change this species may be at a greater risk, not only on its breeding grounds, but also on its wintering grounds.

Distribution

Canada Warblers are found throughout Vermont. The Canada Warbler is considered a neotropical migrant and migrates migrates form its breeding grounds to northern South America

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

A wide range of coniferous and deciduous forests, and mixed forests at all elevations, but especially mid-slopes in Green Mountains. Uses both mature and regenerating forest. Seem to prefer a dense understory with moss, and an uneven forest floor. Hummocks, roots, and debris are used to hide the nest and fledglings. Clearcuts and shelterwood cuts received more use than mature forest in northern New Hampshire. First appear in clearcuts 5 years after harvest, become common after 15 years and remain abundant until the next cutting cycle.

Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Softwood Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Forest succession, loss of forested wetlands, and development all may influence suitable nesting sites. Climate change may alter the plant structure increasing the likelihood that the birds move further north (and out of Vermont to breed). Significant problems may occur on South American wintering grounds (mid-slope of Andes Mts)

Non-Habitat Threats:

Trampling or Direct Impacts

Pollution

Description of non-habitat threat(s): Atmospheric pollution, including airborne mercury, could impact the species directly, as well as damage its habitat. Although not well documented, collisions with glass buildings and wind towers can be a source of mortality for migrating, especially with birds that migrate at night

Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S4B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

In Vermont the results from the second Breeding Bird Atlas indicate this bird is declining in Vermont. Block occupancy dropped 31% between the Atlases. Regional atlases and breeding bird surveys have also demonstrated a decline throughout the region over the past 30 years. As the climate and the forests change this species may be at a greater risk, not only on its breeding grounds, but also on its wintering grounds.

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Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

A wide range of coniferous and deciduous forests, and mixed forests at all elevations, but especially mid-slopes in Green Mountains. Uses both mature and regenerating forest. Seem to prefer a dense understory with moss, and an uneven forest floor. Hummocks, roots, and debris are used to hide the nest and fledglings. Clearcuts and shelterwood cuts received more use than mature forest in northern New Hampshire. First appear in clearcuts 5 years after harvest, become common after 15 years and remain abundant until the next cutting cycle.

Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Softwood Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Forest succession, loss of forested wetlands, and development all may influence suitable nesting sites. Climate change may alter the plant structure increasing the likelihood that the birds move further north (and out of Vermont to breed). Significant problems may occur on South American wintering grounds (mid-slope of Andes Mts)

Non-Habitat Threats:

Trampling or Direct Impacts

Pollution

Description of non-habitat threat(s): Atmospheric pollution, including airborne mercury, could impact the species directly, as well as damage its habitat. Although not well documented, collisions with glass buildings and wind towers can be a source of mortality for migrating, especially with birds that migrate at night

Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	These are reasonably well known overall, but important to understand ecological and demographic differences in core populations that inhabit in prime habitats vs. smaller, more peripheral populations in patchy, secondary habitats
Research	Basic Life History	High	Nest success and productivity are poorly understood, as is age structure of populations in different habitat types. Need to understand demographics in secondary habitats (i.e. small patches) vs. those in core habitats
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Need continued research on effects of forestry practices on populations in both prime and secondary habitats. Research on effects of climate change.
Research	Taxonomy	Low	Taxonomic research led to the recent name change.
Monitoring	Population Change	High	Need to ensure a long-term monitoring program that adequately samples this species, to clearly document declines or increases. Support of Vermont ebird for gathering data from citizen scientists important.
Monitoring	Habitat Change	High	Important to know how species responds to both natural and human-caused habitat changes
Monitoring	Range Shifts	Medium	Ability to shift range may be necessary if climate change has a big impact on Vermont forests
Monitoring	Monitor Threats	medium	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Design and implement forest management strategies to enhance habitat suitability.	Area of potential habitat with long-range management plans which provide for beneficial forms of active forest management.	VFWD, USFS, USFWS	SWG, PR
Planning & Zoning	Medium	Conserve large tracts of core breeding habitats (mid-slope mixed forests, cedar swamps, red maple-conifer swamps).	Number of large forest tracts conserved via public ownership, easements, or town planning/zoning	ANR, USFS, USFWS, Town and RPCs	SWG, PR

Common Name: **Canada Warbler**
Scientific Name: **Wilsonia canadensis**
Species Group: **Bird**

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Common Name: **Eastern Towhee**
Scientific Name: **Pipilo erythrophthalmus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S5B	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Species declining across region due to conversion of necessary early successional/shrub dominated habitats to either non-forest condition or via maturation of forest cover to an unsuitable forest age structure.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills		**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Early-successional/shrub/edge habitats, both mesic and xeric, characterized by dense shrub-small tree cover near ground and well-developed litter layer. Cover may be continuous or discontinuous patches interspersed w/in more open ground. Overstory trees may or may not be present, however open-canopied woodlands are favored over closed canopy coverage.

Habitat Types:

Shrub Swamps

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Common Name: **Eastern Towhee**
Scientific Name: **Pipilo erythrophthalmus**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Description of habitat threat(s):

Description of non-habitat threat(s): Possible nest parasitism by cowbirds.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Basic Life History	High	Studies on reproductive success and demography especially desireable in northeastern U.S. To acquire baseline data via marked birds.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative (modeled on NH's Small Landowner Grant program). Fund for > $50,000/yr with revenues from state lands forest management. This could offset landowner EQIP obligations.	Level of funds raised.	FWD	SWG, PR
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes.	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.	VCE, VA, USFS	SWG, PR
Habitat Restoration	Medium	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon, Forest Products Association, VT Loggers	PR, EQIP

Common Name: **Eastern Towhee**
Scientific Name: **Pipilo erythrophthalmus**
Species Group: **Bird**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Field Sparrow**
Scientific Name: **Spizella pusilla**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Significant long-term population declines in Vermont of 5.3 percent annually 1966-2003, and 4.3 percent annually in the ten years following the first SWAP, 2004-2013 (Sauer et al. 2014). Atlas block occupancy declined by 39% between the first (1979-85) and second (2003-07) Vermont breeding bird atlases (Renfrew 2013).

Distribution

Widely distributed in eastern and western Vermont on either side of the Green Mountains, except in the Northeastern Highlands (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Grasslands with scattered, shrubby vegetation with elevated perches. Habitat declines as woody encroachment progresses. Can be found in orchards and Christmas tree farms (Carey et al. 1994). Areas close to suburban development are avoided (Carey et al. 2008). In Vermont, often found in overgrown meadows dominated by juniper (Renfrew 2013).

Habitat Types:

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Common Name: **Field Sparrow**
Scientific Name: **Spizella pusilla**
Species Group: **Bird**

Description of habitat threat(s): Primary problems to the species are likely due to succession of old fields and conversion of agricultural habitat to urban/suburban development.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): Parasitism is a possible limiting factor, more information needed.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	A better understanding of optimal stem densities and mowing rotations would inform specific management strategies. Better habitat-specific demographics would enable a more thorough understanding of when and why habitat decreases in quality for FISP.
Research	Threats and Their Significance	Medium	Species could be heavily parasitized by cowbirds. More intensive demographic data would elucidate BHCO limiting factor.
Monitoring	Population Change	High	Improved monitoring would elucidate population distribution and trends. A BBS-type survey route for early successional species could help monitor FISP, BWWA, GWWA, BRTH, PRAW, etc.

Common Name: **Field Sparrow**
Scientific Name: **Spizella pusilla**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Finance	Medium	Create a state-funded, private lands, early successional habitat improvement initiative (modeled on NH's Small Landowner Grant program). Fund for > $50,000/yr with revenues from state lands forest management. This could offset landowner EQIP obligations.	Level of funds raised.	VFWD	PR
Habitat Restoration	High	Stabilize declining population trend for Field Sparrows.	Population response to management, BBS surveys.	VFWD, NRCS, TNC.	NRCS
Awareness Raising and Communications	Medium	Initiate public education campaigns to highlight the need for active, even age forest management on public and private lands to create and maintain seedling/sapling forest habitat complexes	Number of media outlets reached, number of audiences reached, number of media products developed, number of participants in programs.		
Habitat Restoration	High	Determine appropriate old field habitat targets for state lands and restore and maintain old field habitats where needed to increase suitable ES songbird habitat.	Number of acres positively affected by management. Population response to management.	ANR, USFS, Audubon-VT, Forest Products Association, VT Loggers	PR, EQIP

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Common Name: **Vesper Sparrow**
Scientific Name: **Pooecetes gramineus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

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In Vermont a 10.9 percent per year decline in 1966-2003, and losses of 7.2 percent annually in the decade since the first SWAP, 2004-2013 (Sauer et al. 2014). Vermont atlas block occupancy declined from 35 to 11 (69%) from the first (1979-85) to second (2003-07) atlas (Renfrew 2013). Also long-term decline survey-wide (Sauer et al. 2014). The generally small size of farming operations in VT seem as though they should create sufficient habitat to support a larger population in the state. The relative rarity of this species suggests that their habitat requirements may be somewhat more specialized than currently understood.

Distribution

An uncommon breeder in Vermont that is sparse and widely distributed. Most records are from the southwestern Champlain Valley (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Unknown
Northern Green Mtns	Probable	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Unknown
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Breeds in dry, open habitats with short, sparse, and patchy herbaceous vegetation; some bare ground; and low to moderate shrub or tall forb cover. In the East, suitable habitats include reclaimed surface mines, crop and haylands, weedy roadsides, natural meadows, and grasslands (Jones and Cornely 2002). In Vermont, suitable habitat generally occurs in agricultural and other human-modified landscapes such as airports, and should be at least 20 hectares (Renfrew 2013).

Common Name: **Vesper Sparrow**
Scientific Name: **Pooecetes gramineus**
Species Group: **Bird**

Habitat Types:

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Grasslands, Hedgerows, Old Field, Shrub, or Orchard

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Description of habitat threat(s): Early hay harvest and more intensive management of other row crops substantially reduces nesting success. Conversion of agricultural habitats to urban/suburban development also a problem. Old field succession and farm abandonment also decreasing habitat availability.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Better information about precise habitat requirements, in particular nest site selection would be helpful for ascertaining potential habitat and developing management recommendations.
Research	Distribution and Abundance	High	Conduct focused surveys, including in areas where they were found during the second atlas, to obtain better information about population distribution in VT.
Monitoring	Population Change	High	Population monitoring, particularly in response to changing agricultural and development practices.
Monitoring	Habitat Change	Medium	Understanding habitat-specific demographic parameters would help us assess management options.

Common Name: **Vesper Sparrow**
Scientific Name: **Pooecetes gramineus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and general public about grassland birds and management options to protect habitat.	Develop a grassland bird outreach program	VFWD, Audubon-VT, VCE, UVM	SWG, PR
Market Forces	Medium	Enroll land into EQIP, CRP Grassland as well as FRPP programs to reduce the Impact of development on this species.		NRCS, VHCB	NRCS
Conservation Payments/Financial Incentives	Medium	Conserve grassland/shrubland habitats on private lands.	Number and total area of sites conserved.	USDA, USFWS, VHCB	FSA, SWG, VHCB

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Common Name: **Grasshopper Sparrow**
Scientific Name: **Ammodramus savannarum**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S2B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Currently listed as Threatened in Vermont. Species has declined throughout region due primarily to loss of grassland habitat and agricultural intensification (early mowing regimes). BBS data show a significant long- (1966-2012; -2.86%/year) and short-term (2002-2012; -2.79%). The species is too rare to assess trends in Vermont; data from the second breeding bird atlas showed a 75% decline in number of blocks with breeding evidence, but the sample size is small (4 blocks to 1 block; Renfrew 2013). Only two or three locations in Vermont consistently support more than a few breeding pairs.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Unknown
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Grasslands, pastures, old fields and airports with minimal grass and litter cover and patches of bare ground. Specific habitat use patterns vary geographically (Vickery 1996). In most locations the species is area-sensitive, with occupancy significantly reduced in patches less than 30 ha (Vickery et al. 1994).

Habitat Types:

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Other Cultural

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Common Name: **Grasshopper Sparrow**
Scientific Name: **Ammodramus savannarum**
Species Group: **Bird**

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Direct loss of nesting habitat due to habitat conversion and agricultural intensification (mowing regimes)

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Early and frequent mowing regimes directly impact nesting and reproductive success. Insufficient information on statewide population size.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Determine habitat requirements specific to Vermont
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Accurately determine population size and location of breeding pairs statewide
Research	Threats and Their Significance	High	Determine impacts of habitat loss and agricultural practices on distribution and nesting success.
Research	Population Genetics	Low	
Monitoring	Population Change	High	Accurately determine population size and trend information throughout the state an particularly at known nesting locations (airports).
Monitoring	Habitat Change	High	Determine statewide changes in grassland habitats and agricultural practices. Identify habitat changes at known nesting locations (airports)
Monitoring	Monitor Threats	High	Monitor limiting factors at current nesting locations (airports) including habitat loss due to development of the site and mowing prcatices.

Common Name: **Grasshopper Sparrow**
Scientific Name: **Ammodramus savannarum**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Educate agricultural community and individuals with grasslands about grassland birds and management options.	Development of a grassland bird outreach program	VFWD, Audubon-VT, VINS, UVM	
Protected Area Management	High	Maintain nesting habitat throughout breeding season by developing site-specific conservation plans which include restricting field mowing until after July 15th on publicly owned lands (WMAs and state airports)	Maintain and increase current acreage under management on state lands	VFWD, Audubon-VT, NRCS, Vtrans	VFWD, Vtrans
Conservation Payments/Financial Incentives	High	Maintain nesting habitat throughout breeding season by restricting field mowing until after July 15th	Increase protection of available habitat through enrollment in EQIP and CRP Grassland	VFWD, Audubon-VT, NRCS	
Habitat Restoration	High	Maintain grassland habitat in suitable locations through active management of woody vegetation within Grassland Bird Focus Areas.	Increase and maintain available habitat in suitable locations	VFWD, private landowners	
Conservation Payments/Financial Incentives	High	Protect privately owned known nesting sites and suitable grassland habitat from development and agricultural intensification by creating Grassland Bird Focus Areas to concentrate management efforts (see the Vermont Grassland Bird Management Plan).	Development of Grassland Bird Focus Areas and increase protection of available habitat through enrollment in EQIP and CRP Grassland.	VFWD, Audubon-VT, NRCS, private landowners	USFWS
Conservation Payments/Financial Incentives	High	Maintain large tracts (> 100 acres) of suitable grassland habitat for entire suite of grassland bird species.	Increase protection of available habitat through enrollment in EQIP and CRP Grassland	VFWD, Audubon-VT, NRCS	

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Common Name: **Bobolink**
Scientific Name: **Dolichonyx oryzivorus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S5B **State Trend:** Declining
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Significant long-term population declines both in VT and survey-wide. Although Vermont atlas block occupancy changed little (Renfrew 2013), abundance declined by 2.6 percent annually from 1966 to 2003, and 2.4 percent per year since the first SWAP, 2004-2013 (Sauer et al. 2014). Much of VT hayed grasslands are likely population sinks. Main threats are loss and degradation of quality habitat, including fragmentation, due to field succession and conversion to development after farms are lost, and intensive management of hay fields (more frequent mowing).

Distribution

Distributed throughout Vermont, most abundant in lowlands of Champlain Valley, less so in other areas of the state in open landscapes that include fields not under intensive rowcrop production.

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Confident
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Grasslands, primarily managed for hay or to a lesser extent, low-intensity grazing. Generally avoids alfalfa, row crops, and grass habitats with standing water. More common in larger (> 5ha), more blocky (as opposed to linear) fields, and in relatively less forested landscapes with large expanses of grassland habitat. Social attraction also plays a role in habitat selection.

Habitat Types:

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Common Name: **Bobolink**
Scientific Name: **Dolichonyx oryzivorus**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Greatest problems are the frequency and timing of hayfield mowing, the succession of agricultural land, and the conversion of agricultural land to development. Fragmentation of grasslands limits patch size and openness of landscape, which is important for nesting Bobolinks. Bobolink distribution expected to shift northward due to climate change, although models need to be refined. Takeover of hayfields and other grasslands by exotic plants such as parsnip and chervil renders habitat unsuitable

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Predation or Herbivory

Description of non-habitat threat(s): Pesticides on migration and wintering grounds, predation of eggs and nestlings, direct mortality from mowing

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Threats and Their Significance	Medium	1) Demographic model of climate change impacts to predict future distribution. 2) Determine relative contribution of seasonal survival of juveniles and adults, and immigration/emigration, to improve assessments of relative importance of productivity and survival in determining population size
Research	Other Research	High	Determine most effective use of resources to maximize acreage of quality nesting habitat using combination of approaches for different types of landowners and interests.
Monitoring	Population Change	High	Determine if the Champlain Valley is a source or sink for Bobolink.
Monitoring	Habitat Change	High	Better information is necessary regarding the timing of hay mowing in landscapes with various proportions of agriculture throughout VT.

Common Name: **Bobolink**
Scientific Name: **Dolichonyx oryzivorus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Easements	Medium	Reduce the amount of grassland habitat being lost to development through strategic acquisition of grassland easements.	Grassland acreage enrolled in easements	NRCS	NRCS, USDA.
Conservation Payments/Financial Incentives	High	Decrease nest losses due to early mowing regimes on fields used for animal forage via EQIP conservation payments. Continue outreach to landowners about incentive programs	Increase in proportion and total area of grasslands in which hay cutting is delayed.	NRCS, UVM, VCE, Audubon-VT	NRCS, USDA
Species Restoration	High	Implement the Vermont grassland bird management and recovery plan (LaBarr et al. 2013)		VFWD, UVM, TNC, NRCS.	SWG, PR, NRCS
Technical Assistance, Training, Learning Networks	High	Improve outreach to (and exchange of information among) landowners with flexibility (e.g., those primarily interested in preventing succession).	Number of acres under a a late-mowing management regime, number of landowners contacted	UVM, NRCS, Audubon-VT, VCE	NRCS, USDA

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LaBarr, M. L., Strong, A., Renfrew, R., Buck, J. and S. Parren. 2013. The Vermont Grassland Bird Management and Recovery Plan. Vermont Fish and Wildlife Department, Montpelier, Vt.

Common Name: **Eastern Meadowlark**
Scientific Name: **Sturnella magna**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S5B
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Upgraded from medium to high priority. One of the most severely declining population trends of grassland bird species throughout its range. In Vermont Eastern Meadowlark populations have declined by 9.6 percent annually from 1966 to 2003 (Sauer et al. 2014), and since the first SWAP, meadowlarks have disappeared from much of Vermont except in the Champlain Valley, which supports most of the remaining population. Between the first and second Vermont Breeding Bird atlas, the species was lost from 63 of 155 (55%) blocks (Renfrew 2013). Regrowth of abandoned farmlands and agricultural intensification resulting in grassland habitat loss, fragmentation, and degradation are the primary causes of declines.

Distribution

Sparsely distributed in relatively large open agricultural (or airfield) areas throughout much of the state, except in the Champlain and Vermont valleys, where it is fairly common in open, agricultural areas with suitable nesting habitat. Nearly absent from southeastern Vermont (Renfrew 2013).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Meadows, old fields, hayfields with thick layer of dead grass. Requires large, open landscapes, large patches of grasslands (>10ha). Can occur at airports with compatible mowing program.

Habitat Types:

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Other Cultural

Common Name: **Eastern Meadowlark**
Scientific Name: **Sturnella magna**
Species Group: **Bird**

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Loss and degradation of habitat due to frequent mowing of hayfields, habitat loss due to succession of farmland to forest, conversion of grassland habitat to development and potentially, solar panel arrays. Takeover of hayfields and other grasslands by exotic plants such as parsnip and chervil renders habitat unsuitable.

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Direct mortality due to mowing.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Other Research	Medium	Determine whether Vermont habitats in the Champlain Valley are sources or sinks
Monitoring	Population Change	High	Species no longer tracked well with BBS methods. Carry out more intensive, standardized monitoring scheme to track population status in the state and determine important breeding areas and compatible management practices.

Common Name: **Eastern Meadowlark**
Scientific Name: **Sturnella magna**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Conservation Payments/Financial Incentives	High	Maintain nesting habitat by delaying mowing until after July 15th	Increased protection of habitat through enrollment in EQIP and CRP Grassland	VFWD, Audubon VT, NRCS	
Technical Assistance, Training, Learning Networks	High	Educate agricultural community, landowners, and general public about grassland birds and management options to protect habitat	Continue grassland bird outreach and networking programs	VFWD, Audubon, VCE, UVM	SWG, PR
Protected Area Management	High	Maintain nesting habitat throughout the breeding season by developing site specific conservation plans which include restricting mowing until after July 15 on publicly owned lands (WMAs, state airports).	Maintain and increase current acreage under management on state and federal lands	VFWD, Audubon-VT, VCE, USFWS NRCS Vtrans	SWG, NRCS
Habitat Restoration	High	Maintain grassland habitat in suitable locations through active management of woody vegetation within focal grassland areas.	Increase and maintain available habitat in suitable locations	VFWD, Audubon-VT, VCE, NRCS, USFWS	USFWS, NRCS
Conservation Finance	High	Decrease nest losses due to early mowing regimes on fields used for animal forage via EQIP conservation payments. Continue outreach to landowners about incentive programs.	Increase in acreage in which hay cutting is delayed.	NRCS, UVM, VCE, Audubon-VT	NRCS
Conservation Finance	High	Focus efforts on relatively large fields (>50 acres) of suitable grassland habitat in open landscapes	Strategic enrollment in EQIP	NRCS	NRCS

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Rusty Blackbird**
Scientific Name: **Euphagus carolinus**
Species Group: **Bird**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3B
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

The continental Rusty Blackbird population has undergone a precipitous decline since the 1966 beginning of the Breeding Bird Survey (BBS) and most significantly in the last 20 years. In eastern North America its decline has been most significant at the southern edge of its breeding range (Maine, New Hampshire, and Vermont). From BBS estimates, Partners in Flight (PIF) estimates there are 5,000,000 Rusty Blackbirds in North America with 20% of them residing in the US. PIF categorizes this estimate as a medium quality. This is likely due to the species' preference for remote boreal coniferous forests near water's edge. The Second Atlas of Breeding Birds of Vermont (2002-07) reported a 26% decline in occupied blocks. The majority of the decline occurred within the Northern Vermont Piedmont biophysical region. In addition to the significant loss of population there is concern among biologists that climate change projections estimate a decline in boreal forest that includes the blackbird's New England habitat. In light of these foreboding estimates Vermont listed the species as endangered in 2014.

Distribution

"Rusty Blackbirds are local and uncommon summer residents of the Northeast Highlands, the North Central region, and the Green Mountains." (Nichols 1985)

Distribution by Biophysical Region:

Champlain Valley	Probable	Southern VT Piedmont	Probable
Champlain Hills	Probable	Vermont Valley	Probable
Northern Green Mtns	Probable	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Wooded swamps, tree-bordered marshes, beaver ponds, boreal bogs and stream borders with alder and willow thickets (DeGraff and Rudis 1986). "Disturbance can be favorable to this species; e.g., nests found in modest openings regenerating from clearcuts (Ellison 1990)" (Avery 1995).

Common Name: **Rusty Blackbird**
Scientific Name: **Euphagus carolinus**
Species Group: **Bird**

Habitat Types:

Hardwood Swamps

Softwood Swamps

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Early Succession Northern Hardwoods

Current Threats

Habitat Threats:

Conversion of Habitat

Description of habitat threat(s): Permanent residence and/or vacation home development on lakeshores/pondshores may reduce available habitat.

Non-Habitat Threats:

Harvest or Collection

Description of non-habitat threat(s): "Substantial mortality to local populations may occur when Rusty Blackbirds are in mixed-species winter roosts subjected to blackbird control in the s. U.S.(Stickley et al. 1986)" (Avery 1995).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Basic Life History	Low	Some evidence of colonial nesting, however nesting by widely-separated individuals seems to prevails in Vermont. Factors governing how habitat might influence whether Rusty Blackbirds nest singly or colonially should be investigated (Avery 1995).
Research	Distribution and Abundance	Medium	More complete surveys of the distribution of breeding Rusty Blackbirds in Vermont are warranted to obtain a better estimate of it's true status.
Research	Threats and Their Significance	Low	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Low	
Monitoring	Monitor Threats	Medium	Shoreline development in the Rusty Balckbird strongholds in Vermont should be monitored.

Common Name: **Rusty Blackbird**
Scientific Name: **Euphagus carolinus**
Species Group: **Bird**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Easements	Medium	Known nesting habitats should be monitored over time to track impacts from development. Easements should be considered to protect important breeding habitats from development. PIF Vermont target population is 226 breeding individuals.	Number of sites identified and conserved.	VFWD, VCE, VA, VHCB	SWG, VHCB
Policy & Regulations	Low	Assist PIF with efforts to reduce mortality from pesticides used on wintering grounds.	Reduction in mortalities due to pesticides	PIF, USFWS	USFWS, USDA, SWG

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Appendix A3

Fish SGCN Conservation Reports

Vermont's Wildlife Action Plan 2015

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G4	**Global Trend:**	Unknown
State Rank:	S1	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Only two sub-populations of Northern Brook Lamprey are known to occur in Vermont, i.e. the Malletts Creek-Indian Brook watershed (Langdon 2014). On a range-wide scale no major threats are known, but the species is vulnerable to local extirpation through indiscriminant use of fish toxicants (COSEWIC 2007; NatureServe 2014). Li et al. (2014) investigated the status of native lamprey populations in the Great Lakes drainage basin where recent declines have been observed and attributed to habitat loss and degradation, anthropogenic stresses, and stream treatment with lampricides. They report that of six species historically found in Pennsylvania streams, current surveys confirmed the presence of four species and absence of two species, including Northern Brook Lamprey, in streams previously known to support them possibly indicating extirpation. The use of lampricides to control Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to Vermont populations. As of yet neither population has been exposed to chemical treatment; however, the U. S. Fish and Wildlife Service recently made it known that it wishes to treat Malletts Creek (Langdon 2015). Northern Brook Lamprey is currently listed as endangered in Vermont, Pennsylvania, Ohio, Indiana and Illinois; and special concern in Minnesota, Ontario and Quebec. Recent research into the genetic relationship between Northern Brook Lamprey and Silver Lamprey seems to indicate that the two species may be ecotypes of one species (Docker et al. 2012), even though each is considered a distinct species in all taxonomic accounts (COSEWIC 2011) and that this convention should remain in place until such time that there is “strong evidence [that] rejects the hypothesis that parasitic and nonparasitic members of a paired species represents distinct species” (Renaud et al. 2009 cited in COSEWIC 2011). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Northern Brook Lamprey occur in the Mississippi and Great Lakes drainages from western New York, Quebec, Ontario, Michigan and eastern Wisconsin; from the north shore of Lake Superior to northern Indiana and Ohio (Scott and Crossman 1973). Only one Northern Brook Lamprey population is known in Vermont. This population is limited to one watershed consisting of Indian Brook and Malletts Creek, both tributaries of Malletts Bay on Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	**Southern VT Piedmont**
Champlain Hills	**Vermont Valley**
Northern Green Mtns	**Southern Green Mtns**
Northern VT Piedmont	**Taconic Mtns**
Northeastern Highlands	

Distribution by Watershed:

Known Watersheds
Winooski River

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Clear streams and small to moderate sized rivers (Scott and Crossman 1973; Smith 1985; Langdon et al, 2006; Morman 1979). The non-parasitic Northern Brook Lamprey spends its entire life in streams. No known populations reside on Lake Champlain's deltas, unlike Sea Lamprey and American Brook Lamprey. It has a 4 to 6 year life span and spends most of it life buried in the substrate, where it grows to about 150mm, metamorphoses, and becomes sexually mature. Adults generally migrate upstream to spawn. Larval habitat includes lotic depositional and estuarine areas of streams with organic matter for feeding and fairly stable substrate in order to maintain burrow. Stream riffle areas with sand and pea gravel up to approximately 15 mm diameter are used for spawning (W. Bouffard, USFWS, personal communication). Spawning water depth is typically <450 mm deep (Scott and Crossman 1998).

Habitat Types:

Aquatic: Fluvial

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts at road crossings may fragment habitat by creating barriers to upstream migration of spawning adult Northern Brook Lamprey. Sedimentation of stream bottoms reduces the quality of spawning habitat. The lower reaches of Malletts Creek and Indian Brook, which converge to form a large wetland complex, may reach the lethal temperature limit of 30.5 °C thereby limiting population distribution between as well beyond those streams.

Non-Habitat Threats:

Genetics

Competition

Pollution

Description of non-habitat threat(s): Due to the small population size, distance from other regional Northern Brook Lamprey populations, and absence of gene flow between populations, there is a potential for inbreeding depression to occur naturally within Vermont's population. No diagnostic characteristics exist for differentiating between Northern Brook and Silver lamprey accomocoetes. These two species were not readily distinguishable using mitochondrial sequence and mitochondrial restriction fragment length polymorphism analyses, raising the question whether they are different species or different ecomorphotypes. (Mandrak et al. 2004). This presents difficulties in understanding current distributions and population trends for Northern Brook Lamprey in the Lake Champlain basin. Competition for larval habitat with Sea Lamprey and Silver Lamprey could reduce survival and/or fitness of Northern Brook Lamprey larvae. Small population sizes and extremely limited geographic distribution increase the vulnerability of the population to a potential pollution event. The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to kill stream-resident Sea Lamprey larvae. These lampricides are toxic to all species of lamprey. Currently, Sea Lampreys are being controlled in streams with Northern Brook Lamprey through the use of traps, eliminating the need for lampricides. The repeated use of lampricides has been shown to adversely affect populations of Northern Brook Lamprey in Lake Superior tributaries (Li et al. 2014; Schuldt and Goold 1980).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Given difficulties in identifying Northern Brook Lamprey from other Ichthyomyzon spp. and apparent low population densities, efforts to survey other streams having suitable habitat to locate potential new populations and better define current distribution
Research	Threats and Their Significance	High	Threats and their significance are poorly understood for this species.
Research	Population Genetics	Medium	Genetic similarities between the disjunct Vermont population and other nearest populations within the region have not been investigated. Investigate gene flow within and between Northern Brook Lamprey populations in the Lake Champlain basin.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Current estimates are needed to ascertain status of known population.
Monitoring	Habitat Change	High	Habitat within species' limited distribution in state is not being monitored.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Northern Brook Lamprey populations.	Number of existing populations of Northern Brook Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Research	Low	Assess, monitor and manage as appropriate the potential for Sea Lamprey competition with Northern Brook Lamprey for spawning and juvenile habitats.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Research	High	Current research indicates Northern Brook Lamprey and Silver Lamprey may be ecotypes of a single species. Both ecotypes should be conserved.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Northern Brook Lamprey**
Scientific Name: **Ichthyomyzon fossor**
Species Group: **Fish**

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Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	Unknown
State Rank:	S2?	**State Trend:**	Stable
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

In Vermont, Silver Lamprey is widely distributed in Lake Champlain and its tributaries. The use of lampricides to control Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to Vermont populations. Other threats to the species include construction of barriers that prevent access to spawning habitats, water pollution, habitat alteration, siltation, water level fluctuation and competition with introduced species (COSEWIC 2011). In conjunction with the program to control Sea Lamprey abundance in Lake Champlain the USFWS conducts quantitative assessment sampling (QAS) typically every four years to estimate Sea Lamprey and Silver Lamprey abundance in seven Vermont treatment rivers: Missisquoi River, Stonebridge Brook, Lamoille River, Winooski River, Lewis Creek, Poultney River, and Hubbardton River. Abundance trends based on QAS (raw data provided by Allaire 2015) indicate declining populations in the Winooski and Poultney rivers; and no discernible trends (decreasing or increasing) in the other streams where multiple treatments have been conducted. However, it needs to be pointed out that QAS estimates typically have very large confidence intervals (Allaire, USFWS, personal communication), so these results must be interpreted with caution. Recent research into the genetic relationship between Silver Lamprey and Northern Brook Lamprey seems to indicate that the two species may be ecotypes of one species (Docker et al. 2012), even though each is considered a distinct species in all taxonomic accounts (COSEWIC 2011) and that this convention should remain in place until such time that there is “strong evidence [that] rejects the hypothesis that parasitic and nonparasitic members of a paired species represents distinct species” (Renaud et al. 2009 cited in COSEWIC 2011). Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

Silver Lamprey are restricted to eastern North America, from the St. Lawrence River as far down as Montmagny, Quebec, west through the Great Lakes, through the upper Mississippi Valley from Wisconsin, to eastern Manitoba; from Manitoba tributaries of Hudson Bay in the north to the Ohio River basin as far south as Kentucky (Scott and Crossman 1973). In Vermont, this species is at the eastern edge of its North American range. Vermont populations are limited to Lake Champlain and the lower reaches of several tributaries up to the fall line.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Mettawee River	Otter Creek

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Lake Champlain
Lamoille River
Missisquoi River
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Generally occurs in large streams and lakes where host fish are present and can be parasitized. Larval habitat includes lotic depositional and estuarine areas of streams with organic matter for feeding and fairly stable substrate required to maintain burrows. Spawning occurs in riffle areas with sand and gravel up to approximately 30 mm diameter (W. Bouffard, U. S. Fish and Wildlife Service, personal communication). In Vermont, the silver lamprey spawns in the lower sections of several tributaries of Lake Champlain (Langdon et al. 2006).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts and dams may constitute barriers to the upstream migration of spawning adults. Sedimentation of stream bottoms reduces the quality of spawning habitat.

Description of non-habitat threat(s): The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to kill stream-resident larvae. These lampricides are toxic to all species of lamprey.

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Population monitoring to determine current status and changes.
Monitoring	Habitat Change	Medium	Habitat assessment and monitoring to assess habitat change and identify limiting factors.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Silver Lamprey populations.	Number of existing populations of Silver Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Research	High	Current research indicates Northern Brook Lamprey and Silver Lamprey may be ecotypes of a single species. Both ecotypes should be conserved.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Invasive Species Control & Prevention	Low	Assess, monitor and manage as appropriate the potential for Sea Lamprey competition with Silver Lamprey for spawning and juvenile habitats.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Silver Lamprey**
Scientific Name: **Ichthyomyzon unicuspis**
Species Group: **Fish**

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Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G4	**Global Trend:**	Unknown
State Rank:	S1	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Populations of American Brook Lamprey are currently known to occur in seven Vermont streams (Langdon 2014), all located in the Lake Champlain Valley biophysical region. NatureServe (2014) identifies no known major threats to the species at the range-wide scale. Nonetheless, all lamprey species are susceptible to mortality caused by the use of lampricides; as such, chemical control of Sea Lamprey in the Lake Champlain basin probably represents the greatest threat to the state's American Brook Lamprey populations. Two American Brook Lamprey populations that have been exposed to lampricides in Vermont are Trout Brook in Milton (treated in 1995) and Winooski River in Winooski (treated in 2004). Brook lamprey mortalities were confirmed to have occurred as a result of treatments in both streams (Chipman 2015). The coastal population in New Hampshire is listed as endangered and those in Massachusetts and Maryland are threatened. Threats to these populations are generally identified as sedimentation, water temperature increases, pollutants, extreme water level changes, and habitat fragmentation often associated with land development activities (MDNR; MDFW 2005; NHFGD 2005). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

American brook lamprey is restricted to east-central North America: on the eastern seaboard from southeastern New Hampshire south to Maryland; and in the St. Lawrence River and tributaries from Montmagny southwest through the Great Lakes, west to southeastern Minnesota, south into the Mississippi River drainage to Tennessee and Missouri (Scarola 1973; Scott and Crossman 1973). In Vermont, it is known to occur in the Missisquoi River and tributaries, Hungerford and Kelly brooks; Winooski River and its tributary, Sunderland Brook; Youngman Brook; and Trout Brook.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Missisquoi River
Winooski River

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Clear, cool streams and small rivers characterized by a large proportion of groundwater inflow (Scott and Crossman 1973; Smith 1985; Langdon et al, 2006; Morman 1979). The non-parasitic American Brook Lamprey spends its entire life in streams and infrequently migrates to lakes, except to reside on some Lake Champlain river deltas particularly in New York, i.e. Ausable and Salmon rivers (Langdon et al. 2006). It has a 4 to 6 year life span and spends most of it buried in the substrate, where it grows to about 200mm, metamorphoses, and becomes sexually mature. Adults generally migrate upstream to spawn. American Brook Lamprey spawn the earliest and initiate spawning in the coolest water (~7ºC) (Hardisty and Potter 1971) compared to other species of lamprey in the Lake Champlain Basin. Larval habitat consists of lotic depositional, estuarine, and lentic areas of streams, with organic matter for feeding and fairly stable substrate in order to maintain burrow. Spawning occurs in riffle areas with sand and pea gravel up to approximately 20 mm diameter (Manion and Hanson 1980; W. Bouffard, USFWS, personal communication). Adults require certain physical factors for successful spawning such as suitable substrate (pea gravel), water velocities (0.3-0.5 m/s), and temperatures (mean 14ºC, range 6.7-20.6ºC) (Manion and Hanson 1980; Hardisty and Potter 1971; Morman 1979).

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Culverts at road crossings and dams may fragment habitat by creating barriers to upstream spawning migration of adult brook lamprey. Sedimentation of stream bottoms reduces the quality of spawning habitat.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition for larval habitat with Sea Lamprey and Silver Lamprey may reduce survival and/or fitness of American Brook Lamprey larvae (Scott and Crossman 1998). The Lake Champlain Fish and Wildlife Management Cooperative is currently involved in a Sea Lamprey control program that includes the use of lampricides to kill stream-resident larvae. These lampricides are toxic to all species of lamprey. In most streams where American Brook Lamprey and Sea Lamprey co-occur, traps are used to remove adult Sea Lamprey before they spawn, eliminating the need to use lampricides. The repeated use of lampricides has been shown to adversely affect populations of American Brook Lamprey in Lake Superior tributaries (Schuldt and Goold 1980).

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Population monitoring to determine current status and changes.
Monitoring	Habitat Change	High	Habitat assessment and monitoring to assess habitat change and identify limiting factors.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Monitor known limiting factors to populations and their habitats.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations, town & regional planning & Cons Comms	Dam owners
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on American Brook Lamprey populations.	Number of existing populations of American Brook Lamprey protected and sustained.	LCFWMC, USFWS, VDEC	VFWD (DJ, SWG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, USFWS, TNC, Echo Center, LCBP, LCI, watershed associations	
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **American Brook Lamprey**
Scientific Name: **Lethenteron appendix**
Species Group: **Fish**

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Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4S5
Extirpated in VT? No

Global Trend: Unknown
State Trend: Stable
Regional SGCN? No

Assessment Narrative:

Historically, Sea Lamprey was abundant in the Connecticut River and tributaries as far upstream as the first barrier falls (Gephard and McMenemy 2004) and are thought to have been capable of ascending the river beyond Bellows Falls at river-mile 174 (Scarola 1987). Like other anadromous fishes (e.g., Atlantic Salmon and American Shad) the construction of the first barrier dam in 1798 near present day Turners Falls, Massachusetts obstructed lamprey passage; however, with the construction of fish ladders at Turners Falls, Vernon and Bellows Falls dams during the 1980s, lamprey was given access to spawning and nursery habitats in the Vermont-New Hampshire shared reaches of the Connecticut as well as in tributaries up to natural and artificial barriers.

The species is recognized as having an ecological role in the river's ecosystem (Weaver et al. 2016): Sea lamprey provide biological benefits by bringing marine-derived nutrients into freshwater systems and by exporting important nutrients out to sea. Sea lamprey eggs, emigrating transformers, and lamprey carcasses provide a valuable source of food for a variety of birds, fish, and mammals. During sea lamprey spawning activities, the loosened and clean substrate improve streambed structure, which benefits other species that utilize this habitat type for spawning, and refugia.

The sea lamprey has benefitted from fish passage facilities constructed for other anadromous fishes (USFWS 2010). The Connecticut River Atlantic Salmon Commission (CRASC) and its partners assume that the native distribution of Sea Lamprey closely followed that of Atlantic Salmon (Gephard and McMenemy 2004). The Connecticut River sea lamprey population appears to be relatively stable (USFWS 2010). For the last 20 years, lamprey counts at Vernon and Bellows Falls dams have averaged about 4,600 and 300 fish per year, respectively. Sea lamprey have been a focal species under the current FERC relicensing process at the three mainstem dams. It is anticipated that under the new license accessibility and improvements to spawning and rearing habitats will benefit sea lamprey in the Connecticut River . A CRASC Management Plan for Sea Lamprey is currently underway. Strategies outlined in the plan will guide management and conservation efforts in the region.

Distribution

Sea lamprey are common on both sides of the Atlantic Ocean; in the west, from southwestern Greenland and the Grand Banks, the Gulf of St. Lawrence, and as far up the St. Lawrence River and its tributaries as Sorel, Quebec, and south to northeastern Florida (Scott and Crossman 1973). Landlocked populations also exist, such as the one in Lake Champlain. Adult sea lamprey frequent the Connecticut River and many of its larger tributaries up to the first impassable barriers during the spawning season. Larval lamprey inhabit these waters wherever suitable habitat exist.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Middle Connecticut	Upper Connecticut-Mascoma
West	
Black-Ottauquechee	
White	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Anadromous populations of sea lamprey, as occurs in the Connecticut River basin, has a life cycle that depends on both marine and freshwater habitats. Adults migrate from the sea and ascend rivers and streams to spawn. Spawning occurs over substrate composed of a mixture of sand, gravel and rubble at water depth of 381-610 mm. Spawning activity starts when stream water temperature warms to 11.1-11.7 C and peaks at 14.4-15.6 C (Scott and Crossman 1973). Larvae take up residence by burrowing into rich organic stream bottoms and feed at the streambed surface by filtering out food organisms.

Habitat Types:

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Energy Infrastructure and Development

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Excessive siltation degrades the quality of spawning habitat. Migration barriers (e.g., dams) fragment habitat and can prevent adults from gaining access to spawning areas. Unnatural flow regimes, erratic flow fluctuations, and inadequate base flows can cause behavioral changes in spawning activity, nest dewatering, nest scouring, and reduced survival and growth of rearing ammocoetes

Description of non-habitat threat(s):

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Identify spawning congregations, spawning habitat, and man-made barriers to improve accessibility and quality of spawning and rearing habitats.
Research	Threats and Their Significance	Low	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Medium	Monitoring adult sea lamprey runs at Connecticut River fishways is critical to detecting any changes in population status and trends.
Monitoring	Habitat Change	Low	
Monitoring	Monitor Threats	Medium	Evaluate impacts of regulated flows during licensing and permitting processes

Common Name: **Sea Lamprey (CT river only)**
Scientific Name: **Petromyzon marinus (CT river only)**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Support the development and implementation of a Connecticut River Atlantic Salmon Commission Management Plan for Sea Lamprey		CRASC, USFS, USFWS, VDEC, NRCS, ACE, CRJC,	USFWS, USFS,
Habitat Restoration	High	Protect and restore in-stream and riparian habitats via water quality, flow and temperature improvements; sediment reduction; riparian corridors.		CRASC, USFS, USFWS, VDEC, NRCS, ACE, CRJC, watershed associations, town planning and conservation commissions	
Habitat Restoration	High	Maintain and restore aquatic organism passage at barriers (e.g., dams, culverts) to provide access to critical habitats.		CRASC, USFWS, CRJC, VTRANS, hydropower companies	
Compatible Resource Use	High	Participate in existing regulatory processes (Act 250, FERC, stream alteration, etc.) to protect and restore sea lamprey critical spawning and rearing habitats.		VDEC, CRJC, RPCs, watershed associations, USFWS	

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Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 | **Global Trend:** Unknown
State Rank: S2 | **State Trend:** Unknown
Extirpated in VT? No | **Regional SGCN?** No

Assessment Narrative:

At present eight populations distributed among the same number of streams are known to occur in Vermont (Langdon 2014). All are in the Lake Champlain Valley biophysical region and are peripheral to the species' continental range. Very little is known of the biology, abundance of these populations, or population threats. On a range-wide scale no major threats are known (NatureServe 2014).

Distribution

The Mottled Sculpin has a wide but discontinuous distribution in North America with the more eastern range encompassing northern Quebec and Labrador, and the drainages of the Great Lakes, Hudson and James bays. Western populations are largely limited to the Columbia River drainage (Scott and Crossman 1973). In Vermont, seven populations of Mottled Sculpin have been identified, all in tributaries to northern Lake Champlain (Allen Brook, Colchester; Bartlett Brook, South Burlington; Englesbee Brook, Burlington; Lamoille River, Milton; Mill River, Georgia; Stonebridge Brook, Milton; Trout Brook, Milton. It is also suspected to inhabit shoreline areas of Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Mottled Sculpin occur in cool streams, small rivers and in lakes. It prefers a bottom of gravel or rubble, rarely being found over sand. In streams it is a riffle dweller. In lakes it inhabits rocky shorelines. Although most reports label Mottled Sculpin as a cold or cool water species, Vermont specimens have been recorded in warmer streams below the fall line (Langdon et al. 2006). Mottled Sculpin are found in areas with substrates composed of clean gravel and rubble/cobble. They are intolerant of habitat degradation (siltation and turbidity) and populations have been reduced in some parts of its range. Spawning takes place in cavities beneath rocks, ledges, or logs generally in May when water temperatures reach 10°C (Smith 1985; Trautman 1981).

Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): Mottled Sculpin are intolerant of habitat degradation due to sedimentation, siltation and turbidity. This is believed to be one cause for the reduction or extirpation of populations in some parts of its range.

Non-Habitat Threats:

Unknown Non-Habitat Threats

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Very little is known about the distribution and abundance
Research	Threats and Their Significance	Medium	Evaluate and monitor the impacts of sedimentation and strategies to reduce sedimentation
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	Monitoring population status needed.
Monitoring	Habitat Change	Medium	Monitor known habitat to ascertain current status and future changes.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Monitor the impacts of sedimentation
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Mottled Sculpin**
Scientific Name: **Cottus bairdi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Low	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Smith, C. L. 1985. Inland fishes of New York State. New York State Department of Environmental Conservation, Albany.

Trautman, M. B. 1981. The fishes of Ohio with illustrated keys. Revised edition. Ohio State University press, Columbus

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Conservation Assessment

Final Assessment:	High Priority	**Global Rank:**	G3G4	**Global Trend:**	Unknown
		State Rank:	S1	**State Trend:**	Unknown
		Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Lake Champlain and the lower reaches of four major tributaries (Winooski, Lamoille and Missisquoi rivers and Otter Creek, all directly accessible from the lake) are habitats for the only Lake Sturgeon population occurring in Vermont.

This population is on the eastern edge of its continental range. Prior to closure of the sturgeon fishery in 1967 commercial landings indicated a rapid decline in sturgeon abundance during the 1940s. In 1975 Lake Sturgeon was designated endangered in the state. Occasional encounters with Lake Sturgeon during VFWD fisheries assessments and incidental catches by anglers persist. Current data has found adult sturgeon ascend the Lamoille and Winooski rivers during the spring spawning season, and spawning has been confirmed by egg trap and drift net sampling done in those rivers as well as the Missisquoi River (MacKenzie 2014). Although sturgeon are known to occur in Otter Creek based on angler catch reports, spawning there has not yet been documented (MacKenzie 2015). Abundance, age class structure and distribution of sturgeon in the lake are unknown. Sturgeon ascending Missisquoi and Lamoille rivers to spawn are limited to suitable habitat located downstream of Swanton Dam and Peterson Dam, respectively, which likely have significantly reduced their historic range within these rivers.

Threats to sturgeon populations generally include overexploitation (including poaching), dams (direct and indirect effects), contaminants, habitat degradation, and introduced species (COSEWIC 2006). Because Lake Sturgeon is a slow growing, late maturing, intermittently spawning species, depleted populations, even when protected, may take many years to recover, if at all (COSEWIC 2006). The species is classified as threatened in New York State (NYSDEC 2005) as well as in the Great Lakes – Upper St. Lawrence unit of Canada (COSEWIC 2006). Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

Lake Sturgeon has a wide distribution occurring from the St. Lawrence River to Hudson Bay, west to the Saskatchewan River in Alberta, south through Lake Champlain, the Mississippi River to the Tennessee River in Alabama and in northern Mississippi; from lakes Winnipeg and Manitoba south through eastern North and South Dakota, northeastern Nebraska and Kansas to eastern Missouri and Arkansas (Scott and Crossman 1973). In Vermont, it inhabits only Lake Champlain with small spawning runs recently documented to occur in the Missisquoi, Lamoille and Winooski rivers (C. MacKenzie, Vermont Fish and Wildlife Department, personal communication). The Vermont population is on the eastern edge of the species North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds

Lake Champlain

Lamoille River

Missisquoi River

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Lake sturgeon is a demersal species inhabiting lakes and large rivers, usually at 5-9 m depth, over mud, sand, and gravel (Page and Burr 1991). Sturgeon prefer spawning in fast, shallow water with rocky substrate (Harkness and Dymond 1961). Chiotti et al. (2008) located spawning sites in the Big Manistee River of Michigan at water depths in the range of 1.5 to 3 m and average water velocities in the range of 0.34 to 1.32 m/s. Lahaye et al. (1992) collected sturgeon eggs on spawning grounds in the Des Prairies and L'Assomption rivers (Quebec) at minimum and maximum water velocities of 0.02 and 1.39 m/s. Age-0 sturgeon prefer shallow (<2 m), riverine areas with substrate of coarse sand or pea-sized gravel, low current velocity (<0.60 m/s), and an absence of rooted vegetation (Kempinger 1996).

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Lake Sturgeon eggs require clean river bottoms for survival and the species has declined in areas where siltation has been high. Dams fragment habitat and create barriers to upstream migrating fish during the spawning season.

Non-Habitat Threats:

Genetics

Pollution

Reproductive Traits

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Harvest or Collection

Description of non-habitat threat(s): Sea Lamprey predation is believed to be the most significant threat to Lake Sturgeon in Lake Champlain, and mortality of sub-adult and adult sturgeon from lamprey predation is the most likely factor limiting recovery of the species in the lake (MacKenzie 2015). Lake Sturgeons are long-lived. Maturity is attained at 14-20 years, and thereafter reproduction occurs approximately every four years. These life history characteristics make Lake Sturgeon extremely vulnerable to harvest and other disturbances. Lake Sturgeon populations exhibit long recovery times because of delayed maturation and the number of years between spawning events. Low population size could lead to inbreeding depression. Over-harvest by sport and commercial fishermen prior to closure of the Vermont fishery in 1967 may have contributed to the decline of the species in Lake Champlain.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Little is known about the current distribution and abundance of Lake Sturgeon in Lake Champlain and spawning tributaries.
Research	Threats and Their Significance	High	
Research	Population Genetics	Medium	Genetic testing of tissue samples from Lake Sturgeon show s that the population is most closely related to that occurring in the St. Lawrence River. Genetic diversity appears to be relatively consistent among populations and heterozygosity is consistent with that observed for most other freshwater fish species. Even though the Lake Champlain population has declined significantly, genetic diversity within the population is not depressed nor is there signs of inbreeding at this time.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Estimates of lake population size and age structure are lacking.
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Legislation	Medium	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public.	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Species Restoration	High	Develop and implement a plan for restoring Lake Sturgeon to Lake Champlain and historic spawning tributaries.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS

Common Name: **Lake Sturgeon**
Scientific Name: **Acipenser fulvescens**
Species Group: **Fish**

Species Restoration	High	Reduce in Sea Lamprey wounding rates observed on Lake Sturgeon.	Sea Lamprey wounding rates.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Compliance & Enforcement	High	Protect Lake Sturgeon from directed and incidental harvest by anglers through law enforcement and enhanced public outreach.	Documented annual number of illegal harvest cases and number of fish harvested.	VFWD	VFWD

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Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G4	**Global Trend:**	Unknown
State Rank:	S2	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Historically, American Eels were common in Vermont and found in watersheds lying east and west of the Green Mountains (Thompson 1853), but since colonial settlement of the state eels have been negatively affected by artificial barriers to their migrations (dams) and habitat loss and alteration (NatureServe 2014). Other identified threats to eel populations are hydro turbine mortality, oceanic conditions, overfishing, parasitism, predation and pollution (NatureServe 2014). MacMartin (1962) reported of his statewide survey of Vermont streams (1952-1960) that eels were found in only one tributary to the Connecticut River (i.e. the West River), where eels were encountered far upstream in the mainstem and in headwater streams. From the late 1980s through the 1990s eels were observed with some regularity in the lower West River (i.e. downstream of Ball Mountain Dam) and in certain tributary streams. However, since that time, eel sightings have become much less frequent in occurrence (K. Cox, Vermont Fish & Wildlife Department, personal communication).

Recent reports from fishermen, resource managers, and scientists indicate a further decline in American eel populations. Harvest pressure and habitat losses are listed as the primary causes of any possible historic and recent decline in abundance (Castonguay et al. 1994a and 1994b). In 2000, the Atlantic States Marine Fisheries Commission adopted an "Interstate Fishery Management Plan for American eel" to protect and restore the species. Management actions, conservation strategies and information needs outlined in ASMFC American Eel Fishery Management Plan guide regional efforts to improve eel abundances of all life stages within their native range including the Connecticut River and its tributaries.

The ASMFC (2012) reported "[a]ccording to the 2012 benchmark stock assessment, American Eel population is depleted in U.S. waters. The stock is at or near historically low levels due to a combination of overfishing, habitat loss, food web alterations, predation, turbine mortality, environmental changes, toxins and contaminants, and disease." In 2010 the U.S. Fish & Wildlife Service (USFWS) was petitioned to list American Eel as a threatened species (ASMFC 2014). In September 2015 USFWS announced its decision that listing "is not warranted at this time." The decision acknowledged that although local populations suffer losses from harvest mortality and hydroelectric projects, these stressors alone do not pose an overall threat to the species.

American eel was selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The American Eel occurs from Greenland throughout much of eastern Canada, south through most of eastern United States to the Gulf coast, along the eastern seaboard of Mexico to the Yucatan Peninsula, the West Indies and Bermuda to the Gulf of Mexico, Panama and the West Indies and Bermuda (Scott and Crossman 1973). Spawning grounds are in the Sargasso Sea. In Vermont, eel historically was found through much of Vermont (Lake Champlain and Connecticut River drainages).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Not Probable

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Upper Connecticut	Waits
White	Upper Connecticut - Mascoma
Middle Connecticut	Deerfield
West	Passumpsic
Black - Ottauquechee	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

American Eel is a catadromous species and is reported to only spawn in the Sargasso Sea of the Atlantic Ocean. Larvae are carried by ocean currents to coastal areas where they transform into glass eels, then elvers and begin a long upstream migration to inland waters where they can live more than 20 years (as immature yellow eels) before returning to the sea to spawn (as silver eels). The only life stages occurring in Vermont is the immature yellow phase and at the beginning of their downstream migration the silver phase. Yellow-phase American Eels have occurred in both the Connecticut River and Lake Champlain drainages of Vermont, where they can live in a wide variety of habitats including ponds, lakes, rivers and streams. They often occupy areas where they can find cover (rocks, snags, weeds) during daylight hours.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Being a catadromous species, American Eels are subjected to a wide variety of challenges associated with extensive migrations and residency in both marine and freshwater environments. Obstructions, such as dams, can fragment habitat and limit access to valuable rearing habitats. Delays and mortality associated with hydro facilities during outmigration can limit spawning potential and reduce total production. Therefore, successful upstream and downstream fish passage at barriers is critical to maintaining a spawning stock biomass from the U.S. Atlantic coast (Lary and Busch, 1997). Studies by Knights (2003) and Wirth and Bernatchez (2003) suggest that climate change may be

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

affecting ocean temperatures and currents such that food and dispersal of eel larvae have been negatively impacted, thereby reducing survival and recruitment.

Non-Habitat Threats:

Pollution

Harvest or Collection

Description of non-habitat threat(s): Poor water quality can result in contaminants bio-accumulating in the reproductive tissue of eels, resulting in impairments to reproduction. Potential impacts from contaminants include mortality, changes in behavior, and decreases in fecundity (AMFC 2000). Artificial reproduction using mature eels to support the commercial industry is not yet feasible. Therefore, naturally reproduced glass eels and elvers have been harvested in coastal areas and tributaries of North America for many years to support an intensive aquaculture industry in eastern Asia (Moriarty and Dekker 1997). In recent years, glass eel and elver overharvest has given rise to serious concern as to the future viability of the eel industry (AMFC 2000).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Gain information on current distribution and abundance in tributaries, lakes and ponds or below potential barriers.
Research	Threats and Their Significance	High	1) Pollution and contaminants: analyze tissue samples for contaminants; monitor water quality in known rearing sites. 2) Passage: evaluate, and investigate technologies to improve, fish passage facilities for eels on the Connecticut River and tributaries; assess impacts of turbine mortality on out-migrating eels and investigate technologies to improve safe and timely downstream passage; and investigate congregations of eels below barriers to determine eel passage requirements.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitor populations and maintain an eel database.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to rearing habitats and ensure safe, timely and effective downstream passage of silver eels. Require eelways where warranted for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, TNC, watershed associations, town & regional planning & conservation commissions	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Invasive Species Control & Prevention	Low	Monitor health of American Eels populating the Connecticut River Basin. Enforce fish importation regulations and disease management protocols.	Enforcement of importation regulations.	VFWD, NHFGD, CRASC, USFWS	VFWD, NHFGD, CRASC, USFWS
Policy & Regulations	Low	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).		VFWD, NHFGD, CRASC, USFWS	VFWD, NHFGD, CRASC, USFWS

Common Name: **American Eel (CT River population)**
Scientific Name: **Anguilla rostrata (CT R)**
Species Group: **Fish**

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Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G4
State Rank: S2
Extirpated in VT? No

Global Trend: Unknown
State Trend: Increasing
Regional SGCN? Yes

Assessment Narrative:

American Eel was once an abundant species in the Lake Champlain drainage. As recently as the early 1980s, it was harvested commercially in Lake Champlain. For at least 150 years the Richelieu River, which flows out of Lake Champlain, supported a significant commercial eel fishery. Canadian fishery scientist estimated the average annual eel harvest between 1920 and 1980 was 35 metric tons; however, since 1981 landings decreased from 72.9 tons to only 4.7 tons (Dumont et al. 2004). Construction of large dams on rivers once ascended by eels have blocked juvenile fish access to critical rearing habitats. Dams used for hydropower generation have also been implicated in causing high levels of mortality as eels are subjected to turbine losses during their outmigration to sea. High commercial harvest of juvenile eels in coastal waters has further contributed to depressed U. S. stocks. Global climate change has also been identified as a potential limiting factor.

Recent reports from fishermen, resource managers, and scientists indicate a further decline in American eel. Harvest pressure and habitat losses are listed as the primary causes of any possible historic and recent decline in abundance (Castonguay et al. 1994a and 1994b). In 2000, the Atlantic States Marine Fisheries Commission adopted an "Interstate Fishery Management Plan for American eel" to protect and restore the species. Management actions, conservation strategies, and information needs outlined in ASMFC American Eel Fishery Management Plan, guide regional efforts to improve eel abundances of all life stages within their native range including the Champlain drainage.

In 2010 the U. S. Fish and Wildlife Service (USFWS) received a petition to list the American Eel as a threatened or endangered species under the Endangered Species Act. In September 2015, the USFWS announced its decision that listing is not warranted. The decision acknowledges that although local populations suffer losses from harvest mortality and hydroelectric projects, these stressors alone do not pose an overall threat to the species. In Lake Champlain abundances have recently increased due to management activities including elver stocking and the installation of eel passes on the Richelieu River, Quebec. However, without safe downstream passage facilities, it is not known to what extent these eels will contribute to the spawning population considering they have yet to make their spawning migration to sea.

Distribution

The American eel occurs from Greenland throughout much of eastern Canada, south through most of eastern United States to the Gulf coast, along the eastern seaboard of Mexico to the Yucatan Peninsula, the West Indies and Bermuda to the Gulf of Mexico, Panama and the West Indies and Bermuda (Scott and Crossman 1973). Spawning grounds are in the Sargasso Sea. In Vermont, eels historically were found through much of Vermont (Lake Champlain and Connecticut River drainages).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Probable

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Northern VT Piedmont Probable **Taconic Mtns** Not Probable

Northeastern Highlands Probable

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Lake Champlain	Lamoille River
	Missisquoi River
	Otter Creek
	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

American Eel is a catadromous species and is reported to only spawn in the Sargasso Sea of the Atlantic Ocean. Larvae are carried by ocean currents to coastal areas where they transform into glass eels, then elvers and begin a long upstream migration to inland waters where they can live more than 20 years (as immature yellow eels) before returning to the sea to spawn (as silver eels). The only life stages occurring in Vermont is the immature yellow phase and at the beginning of their downstream migration the silver phase. Yellow-phase American Eels have occurred in both the Connecticut River and Lake Champlain drainages of Vermont, where they can live in a wide variety of habitats including ponds, lakes, rivers and streams. They often occupy areas where they can find cover (rocks, snags, weeds) during daylight hours.

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Being a catadromous species, American Eel are subjected to a wide variety of challenges associated with extensive migrations and residency in both marine and freshwater environments. Obstructions, such as dams, can fragment habitat and limit access to valuable rearing habitats. Delays and mortality associated with hydro facilities during outmigration can limit spawning potential and reduce total production. Therefore, successful upstream and downstream fish passage at barriers is critical to maintaining a spawning stock biomass from the U.S. Atlantic coast (Lary and Busch, 1997).
Studies by Knights (2003) and Wirth and Bernatchez (2003) suggest that climate change may be affecting ocean temperatures and currents such that food and dispersal of eel larvae have been negatively impacted,

Common Name: **American Eel (Lake Champlain population)**
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thereby reducing survival and recruitment.

Non-Habitat Threats:

Pollution

Harvest or Collection

Description of non-habitat threat(s): Poor water quality can result in contaminants bio-accumulating in the reproductive tissue of eels, resulting in impairments to reproduction. Potential impacts from contaminants include mortality, changes in behavior, and decreases in fecundity (AMFC 2000).
For decades, eels from Lake Champlain have been harvested in Canada as they migrate out (silver eels) along the Richelieu and St. Lawrence rivers. In addition, eels were harvested for commercial sale in Vermont waters of Lake Champlain by electrofishing for a few years in the 1980s. The commercial harvest of eels in Lake Champlain was made illegal in 2002. Artificial reproduction using mature eels to support the commercial industry is not yet feasible. Therefore, naturally reproduced glass eels and elvers have been harvested in coastal areas and tributaries of North America for many years to support an intensive aquaculture industry in eastern Asia (Moriarty and Dekker 1997). In recent years, glass eel and elver harvest has given rise to serious concern as to the future viability of the eel industry (AMFC 2000).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Contribution of eels in northern regions to overall stock is unknown. Gain information on the current distribution and abundance in tributaries, lakes and ponds or below potential barriers.
Research	Threats and Their Significance	High	1) Pollution and contaminants: analyze tissue samples for contaminants; monitor water quality in known rearing sites 2) Passage: evaluate, and investigate technologies to improve, fish passage facilities for eels on Richelieu River and other known rearing waterbodies; assess impacts of turbine mortality on out-migrating eels and investigate technologies to improve safe and timely downstream passage; and investigate congregations of eels below barriers to determine eel passage requirements.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitor populations and maintain an eel database.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Eel (Lake Champlain population)**
Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for American Eel.	VDEC, VFWD, USFWS, dam owners	Dam owners
Research	Low	Investigate the significance of recreational eel harvest in Lake Champlain and whether harvest protection measures are warranted.	Issue was reviewed with recommendations.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to rearing habitats and ensure safe, timely and effective downstream passage of silver eels. Require eelways where warranted for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored	Dam Owners, VDEC, VFWD, USFWS	Dam owners
Invasive Species Control & Prevention	Low	Monitor health of American Eels populating Lake Champlain Basin. Enforce fish importation regulations and disease management protocols.	Enforcement of importation regulations.	VFWD, USFWS, NYDEC	VFWD (SWG, DJ), USFWS
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI

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Scientific Name: **Anguilla rostrata**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	Unknown
State Rank:	SU	**State Trend:**	Historic
Extirpated in VT?	Yes	**Regional SGCN?**	Yes

Assessment Narrative:

Blueback Herring were once common in the Connecticut River mainstem as far upriver as the natural barrier (falls) at Bellows Falls, Vermont and North Walpole, New Hampshire, a distance of 174 river-miles from the river mouth on Long Island Sound. Construction of the first dam on the river in 1798 near present-day Turners Falls, Massachusetts extirpated the species from the upper river (Gephard and McMenemy 2004). With restoration of fish passage at Turners Falls (MA) and Vernon (VT) dams during the early 1980s Blueback Herring as well as other anadromous fishes once again have access to critical habitats in the upper river. During the first 10 years that the Vernon fish ladder was operated (1981-1990) an average of 35 Bluebacks were observed annually passing into the Vernon head pond which extends upriver nearly to Bellows Falls. In 1991 the Vernon Dam herring run peaked at 383 fish which was followed over the next nine years (1992-2000) with a downward trend (average annual passage count 22 fish). Since then, Blueback Herring have not been observed above Vernon Dam. A similar trend has occurred in the lower Connecticut River, represented by passage counts made at the Holyoke (MA) Dam fishlift, i.e. an increasing trend from the 1970s through mid-1980s followed decreasing numbers thereafter. Such declines have been noted in other U.S. river stocks ranging from Maine to Delaware. Stock assessments for Blueback Herring and Alewife, collectively reported as river herring, made by the Atlantic State Marine Fisheries Commission (ASMFC) concluded that 23 (including the Connecticut River) of the 52 stocks assessed are depleted relative to historic levels (ASMFC 2012). NatureServe (2013) lists Blueback Herring as vulnerable based on "drastic declines in abundance…in many areas in recent decades." Causes for stock declines are not fully understood at present; however, restoration of Blueback Herring to the VT-NH shared section of the Connecticut River is contingent on appropriate management actions implemented by coastal state fishery agencies and the federal government. Freshwater threats to Blueback Herring stocks include obstruction of migration routes by dams and other barriers, entrainment and impingement mortality, habitat degradation, overfishing, and predators e.g. striped bass (NatureServe 2013; Savoy and Crecco 2004). Selected as an Regional-SGCN by the 13 Northeastern states in 2014

Distribution

The Blueback Herring reaches its northern limit in Canadian waters and occurs along the eastern North American seaboard from Cape Breton, Nova Scotia south to northern Florida (Scott and Crossman 1973). Landlocked populations are also known to occur, including Lake Champlain. Anadromous Blueback Herring occur naturally in the Connecticut River basin, although their historic occurrence in the Vermont-New Hampshire shared section of the Connecticut River is reported to have been similar to that of American Shad. The upriver limit to their distribution extended to the natural barrier on the river between Bellows Falls, Vermont and North Walpole, New Hampshire. Although Blueback Herring are also found in Lake Champlain (since 1979), the species is not indigenous to that waterbody and is believed to have gained access to the lake by the Hudson Barge Canal connection to the Hudson River. The last year Blueback Herring 2 individuals) have been observed in Vernon fish ladder was 2000.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Probable Watersheds
Middle Connecticut

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Blueback Herring is an anadromous species spending portions of its life in both marine and freshwater environments. In freshwater, it migrates up rivers to spawn. Generally the upstream migration of Blueback Herring does not extend as far as for other clupeid species (e.g., Alewife); spawning may occur in both brackish and fresh waters (Scott and Crossman 1973). Spawning occurs in a diversity of habitats, including large rivers, small streams, ponds and large lakes over a range of substrates, such as gravel, sand, detritus, and submersed vegetation and other structures. Swift flowing waters are used as spawning sites. Blueback Herring spawn in rivers releasing their eggs into the water column whereupon the eggs settle and adhere to the substrate, including stones, gravel and sticks (Scott and Crossman 1973). Larval and juvenile Blueback Herring reside in the river during their first summer before out-migrating the following fall. Spawning success and survival of adults and juveniles are dependent on successful passage past manmade obstacles, such dams and hydroelectric generation plants.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Habitat Fragmentation

Description of habitat threat(s): Spawning success and survival of adults and juveniles are limited by the existence and development of dams and hydroelectric generation plants which may impede access to spawning and nursery habitats, as well as cause mortality to out-migrating fish. River flow regimes as manipulated by hydroelectric poer generation activities can affect Blueback Herring habitat.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): Migrating adult and juvenile Blueback Herring are susceptable to predation, especially fish predators. Improvements in stock strength of Striped Bass and Bluefish are believed to have increased predatory pressure on migrating clupeid populations, including Blueback Herring and American Shad. Being an anadromous species, blueback herring are subjected to a wide variety of problems associated with extensive migrations and residency in both marine and freshwater environments. Out-migrating adult and juvenile herring may be exposed to turbine mortality at power dams resulting in high losses.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	Medium	Turbine passage and mortality studies.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	Research is being conducted by other agencies to which Vermont is a cooperator.
Monitoring	Population Change	High	Monitor herring passage at Connecticut River fishpasses.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, USFWS, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to spawning and juvenile habitats and expedite outmigrants (post-spawned adults, juveniles) to sea. Operate and maintain existing fishways for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Natural Processes Restoration	High	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for Blueback Herring.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, TNC, power companies, watershed associations, town & regional planning & Cons Comms	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, power companies, watershed associations, town & regional planning & conservation commissions
Species Restoration	High	Provide technical support to regional restoration plans and efforts as necessary.	CRASC River Herring Restoration Status & Plan in the Connecticut River Basin; ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, USFWS, NMFS, ASFMC, CRWC	CRASC, USFWS, NMFS, ASFMC, CRWC
Research	Medium	Striped Bass and other predator threats to American Shad stocks.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, NMFS, ASMFC	CRASC, NMFS, ASMFC
Policy & Regulations	Medium	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).	Implement Connecticut River Basin Management Plan for Blueback Herring. Percent of tasks implemented as prescribed in the plan.	VFWD, NHFGD, CRASC, USFWS, ASMFC	VFWD, NHFGD, CRASC, USFWS
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC	

Common Name: **Blueback Herring (CT River only)**
Scientific Name: **Alosa aestivalis**
Species Group: **Fish**

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Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries research Board of Canada Bulletin 184, Ottawa.

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend: Unknown
State Trend: Increasing
Regional SGCN? Yes

Assessment Narrative:

American Shad were once common in the Connecticut River mainstem as far upriver as the natural barrier at Bellows Falls, Vermont and North Walpole, New Hampshire, a distance of 174 river-miles from the river mouth on Long Island Sound. Construction of the first dam on the river in 1798 near present-day Turners Falls, Massachusetts extirpated the species from the upper river (Gephard and McMenemy 2004). With restoration of fish passage at Turners Falls (MA) and Vernon (VT) dams during the early 1980s shad as well as other anadromous fishes are once again provided access to critical habitats in the upper river. During the first eleven years that upstream fish passage was provided at Vernon Dam the number of adult shad passed above the dam followed an increasing trend from 97 shad counted in 1981 to 37,197 shad in 1991. Over the following 20 years the shad passage above the dam declined from 31,155 fish in 1992 to 290 in 2011. Since then annual shad passage counts at the dam have been in the range of 10,175 and 27,706 fish. Factors affecting shad abundance above Turners Falls Dam are complicated but illustrate the some of the threats that beset the species and challenge restoration of the species to the upper Connecticut River. Specifically, after 1990 commercial shad landings along the Atlantic seaboard and stock abundance in several rivers declined significantly. In the Connecticut River, 1.6 million shad were estimated to have returned to the river in 1992; by 1995 returns had declined to 304,500 fish (ASFMC 1999). Striped Bass predation on adult and juvenile shad has also been suggested (Savoy and Crecco 2004). It was also hypothesized that the thermal discharge from Vermont Yankee Nuclear Power into the Vernon headpond may have had negative effects on adult and juvenile shad migrations and survival. And lastly, structural and operational factors at both Turners Falls and Vernon fish ladders affecting fish passage were identified and corrected which appears to explain increased passage at Vernon observed in 2012-2014. Threats to American Shad habitats include the following: barriers to migration, water withdrawals, toxic and thermal wastewater discharge, channelization, dredging and instream construction, inappropriate land uses, atmospheric deposition, climate change, competition and predation by invasive and managed species, fisheries activities, and instream flow regulation (ASMFC 2010). Selected as an Regional-SGCN by the 13 Northeastern states in 2014

Distribution

American Shad inhabit waters along the Atlantic Coast from Newfoundland south to Florida; it has also been introduced to the Pacific Coast of North America (Scott and Crossman 1973). In Vermont, it is restricted to the Connecticut River from the Massachusetts state line upstream to at least Bellows Falls dam. Low numbers in some years are passed above Bellows Falls via the fish ladder there. The last year shad were observed in the ladder was 2005. Shad have also been observed in the lower West River.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Middle Connecticut	Black - Ottauquechee
West	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

As an anadromous fish, the American Shad divides its life between marine and freshwater environments. Adults ascend rivers and streams to spawn. Once the eggs hatch, larval and juvenile shad inhabit riverine habitats, including setbacks, through their first summer of life before out-migrating to the ocean in the fall. Maturity is attained at sea. Stier and Crance (1985) review the habitat requirements of American shad. Adults utilize well oxygenated (>=5 ppm), flowing water, although they do not appear to have specific preferences for spawning locations other than broad flats and shallow water. Spawning may occur over a variety of substrate types providing water velocity is sufficient enough to keep sedimentation minimal. Spawning generally occurs at water temperatures of 8-26°C with peak activity occurring within the range of 14-21°C. Temperatures for maximum egg hatch and survival is 15.5-26°C. Temperatures at or near 11°C are minimal for egg incubation, and temperatures in excess of 26.7°C are unsuitable. Juvenile shad are found at water temperatures of 10-31°C. Temperatures less than 10°C cannot be tolerated. Juvenile outmigration begins when the water temperature go below 15.5°C.

Current Threats

Habitat Threats:

Habitat Fragmentation

Description of habitat threat(s): Spawning success and survival of adults and juveniles are limited by the existence and development of dams and power generation plants which may impede access to spawning and nursery habitats, as well as impose artificial flow regimes associated which in turn alter and degrade habitat for shad. Fishway design deficiencies at ladders on the Connecticut River at Turners Falls, Massachusetts are being examined as likely causes for the significant reduction in shad run abundance into Vermont and New Hampshire. This exacerbates the habitat fragmentation problem.

Non-Habitat Threats:

Predation or Herbivory

Harvest or Collection

Description of non-habitat threat(s): Migrating adult and juvenile shad are susceptable to predation, particularly fish predators. Improvements in stock strength of striped bass and bluefish are believed to have increased predatory pressure on migrating clupeid populations, including shad. Being an anadromous species, shad are subjected to a wide variety of problems associated with extensive migrations and residency in both marine and freshwater environments. Excessive commercial harvest off the Atlantic seaboard and within the estuaries represents a problem for shad stocks. Out-migrating adult and juvenile shad may be exposed to turbine mortality at power dams resulting in high mortality.

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Data are needed to design fish ladders for improved fish passage performance.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	High	Research is being conducted by other agencies to which Vermont is a cooperator.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Natural Processes Restoration	High	Improve flow regimes below hydroelectric generation and flood control projects.	Number of projects which operate under flow regimes that provide suitable habitat for American Shad.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC	
Natural Processes Restoration	High	Restore fish passage at dams to allow upstream migrants access to spawning and juvenile habitats and expedite outmigrants (post-spawned adults, juveniles) to sea. Operate and maintain existing fishways for peak passage performance.	Number of dams or other obstructions removed or mitigated to restore fish access to critical habitat; and number of miles of habitat that access was restored.	VDEC, VFWD, NHDES, NHFGD, CRASC, USFWS, CRWC, dam owners	Dam owners

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, TNC, power companies, watershed associations, town & regional planning & conservation commissions	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRASC,CRWC, power companies, watershed associations, town & regional planning & conservation commissions
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Species Restoration	High	Provide technical support to regional restoration plans and efforts as necessary.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, USFWS, NMFS, ASFMC, CRWC	CRASC, USFWS, NMFS, ASFMC, CRWC
Research	Medium	Striped Bass & other predator threats to American Shad stocks.	ASMFC Interstate Fishery Management Plan for Shad & River Herring	CRASC, NMFS, ASMFC	CRASC, NMFS, ASMFC
Policy & Regulations	High	Support and cooperate with the inter-agency program for the restoration of anadromous fishes to the Connecticut River basin (e.g., CRASC).	Implement Connecticut River Basin Management Plan for Blueback Herring. Percent of tasks implemented as prescribed in the plan.	VFWD, NHFGD, CRASC, USFWS, ASMFC	VFWD, NHFGD, CRASC, USFWS

Common Name: **American Shad**
Scientific Name: **Alosa sapidissima**
Species Group: **Fish**

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Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: SU
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

In Vermont, Mooneye is confined to Lake Champlain, where it is on the eastern edge of its continental range. Very little is known of its biology, distribution and habitat use, and past and present population abundance in the lake. On a range-wide scale no major threats are known (NatureServe 2014); however in New York, it is listed as threatened (NYSDEC 2014). The cause(s) for declines in New York populations are not as yet known, but increased siltation in part is suspected (NYSDEC 2014). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Mooneye is a North American species with a range extending from James Bay, Ottawa River to the Lake Champlain and St Lawrence watershed, southwest of the Appalachian Mountains through western New York and Pennsylvania to Arkansas and Oklahoma, north through eastern Kansas to North Dakota, southeastern Saskatchewan and southern Manitoba (Scott and Crossman 1973). In Vermont, it is a peripheral species at the eastern most extent of its range and has been recorded only from Lake Champlain, including the southern part of the lake, and near the mouths of the Missisquoi and Lamoille rivers and Otter Creek.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Lake Champlain	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Mooneyes are found in shallow areas of large lakes and deep pools of clear rivers where the bottom is relatively free of silt (Langdon et al. 2006). Although it is generally found in non-flowing waters, it may also occur in swift waters, such as below dams (Trautman 1957). Mooneyes have rarely been taken with collection gear at depths greater than 10.7 m (Scott and Crossman 1973). Mooneye is a warm water species, preferring water temperatures in the range of 27.5-29.0 C, and migrate up rivers to spawn when the water temperatures reach 19.4 C (Langdon et al. 2006).

Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Mooneye is not tolerant of silted habitats or turbidity (Scott and Crossman 1973).

Non-Habitat Threats:

Unknown Non-Habitat Threats

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Assess habitat requirements and use by mooneye in Lake Champlain.
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Very little is known about the distribution and abundance of mooneye in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitoring population status needed.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Mooneye**
Scientific Name: **Hiodon tergisus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 | **Global Trend:** Unknown
State Rank: S4 | **State Trend:** Unknown
Extirpated in VT? No | **Regional SGCN?** No

Assessment Narrative:

In Vermont, Cisco is confined to Lake Champlain, and little is known of the population's biology, distribution and habitat use, and past and present abundance. It is not frequently encountered during fish population lake surveys and appears to be susceptible to competition from other fishes occupying similar trophic niches, e.g. invasive Alewives; possibly Sea Lamprey parasitism; and eutrophication of the lake (NatureServe 2014). All three threats are present in Lake Champlain. The species has experienced population declines in the Great Lakes (COSEWIC 2005; NatureServe 2014). The Vermont population appears to have been much more abundant back in the 1950s than it is today. Halnon (1963) described the fishery at that time as follows: "…occurs in large numbers and is taken by ice fishermen who seek this species. It was not uncommon to check fishermen with several hundred specimens during the intensive ice-fishing checks of the 1950's. Summer population studies regularly took the species in nearly all deep water gill net collections." Combined numbers of Cisco collected during rainbow smelt trawling at four locations in Lake Champlain from 1999 to 2013 indicate a declining trend over these years, although a peak did occur during 2002 to 2004 (data provided by N. Staats, U. S. Fish & Wildlife Service, personal communication).

Distribution

This species is the most widely distributed of the 14 species of the genus Coregonus occurring in North America. It is found from eastern Quebec to the Hudson Bay, through the Great Lakes system, Ontario, Manitoba, Saskatchewan and Alberta, north into the Northwest Territories, and in the Mackenzie River system north to Great Bear Lake (Scott and Crossman 1973). In Vermont, where it occurs on the eastern edge of its range, Cisco is restricted to Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

In Vermont, Cisco inhabit the cold, deep areas of Lake Champlain. It is an open-water, schooling species inhabiting cool mid-lake areas during the summer, shifting to shallower waters inshore from fall to spring. It cannot tolerate water temperatures of over 26.1°C. Cisco spawn in late fall, just prior to ice formation, at depths of about .9-3 m, over gravel to rubble bottom (Langdon et al. 2006).

Habitat Types:

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): The appearance of Alewife in Lake Champlain is of great concern due to to its potential impact through competition with other pelagic planktivores, such as Cisco. The species also require deep, cold water. If climate change has a significant impact on the thermal structure of Lake Champlain, this could affect the Cisco population.

Non-Habitat Threats:

Competition

Parasites

Loss of Prey Base

Description of non-habitat threat(s): Sea Lamprey have negatively impacted cisco in other bodies of water (Smith 1985, Bronte et al. 2003). As soft-scaled members of the salmon family, Cisco is susceptible to parasitism/predation by Sea Lamprey. Lamprey predation was identified as a contributing factor to the decline of Cisco in Lake Superior (Bronte et al. 2003), and 80% of Cisco in Oneida Lake, NY that died off during high summer temperatures had lamprey scars (Smith 1985). So far there are no direct reports of lamprey impacts on Cisco in Lake Champlain. Cisco is primarily pelagic (open-water) feeders on zooplankton, and therefore might compete with other species with similar feeding habits, such as smelt. The appearance of alewife in Lake Champlain could pose a problem to both of these native open-water planktivores.

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Develop population indices through forage base monitoring in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitats occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Research	Medium	Currently under VFWD fishing regulations Cisco is an unregulated activity. Whether or not harvest poses a threat to Cisco population(s) should be reviewed.	Review was conducted and recommendations were considered.	VFWD, UVM	VFWD (SWG, DJ), UVM
Research	Medium	Investigate whether predation on Cisco presents significant threat to the species.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP	
Research	Medium	Investigate whether Sea Lamprey parasitism is a significant threat to Cisco.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Cisco or Lake Herring**
Scientific Name: **Coregonus artedi**
Species Group: **Fish**

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Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4?
Extirpated in VT? No

Global Trend: Unknown
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

In Vermont, Lake Whitefish is found only in Lake Champlain. Halnon (1963) expressed concern for the Lake Champlain population and pointed out observations that imply the species may have been experiencing problems as far back as the 1800s. In the later part of that century there were calls for a prohibition on commercial seining during the whitefish spawning season; it was not until 1913 that this fishery ended (Halnon 1963). Later in his 1963 review of Lake Champlain fisheries he stated the species is essentially untouched by fishermen. Historically, the Lake Whitefish fisheries were concentrated in the South Lake, Missisquoi Bay, and near St. Albans Bay (Halnon 1963, Marsden and Langdon 2012). 2012 was last year whitefish was harvested commercially in Vermont ; the fishery was closed the following year (Halnon 1963). In more recent years (1930s to late 1990s), Lake Whitefish have been encountered during biological surveys only incidentally (Herbst et al. 2011). Currently, little is known about the status of Lake Whitefish nor of the causes which may be affecting its population. Van Oosten and Deason (1939) studied the population in the 1930s but not much attention has been given to it since with the exception of recent studies undertaken by Dr. Marsden at the University of Vermont (see Herbst et al. 2011, Herbst et al. 2013, Marsden et al. 2014). Herbst et al. (2011) came to the conclusion that the population is stable and unexploited; however, they also concluded that (1) some local populations, namely those that existed off Larrabee's Point and in Missisquoi Bay, may have been extirpated due to past exploitation, (2) areas where they historically were found appear to be staging rather than spawning areas, and (3) spawning substrates have been degraded. Additionally, they hypothesize that past and current land use and riparian practices resulting in increased sediment loads and phosphorus to the lake may be responsible for degraded spawning habitat particularly affecting northern and southern regions of the lake. Similar impacts have been suspected of having contributed in Lake Whitefish population declines in Lake Michigan (NatureServe 1014) and Lake Simcoe (COSEWIC 2005). Other threats to Lake Whitefish in Lake Champlain are competition with exotic species (e.g. Alewife) and Sea Lamprey parasitism.

Distribution

Lake Whitefish is a widely distributed North American species. Its range includes virtually all of Canada and Alaska, the Great Lakes, the St. Lawrence River including northern New York, Vermont, New Hampshire and Maine (Scott and Crossman 1973). In Vermont, it is confined to Lake Champlain. However, in 1878 Lake Whitefish were introduced into five other Vermont lakes, such as Lake Dunmore in Addison County and Lake St. Catherine in Rutland County, but none of these introductions was successful (Langdon et al. 2006).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Lake Whitefish inhabit cold lakes which are deep and clear. Lake Whitefish spawn during November and December at water temperatures below 7.8 C; spawning occurs near the surface in water less than 7.6 m deep, and the adhesive eggs sink to the bottom onto a usually gravel or rubble and occasionally sand substrate (Langdon et al. 2006).

Habitat Types:

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Climate Change

Description of habitat threat(s): Lake Whitefish also require deep, cold water. If climate change has a significant impact on the thermal structure of Lake Champlain, this could affect the population of Lake Whitefish.

Non-Habitat Threats:

Competition

Parasites

Description of non-habitat threat(s): The appearance of alewife in Lake Champlain is of great concern due to their potential impact through competition with other pelagic planktivores, such as Lake Whitefish. Sea Lamprey has negatively impacted Lake Whitefish in Lake Superior (Bronte et al. 2003). As soft-scaled members of the salmon family, Lake Whitefish are susceptible to parasitism/predation by Sea Lamprey. Lamprey predation was identified as a contributing factor to the decline of Lake Whitefish in Lake Superior (Bronte et al. 2003), and whitefish populations rebounded after implementation of lamprey control.

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Develop population indices through forage base monitoring in Lake Champlain.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Medium	University of Vermont (E. Marsden) is currently engaged in a genetics study of sub-populations in Lake Champlain,.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Natural Processes Restoration	Medium	UVM is studying the effects of physical isolation/reduced connectivity on Lake Champlain bays and changed water movement, nutrient retention, and potential population sub-structuring of Lake Whitefish.	Completion of study and recommendations that may come from it.	VDEC, VFWD, USFWS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP	
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)

Common Name: **Lake Whitefish**
Scientific Name: **Coregonus clupeaformis**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Research	Medium	Investigage whether Sea Lamprey parasitism is a significant threat to Lake Whitefish. Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM	
Research	Low	Currently under VFWD fishing regulations Lake Whitefish is an unregulated activity. Whether or not harvest poses a threat to Lake Whitefish population(s) should be reviewed. Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM	

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Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No

Global Trend: Unknown
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

Until recently Round Whitefish populations were reported from four lakes, all in northeastern Vermont and the St. Francis River drainage (Willoughby Lake, Lake Seymour, Holland Pond, Beaver Pond), and the upper Connecticut River. There is historic reference (Titcomb and Bailey 1896) to a whitefish species distinct from Lake Whitefish (Coregonus clupeaformis) in Lake Memphremagog, but it is ambiguous which coregonine species was intended; the persistence of Round Whitefish upstream in the watershed is evidence that Round Whitefish was indeed the so-called "shad" (i.e. whitefish) noted for Lake Memphremagog (Gerardi 2015). Sampling conducted by electrofishing, experimental gill nets and beach seines between 2006 and 2012 failed to collect whitefish in Seymour Lake, Holland Pond and Beaver Pond suggesting these populations may be extirpated (Kratzer 2011). Likewise, extensive sampling by McGill University staff and students at Lake Memphremagog in the early 1970s provided no documentation of Round Whitefish remaining in the lake (Nakashima and Leggett 1975; Gascon and Leggett 1977). Several possible causes of population elimination are Smallmouth Bass introduction and predation in Lake Seymour, competition with the resident White Sucker population in Beaver Pond, Chain Pickerel (Esox niger) predation and/or anoxia in the hypolimnion in Holland Pond (Kratzer 2011), along with major fish community changes in Lake Memphremagog brought about by introduction of many species not native to the lake (Gerardi 2015). As recently as 2011 sampling of the upper Connecticut River by New Hampshire Fish & Game Department captured Round Whitefish, which population is characterized as being abundant (Kratzer 2011). Historically, Round Whitefish were reported to be in Lake Champlain as early as 1894 (Evermann and Kendall 1902) but does not appear to have been encountered during the 1929 biological survey of the lake (Greeley 1930). Current reports of Round Whitefish in the lake appear to be lacking (Marsden 2014; Parrish 2014; Pientka 2014). Potential threats to the species have been identified by NatureServe (2014) to include habitat loss through either siltation of spawning streams or lake shores and decreased water quality resulting from poor forest management practices and land development; road, bridge and in-stream construction projects with negative effects on spawning habitat or obstruction of whitefish access to spawning habitat; piscicides; and exotic fish introductions. Round Whitefish is classified as an endangered species in New York in 1983. Historically, the species was found in over 80 lakes in the state but has now declined to populations numbering fewer than eight (NYSDEC 2015a). Possible reasons for the decline of the species in New York are predation by invading Smallmouth Bass and Yellow Perch, competition with Lake Whitefish, overfishing, loss of spawning habitat, siltation, and lake acidification (NYSDEC 2015b). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

In Vermont, Round Whitefish is found in lakes Seymour, Willoughby and in Beaver Pond in Holland. A historic record of "Lake Whitefish" in Holland Pond (located near Beaver Pond in Holland) is believed actually to have been a Round Whitefish.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
St. Francois River
Upper Connecticut

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Round Whitefish is an inhabitant of cold, clear lakes and rivers. In rivers it occurs over rocky bottoms. In the Great Lakes it is commonly found inshore at depths of less than 36.6 m. It sometimes occurs in brackish waters. The Round Whitefish is a benthic insectivore, feeding on benthic invertebrates and occasionally fishes and fish eggs. Round Whitefish require gravel for spawning. Since eggs incubate overwinter with no parental care, a silt-free spawning substrate probably is essential for successful recruitment as for other salmonids.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): This species was once common to many of New York's Adirondack lakes. Recent surveys have shown its distribution there significantly reduced. The New York DEC has speculated on the possible causes: "predation by invading yellow perch on whitefish eggs and fry; predation by smallmouth bass; competition with lake whitefish; over fishing; loss of spawning sites; siltation; and lake acidification". Given the current and past locations in Vermont, only the following causes are possible for Vermont lakes: predation by Yellow Perch on whitefish eggs and fry (in lakes Seymour and Willoughby); predation by Smallmouth Bass (Lake Seymour only); loss of spawning sites and siltation (lakes Seymour and Willoughby). Beaver Pond is a small remote pond with no human structures along the shore and only seasonal human use within the watershed. With a low alkalinity (about 4mg/l) lake acidification, however, exists as a potential problem to that population. pH values for beaver Pond have been observed to drop well below 6.0 during spring runoff. Since this species is a benthic insectivore it relies entirely on invertebrates on the bottom as a food source. Loss or reduction of this food through sedimentation would limit its existence. Sedimentation may also limit egg survival by reducing oxygen exchange with surrounding water. Eggs incubate for months unguarded and unmaintained making a low sedimentation rate necessary for egg survival. Loss of spawning sites through siltation is also a threat. Climate change could result in the warming of the coldwater thermal regime that Round Whitefish require.

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Non-Habitat Threats:

Competition

Pollution

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Beaver Pond is a small remote pond with no human structures along the shore and only seasonal human use within the watershed. With a low alkalinity (about 4mg/l) lake acidification is a potential threat to that population. Acidification would first impact newly hatched eggs, since this stage is normally the most vulnerable to acidity. Multiple year class failures would result in reductions or possible extermination of the species. Predation on whitefish eggs and fry by Yellow Perch in lakes Seymour and Willoughby and by Smallmouth Bass in Lake Seymour is a threat to these populations. Lake Whitefish may be a competitor with Round Whitefish.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	Identify potential limiting factors.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, CRWC, TNC	
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, TNC, CRWC	
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, VFWD	VDEC (ANCG)
Policy & Regulations	High	Currently under VFWD fishing regulations Round Whitefish is an unregulated activity. Whether or not harvest poses a threat to Round Whitefish population(s) should be reviewed.	Review was conducted and recommendations were considered.	VFWD	VFWD (SWG, DJ)
Species Restoration	High	Develop and implement a plan for restoring Round Whitefish to additional waters that have the habitat and fish community makeup to sustain whitefish populations.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFGD, CRWC, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Research	High	Investigate whether predation on Round Whitefish presents significant threat to the species.	Review was conducted and recommendations were considered.	VFWD, UVM	VFWD (SWG, DJ), UVM

Common Name: **Round Whitefish**
Scientific Name: **Prosopium cylindraceum**
Species Group: **Fish**

Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? Yes

Global Trend: Unknown
State Trend: Historic
Regional SGCN? Yes

Assessment Narrative:

Whether or not landlocked Atlantic Salmon were endemic to Vermont is not at all clear. Thompson (1853) described salmon spawning runs in the state as follows: "They came up the Connecticut river [sic] about the 25th of April, and proceeded to the highest branches. Shortly after they appeared [emphasis added] in lake [sic] Champlain and the large streams which fall into it." In that salmon are described as "appearing" in the lake seems to suggest that adult fish are not present year round but rather seasonally as is characteristic of anadromous salmon. Thompson (1842) mentions salmon as being in Lake Champlain but does not make any distinction between the population as being anadromous and/or landlocked ecotypes. However, the State of Vermont Fish Commissioners (VFC 1892) stated of landlocked salmon that it "is not known to be indigenous to any lakes in Vermont" and that "Atlantic salmon…entered Lake Champlain by way of the St. Lawrence and Richelieu rivers during their migratory period for the purpose of spawning…." As a consequence of the construction of dams and other obstructions anadromous salmon were prevented access to the lake, and subsequently landlocked salmon were introduced (VFC 1892). Greeley (1930) identified landlocked salmon in Lake Champlain as an introduced species. On the other hand, Behnke (2007) offers the opinion that landlocked salmon were native to Lake Champlain. Likewise, by all accounts, landlocked salmon were not indigenous to Lake Memphremagog but were introduced from Maine (Grand Lake, East Grand lake or Sebago strains) in the late 1800s (Gerardi 2015). As a result of stocking, landlocked salmon became naturalized in the Clyde River and established a vibrant fishery, based at least in part on natural reproduction until it collapsed during the 1940s as a result of expanded hydroelectric generation on the river (Gerardi 2015). Although not substantiated, anadromous Atlantic Salmon may have had access to Lake Memphremagog and its tributaries prior to European colonization and damming of the St. Francis River at Drummondville, Quebec (Gerardi 2015). Without regard to which ecotype was native to Lake Champlain and Lake Memphremagog threats to future restored populations are similar to both: dams and water pollution, stream acidification, sedimentation of spawning and holding habitats, and possible changes in water temperature have been attributed to declines of some populations; landlocked populations have also suffered from Northern Pike and/or Esox hybrid predation (NatureServe 2014). With the appearance of Alewife (Alosa pseudoharengus) in Lake Champlain salmon have become more reliant on this species as prey. This may result in thiamine deficiency and consequently lead to salmon reproductive failure otherwise known as early mortality syndrome of salmon fry (Chipman 2015).

Distribution

Landlocked populations of Atlantic salmon occur principally in Newfoundland, Labrador and Quebec (Scott and Crossman 1973). Natural populations were also located in Maine and presumably in Vermont, i.e. lakes Champlain and Memphremagog. Scarola (1973) reports all landlocked salmon populations in New Hampshire are introduced. Landlocked populations have been stocked extensively to supplement natural populations, as well as to establish new fisheries. Even though salmon still occur in Lake Champlain, this is principally the result of a stocking program designed to restore a naturally reproducing population to the watershed, albeit there is little evidence of significant natural reproduction occurring there at this time. The Lake Memphremagog population does reproduce naturally with spawning occurring in the Clyde River.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Champlain Hills	Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
St. Francois River	Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

The landlocked salmon is a fish of oligotrophic waters, i.e., deep, well oxygenated, relatively infertile lakes. As the spawning season sets in fish leave the depths of the lake to suitable spawning habitat located in shallow lake shore areas or to ascend tributary streams or use lake outlets (Scarola 1973). Habitat studies conducted in Lake Winnipesaukee, New Hampshire found salmon have a preference for depths below the thermocline during the summer period (12-21 m) (Scarola 1973). Water temperatures at this time of year are in the mid 10s (C). Salmon can survive water temperatures into the 21s for brief periods of time but such temperatures are usually avoided if cooler water is available. Longer exposure to these temperatures can cause the fish physiological stress. Temperatures into the 27s can be lethal. Spawning habitat preferences are similar to those for anadromous Atlantic Salmon.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Salmon require cool streams for spawning and juvenile rearing. Many of the historical salmon streams in Vermont have barriers that impede their access to these habitats (e.g., Missisquoi, Lamoille, Winooski, Clyde rivers and Otter Creek). Dams and other impassable barriers, such as culverts, also fragment habitats that are needed to access spawning and rearing habitats but also for seasonal movements (e.g., summer feeding, temperature refugia, overwintering habitats). Water quality degradation, such as in mean annual temperatures, have occurred due to losses in mature riparian canopies, impacts from land use practices, urban stormwater runoff, and water retention in impoundments. Stream habitats have been degraded and habitat complexity decreased from channelization and removal and reduced recruitment of large woody debris to rivers. Habitat degradation from a variety of stressors has

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

reduced the quality of spawning and juvenile rearing habitats in Vermont streams. The appearance of alewife in Lake Champlain is of great concern due to their potential impact through competition with other pelagic planktivores, such as landlocked Atlantic Salmon.

Non-Habitat Threats:

Genetics

Parasites

Competition

Description of non-habitat threat(s): The native stocks of landlocked salmon in Lake Champlain were extirpated by the mid 1800s. It is questionable whether past and current restoration efforts are using genetically appropriate strains for restoration given the habitat conditions present in the lake. Competition and displacement by introduced salmonids, such as rainbow trout, may impact juvenile rearing stages of salmon. Sea lamprey parasitism has been found to be a significant source of mortality affecting salmon restoration.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Impacts of Alewife consumption on thiamine levels in salmon and reproduction. Medium priority: inter-specific non-native salmonid competition.
Research	Population Genetics	High	Evaluation of strains being stocked in Lake Champlain for restoration purposes.
Research	Taxonomy	Low	
Research	Other Research	High	Accelerate the development of Lake Champlain salmon strain(s) which are more appropriate to the environmental conditions of those waters.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP, TU	VDEC (ANCG)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, TU, dam owners	Dam owners
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners	Dam owners
Species Restoration	Medium	Evaluate strains of salmon to be used for species restoration with focus on identifying ones best adapted to the environments where restoration is to occur and have desirable survival and growth characteristics.	Assess strains.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP, TU	VDEC (ANCG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Species Restoration	High	Implement salmon restoration plan in Lake Champlain.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, USFWS	SWG, DJ, USFWS

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU	
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations.	VFWD	VFWD (DJ)
Species Restoration	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations. Reduction of Sea lamprey wounding rates.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Atlantic Salmon (naturally reproducing populations**
Scientific Name: **Salmo salar**
Species Group: **Fish**

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Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? No

Global Trend: Unknown
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

Brook Trout is the most widely distributed and abundant salmonid species indigenous to Vermont. Today, wild populations occur throughout the state wherever suitable habitat exists. Brook Trout is sensitive to pollution and habitat degradation. Deforestation, water development projects, pollution, habitat degradation, and competition and/or predation from introduced fishes have all taken a toll on wild populations throughout its range. Beginning around the mid-1800s and continuing up to present time Brook Trout have been cultured in hatcheries and stocked to provide fishable populations throughout the state. While the stocking of hatchery-reared trout is an important fisheries management tool, this practice poses several risks to wild trout populations including direct competition, displacement, genetic alteration and the introduction of diseases. Efforts to minimize potential negative interactions of hatchery and wild populations in Vermont have focused on wild trout management (no stocking) where robust populations exist, improved fish health protocols and development of triploid (sterile) Brook Trout to minimize potential genetic impacts. Wild Brook Trout populations are at risk from genetic interactions with stocked fish, as hatchery-reared trout only survive a few months after stocking to spawn with wild stocks. Although cases of reproductive isolation have been observed in conjunction with long-term stocking programs, introgression and hybridization between wild and hatchery stocks has been well documented for many salmonid species, including Brook, Brown and Rainbow trout (Kirn 2003). Genetic testing of five Brook Trout from geographically distinct Vermont watersheds was conducted in 2006. Results indicate that these populations are genetically diverse, highly differentiated and show no evidence of influence from past stocking practices (T. King, U. S. Geological Survey, personal communication). The existence of genetically distinct wild Brook Trout populations reinforces the need for a prudent approach to trout stocking (Kirn 2007). These results are consistent with other studies where wild Brook Trout have shownsinificant variation among populations, even within the same minor river drainage, and suggest that individual populations should be the primary ecological unit considered for conservation and management programs (Perkins et al. 1993, Jones et al. 1996).

hreats to Brook Trout populations include loss and degradation of habitats resulting from adjacent land use, channel alterations, artificial flow regimes, water pollution, habitat fragmentation by dams and other obstructions (e.g. culverts), reduction of riparian vegetation resulting in stream water temperature increases and loss of complex instream fish cover (e.g. large wood). Spawning habitat and trout egg and fry survival are negatively affected by sedimentation. Climate change is predicted to increase water temperatures at the expense of populations at state as well as continental range levels. Climatic warming will likely decrease thermally suitable summer habitat for lotic Brook Trout populations Meisner (1990). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The Brook Trout is native to most of eastern Canada from Newfoundland to west of Hudson Bay; south in the Atlantic, Great lakes and Mississippi River basins to Minnesota and through the Appalachian Mountains to Georgia (Page and Burr 1991). It has been introduced widely outside of its natural range. In Vermont, the species is distributed throughout the state where suitable habitat is available and competing species are absent or low in abundance.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Distribution by Biophysical Region:

Champlain Valley	Not Probable	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Certain
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Certain
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Lamoille River
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut
White
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Brook Trout occur in headwater streams, small to medium rivers, and lakes and ponds where waters are clear, cool and well-oxygenated. Raleigh (1982) gives a comprehensive review of Brook Trout habitat requirements. Riverine Brook Trout habitat is characterized by being influenced by cold-springs, having silt-free rocky substrate in riffles and runs, well vegetated stream banks, abundant instream cover, and relatively stable stream flows, temperatures and stream banks. Lacustrine habitats are typically oligotrophic in character. The temperature range for Brook Trout is 0-24°C, with optimal temperatures for growth and survival in the range of 11-16°C. Warm water temperatures appears to be the single most critical factor influencing Brook Trout survival and production. Brook Trout normally require high dissolved oxygen concentrations, optimally near saturation or >= 7 mg/L at temperatures <=15°C and >= 9 mg/L at temperatures >= 15°C. Instream and riparian cover is recognized as an important component of Brook Trout habitat. Brook Trout tends to be more tolerant of low pH water than other salmonid species. Most spawning occurs in stream habitat, although Brook Trout may spawn directly in lakes and ponds where there are upwellings.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Brook Trout habitat has been degraded by alterations of natural stream channel morphology and flow regimes; water pollution; fragmentation (e.g., dams and culverts); reduction of riparian vegetation resulting in stream water temperature increases and loss of instream cover (e.g., large woody debris) Spawning habitat and trout egg and fry survival are negatively affected by sedimentation. Climate change could potentially degrade temperature regimes required by Brook Trout throughout its distribution.

Non-Habitat Threats:

Genetics

Disease

Competition

Pollution

Predation or Herbivory

Description of non-habitat threat(s): Brook Trout compete poorly with introduced salmonids, such as Brown and Rainbow trout, as well as warmwater species (e.g., centrachids, percids and esocids). Additionally, these competitors may prey upon Brook Trout. Stocking of non-native brook trout strains on wild populations may result in inbreeding, loss of genetic characteristics necessary for species survival, and intra-specific competition. Stocking also puts heritage populations at risk of introducing disease causing pathogens, such as whirling disease.

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Identify currently non-stocked wild Brook Trout populations to inform planning and management
Research	Threats and Their Significance	High	1) Evaluate the impact of culverts and other artificial obstructions on brook trout passage and distribution. 2) Identify and evaluate stream barriers as fish passage barriers to critical habitat and/or their value in isolating wild populations.
Research	Population Genetics	Medium	Nothing is known about the genetic characteristics of Vermont's wild populations and the possible existance of heritage strains.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TU, TNC, EBTJV, Echo Center, LCBP, LCI, CRWC	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Monitor populations for high priority disease organsims. Enforcement of importation regulations.	VFWD, USFWS	VFWD (SWG, DJ)
Habitat Restoration		Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NRCS, USFWS, LCBP, TU, EBTJV, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, TU, EBTJV, LCBP, CRWC	
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, EBTJV, TU, dam owners, watershed associations, town & regional planning & Cons Comms	VFWD (SWG), USFWS (AOPG), EBTJV, VTrans,

Common Name: **Brook Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus fontinalis**
Species Group: **Fish**

Research	Medium	Take into consideration the strains of trout stocked into wild populations, including stocking avoidance where possible, and/or use of triploid fish.	Number of wild populations where management actions are being implemented.	VFWD, TU, private hatcheries	VFWD (SWG, DJ)
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, EBTJV, TU, dam owners	Dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, EBTJV, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Eighteen lakes in Vermont are currently being managed for Lake Trout fisheries. With a few exceptions more than half of these populations exhibit little to no natural reproduction and therefore stocking hatchery-reared fish is necessary to maintain fishing quality. Presently, eight lakes (up from six reported in the 2005 WAP), all located in the northeastern part of the state, have populations that exhibit significant natural reproduction: Big and Little Averill lakes, Averill; Maidstone Lake, Maidstone; Echo Lake, Charlestown; Caspian lake, Greensboro; Willoughby Lake, Westmore; Seymour Lake Morgan; Crystal Lake, Barton; two other populations, Eligo Lake in Greensboro-Craftsbury and Shadow Lake in Glover, also have been demonstrated support wild reproduction but currently considered too low to maintain Lake Trout fisheries without stocking (Gerardi 2015). Despite natural reproduction occurring in Willoughby and Seymore lakes, these populations are supplemented with stocked Lake Trout, although this contribution is minor in comparison to the total population at large, estimated to be in the range of 5 to 30% (Gerardi 2015). Maidstone Lake has populations representing two distinct morphs (i.e. common and lunge) (Baille et al. In press). Stocking cultured (hatchery-reared) fish has a long history in fisheries management as a tool to increase and sustain commercial and recreational fisheries that have become overfished, decimated by predation (e.g. Sea Lamprey) and/or have experienced habitat degradation and loss, and this is no less true of Lake Trout management (Page et al. 2004, Valiquette et al. 2014). Genetic implications of stocking cultured Lake Trout on top of wild stocks have been investigated and reported fairly extensively and have found that stocking can profoundly alter the genetic integrity of wild populations and possibly reduce genetic variability and environmental adaptation within individual populations (Valiquette et al. 2014). Historically, Lake Champlain supported a wild population, which subsequently became extirpated. A restoration program is in progress and although Lake Trout reproduction has been documented (Ellrott and Marsden 2004) a fully self- sustaining population without stocking has yet to be established. Restored naturally reproducing and self- sustaining Lake Trout populations within the species natural range warrant special conservation attention. Lake Trout populations are susceptible to habitat alteration or degradation including lake eutrophication, oxygen depletion in the hypolimnion, spawning shoal sedimentation, and lake level manipulation. Climate change is also a concern in that it may alter the temperature regimes of habitats adversely affecting wild Lake Trout populations as well as favoring other species (e.g. Smallmouth Bass) that may compete and/or prey upon trout. Year-class strengths of Lake Trout populations are projected to weaken, and that of Smallmouth Bass to strengthen as a consequence of water temperature increases during each species respective spawning season (Casselman 2002). Introduced species, such Alewife, are known to contribute to reproductive failure by disruption of thiamine metabolism in Lake Trout. Sea Lamprey parasitism on Lake Trout in the Great Lakes and Lake Champlain has been responsible for major population declines. And, as mentioned previously, wild populations may be put at risk genetically by stocking fish from long domesticated hatchery lineages or wild fish introduced from external populations.

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Distribution

The natural occurrence of lake trout is limited to North America. Its natural range closely aligns with the limits of the Pleistocene glaciation. In Vermont, the species has been stocked extensively throughout the state; however, with perhaps very few exceptions these populations are not self-sustainable and are completely dependent on continued stocking for the populations to exist. The few self-sustaining populations in Vermont are all located in the Northeast Kingdom: Big and Little Averill ponds, Averill; Maid stone Lake, Maidenstone; Echo Lake, Charleston; Caspian Lake, Greensboro; and Crystal Lake, Barton (Gerardi 2015). Natural reproduction has been documented in Lake Champlain, but that population is not at the present time sustainable without stocking.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Certain	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

St. Francois River

Upper Connecticut

Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

Lake Trout is a species of oligotrophic lakes. In the southern part of their range the species inhabits deep, cold lakes whereas at more northern latitudes they are also found in shallow and deep waters. This species is intolerant of waters with low oxygen content, and prefers cold water, seeking areas with temperatures below 16°C (Langdon et al. 2006). Lake Trout spawn over rocky shoals and along wave-swept shorelines. Spawning in riverine habitat is rare. Lake Trout can spawn in depths of water from .3-61 m over gravel that measures 3.8-10.2 cm in diameter, typically aggregating in the fall over clean substrate, with deep interstitial spaces (Langdon et al. 2006). Lake Trout prefer eating small crustaceans, insects, and fish. Young lake trout eat plankton, insects, and small aquatic invertebrates.

Habitat Types:

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): eutrophication, hypolimnion oxygen depletion, spawning shoal sedimentation, lake level manipulations. Introduced species, such as Alewives, are known to contribute to reproductive failure by disruption of thiamine metabolism in Lake Trout. Sea Lamprey predation in Lake Champlain on Lake Trout may be a significant factor in population declines there. Dams constructed at lake outlets raise lake levels that can erode shoreline soils, increasing sedimentation of spawning shoals and decreasing reproductive success. Water level fluctuations, associated with water storage for hydropower, may result in dewatered Lake Trout egg and embryos, also negatively impacting reproductive success.

Non-Habitat Threats:

Genetics

Parasites

Harvest or Collection

Description of non-habitat threat(s): Lake Maidstone contains a population of Lake Trout (a.k.a. locally as lunge) that is morphologically distinct from Lake Trout in all other Vermont lakes. It is possible that this population is genetically distinct and represents a unique population that is native to Vermont. Because it is unknown whether this population is genetically distinct, no strategies exist to protect this population. Lake trout are highly valued by anglers due to the large size that this species can attain. Overfishing could result in the loss of self-sustaining, native lake trout populations (Ellrott and Marsden 2004).

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	Low	
Research	Population Genetics	Low	Investigated: see Baille et al. In press. Deciphering hatchery stock influences on wild populations of Vermont Lake Trout Salvelinus namaycush. Transactions of the American Fisheries Society, Bethesda, Maryland.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC	VFWD, USFWS, VDEC, TU, TNC, Echo Center, LCBP, LCI, CRWC
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations.	VDEC, USFWS, LCBP	VDEC (ANCG)
Natural Processes Restoration		Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration		Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, TU, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Research		Evaluate strains of Lake Trout to be used for species restoration with focus on identifying ones best adapted to the environments where restoration is to occur and have desirable survival and growth characteristics.	Assess strains.	VFWD, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

Natural Processes Restoration		Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Invasive Species Control & Prevention		Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN. Reduction in Sea Lamprey wounding rates observed on Lake Sturgeon.	VFWD, VDEC, USFWS, TU	VDEC (ANCG)
Legislation		Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Compliance & Enforcement		Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Species Restoration	High	Implement Lake Trout restoration plans in Lake Champlain. Undertake appropriate management actions as needed to conserve and enhance populations in other lakes in Vermont.	Components of the restoration plan that are implemented within the timeframe of the current WAP.	VFWD, NYDEC, USFWS	SWG, DJ, USFWS
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species (including pathogens) introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail. Reduce Sea Lamprey wounding rates where the threat exists (Lake Champlain).	Enforcement of importation regulations. Sea lamprey wounding rates.	VFWD, VDEC, USFWS, NYDEC	USFWS, VFWD, NYDEC, GLFC

Common Name: **Lake Trout (naturally reproducing populations)**
Scientific Name: **Salvelinus namaycush**
Species Group: **Fish**

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Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	Unknown
State Rank:	S4	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	No

Assessment Narrative:

Seven populations have been identified in Vermont (Langdon 2014). On a range-wide scale no major threats are known (NatureServe 2014); however, interspecies hybridization has been reported (Esox americanus X E. niger and E. americanus X E. lucius) which could pose a threat to populations where the Redfin Pickerel is the only resident esocid in the fish community and whether by intention or accident another esocid species might be introduced. Redfin Pickerel is listed as endangered in Maine (MDIFW 2013).

Distribution

The Redfin Pickerel (Esox americanus americanus) is the subspecies restricted to eastern United States; the Grass Pickerel (E. a. vermiculatus) is the western subspecies. Redfin Pickerel is a fish primarily associated with the eastern coastal plain. It is distributed from the St. Lawrence River (Lac St. Pierre) south through the Richelieu-Champlain-Hudson system into New York, east through southern Vermont and New Hampshire to Long Island and south along the coastal plain to Georgia (Scott and Crossman 1973). In Vermont, Redfin Pickerel appears to be limited to the Poultney-Castleton rivers drainage, South Fork of East Creek in Orwell, and Pond Brook in Monkton.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Redfin Pickerel occurs in weedy areas of lakes, ponds and slow rivers. The Redfin is often found in tea-colored, acidic waters with pH values as low as 4.3. The Redfin pickerel spawns during April and May when water temperatures reach 10°C (Langdon et al. 2006). Adults congregate to spawn and adhesive eggs are broadcast randomly in heavily vegetated, shallow areas along lakeshores or streambanks. Young Redfins first consume zooplankton, snails and crustaceans, switching to fish as they grow older. Adults feed on fish and crayfish, but may supplement these food items with small crustaceans and insects (Jenkins and Burkhead 1993). This species may play a significant role in fish community structure because of its preference to predate

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

on fish.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Loss or alteration (i.e. through flow alteration, dewatering, sedimentation) of vegetated, shallow areas along lakeshores or streambanks would pose a problem to the reproductive success of the species.

Non-Habitat Threats:

Genetics

Description of non-habitat threat(s): This species has a limited distribution in Vermont, located in three drainages. If any of these populations undergo a reduction in population size (i.e., population bottleneck), then it is possible that genetic variation will be lost, forfeiting the evolutionary potential of the species. Natural selection can only act in the presence of genetic variation, and, therefore, the higher the genetic variability in a population, the higher the likelihood for population persistence. If gene flow between the 3 populations is limited, then the genetic variability of each population could decrease over time. Also, Redfin Pickerel have been reported to hybridize with Northern Pike and Chain Pickerel (Jenkins and Burkhead 1993), which poses further genetic concerns. The introduction of Northern Pike or Chain Pickerel to waters populated by Redfin Pickerel poses the risk of hybridization, as well as introduce inter-specific predation and competition for habitat and forage. Decreased genetic variation in Redfin Pickerel would hinder the ability of the populations to adapt to changing conditions over time.

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Identify number of Redfin Pickerel populations in Vermont and those which are not co-habitants with other esocid species.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	The introduction of Northern Pike and Chain Pickerel to Redfin Pickerel waters limits the species by hybridization and should be monitored.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Invasive Species Control & Prevention	High	Identified populations which are not sympatric with other Esocid species should be managed to prevent to potential for interspecific competition and hybridization.	Number (percentage) of redfin pickerel waters remaining free of competing esocid species.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners, lake associations	Dam owners, lake associations
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	Medium	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)
Invasive Species Control & Prevention	High	Protect habitats currently supporting Redfin Pickerel populations from the introduction of other esocid species (e.g., Chain Pickerel, Northern Pike) which may compete for available habitat and/or potentially hybridize with Redfin Pickerel.	Number (percentage) of redfin pickerel waters remaining free of competing esocid species.	VDEC, VFWD, lake associations	VDEC (ANCG), VFWD (SWG, DJ)

Common Name: **Redfin Pickerel**
Scientific Name: **Esox americanus**
Species Group: **Fish**

Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3
State Rank: S1?
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Seven populations are known to occur in Vermont (Langdon 2014), although two or more of these are outdated reports (Hospital Creek, 1935; Lake Memphremagog, 1975). Bridle shiners were captured in the Canadian portion of Lake Memphremagog in 1999 (COSEWIC 2013). The species was also collected in the Connecticut River in the vicinity of Hanover, New Hampshire in 2008 (Yoder et al. 2010). Scarola (1987) states that bridle shiner in New Hampshire only occurs in the Merrimack and Coastal drainages, therefore the origin of the species in the upper Connecticut River is unknown but is presumed to be native. The species was frequently encountered in the Richelieu River watershed between 1965 and 1970; in 1990 six were collected in Missisquoi Bay near its mouth but were not captured during sampling efforts done in 2003 and 2012 (COSEWIC 2013). Threats to populations have been identified as reduction or removal of aquatic vegetation and increased turbidity, including agricultural pollution, as well as predation from introduced fish species (NatureServe 2014). Bridle Shiner is also potentially at risk to climate change (COSEWIC 2013). While population status and specific threats acting on Vermont populations are unknown, until water quality issues identified for Lake Champlain including Missisquoi Bay (LCBP 2012) are corrected, efforts for the population to recover to a more secure status may not be possible. Bridle shiner is listed as endangered in New Hampshire and Pennsylvania; special concern in Massachusetts, Connecticut, Ontario and Quebec; and extirpated in Maryland. Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

This North American species occurs in the Atlantic drainage from southern Maine to Virginia, west through Lake Champlain to New York and the Lake Ontario basin (Scott and Crossman 1973). In Vermont, bridle shiner are found in Lake Champlain, several other locations within that watershed, and has been reported to occur in Lake Memphremagog.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Historic Record(s) Only	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Lake Champlain	Missisquoi River

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The Bridle Shiner is a species of quiet streams, lakes and ponds (Scott and Crossman 1973, Page and Burr 1991). Honeyfield and Ross (2004) describe its habitat as slow, warm backwater eddies of low gradient streams and ponds with dense vegetation and substrate of mud, sand or gravel. Spawning occurs in areas of calm water, at a depth of about two feet, and in openings within stands of dense emergent aquatic vegetation (Cornell web site). Holms et al. (1999) suggest Bridle Shiner require open water above aquatic plant stands to spawn. The species has a strong preference for clear water necessary for this daytime, sight-feeder to forage on prey organisms (Honeyfield and Ross 2004). It is tolerant of brackish water but is not acid tolerant (Holm et al. 1999).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Threats include stream channelization, erosion, point-source discharges, loss of riparian vegetation, and large-scale development all been identified aspractices that have have been identified as practices that have increased turbidity and altered Bridle Shiner habitat where the species have become extirpated (Sabo 2000). Sedimentation and siltation are suspected as being major factors for the decline of Bridle Shiner in the Delaware River Basin (Honeyfield and Ross 2004). They also suggest the species may be vulnerable to highway construction activities which alter bridle shiner habitat including streamflow regimes, channel structure, water quality, and aquatic plant abundance. Being a sight-feeder turbid water conditions interfere with bridle shiner feeding and suppresses the growth of aquatic vegetation on which the fish is dependent for feeding, reproduction and cover (Holm et al. 1999). They also identify the spread of Eurasian milfoil as a potential problem to the species. This plant can alter the composition of the plant community by replacing native vegetation and invading the entire water column thereby eliminating clear water areas above the plants that are necessary for spawning (Sabo 2000).

Non-Habitat Threats:

Genetics

Pollution

Predation or Herbivory

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Description of non-habitat threat(s): Scott and Crossman (1973) state Bridle Shiner are an important forage species for pickerel as well as other piscivorus fishes (e.g., Yellow Perch, Smallmouth Bass, crappie) where these species co-exist. In some New England lakes and ponds, where significant reduction or removal of submersed aquatic plant stands has occurred, fish predators (e.g., bass) have decimated bridle shiner populations (Sabo 2000). Honeyfield and Ross (2004) state, that within the species range populations appear to be highly fragmented and declining with separation distances between known populations exceeding 200 km. They suggest this may have resulted in genetic divergence among populations, although this has not been investigated. This species is sensitive to sedimentation and chemical runoff from agricultural lands (Ontario's Biodiversity website). The Bridle Shiner is not tolerant of acidic water making it vulnerable to atmospheric deposition (Holm et al. 1999).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Monitoring program is recommended to assess changes in species abundance and distribution.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners

Common Name: **Bridle Shiner**
Scientific Name: **Notropis bifrenatus**
Species Group: **Fish**

Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

Seven populations are known to occur in Vermont (Langdon 2014). Very little is known of its biology, distribution and habitat use, and past and present abundance of these populations. On a range-wide scale no major threats are known (NatureServe 2014). Blackchin Shiner has all but disappeared from southern New York watersheds; possible threats identified include fluctuating water levels and habitat loss due to siltation; species also has a low tolerance to salt (NYNHP 2013).

Distribution

This North American species occurs only in the Great Lakes basin, the upper Mississippi River drainage, and downstream through the St. Lawrence River drainage into western Quebec (Scott and Crossman 1973). In Vermont, the species on the eastern edge of its distribution and if limited to a few locations within the Lake Champlain watershed.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Confident
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Probable Watersheds
Lake Champlain
Metawee River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Trautman (1957) describes the Blackchin Shiner as a fish of glacial lakes and streams characterized by having very clear water, substrate of clean sand, gravel or organic debris, and the presence of dense beds of submersed vegetation. Scott and Crossman (1973) also note the species' preference for quiet pools in streams and weedy inshore areas of lakes. This shiner is also found in inlet and outlet streams of lakes (Becker 1983). Scott and Crossman (1973) state "clear, clean, weedy waters are essential for the survival of the blackchin shiner," but little information has been reported on spawning site preference and behavior. This species is an indicator of good water quality.

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Sedimentation

Invasion by Exotic Species

Description of habitat threat(s): The Blackchin Shiner is intolerant of silt. Trautman (1957) notes that it has disappeared from Ohio waters once they became turbid, silt covered the bottom, and the aquatic vegetation disappeared. The continuing expansion of the submersed exotic weed Eurasian milfoil in Vermont's lakes and ponds threatens Blackchin Shiner populations. Milfoil may displace native plant communities and alter the composition and fish habitat value of the aquatic plant community. Additionally the propensity for this invasive plant to establish dense beds impairing the use of some lakes for boating, swimming and fishing has resulted in the increased use of herbicides. Significant reduction in aquatic plant abundance could degrade habitat necessary for this species. One such herbicide in common use in Vermont is floridone (Sonar). The Michigan Environmental Science Board has concluded that this broad spectrum herbicide will not only control Eurasian milfoil but also significantly impact native aquatic plant species when applied at the labeled rate (Premo et al. 1999). Significant reduction in milfoil beds can subject Blackchin Shiner populations to increased predation pressure before native aquatic plants become reestablished restoring cover habitat for the shiner.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): The Blackchin Shiner does not appear to be particularly abundant in any of the waters it is known to occur in Vermont. Aggressive aquatic plant control activities in these waters could significantly reduce this important refuge habitat and subject the shiner populations to increased predation.

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	A greater understanding of the habitat requirements of this species is needed, especially the association with aquatic vegetation.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	Impacts of aquatic plant control (e.g., herbicide and mechanical treatments) on Blackchin Shiner habitat, biology, and aquatic community structure and function (e.g., species interactions, increased vulnerability to predation). Investigate and monitor these effects.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Blackchin Shiner**
Scientific Name: **Notropis heterodon**
Species Group: **Fish**

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Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G4	**Global Trend:**	Unknown
State Rank:	S1	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

Six populations are known to occur in Vermont (Langdon 2014). Very little is known of its biology, distribution and habitat use, and past and present abundance of these populations. On a range-wide scale no major threats are known (NatureServe 2014). Blacknose Shiners require very clear water and moderate amounts of vegetation; the species quickly disappears from habitat that becomes turbid and substrate that is degraded by sedimentation (ODNR 2012).

Distribution

The Blacknose Shiner is a widely distributed species occurring from the Hudson Bay drainage to the New England states west to Iowa (Scott and Crossman 1973). In Vermont, it appear to be most frequently encountered in the Lake Champlain watershed, albeit there are a few occurrences from other locations within the state.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Lake Champlain	Black-Ottauquechee
Missisquoi River	
Winooski River	

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Blacknose Shiner is a species of clear, shallow water habitats in glacial lakes and small streams (Scott and Crossman 1973). Most recorded occurrences in Vermont (11 out of 13 records) have come from riverine habitats (Langdon 2014). The species does not appear to have any particular preference for substrate type, although Trautman (1957) states it has been found in waters with bottoms comprised of sand, gravel, muck, peat or organic debris. The presence of submersed vegetation is an important component of Blacknose Shiner habitat (Page and Burr 1991, Trautman 1957). Backlund (1995) reports the fish requires cool well-oxygenated water. This species is intolerant of sedimentation and turbid water (Backlund 1995, Eddy and Underhill 1974, Trautman 1957). This species is an important indicator of pristine, high quality waters (Backlund 1995). The

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

biology and detailed habitat requirements of the Blacknose Shiner apparently have either been not thoroughly investigated or reported. Backlund (1995) states that the Blacknose Shiner is a host fish for the freshwater mussel cylindrical papershell Anodontoides ferussacianus, a state listed endangered species in Vermont.

Habitat Types:

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Sedimentation

Invasion by Exotic Species

Description of habitat threat(s): Backlund (1995) states the Blacknose Shiner is intolerant of turbid, polluted waters and that in South Dakota it has disappeared from may streams due to sedimentation, loss of aquatic vegetation and food, water temperature increases, and lowered dissolved oxygen. Aquatic plant control also poses a problem to Blacknose Shiner populations. In Minnesota the removal of aquatic vegetation along lake shorelines and increase sedimentation and turbidity levels have reduced this species (Eddy and Underhill 1974).

Non-Habitat Threats:

Pollution

Predation or Herbivory

Description of non-habitat threat(s): The Blacknose Shiner is reported to be intolerant of water pollution (Backlund 1995). Elimination of aquatic plant beds can expose this species to increased predation.

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	A greater understanding of the habitat requirements of this species is needed, especially the association with aquatic vegetation.
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Little quantitative data exists for Vermont populations; better distributional data is needed.
Research	Threats and Their Significance	High	Investigate and monitor the effects of aquatic vegetation control programs (e.g., Eurasian milfoil) on Blacknose Shiner populations.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Habitat Change	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Known populations, particularly those exposed to aquatic plant control activities, are in need of monitoring.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Blacknose Shiner**
Scientific Name: **Notropis heterolepis**
Species Group: **Fish**

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Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

Bailey et al. (2004) and Page and Burr (2011) recently recognized Northern Pearl Dace (Margariscus nachtriebi) as a species, elevating it from the previous subspecies status M. margarita nachtriebi. Previously it was considered a subspecies of M. margarita, a species now referred to as the Allegheny Pearl Dace (M. margarita margarita). The latter species is a larger scaled form that ranges from southern New York and southwestern Vermont to Virginia (Bailey et al. 2004). Currently, Northern Pearl Dace are known from the Upper Rock and Pike river watersheds in northwestern Vermont (Franklin County near the Canadian border). Both watersheds drain to Missiquoi Bay in Lake Champlain. Allegheny Pearl Dace populations in Vermont (nine records) are distributed in Otter Creek, Poultney River and Batten Kill watersheds (Langdon et al. 2006).

Distribution

Upper Rock and Pike river watersheds in northwestern Vermont (Franklin County near the Canadian border). Both watersheds drain to Missiquoi Bay in Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Confident
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Confident
Northeastern Highlands	Unknown		

Distribution by Watershed:

Probable Watersheds
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Pools of cool, clear headwater streams, bogs, ponds and small lakes with silt, sand and gravel bottoms, close to aquatic vegetation; preferred water temperature is 16.2°C (Eakins 2015).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

Current Threats

Description of habitat threat(s): While localized threats may exist, no major threats are identified for this species at the range-wide scale (NatureServe 2013).

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Determine current distribution of species in vermont.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	Low	
Monitoring	Habitat Change	Low	
Monitoring	Monitor Threats	Medium	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Better deliniate Northern Pearl Dace distribution and abundance. Assess potential threats and develop management strategies as needed.	Number of streams, lakes and ponds identified as supporting Northern Pearl Dace populations.	VFWD, UVM	VFWD

Common Name: **Northern Pearl Dace**
Scientific Name: **Margariscus nachtriebi**
Species Group: **Fish**

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Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S2
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

In Vermont, Silver Redhorse is confined to Lake Champlain and the lower accessible reaches of larger tributary rivers to the lake, e.g. Missisquoi River, Winooski River, Otter Creek and Poultney River (Ferguson 2014). The population is on the eastern edge of its continental range. Little is known of its distribution and population status; however, based on anecdotal observations it is but appears to be less abundant than Shorthead Redhorse (M. macrolepidotum) but more abundant than Greater Redhorse (M. valenciennesi) (Ferguson 2014; Langdon 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). Eaton and Scheller (1996) identify Silver Redhorse as potentially at risk from climate change. NatureServe (2014) identifies no known major threats to the species at the range-wide scale, but acknowledges that localized threats may exist. In Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

A North American species which occurs east from the St. Lawrence River, south through central New York, southwest through the western half of the coastal states to northern Alabama, northwest through eastern Arkansas and Missouri, north through North Dakota, and into Saskatchewan and Alberta (Scott and Crossman 1973). In Vermont, the silver redhorse is on the eastern edge of its North American range and occurs only in Lake Champlain and up to the fall line in the Missisquoi and Poultney rivers.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	Probable Watersheds
Lake Champlain	Lamoille River
Winooski River	Missisquoi River
	Otter Creek

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Silver Redhorse is found in small to moderately-sized rivers and occasionally lakes. In rivers it prefers deep pools with some current (Meyer 1962). During their first year of life Silver Redhorses sometimes remain in small streams where they were hatched. This species avoids silty bottoms and may also be intolerant to general environmental degradation (Langdon et al. 2006). Adult Silver Redhorse perform annual migrations to spawn. Seasonal movement patterns may prove important for successful spawning. Silver Redhorse are early spawners and in their southern range breed from April through early May in water temperatures of 11-15°C. Spawning usually occurs in shallow riffles over gravel and cobble (Jenkins and Burkhead 1993). Silver Redhorse feed on insect larvae, microcrustaceans, mollusks, algae, detritus, crayfishes, and the fry of shiners (Jenkins and Burkhead 1993).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Flow alteration, temperature alteration, or decreased habitat diversity (i.e. loss of deep pool habitat) will most likely have negative effects for different life stages of Silver Redhorse. Fragmentation of Silver Redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Disruption to the spawning efforts of this species poses a problem to population viability (i.e. weak year classes over time compound negative influences and population declines). If the quantity or quality of Silver Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activity, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment for Silver Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Silver Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e. spawning, feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, such as aquatic insects, a source of food for Silver Redhorse. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fishes (Berkman and Rabeni, 1987).

Non-Habitat Threats:

Pollution

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Description of non-habitat threat(s): Water pollution may indirectly influence silver redhorse through negative impacts to its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Silver Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sediment and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Research	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners

Common Name: **Silver Redhorse**
Scientific Name: **Moxostoma anisurum**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Scott, W. B., and E. J. Crossman. 1973. Fisheries Research Board of Canada Bulletin 184, Ottawa.

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	Unknown
State Rank:	S2	**State Trend:**	Unknown
Extirpated in VT?	No	**Regional SGCN?**	No

Assessment Narrative:

Shorthead Redhorse in Vermont is confined to Lake Champlain and the lower accessible reaches of larger tributary rivers to the lake (Langdon et al. 2006). It appears to be a widespread species within its Vermont range but based on anecdotal observations appears to be fairly abundant where found (Ferguson 2014; Langdon 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). NatureServe (2014) identifies no known major threats to the species at the range-wide scale, but acknowledges that localized threats may exist. In Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

The Shorthead Redhorse is the most widely distributed of the redhorse species in North America. It occurs from the upper St. Lawrence River, south into the Lake Champlain drainage to the coast in New York, east of the Appalachian Mountains to South Carolina, west through Pennsylvania and Ohio, southwest into Indiana and Arkansas, the Tennessee River drainage in Alabama, west to Texas, northwest through eastern Colorado and Montana, north to central Alberta, east to southern Hudson Bay and the east shore of James Bay (Scott and Crossman 1973). In Vermont, the species is on the eastern edge of its North American range and is confined to Lake Champlain and several large tributaries up to the fall line.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Winooski River
Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

This species prefers the clear water of small to large rivers and sometimes lakes. Most individuals have been observed holding or feeding in deep pools. It is found over clean sand, gravel, and cobble substrate, and is tolerant of water temperatures up to 37°C. It requires a silt-free habitat and is thought to be susceptible to many forms of water pollution (Langdon et al. 2006). It is common to find this species living in the same areas as other redhorse species. In Vermont, the Shorthead Redhorse is restricted to the larger tributaries of Lake Champlain (Langdon et al. 2006). The spawning period for Shorthead Redhorse occurs in spring from early April to early July, as influenced by local regional conditions (i.e. climate). Spawning water temperature is 11- 21°C. Spawning occurs in slow and moderate runs and pools over large gravel (Jenkins and Burkhead 1993). Shorthead Redhorse may perform spawning migrations to find optimal spawning habitat. Spawning groups of this species have been observed in streams where adults are normally not found except during breeding time (Jenkins and Burkhead 1993). Seasonal movement patterns may prove important for successful spawning.

Shorthead Redhorse is specialized to benthically feed on aquatic insects, small crustaceans, mollusks, algae, and detritus (Jenkins and Burkhead 1993). Highly silted or embedded substrate may preclude this species from consuming its preferred food items. Studies have shown that the principal, insect food items of redhorses are chironomids, ephemeropterans, and trichopterans (Meyer 1962)

Habitat Types:

Aquatic: Fluvial

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Description of habitat threat(s): Flow alteration, temperature alteration, or decreased habitat diversity (i.e. loss of deep pool habitat) will most likely pose negative effects for different life stages of Shorthead Redhorse. For instance, shallow, channel margin habitats that are indicative of slower velocities are important for young redhorses. Anthropogenic flow alteration has been shown to alter and limit this habitat, affecting juvenile life stages (Scheidegger and Bain, 1995). Fragmentation of Shorthead Redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Disruption to the spawning efforts of this species poses a problem to population viability (i.e. weak year classes over time compound negative influences and population declines). If the quantity or quality of Shorthead Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activity, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment for Shorthead Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Shorthead Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e. spawning, feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, such as aquatic insects, a source of food for shorthead redhorse. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fishes (Berkman and Rabeni, 1987).

Non-Habitat Threats:

Pollution

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Description of non-habitat threat(s): Water pollution may indirectly influence Shorthead Redhorse through negative impacts to its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Shorthead Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	Medium	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sedimentation and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)

Common Name: **Shorthead Redhorse**
Scientific Name: **Moxostoma macrolepidotum**
Species Group: **Fish**

Policy & Regulations	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S1
Extirpated in VT? No
Global Trend: Unknown
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

Based on current survey information, which is scant, Greater Redhorse appears to have the most restricted distribution of the three Moxostoma species occurring in Vermont, i.e. limited to northern Lake Champlain and the lower accessible reach of the Missisquoi River (Langdon et al. 2006). In 2009, it was documented to occur in Lake Memphremagog (Kratzer 2015). Whether Greater Redhorse has long been resident of the lake but has evaded detection until recently is no known. It is reported to be not difficult to find in the Missisquoi River during the spring season (Ferguson 2014). Threats include poor water quality resulting from agricultural and urban pollution, artificial flow regimes, and habitat fragmentation (Cook et al. 2005). However, in Vermont, little is known of this population or threats to it. Because populations are not being monitored, trends influenced by threats may not be detected.

Distribution

The Greater Redhorse is generally distributed in central and eastern North America primarily in the upper Mississippi and Great Lakes-St. Lawrence systems (Scott and Crossman 1979). This species has been recorded from northern Lake Champlain and the lower reach of the Missisquoi River (Langdon et al., 2006). In Vermont, the species is on the eastern edge of its North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds	**Probable Watersheds**
Lake Champlain	Lamoille River
Missisquoi River	Otter Creek
St. Francois River	Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Greater Redhorse inhabits medium to large rivers, large lakes and impoundments. It prefers coarse substrate, such as gravel, cobble, and boulders in clean water. In rivers, this species is frequently found in moderate to swift current in run or riffle habitat and may also be found in large river pools. Generally, it is not found in silty areas and is believed to be intolerant of silt and turbidity (Jenkins and Burkhead 1993).

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Spawning occurs in spring or summer in high velocity riffle habitat over gravel or cobble substrate that is silt free. Spawning has been found to occur in moderate stream velocities (3.8-116.9 cm/s) and at shallow depths (10-100 cm) (Healy 2002). Greater redhorse may perform annual migrations upstream to spawn and downstream after spawning. In an Ontario river, this species was observed dispersing up to 15 km downstream from its spawning habitat (Healy 2002). This species demonstrates important seasonal movement patterns. Different life stages have specific habitat preferences. Age-0 fish were found in shallow (20 cm), slow velocity pools (21 cm/s). Juvenile fish (greater than age-0 but not sexually mature) were found in slightly deeper pools (60-149 cm) and higher velocities (37 cm/s) (Healy 2002). The Greater Redhorse is a specialized benthic feeder such that highly silted or embedded substrate may preclude this species from consuming its preferred food items.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Habitat Fragmentation

Unknown Habitat Threats

Description of habitat threat(s): Flow alteration, temperature alteration, or low habitat diversity (i.e., loss of deep pool habitat, shallow riffles, or large woody debris due to human-induced change) will most likely pose negative effects for different life stages of greater redhorse. For instance, shallow channel margin habitats that are indicative of slower velocities are important for young redhorses. Flow alteration has been shown to alter and limit this habitat for juvenile life stages (Scheidegger and Bain 1995). Fragmentation of greater redhorse habitat may disrupt the seasonal movement patterns of this species. For example, these movement patterns may prove critical for successful reproduction, and therefore the completion of the species life cycle. Viability of Greater Redhorse populations most likely depends on optimal habitat availability (i.e., optimal or suitable depths, velocities, substrate, temperature, and flow regimes). Some evidence suggests that Greater Redhorse presence and abundance are correlated with longer contiguous river reaches (Healy 2002). If the quantity and quality of Greater Redhorse habitat is limited in a system, then interconnected river reaches will prove necessary for this species to find and occupy optimal or suitable habitat. Loss of riparian vegetation, general construction activities, road maintenance activities (ditching, sanding), bridge and culvert construction, agriculture, timber harvest, dam failure, rapid drawdown of dam impoundments, streambank erosion, and shifts in channel form or location are sources of sediment into Greater Redhorse habitat. Controlling sediment input into streams may be crucial to prevent detrimental effects to Greater Redhorse, because sedimentation decreases the quality and quantity of optimal habitat (i.e., spawning , feeding) for this species. Sedimentation eliminates interstitial spaces which could be critical for egg deposition and development and for production of benthic organisms, a primary food source for Greater Redhorse. Specialized benthic feeders, such as greater redhorse, represent a very ecologically vulnerable group to increased sedimentation, because they are unable to modify their feeding habits. Sedimentation has been shown to cause loss or reduction in fish populations, and disrupt the feeding and reproductive activities of fish (Berkman and Rabeni 1987). The Greater

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Redhorse seems to be rare over the majority of its range (Healy 2002). Determining the primary mechanism behind this trend is a challenge. Unknown habitat problems may exist.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): The reproductive strategy of the Greater Redhorse is a crucial aspect to its conservation. It becomes sexually mature at a late age, is highly fecund, and spawns seasonally. Disruption to the spawning efforts of this species poses a problem to population viability (i.e., week year classes over time compound negative influences and population declines). Water pollution may indirectly influence Greater Redhorse through negative impacts on its prey base. Depletion of food items will negatively affect species growth and survival.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Distribution, abundance and dynamics of Greater Redhorse populations in Vermont are poorly understood.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	Sediment and pollution
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Policy & Regulations	Medium	Currently under VFWD fishing regulations Moxostoma species are "cull" fishes and as such their harvest and collection is essentially an unregulated activity. Whether or not Moxostoma are threatened by unrestricted harvest should be reviewed.	Review was conducted and recommendations were considered.	VFWD, USFWS, NYDEC, UVM	VFWD (SWG, DJ), USFWS, UVM
Legislation	High	Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN.	Adopt appropriate legislation & policies developed to reduce greenhouse emissions & reduce climate change risks to SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP	

Common Name: **Greater Redhorse**
Scientific Name: **Moxostoma valenciennesi**
Species Group: **Fish**

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Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Two populations are known to occur in Vermont: one in the Missisquoi River and the other in the LaPlatte River. In the Missisquoi River sub-populations occur immediately below Swanton Dam and the other from that dam upriver to the Highgate Falls Dam. In the LaPlatte River sub-populations occur down- and upstream of Shelburne Falls. The Vermont Cooperative Fish and Wildlife Research Unit at the University of Vermont is currently conducting research of populations in both rivers including estimating abundance, age structure, distribution and habitat use. The project is partially funded by a Vermont Fish and Wildlife Department State Wildlife Grant. On a wide-range scale no major threats are known; however, localized threats to populations may exist such as siltation, pollution and impoundment of habitat (NatureServe 2013). Low winter flows effects on overwinter survival are believed to be the most likely factor influencing stonecat abundance in the Milk River in Alberta (ASRD 2004). During the summer of 2012, stonecat stranding and mortality was observed immediately below Swanton Dam (Pientka 2014; Puchala 2014). The lack of adequate spillage over the dam to keep stonecat habitat under water as a consequence of unusually low base river flows and dam leakage are believed to have been the cause. Chemical control of parasitic Sea Lamprey also has the potential to cause non-target mortality. Large numbers of Stonecats are typically killed when the Great Chazy River in New York is treated with lampricides. Incidental mortality has also occurred in the lower Missisquoi River when lampricide has been applied to habitat holding stonecats. Recently, the U.S. Fish & Wildlife Service announced an interest in treating the LaPlatte River with lampricide to control Sea Lamprey ammocoetes numbers there (Langdon 2014).

Distribution

This is a North American species with a distribution described by Scott and Crossman (1973) as the St. Lawrence River and tributaries in Quebec, south in the Hudson, Allegheny and Mohawk systems in New York, west to the Appalachian Mountains, to western North Carolina and northern Alabama (Tennessee River), north through central Tennessee, west through northern Missouri, Kansas and northeastern Colorado, Wyoming to Alberta, east through North Dakota into Manitoba, southeast through the tip of Lake Superior to central Michigan, and into southern Ontario and Quebec (Scott and Crossman 1973). Only two populations of Stonecat are known to occur in Vermont. One population is located within a relatively short reach of the LaPlatte River immediately above and below the fall line; and the second is in Hungerford Brook, a tributary of the Missisquoi River. In Vermont, the species is on the eastern edge of its North American range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Known Watersheds

Lake Champlain

Missisquoi River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

The Stonecat prefers moderate currents of medium to large rocky-bottomed streams. It is absent, however, from high gradient streams with fast currents. It is also found in lakes near gravel shoals where the current is produced by wave action. The Stonecat appears to require a current to prosper, since it has been eliminated from streams where flows have been slowed by the construction of dams. It appears to be intolerant to siltation and general habitat degradation. The Stonecat is a state listed endangered species in Vermont with one known population in the state. This population is in a very short section of the river encompassing habitat immediately below and above the fall line. Population monitoring suggests the population has been declining due to unidentified causes. It appears from the literature and Vermont data from the LaPlatte River that this species requires moderate current and a low silt, coarse substrate. Stonecat prefer to use large cobble and boulders for hiding. The combination of habitat requirements of low silt, moderate current, and large substrate represent a somewhat restrictive combination within the Champlain Valley biophysical region.

Habitat Types:

Aquatic: Fluvial

Aquatic: Large Lake Champlain Tribs Below Falls

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): It has been reported that this species is sensitive to siltation but the exact mechanism of impact is not known. It may be that siltation covers the developing eggs; however, this may not be a problem, since parents are cavity nesters, preparing the nest and providing care for the young. Or, siltation may embed coarse substrate materials eliminating cover habitat and nesting sites. Since in Vermont the stonecat is only found in the LaPlatte River and Hungerford Brook, a primary conservation consideration is the limiting of upstream land use activities that increase siltation in moderate gradient habitats.

Non-Habitat Threats:

Genetics

Loss of Prey Base

Description of non-habitat threat(s): Stonecat is a benthic insectivore, specializing in aquatic insects. Excess sedimentation can impact aquatic insects populations and reduce this species' food base. This species would have difficulty shifting to non-benthic foods. Because stonecat has one of the most restricted distributions of any other fish species in Vermont, reductions in population size causing a bottleneck which could possibly result in a loss of genetic variation forfeiting the evolutionary potential of the species. Natural selection can only act in the presence of genetic variation, and therefore, the higher the genetic

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

diversity in a population, the higher the likelihood for population persistence. If gene flow is limited to within one population of stonecat (estimated number probably much less than 100 individuals), the species is not prepared to adapt to environmental changes of time.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Comparative studies of habitat occupied by the more abundant New York populations to LaPlatte River habitat.
Research	Basic Life History	High	
Research	Distribution and Abundance	High	
Research	Threats and Their Significance	High	
Research	Population Genetics	Medium	Investigate genetic characteristics of the LaPlatte River Stonecat population and genetic similarity to populations in New York.
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Stonecat populations.	Number of existing populations of Stonecat protected and sustained.	VFWD, USFWS	USFWS, VFWD
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Natural Processes Restoration	High	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, VTrans, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners, VFWD (SWG), USFWS, VDEC, VTrans

Common Name: **Stonecat**
Scientific Name: **Noturus flavus**
Species Group: **Fish**

Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

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Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Scarola (1973) reported Redbreast Sunfish to be in the New Hampshire portion of the Connecticut River watershed. More recently (2008), Yoder et al. (2010) during a fish assemblage assessment of the Connecticut River extending from Lake Francis in NH downriver to Turners Falls Dam in MA collected two Redbreast Sunfish from separate locations in the river situated between Bellows Falls and Wilder dams. NAI (2004) fish community monitoring conducted in the vicinity of Vermont Yankee Nuclear Power Station (Vernon, VT and Hinsdale, NH) captured a total of 14 Redbreast Sunfish from the Connecticut River during the years 1991-1999. Reports of the species occurring in Vermont "inland" waters, as far as known, appear to be limited to Lake Morey and Lake Fairlee. Extensive sampling in both waters over the past 25 years has not resulted in a confirmed observation of this species. This strongly suggests the species is uncommon in both the Connecticut River and likely extirpated from the two "inland" lakes where it was previously reported in Vermont.

NatureServe (2014) states there are no known threats to the species; however, dams and pollution have caused local declines. COSEWIC (2008) reports there is little information in the literature which addresses limiting factors affecting Redbreast Sunfish, although the species appears adaptable to a wide range of environmental conditions. COSEWIC (2008) identifies the shoreline development including seasonal and year-round homes, forestry and agricultural activities, and stream alterations to be the most obvious threat to the species in New Brunswick, although waterbody-specific assessments conducted in that province failed to demonstrate correlations between shore development and water quality parameters to Redbreast Sunfish abundance. Selected as a Regional-SGCN by the 13 Northeastern states in 2014

Distribution

The Redbreast Sunfish occurs along the Atlantic Slope from New Brunswick to Florida. It is also found in Gulf Coast drainages in Georgia and Florida, north into Kentucky and Arkansas. In Vermont , Redbreast Sunfish are found in the Connecticut River and lakes Morey and Fairlee (Orange County) and the Black River (Windsor County). Historically, the species has been recorded from New York waters within the Lake Champlain drainage (e.g., Lake George and its outlet, the Mettawee River and Little Chazy River) (Greeley 1930); however, no records, past or present, are known from Lake Champlain.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Middle Connecticut

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

West

Upper Connecticut-Mascoma

Black-Ottauquechee

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

This species inhabits the shores of lakes and ponds, and pools of clear streams with little current, but unlike other Vermont sunfishes it is more of a stream-adapted species. Aho et al. (1986) report cover, current velocity, and variables correlated with velocity (e.g., gradient, riffle/pool ratios) to be major factors determining the distribution and abundance of Redbreast Sunfish in riverine systems. Both juveniles and adults are usually found in shallow water near cover, although fish may occupy deeper habitats under warmwater summer conditions and during winter. Important cover include fallen trees, stumps and aquatic vegetation.

These hard structures appear to be important habitat components for spawning site selection. Additionally, hard structures have been attributed to being the substrate producing more than 60% of the food organisms consumed by sunfish species, including Redbreast Sunfish. Scarola (1973) states Redbreast Sunfish can be found over gravelly bottoms with or without vegetation; however, unlike the Pumpkinseed, it does not rely as much on there being aquatic vegetation present. Aho et al. (1986) quantify variables critical to habitat suitability models in both lotic and lentic environments for Redbreast Sunfish. Water temperatures regarded as suitable for growth and survival of adult and juvenile fish are assumed to be in the range of 15-35°C; for spawning and incubation the optimal range is assumed to be 21.1-27.2°C. Nests are generally constructed at depths less than 1.5 m. Water velocities at nest sites are less than 0.06 m/s with an average of 0.02 m/s. Based on available information for other sunfish species, 25-70% hard structure cover is estimated to be most productive for Redbreast Sunfish. This species appears to require a mixture of coarse sand and gravel substrate at spawning sites to be successful.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Abundance of hard structures for cover are critical components of Redbreast Sunfish habitat. Removal of such cover or inadequate structure being recruited into lakes and streams (e.g., from forested riparian areas) may negatively affect the suitability of habitat for this species. It may be sensitive to acidity (i.e., long term pH values <4.0), but is tolerant of high temperatures (<35°C) (Aho et al. 1987). Rapid reductions in water level of more than 0.9 m during the spawning season may adversely affect embryo development and survival (Aho et al. 1987).

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Aho (1987) identify several potential threats to this species. Low

Common Name: **Redbreast Sunfish**
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to moderate turbidity levels are suitable to this species; however, excessive levels may impact fish growth and abundance. Pesticide contamination of waters supporting Redbreast Sunfish has been a suspected cause for the observed decline of some populations.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) Determine its distribution in Vermont waters. It may be present in more streams of suitable habitat in the Connecticut Valley than is presently known. 2) The spatial extent of its presence in the Connecticut River and its larger tributaries should also
Research	Threats and Their Significance	Low	Evaluate and monitor pesticide levels in known populations of Redbreast Sunfish.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	Medium	Monitor known populations.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, CRWC, TNC	
Habitat Restoration	Medium	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, CRWC, TNC	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, CRWC, TNC, lake associations , dam owners	Lake associations, dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Redbreast Sunfish**
Scientific Name: **Lepomis auritus**
Species Group: **Fish**

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Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3 **Global Trend:** Unknown
State Rank: S1 **State Trend:** Unknown
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

The number of populations known to occur in Vermont stands at four located in the Missisquoi, Lamoille, Winooski and Poultney rivers (Grandmaison et al. 2004; Langdon 2014), or five if the Winooski River is considered to have two populations separated by the natural fall line (present day Winooski One dam). Vermont populations are disjunct from the species' main distribution which encompasses the Midwestern states. Although populations in the Vermont are presumed to be stable, systematic and temporal assessments have not been conducted to quantify abundance trends. However, there is general agreement that the abundance of the species is declining throughout much of its continental range (Kuehne and Barbour 1983 cited in Grandmaison et al. 2004). Various sources summarized by Grandmaison et al. (2004) speculate that Vermont populations at present appear to be abundant enough to be viable; however, historical data and current monitoring activities are inadequate or lacking from which confident abundance trends can be derived and such conclusions are at best speculative. Grandmaison et al. (2004) present a summary of potential threats to Eastern Sand Darters in nine states within the species range. The most cited threats to the species are habitat destruction or degradation resulting from impoundment, channelization, channel dredging and siltation. Threats identified for Vermont populations are sedimentation resulting from bank erosion and storm water discharges; water quality degradation from livestock manure runoff, and chemicals and other catastrophic spills. The potential for sedimentation to impair critical habitat necessary for Eastern Sand Darters is a persistent problem within its Vermont range given most of the populations lie within drainages with high agricultural and land development activity. Sea Lamprey control measures employing lampricides (e.g. TFM) have also been a concern in Vermont. Bioassay testing on sand darters has determined the maximum no-effect concentration is 1.3 to 1.4 times the minimum lethal concentration of TFM needed to control Sea Lamprey. The range of Eastern Sand Darter encompasses nine states and two Canadian provinces. Of these, it is a species of special concern in two (Indiana, Ohio), threatened in five (Illinois, Michigan, New York, Vermont, Canada) and endangered in one (Pennsylvania) (Grandmaison et al. 2004). Selected as a Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

Eastern Sand Darters range from the St. Lawrence River drainage, southern Quebec, Vermont and New York; through the Great Lakes and Ohio River basins from western New York to eastern Illinois; and south to Kentucky (Page and Burr 1991). In Vermont, populations are known to occur below the fall line in the Missisquoi, Lamoille, Winooski, and Poultney rivers. There is one recent occurrence of the species being collected from above the fall line on the Winooski River. One individual has also been collected in Lake Champlain at the mouth of the Lamoille River in Malletts Bay. During Lake Sturgeon larval drift sampling downstream of Swanton Dam sand darters have been captured which occurred during a Missisquoi River high flow event (MacKenzie 2015). It is believed that the darters originated from above the dam but were transported downstream by the high water as there is little to no sand darter habitat downstream of the dam. In Vermont, this species is on the eastern edge of its range.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds

Lake Champlain

Lamoille River

Missisquoi River

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Eastern Sand Darter shows a strong preference for sandy areas of rivers and streams with slow to moderate currents, where it spends most of its time burrowed into the sand with only its eyes or head protruding. It has also been reported from sandy shoals in Lake Erie, but has not been reported in Lake Champlain, except for one individual at the mouth of the Lamoille River in Malletts Bay. The Eastern Sand Darter requires medium to fine sand, so water velocity and sedimentation are important factors in habitat suitability. Habitat use and preference studies indicate that the fish use areas with a large percentage of sand particles 0.23 to 1 mm in size. It is quite sensitive to sedimentation and poor water quality.

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): The range of the Eastern Sand Darter is believed to be shrinking due to the loss of clean sand habitat caused by increased siltation from soil erosion and agricultural activities. Hydroelectric power generation should be regulated to maintain suitable flows and habitat.

Description of non-habitat threat(s): Chemical lampricides (TFM and TFM/Niclosamide) are used extensively in the Lake Champlain watershed for the control of Sea Lamprey ammocoetes reducing adult lamprey parasitism rates on other fish species inhabiting the lake, such as Lake trout, Landlocked Atlantic Salmon, Walleye, Lake Sturgeon and whitefish. Non-target impacts on other fishes, including state threatened Eastern Sand darter, have been and continue to be a concern. TFM toxicity tests conducted on adult sand darters show it to be one of the more TFM-resistant darter species (LCFWMC 2001). Nonetheless concerns remain regarding long-term lampricide effects on sand darters at the population level. To date annual assessments of darter populations in treatment streams have not been designed or carried out to demonstrate that darter abundance is being maintained at no-effect levels.

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determination of optimal microhabitat requirements (e.g., depth, velocity and substrate).
Research	Basic Life History	Medium	
Research	Distribution and Abundance	High	Increase sampling efforts in rivers with known populations, including sampling beyond known areas of occurrence.
Research	Threats and Their Significance	High	Effects of limiting factors (e.g., hydro-generation) on habitat, and possible long term effects of lampricide treatment on populations.
Research	Population Genetics	Medium	How closely are Vermont populations linked genetically to one another and to other populations located outside of the state.
Research	Taxonomy	Low	
Research	Other Research	Low	Diet studies.
Monitoring	Population Change	High	
Monitoring	Habitat Change	Medium	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, USFWS, NRCS, LCBP, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	Medium	Restore/maintain connectivity within aquatic systems supporting sustainable SGCN population(s); provide for safe & efficient up- and downstream SGCN passage at dams & other obstructions.	Based on historic distribution of the SGCN, number of miles of habitat to which access to critical habitat has been restored or maintained.	VDEC, VFWD, USFWS, dam owners	Dam owners
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, dam owners	Dam owners
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Eastern Sand Darter**
Scientific Name: **Ammocrypta pellucida**
Species Group: **Fish**

Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Eastern Sand Darter populations.	Number of existing populations of Eastern Sand Darter protected and sustained.	VFWD, USFWS	USFWS, VFWD
Invasive Species Control & Prevention	High	Adopt/implement appropriate actions that minimize the potential for new invasive species introductions of potential threat to SGCN; control in-state invasive species populations when/where opportunities avail.	No increase in numbers of invasive organisms in habitat occupied by the SGCN.	VDEC, USFWS, LCBP	VDEC (ANCG)

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Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S1
Extirpated in VT? No

Global Trend: Unknown
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

Four populations are currently known in Vermont. These are located in the Winooski, LaPlatte and Poultney rivers. Little, if anything, is known of the size, structure, and trends of these populations. Channel Darter has very specific habitat requirements and as such populations tend to restricted is size and distribution (COSEWIC 2002). NatureServe (2014) ranks the overall threat to populations to be high with reductions of Channel Darter populations occurring throughout its continental range. Threats to populations include habitat loss and degradation due to siltation, pollution, flow modification, and impoundments; fragmented populations have a reduced likelihood of recovering (COSEWIC 2002; NatureServe 2014). Potential causes of declines in Lake Erie include eutrophication, shoreline modifications from development, and invasive Round Goby (NatureServe 2014). Population declines and extirpation of some populations have been reported from Lake Erie, Ohio, Michigan, Ontario and Quebec (NatureServe 2014). Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

This is a wide ranging species but is highly localized in the St. Lawrence, Great Lakes and Mississippi River drainages from southern Quebec and Vermont, south to northern Louisiana; along the Gulf Slope in Mobile, Pascagoula and Pearl River drainages (Page and Burr 1991). In Vermont, the species is on the eastern edge of its range with populations known to occur below the fall line in the Winooski, LaPlatte and Poultney rivers. There is a historic record from Lake Champlain on the New York side (Greeley 1930); however, no occurrences have been made within the Vermont portion of the lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Channel Darter is a bottom dweller of gravelly or sandy shoals of warm lakes and rivers. In rivers, it is found in areas with coarse sand and gravel substrate. These areas have low to moderate current, but enough

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

water velocity to prevent silt deposition. Channel Darters are found in areas with substrates composed of gravel and sand. Preferred habitat is low in sediments and turbidity. Some studies of spawning in rivers and aquaria indicate that Channel Darters require swift currents (0.03-0.04 m/sec) presumably with gravel substrate.

Habitat Types:

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Description of habitat threat(s): Channel darters are limited by the loss of clean gravel substrate resulting from increased siltation and turbidity from soil erosion and agricultural activities. Alteration of river flow regimes from hydroelectric power generation may also degrade habitat quality.

Description of non-habitat threat(s): Chemical lampricides (TFM and TFM/Niclosamide) are used extensively in the Lake Champlain watershed for the control of Sea Lamprey ammocoetes reducing adult lamprey parasitism rates on other fish species inhabiting the lake, such as Lake trout, Landlocked Atlantic Salmon, Walleye, Lake Sturgeon and whitefish. Non-target impacts on other fishes, including state endangered Channel Darter, have been and continue to be a concern. TFM toxicity tests conducted on adult Channel Darters show it to be moderately sensitive to TFM (LCFWMC 2001). Concerns remain regarding long-term lampricide effects on Channel Darters at the population level. To date annual assessments of darter populations in treatment streams have not been designed or carried out to demonstrate that darter abundance is being maintained at no-effect levels.

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Increase sampling efforts in rivers with known populations, including sampling beyond known areas of occurrence.
Research	Threats and Their Significance	High	
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	High	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	High	Monitor impacts of sea lamprey control in the Lake Champlain watershed on channel darter populations.
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	High	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	VFWD, VDEC, USFWS, NRCS, LCBP, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG), VFWD (DJ, SWG)
Natural Processes Restoration	High	Restore flow regimes and/or water levels that support sustainable SGCN population(s) & at targeted abundance levels.	Number of miles of SGCN habitat improved or restored.	VDEC, VFWD, USFWS, TU, dam owners, watershed associations , town & regional planning & Cons Comms	Dam owners
Invasive Species Control & Prevention	High	Manage potential non-target impacts of the Lake Champlain Sea Lamprey control program on Channel Darter populations.	Number of existing populations of Channel Darter protected and sustained.	VFWD, USFWS	USFWS, VFWD
Habitat Restoration	High	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations , town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)

Common Name: **Channel Darter**
Scientific Name: **Percina copelandi**
Species Group: **Fish**

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Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5 **Global Trend:** Unknown
State Rank: S4S5 **State Trend:** Declining
Extirpated in VT? No **Regional SGCN?** Yes

Assessment Narrative:

Lake Champlain supports the only Sauger population in Vermont, where the species is on the eastern edge of its continental range. In Lake Champlain, historically they were more abundant in the southern than northern portion of the lake (Halnon 1963). Once described as common in Lake Champlain (Anderson 1978), Saugers have been rarely seen during the last 20 years (MacKenzie 2014) and has apparently declined to the point that it eluded detection by New York and Vermont fisheries biologists from 1994 (Nettles et al. 2005) until 2010 (NYDEC 2013). The species was once widely distributed in New York but is now extirpated from much of its historic range with exception of Lake Champlain. Sauger has declined in abundance and distribution across its range (Rawson and Scholl 1978; Hesse 1994; Pegg et al. 1997). Threats to the species include angler harvest, channelization, water flow fluctuations, migration barriers, loss of spawning and rearing habitat, and environmental degradation (Rawson and Scholl 1978; Hesse 1994; Pegg et al. 1997). Selected as an Regional-SGCN by the 13 Northeastern states in 2014.

Distribution

The distribution of sauger in North America is from the St. Lawrence-Lake Champlain system south, west of the Appalachian Mountains to Tennessee River in Alabama, southwest to northern Louisiana, northwest through eastern Oklahoma to central Montana and central Alberta east below James Bay to Quebec (Scott and Crossman 1998). The distribution of Sauger in Vermont is limited to Lake Champlain, where it may have been more numerous in the southern portion of the lake. Anderson (1978) reported Sauger to be present in all sections of the lake except for the Main Lake.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Known Watersheds
Lake Champlain

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Many of the general habitat requirements are similar between Sauger and walleye; however, Sauger habitat preferences are for large, shallow sections of lakes which are turbid with colloidal clay suspension, as well as

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

large, turbid, slow flowing rivers (Anderson 1978; Scott and Crossman 1978). Scott and Crossman (1978) considered Sauger "less adaptable" than walleye because of these preferences. Walleye and Sauger may utilize the same shoals or gravel to rubble in large turbid lakes for spawning (Scott and Crossman 1978). Preferred spawning habitats are shallow shoreline and shoals of lakes and riffles in rivers, including areas immediately below dams providing there is rocky substrate and good water circulation from wave action and river currents (McMahon et al. 1984). Sauger have been found to be highly selective for spawning sites and in some parts of their range have been shown to be reliant on access to a few discrete areas in large tributaries (Nelson 1968; Gardner and Steward 1987; Penkal 1992; Jaeger 2004). Sauger fry must reach their initial feeding grounds within 3-5 days before yolk-sac absorption or they will perish from lack of food (McMahon et al. 1984).

Habitat Types:

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Sauger are considered to be the most migratory percid and are heavily dependent dependent throughout their life history on unimpeded access to a wide diversity of physical habitats (Collette 1977; Jaeger 2004). The historic spawning grounds of Sauger in Lake Champlain are not well known. Undoubtedly, dams have decreased their accessibility to many of the historical spawning grounds in the basin. For example, recent Lake Sturgeon and Walleye habitat assessments conducted on the Missisquoi River indicate most of the quality spawning habitat occurs above Swanton Dam (Madeline Lyttle, U. S. Fish and Wildlife Service, personal communication). Sauger also appear to be sensitive to changes in water quality. Sauger may be more dominant than Walleye under very turbid water conditions where they co- occur; however, dominance may shift with changing water quality (Scott and Crossman 1998). Improvements in Lake Champlain water quality may explain the perceived reduction in Sauger abundance, but this needs to be investigated.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): The Sauger population was once abundant in portions of Lake Champlain and were captured in considerable numbers as recently as the 1980s. Recent surveys of the South Bay, where Sauger was formerly abundant, failed to produce even in a single capture. Predation by native species, such as Smallmouth Bass (Johnson and Hale 1977) have been found to influence recruitment of walleye, a close relative to Sauger, in natural systems (as referenced in Quist et al. 2003). Others have speculated that native piscivorous predators, such Northern Pike, Smallmouth Bass, Lake Trout, Burbot and Atlantic Salmon, can be a major source of mortality for age-0 Walleye in Lake Champlain (Frater 2002). We would expect these interactions to be as important, if not more so, for Sauger. For example, the introduction of Black Crappie in Black Lake (New York) was believed to have caused successive Walleye year-class failures (Schiavone 1983). While Black Crappies are believed to be native to Lake Champlain, its cogener the White Crappie is not. It too has been found to be a significant walleye fry predator in some

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

systems (Quist et al. 2003). White crappies are known to occur in large numbers in areas where Sauger were historically abundant, e.g. South Bay (David Nettles, U. S. Fish and Wildlife Service, personal communication). Another exotic in Lake Champlain, the White Perch, has been found to be an important predator of Walleye eggs (Roseman et al. 1996; Schaeffer and Margraf 1987). White Perch have become or are becoming one of the most dominant species in the fish assemblage in some areas of the lake, e.g. Missisquoi Bay (Pierre Bilodeau, Quebec Parks and Wildlife, personnel communication).

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Determine the current population status of Sauger in Lake Champlain (Vermont and New York sections), and identify critical spawning and juvenile habitats.
Research	Threats and Their Significance	High	1) Determine the effect of recent invasions of non-indigenous species (e.g., White Crappie, White Perch, Zebra Mussel) on Sauger in Lake Champlain. 2) Determine the effect, if any, changing water quality may have on the Sauger population.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	N/A	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	N/A	
Monitoring	Monitor Threats	Medium	
Monitoring	Other Monitoring Needs	N/A	

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications		Enhance public awareness of SGCN and threats to Vermont's populations; a greater understanding of the effects of their own actions on SGCN and measures they can take to restore the population to the lake; develop public and professional partnerships to promote stewardship of aquatic habitat through outreach, education, and on-the-ground cooperative efforts.	Number of outreach efforts made to better inform the public .	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI	VFWD, USFWS, VDEC, TNC, Echo Center, LCBP, LCI
Habitat Restoration	Medium	Enforce and monitor compliance with applicable environmental protection laws & regulations. Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels.	Increase and/or maintain available habitat in terms of quantity and quality required for all life stages of the SGCN.	VDEC, VFWD, NHDES, NHFWD, NRCS, USFWS, CRWC, watershed associations, town & regional planning & Cons Comms	VDEC (ERG, VWG, WPAG, VBBRG, 604b), NRCS (EQIP)
Habitat Restoration	High	Increase and/or maintain available habitat (river-miles or surface acres) in terms of quantity and quality required for all life stages of the SGCN.	Change in habitat quantify and quality	USFWS, NRCS, DEC, VT Rivers Conservancy	ANR, DEC, NRCS, FSA

Common Name: **Sauger**
Scientific Name: **Sander canadense**
Species Group: **Fish**

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Appendix A4

Invertebrate SGCN Conservation Reports

Vermont's Wildlife Action Plan 2015

Common Name: **Ant Group**
Scientific Name: **Ant Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Unknown

Extirpated in VT? No

Regional SGCN?

Assessment Narrative:

This group consists of the following two species:
-- Temnothorax pilagens: This species is known from only three sites worldwide and is rarely observed. The only VT site is in a state park, which could provide some protection; however, the ant is not a conservation target for the park at this time. More survey work is needed to determine the extent of its range. First collected in 1986 in VT, it hasn't been found here since then despite 14 years of subsequent collecting effort at the park. Recent efforts to collect it again in NY have been unsuccessful.

--Myrmica lobifrons: This species is not considered rare, but is a habitat specialist. At least in New England, it has only been collected in or very close to ombrotrophic bogs. The potential that it could be found in fens, marshes, or other bodies of water with more flow and higher calcium and nutrient levels is uncertain.

Distribution

--Temnothorax pilagens: Known VT location is in Niquette Bay State Park, Colchester. Described as a Nearctic species, it is found in northeastern parts of the United States and possibly southeastern Canada. Only known from three sites, all in the northern US: Niquette Bay State Park, VT (1986); E.N. Huyck Preserve, Rensselaerville, NY (2002 and 2003); and Sleeping Bear National Lakeshore, Empire, MI (2011 and 2013).

--Myrmica lobifrons: May occur throughout the state where ombrotrophic bogs occur.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Probable
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Probable
Northeastern Highlands	Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Temnothorax pilagens: Occurs in forests, woodlands, and parks; preferentially wooded sites with little understory, and a high density of suitable nest sites. The Vermont site is described in literature as second-growth temperate deciduous forest that has been protected from logging since the 1930's. The forest is dominated by oaks, while hemlock, birch, and pine contribute strongly to the canopy. The site is flat, possibly situated on a floodplain at about 30m elevation. Nests occur in preformed cavities in acorns, hickory nuts or sticks. This species utilizes a social "parasite" strategy, enslaving workers of two congeneric species (T.

longispinosus and T. ambiguous) to perform tasks of the nest. The slave-makers and their hosts live in nest sites in the litter and surface soil layers. In all three known populations, T. pilagens was enslaving both T. longispinosus and T. ambiguus; most often, nests contained slaves of both host species. Nests contain on average four T. pilagens workers (ranging from 0 to 16) and 13 slaves (ranging from 2 to 50 workers). One exceptional example contained 27 T. pilagens and 55 slave workers.

--Myrmica lobifrons: A habitat specialist. At least in New England, it has only been collected in or very close to ombrotrophic bogs. The potential that it could be found in fens, marshes, or other bodies of water with more flow and higher calcium and nutrient levels is uncertain.

Habitat Types:

Oak-Pine Northern Hardwood

Open Peatlands

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): --T. pilagens: Oaks are necessary, as they supply acorns used for habitation; hickory nuts are also used. Loss/reduction of oaks would impact habitat availability. Habitat loss may occur in areas tha have not been surveyed, but may support this species.

--M. lobifrons: occurs in bog habitat that may be vulnerable to climate change.

Non-Habitat Threats:

Competition

Pollution

Loss of Relationship with Other Species

Unknown Non-Habitat Threats

Description of non-habitat threat(s): Pesticide use could negatively impact the ground-dwelling T. pilagens. Abundance has been declining at the state park for many species of ants, including the hosts of T. pilagens. This could result in loss of colony functions and could reduce survival. The other slave-making ant known from the T. pilagens site is more abundant and utilizes the same host ant species and habitat. It does not appear to yet be impacted by declining host numbers. There may be significant competition for nesting cavities. Low abundance of T. pilagens makes this ant vulnerable to fluctuations in population density. Recolonization or rebound following large population drops may not be possible.

Common Name: **Ant Group**
Scientific Name: **Ant Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine whether M. lobifrons habitat requirements are broader than ombrotrophic bogs.
Research	Distribution and Abundance	High	Use existing habitat description to help identify other sites in the state where T. pilagens may exist. An intensive survey of these potential sites will be needed.
Research	Threats and Their Significance	High	Potential limiting factors to populations of T. pilagens need to be evaluated. This should particularly focus on factors at the state park site.
Monitoring	Population Change	High	Original site where T. pilagens was reported should continue to be intensively surveyed to determine if this ant is still present and, if so, at what level of abundance.
Monitoring	Range Shifts	Medium	Develop and initiate a statewide monitoring program that can assess ant species movements in response to climate change for both native species (e.g., Camponotus chromaoides) and invasives (e.g., Myrmica rubra).
Monitoring	Monitor Threats	High	Limiting factors identified as significant at sites of T. pilagens occurrence need to be monitored.

Common Name: **Ant Group**
Scientific Name: **Ant Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Use existing habitat description to help identify other sites in the state where T. pilagens may exist. Intensive surveys of these potential sites should be conducted. Niquet State Park needs to be intensively resurveyed and level of abundance determined.	Number of new potential sites surveyed.	FWD, FPR, USFS, UVM, VT Entomological Society	SWG, FPR
Easements	High	Acquisition/easement of high priority SGCN ant sites	Number of unprotected sites that become protected	FWD, FPR, USFS, VLT, TNC, other land trusts	SWG, FPR, USFS, VHCB
Protected Area Management	High	Ensure that bog sites are protected for M. lobifrons. Inform landowners and managers of its presence.	Number of landowners/managers provided with technical assistance specific to M. lobifrons	FPR, FWD, USFS, land trusts, UVM, TNC, other landowners and land managers	SWG, FPR, USFS
Protected Area Management	High	Work with FPR to address conservation and enhancement of T. pilagens in management plan for Niquet State Park.	Inclusion of T. pilagens in management plan, with monitoring plan.	FPR, FWD	SWG, FPR
Compatible Resource Use	High	Evaluate potential threats for T. pilagens populations. This should particularly focus on factors at the state park site.	Completion of threat assessment with recommendations.	FWD, FPR, USFWS, UVM, VT Entomological Society	SWG, FPR

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Common Name: **Bumble Bee Group**
Scientific Name: **Bumble Bee Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

State Rank:

Extirpated in VT?

Global Trend:

State Trend:

Regional SGCN?

Assessment Narrative:

This group consists of nine species. Research indicates that declines in North American bumble bees have been associated with increased levels of pathogen infections and reduced genetic diversity. Also, habitat loss/degradation, pesticides, climate change, and competition with honey bees may have contributed to the range-wide decline of several species.

--B. affinis: A previously widespread species in Vermont, with no records since 1999.
--B. ashtoni: nest parasite of only B. affinis and B. terricola, two species which are in severe decline.
--B. citrinus: Despite being a parasite of very common Bombus species, it is reported to have declined precipitously in much of the range, including Vermont.
--B. fernaldae: Widely scattered records across the eastern range with only one know for Vermont, despite being in the central part of the eastern range.
--B. fervidus: Much more prevalent in historic VT collections than presently found. Above ground nesting in thatch in grassy areas and gardens may make it vulnerable.
--B. pensylvanicus: A thatch nester, vulnerable to mowing; previously common in Champlain Valley, now appears extirpated in Vermont; has disappeared from northern part of range.
--B. perplexus: More prevalent in the historic record.
--B. rufocinctus: Possible recent declines compared to historic collections.
--B. terricola: Historically, appeared to be a common component of the Vermont bee fauna. Regional data suggest that it was probably found throughout the entire state. It represented about 13% of the 1915- 2011 records, the 2nd most common of 17 known species in Vermont. A severe population decline in was noted in 2000 with few observations of the species until 2007 when perhaps a slight recovery began. In 2012 and 2013, this species represented less than 1% of specimens collected during the Vermont Bumble Bee Survey. It was encountered rarely in southern Vermont, in widely scattered locations in the Champlain Valley and central Vermont, and was more widespread in the Northeast Kingdom region.

With respect to climate change impacts, Kerr et al. (2015) looked at data on bumblebees across North America and Europe over the past 110 years. Bumblebees have not shifted northward and are experiencing shrinking distributions in the southern ends of their range. Such failures to shift may be because of their origins in a cooler climate, and suggest an elevated susceptibility to rapid climate change.

Distribution

--B. pensylvanicus - Previously known from Champlain Valley; due to limited historical survey effort, may have been present in Northern and Southern VT Piedmont, Northeastern Highlands, Vermont Valley.
--B. affinis - previously widespread; no recent records.
--B. ashtoni - previously widespread; no recent records.
--B. citrinus - previously widespread; most recent records are from Addison Co.
--B. fernaldae - one historic record from Essex Co. Always rare throughout range.
--B. fervidus - previously widespread; recent records from Franklin, Chittenden, Addison, Bennington counties.
--B. perplexus - widespread, though less common than historically.

Common Name: **Bumble Bee Group**
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--B. rufocinctus - previously widespread; now collected mostly in the Champlain Valley.
--B. terricola - widespread, though now much more rare than historically. Nearly disappeared rangewide from 1999 until 2012. Vermont currently has greater numbers in recent collections than other similar latitudes and to the south.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Many species require open, unmanaged grasslands for nesting and foraging. Change in microhabitat features could impact overwintering queens. Climate change and local land-use may affect this critical stage. Bumble bees need diversity (taxonomic and phenologic) of nectar sources.
B. pennsylanicus - thatch nester in large, unmanaged grasslands.

Habitat Types:

Outcrops and Alpine

Oak-Pine Northern Hardwood

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Building or Structure

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Other Cultural

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Common Name: **Bumble Bee Group**
Scientific Name: **Bumble Bee Group**
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Habitat Succession

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Unknown Habitat Threats

Description of habitat threat(s): Apis melifera is a foraging competitor and possibly disease vector. Changes in land management can alter microhabitat conditions. Climate change may affect spring ephemeral flowering phenology.

Non-Habitat Threats:

Genetics

Competition

Parasites

Pollution

Reproductive Traits

Loss of Relationship with Other Species

Disease

Loss of Prey Base

Description of non-habitat threat(s): Low numbers of individuals may cause decline in genetic health. Bumble bee trade and transport for agriculture is considered to have introduced parasites and diseases to native populations. This trade is poorly regulated. Pesticides, introduced diseases, and competition with non-native honey bee all may be impacting these species.

Common Name: **Bumble Bee Group**
Scientific Name: **Bumble Bee Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Define foraging and nesting requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Basic Life History	High	Determine over wintering habitat needs and survival rate of queens.
Research	Other Research	High	Study the affects of land use changes on Bombus species. This may include mowing, development, conversion of open grass areas, succession to forest land.
Monitoring	Population Change	High	1) Monitor known SGCN bumble bee populations. 2) Population monitoring could be employed to track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.
Monitoring	Habitat Change	Medium	Track the change in open grassland habitat in Vermont.
Monitoring	Monitor Threats	High	Assess and monitor the use of domesticated Bombus in agriculture.
Monitoring	Other Monitoring Needs	High	Monitor the use of insectides in Vermont that may be problematic to Bombus. Agricultural use and home use probably represent different threats.

Common Name: **Bumble Bee Group**
Scientific Name: **Bumble Bee Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Alliance Development	High	Participate in region-wide approach to bumble bee conservation.	Development of regional conservation plan or management guidelines.	FWD, Other Northeastern States, USFWS	SWG, RCN, LLC, USFWS
Species Restoration	High	Develop species-specific restoration and reintroduction plans.	Number of plans produced.	FWD, VCE, UVM	SWG
Technical Assistance, Training, Learning Networks	High	Reduce the use of neonicotinoids and other insectides that bees are vulnerable to, in agricultural, residential, and other settings. Use of education to accomplish this may be best approach.	Number of people reached through outreach efforts.	FWD, AAFM, EPA, USFWS, VCE, USDA	SWG, EPA, AAFM, USFWS
Compatible Resource Use	High	Experiment with and encourage use of pollinator-friendly buffers in agriculture and other areas where Bombus foraging can be enhanced.	Gain enough information to develop a landowner management guide.	FWD, AAFM, NRCS, USFWS, UVM, Middlebury College, VCE	SWG, NRCS, LCC, RCN
Research	High	Study the level and pattern of use of Bombus in agriculture within Vermont; determine whether this is associated with the pattern of decline in Bombus species.	Develop a map of current use of Bombus in hot houses and other agriculture; to be used in analysis of population declines.	FWD, AAFM, VCE, USDA	SWG, AAFM
Research	High	Studying the affects of various grassland management practices on bumble bee diversity and abundance.	Gain enough information to develop a landowner management guide.	FWD, USFWS, UVM, VCE, AAFM, NRCS, Middlebury College	SWG, NRCS, LCC, RCN

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Common Name: **Beetles-Carabid Group**
Scientific Name: **Beetles-Carabid Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:

State Rank:

Extirpated in VT?

Global Trend:

State Trend: Unknown

Regional SGCN?

Assessment Narrative:

This group contains a great number of species that are ranked as rare, but for which more information is needed before conservation strategies can be developed. Compilation of existing information as well as gathering new data is required. Our understanding of distribution, abundance, and status of the many rare species in this group is limited. Existing information is currently being gathered and compiled. These beetles vary in their distribution and habitat requirements. This group includes 30 species:

--Agonum crenistriatum: two VT locations. Uses vulnerable habitat.
--Agonum darlingtoni: 4 locations. Habitat specialist; uses vulnerable habitat.
--Agonum decorum: nineteen locations. Occurs along much of Lake Champlain shoreline. Remove
--Agonum moerens: three locations. Low elevation species near Lake Champlain.
--Agonum picicornoides: six locations. Habitat specialist.
--Agonum punctiforme: one location. Uses human-influenced areas.
--Agonum superioris: ten locations. Variety of locations in state. Northern species; may be vulnerable to climate change.
--Amara erratica: one location. Uses vulnerable habitat.
--Amara laevipennis: ten locations. Uses forest openings, including human influenced sites.
--Apristus latens: two locations. Specialist of habitat along rivers (dry, unshaded sand).
--Atranus pubescens: two locations. Found in beaver lodges.
--Bembidion affine: three locations. Southern species that extends well to south of VT.
--Bembidion cordatum: one location. May be recent “irruption” from western populations.
--Bembidion grapii: seven locations. Uses vulnerable habitat.
--Bembidion mutatum: six locations. High mountain, relict populations in VT.
--Bembidion quadratulum: two locations. Uses vulnerable habitat. Northern species on edge of range in VT.
--Bembidion robusticolle: one location. On northeast edge of range in VT; uses common habitat.
--Bembidion rolandi ten locations. Sites include many on Lake Champlain.
--Bembidion rufotinctum: six locations. Habitat specialist.
--Blethisa hudsonica: six locations. Status uncertain.
--Blethisa julii: one location. Found only at one somewhat unique site.
--Blethisa quadricollis: two locations. Uses specialized habitat.
--Carabus goryi thirteen locations. Appears to be advancing northward.
--Carabus maeander: six locations. Many locations on or near Lake Champlain.
--Dicaelus dilatatus dilatatus: three locations. Habitat specialist.
--Dicaelus teter: three locations. Uses localized habitat.
--Dicheirotrichus cognatus: four locations. Uses rare habitat.
--Diplocheila impressicollis: five locations. Uses common habitat over a large area of VT.
--Diplocheila striatopunctata: six locations. Uses specialized habitat.
--Dyschirius brevispinus: one location. On northeast edge of range; uses human-influenced habitat.
--Dyschirius erythrocerus: six locations. On northeast edge of range; status uncertain.
--Dyschirius politus politus: seven locations. Northern species on edge of range.
--Elaphropus dolosus: three locations. Western species on edge of range in VT; possible recent arrival.
--Elaphropus levipes: one location. Status uncertain.
--Elaphrus fuliginosus: five locations. Rare even though VT is within the general range.
--Geopinus incrassatus: four locations. Sites are localized along one river.

Common Name: **Beetles-Carabid Group**
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Species Group: **Invert**

--Harpalus fulvilabris: four locations. Limited occurrences, including high elevation sites; unclear whether a habitat specialist.
--Harpalus indigens: six locations. Found over large area in VT in generalized habitat.
--Harpalus providens three locations. Appears to be somewhat of a habitat generalist over a large area of VT.
--Lophoglossus scrutator: four locations. Localized in VT.
--Nebria suturalis: one location. Highly localized in specialized habitat (Mt. Mansfield).
--Notiobia sayi: three locations. Though limited area of occurrence, it utilizes common habitat.
--Notiophilus aquaticus: two locations. Although one occurrence is high elevation, it may utilize more common habitats.
--Notiophilus borealis: one location. Apparently limited to one site on rare habitat (Mt. Mansfield).
--Notiophilus nemoralis: nine locations. High elevation specialist; habitat may be vulnerable to climate change.
--Notiophilus novemstriatus: one location. Though localized, it is a southern species on edge of range.
--Olisthopus micans: four locations. Specialist of habitat that is limited along Lake Champlain.
--Patrobus foveocollis: two locations. Specialist of high elevation sites. Northern species on edge of range; may be vulnerable to climate change.
--Pentagonica picticornis: four locations. Habitat specialist, but on fairly common habitat. Southern species on edge of range.
--Pericompsus ephippiatus: four locations. Southern species on edge of range.
--Philodes alternans: one VT location. Rare species, though not on edge of range.
--Philodes rectangulus: two VT locations. Northern species on edge of range. Uses common habitat by Lake Champlain.
--Platynus cincticollis: three locations. Utilizes variety of habitats. Southern species.
--Platypatrobus lacustris: three locations. Probably more widespread than occurrences indicate, due to difficulty of collection.
--Pseudamara arenaria: six locations. Most specimens from mid-, high elevation; but some habitat uncertainty.
--Pterostichus brevicornis brevicornis: seven locations. High elevation specialist; mountain crests. Northern species; on edge of range.
--Pterostichus castor: six locations. Common habitat type.
--Pterostichus pinguedineus: three locations. High elevation and habitat specialist. Northern species on edge of range.
--Pterostichus punctatissimus: fourteen locations. Several occurrences, but specialized on rare habitats in limited area.
--Scaphinotus bilobus: three locations. Status uncertain.
--Schizogenius ferrugineus: two locations. Few occurrences, but in common habitat. Southern species.
--Sericoda obsoleta: two locations. Status uncertain.
--Sericoda quadripuncata: three locations. Widespread species; status uncertain.
--Sphaeroderus nitidicollis: six locations. Northern species with relict populations in Adirondacks and New England mountains.
--Tachys oblitus: six locations. Occurs over wide area of VT; uses common habitat.
--Tachys rhodeanus: two locations. Only two occurrences despite use of common habitat and VT being in interior of range.
--Tetragonoderus fasciatus: four locations. Widespread species to south and west of VT. On edge of range.
--Tetraleucus picticornis: one location. Widespread species to south and west of VT. On edge of range

Common Name: **Beetles-Carabid Group**
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Species Group: **Invert**

Distribution

Information is being gathered and compiled regarding known occurrences of these species. Biophysical regions of known collection sites are reflected below for each species. Additional collection effort is needed to gain a more complete picture of distributions.

--Agonum crenistriatum: Champlain Valley
--Agonum darlingtoni: Champlain Valley, Northern Green Mountains, Southern Green Mountains
--Agonum moerens: Champlain Valley
--Agonum picicornoides: Northern Green Mountains, Southern Green Mountains
--Agonum punctiforme: Vermont Valley
--Agonum superioris: Champlain Valley, Northern Highlands, Northern Green Mountains, Southern Green Mountains, Southern Vermont Piedmont
--Amara erratica: Northern Green Mountains
--Amara laevipennis: Northern Highlands, Northern Green Mountains, Taconic Mountains, Southern Vermont Piedmont
--Apristus latens: Northern Green Mountains, Southern Vermont Piedmont
--Atranus pubescens: Northern Green Mountains
--Bembidion affine: Southern Green Mountains, Southern Vermont Piedmont
--Bembidion cordatum: Champlain Valley
--Bembidion grapii: Northern Green Mountains, Southern Green Mountains
--Bembidion mutatum: Northern Green Mountains
--Bembidion quadratulum: Northern Highlands, Northern Green Mountains
--Bembidion robusticolle: Champlain Valley
--Bembidion rolandi: Champlain Valley, Southern Green Mountains, Taconic Mountains
--Bembidion rufotinctum: Champlain Valley, Northern Vermont Piedmont, Southern Vermont Piedmont
--Blethisa hudsonica: Champlain Valley
--Blethisa julii: Northern Green Mountains
--Blethisa quadricollis: Northern Highlands, Northern Green Mountains
--Carabus goryi: all biophysical regions possible except Northern Highlands
--Carabus maeander: Champlain Valley, Champlain Hills
--Dicaelus dilatatus dilatatus: Champlain Valley, Northern Vermont Piedmont
--Dicaelus teter: Champlain Valley
--Dicheirotrichus cognatus: Northern Highlands, Northern Green Mountains
--Diplocheila impressicollis: Champlain Valley, Northern Vermont Piedmont
--Diplocheila striatopunctata: Champlain Valley
--Dyschirius brevispinus: Champlain Valley
--Dyschirius erythrocerus: Champlain Valley, Vermont Valley
--Dyschirius politus politus: Champlain Valley, Northern Highlands
--Elaphropus dolosus: Champlain Valley, Southern Vermont Piedmont
--Elaphropus levipes: Champlain Valley
--Elaphrus fuliginosus: Champlain Valley, Northern Highlands, Northern Green Mountains, Northern Vermont Piedmont
--Geopinus incrassatus: Champlain Valley
--Harpalus fulvilabris: Northern Green Mountains, Southern Green Mountains
--Harpalus indigens: Northern Highlands, Northern Green Mountains, Northern Vermont Piedmont, Southern Vermont Piedmont, Taconic Mountains, Champlain Valley
--Harpalus providens: Champlain Valley, Vermont Valley
--Lophoglossus scrutator: Champlain Valley
--Nebria suturalis: Northern Green Mountains
--Notiobia sayi: Champlain Valley

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--Notiophilus aquaticus: Champlain Valley, Northern Green Mountains
--Notiophilus borealis: Northern Green Mountains
--Notiophilus nemoralis: Northern Green Mountains, Southern Green Mountains, Taconic Mountains
--Notiophilus novemstriatus: Champlain Valley
--Olisthopus micans: Champlain Valley
--Patrobus foveocollis: Northern Green Mountains
--Pentagonica picticornis: Champlain Valley, Northern Green Mountains
--Pericompsus ephippiatus: Southern Vermont Piedmont
--Philodes alternans: Taconic Mountains
--Philodes rectangulus: Champlain Valley
--Platynus cincticollis: Champlain Valley, Northern Green Mountains
--Platypatrobus lacustris: Champlain Valley, Northern Green Mountains
--Pseudamara arenaria: Champlain Valley, Northern Green Mountains
--Pterostichus brevicornis brevicornis: Northern Green Mountains
--Pterostichus castor: Northern Green Mountains
--Pterostichus pinguedineus: Northern Green Mountains
--Pterostichus punctatissimus: Northern Green Mountains
--Scaphinotus bilobus: Northern Highlands, Northern Green Mountains, Southern Vermont Piedmont
--Schizogenius ferrugineus: Champlain Valley, Northern Highlands
--Sericoda obsoleta: Champlain Valley, Northern Green Mountains
--Sericoda quadripuncata: Champlain Valley, Northern Green Mountains, Southern Vermont Piedmont
--Sphaeroderus nitidicollis: Northern Highlands, Northern Green Mountains, Northern Vermont Piedmont
--Tachys oblitus: Champlain Valley, Northern Green Mountains, Southern Vermont Piedmont
--Tachys rhodeanus: Champlain Valley, Southern Vermont Piedmont
--Tetragonoderus fasciatus: Champlain Valley, Southern Vermont Piedmont
--Tetraleucus picticornis: Champlain Valley

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Existing information on habitat use and requirements of these beetles is being gathered and compiled. Much work is still needed to better defined habitat use and needs. Some are known to use specialized habitats and natural communities.

--Agonum crenistriatum: One from an area of sand dunes (since destroyed). The other were on limestone pavements (alvars). Elsewhere this species has been collected from other hot, dry habitats, such as gravel pits, sandy fields and croplands, sea and lake shores.

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--Agonum darlingtoni: Sphagnum bogs.
--Agonum moerens: Soft, wet mud by ponds, streams, and fens. In VT restricted to very low elevations, below 35 m near Lake Champlain.
--Agonum picicornoides: In VT, usually by beaver ponds, bare mud in willow, alder thickets. Usually at 300 m or above (never at Sphagnum bogs).
--Agonum punctiforme:: Open areas such as croplands, pastures, also forests.
--Agonum superioris: Among emergent vegetation in marshes, bogs, and swamps, usually above 300 m.
--Amara erratica: Grasslands on high mountains.
--Amara laevipennis: Clearings in forests, such as beaver ponds, clearcuts, roadsides.
--Apristus latens: Dry, unshaded sand along rivers.
--Atranus pubescens: In VT, taken from an abandoned beaver house. Elsewhere, it has been found in heaps of leaves, sticks, and mud along rivers and brooks (flood debris) as well as beaver houses. The larva has been found in beaver houses.
--Bembidion affine: VT specimens were taken on bare, wet mud on the margins of marshy pools.
--Bembidion cordatum: Mud or muddy sand beside lakes, ponds, impounded sections of streams.
--Bembidion grapii: Restricted to high mountains where it is found on rocky summits which are bare or have only small or stunted trees. Most records are from 1200 m or higher and are associated with some tundra plants.
--Bembidion mutatum: High mountain relict populations. In VT, collected under dry clumps of moss on barren, smooth bedrock. Records are mostly from alpine tundra. Further north, it has been recorded from barren spots on dry moraines. More northern records from QC are from roadsides, fields, and sand pits.
--Bembidion quadratulum: Sphagnum mats of bogs.
--Bembidion robusticolle: Sand banks by rivers.
--Bembidion rolandi: Gravelly areas along lakes and rivers, especially in the angular shale gravel below bluffs along Lake Champlain.
--Bembidion rufotinctum: On rock ledges along big rivers by rapids or falls. Usually they are within a meter of the water's edge where spray moistens and cools the rocks. Often there are thin mats of hair-like green algae. They can be found on isolated rocks or islets within the rapids.
--Blethisa hudsonica: Floating mats of vegetation in lakes and still portions of rivers.
--Blethisa julii: In NH, occurs in moss and grass beside small high elevation lakes. VT location is a lower (220m) elevation pond, which is shaded most of the day.
--Blethisa quadricollis: Sphagnum mats in acid bogs.
--Carabus goryi: Deciduous forest at least to 300 m elevation.
--Carabus maeander: An amphibious species inhabiting swampy spots with shallow water usually with cattails (Typha) or sedges (Carex).
--Dicaelus dilatatus dilatatus: Dry deciduous forests and sand areas. Adapted to dry conditions.
--Dicaelus teter: Deciduous forests, especially oaks growing on limestone. Forages at night on fallen logs and climbs standing trees. Recorded as feeding on snails and caterpillars.
--Dicheirotrichus cognatus: Open areas just below the tree line, and in the alpine tundra. Has been taken several times in beaver houses.
--Diplocheila impressicollis: In cattail (Typha) marshes and other wetlands.
--Diplocheila striatopunctata: In VT, only in bottomland, swamp forests by Lake Champlain.
--Dyschirius brevispinus: VT specimens were taken under small stones on bare cultivated soil. Elsewhere it has been collected in gravel pits.
--Dyschirius erythrocerus: Recorded habitats include river banks, lake shore, and sea beaches. Most of our specimens however, were caught at light traps.
--Dyschirius politus politus: According to general literature, it is found in sand by rivers and lakes but also in sand pits. It is rarely found in riverside or lakeside sand in the Burlington area where the similar D. sphaericollis is abundant. Relatively common in light traps despite its apparent rarity along rivers.
--Elaphropus dolosus: Bare sand along rivers and lake shores.

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--Elaphropus levipes: River banks on muddy sand. Shelters by day in soil or under bark.
--Elaphrus fuliginosus: Habitat difficult to characterize and variously described in literature, but generally open places with sparse vegetation on wet, sandy or fine mud soils; sometimes with mosses such as sphagnum.
--Geopinus incrassatus: Sand or very sandy soil, especially in the higher, drier parts of sand banks along rivers. A specialized burrower, usually deeply buried by day.
--Harpalus fulvilabris: Open or partically shaded areas in the mountains, including exposed bedrock.
--Harpalus indigens: Open areas on poor soil, usually sand, but also found on a sterile, sloping field of clay and gravel.
--Harpalus providens: A forest species, with records from a forestry plantation on sand, and from an open oak forest on a limestone ridge.
--Lophoglossus scrutator: In VT, on very soft mud on natural levees within river delta; most found under large logs embedded in the soft, shaded mud. Reported elsewhere from open marsh habitats among dense vegetation.
--Nebria suturalis: In VT, confined to above 1200 m elevation on Mount Mansfield. Confined to series of deep joint crevices in warm or dry weather; in cool, wet weather may extend to nearby fell field and talus. Larva has been found in crevices where snow lingers until early summer.
--Notiobia sayi: Sand areas near Lake Champlain among sparse vegetation, including croplands.
--Notiophilus aquaticus: Relatively dry, open ground in alpine tundra on Mt. Mansfield, but also found on bare soil in a low elevation apple orchard near Lake Champlain.
--Notiophilus borealis: Alpine tundra. Reported from dry moss.
--Notiophilus nemoralis: Found amid litter and mosses in spruce-fir forests, 900 – 1200 m elevation.
--Notiophilus novemstriatus: General habitat is dry forest edges.: VT specimens found in tufts of grass on quartzite ledges above cliffs. Reported from IL in oak forest at edge of shale bluffs along river valleys.
--Olisthopus micans: By river mouths, in forests that are flooded by Lake Champlain in the springtime.
--Patrobus foveocollis: Dry openings in spruce-fir forest of high elevation (900-1200 m).
--Pentagonica picticornis: In VT, quartzite and schist rock ledges. Also reported as found under moss clumps on boulders.
--Pericompsus ephippiatus: Found only on short stretch of Connecticut River in southeastern VT.: Barren or sparsely vegetated sand bars where sand is usually dry but close to the water.
--Philodes alternans: Found under a large flat stone at the margin of the Battenkill, below an eroding bank about 1.3 m height.
--Philodes rectangulus: records are from the wet mud banks by Lake Champlain at the mouths of two small rivers, elevation about 30 m.
--Platynus cincticollis: Floodplain forests and forests bordering ponds and slow streams. Occasionally found in beaver houses, tree cavities, or under plant debris on beaches.
--Platypatrobus lacustris: Active beaver huts (beaver present).
--Pseudamara arenaria: Usually above 400 m elevation, in mountain forests.: Some habitat uncertainty.
--Pterostichus brevicornis brevicornis: High, cold parts of the coniferous forest; 750-1130 m elevation.
--Pterostichus castor: Beaver houses, both active and abandoned.
--Pterostichus pinguedineus: Most specimens collected in deep rock crevices at or above tree line on mountain tops. Share habitat with Nebria suturalis. Lowest VT record is 750 m elevation; others all above 1200 m.
--Pterostichus punctatissimus: Boreal species. Two habitat types: (1) in higher mountains above 900 m, found under cover (especially mosses) in fir and spruce forests; (2) near some bogs where cold air accumulates
--Scaphinotus bilobus: Generally spruce forests.
--Schizogenius ferrugineus: Clean sand or sandy fields, often near water. Found under woody debris or in grass tufts.
--Sericoda obsoleta: Found in wood ashes. Have been taken under bark of standing dead trees, in fire places in campgrounds, and in houses which have wood stoves or furnaces. May arrive at sites while fires are still burning.
--Sericoda quadripuncata: Found in wood ashes. Have been taken under bark of standing dead trees, in fire places in campgrounds, and in houses which have wood stoves or furnaces. May arrive at sites while fires are

Common Name: **Beetles-Carabid Group**
Scientific Name: **Beetles-Carabid Group**
Species Group: **Invert**

still burning.
--Sphaeroderus nitidicollis: Coniferous and mixed forest, generally higher elevation in VT, 600-750 m.
--Tachys oblitus: Muddy borders of lakes and rivers, usually in vegetation.
--Tachys rhodeanus: On margins of slow rivers, lakes, and marshes; on very moist soil which is bare or with sparse vegetation.
--Tetragonoderus fasciatus: Dry sand areas near large rivers and lakes; found in sunny spots, but usually near shade. Less than 90 m elevation.
--Tetraleucus picticornis: South of VT, reported from cypress swamps and along swampy shore of rivers.: VT specimens were found beneath driftwood along a seasonally flooded ditch beside a dirt road within forest.

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Other Cultural

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Succession

Habitat Alteration

Sedimentation

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Incompatible Recreation

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Description of habitat threat(s): Habitat problems are known for some species, and are related to habitat loss, change, and degradation. Being rare species, habitat fragmentation would lead to smaller, more vulnerable populations.

Non-Habitat Threats:

Genetics

Pollution

Unknown Non-Habitat Threats

Trampling or Direct Impacts

Description of non-habitat threat(s): The problems not related to habitat are poorly known for these beetles and need study. As rare species with often small populations, loss of metapopulation structure and function would be a problem. Some species are alpine, where heavy recreational use can result in trampling.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Gather information on habitats in which each SGCN carabid species reportedly occurs (literature research, consult researchers and hobbyists, etc.); this will be needed to refine distributional field surveys.
Research	Basic Life History	High	Life history information is needed for all species
Research	Distribution and Abundance	High	Conduct literature research and field surveys to update information on distribution of SGCN carabid species in Vermont.
Research	Threats and Their Significance	High	Research is needed on the vulnerability of species to various significant limiting factors to each habitat type.
Monitoring	Population Change	High	Revisit and survey sites with previous records of SGCN carabids to determine presence/absence; where present, determine
Monitoring	Range Shifts	High	Document changes in distribution, utilitizing historic and recent records.

Common Name: **Beetles-Carabid Group**
Scientific Name: **Beetles-Carabid Group**
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Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Visit known sites of occurrences which has undergone recent development or other disturbance.	Number of sites visited.	FWD, VMC	SWG
Technical Assistance, Training, Learning Networks	High	Sponsor training workshops for carabid identification, survey techniques, web database use	Number of workshops; number of participants	FWD, FPR, VCE, Eagle Hill	SWG
Research	High	Revisit historic sites to update records and monitor species.	Number of historic sites visited.	FWD	SWG
Alliance Development	High	Develop web-based database accessible to professionals and site record providers.	Publication on web site	FPR, FWD, VCE, VT Entomological Society, Carabid specialists	SWG, Lintillac Foundation
Awareness Raising and Communications	High	Publish "Carabidae of Vermont and New Hamphire", which is currently in final draft, as a hard copy and on-line resource.	Availability of Carabidae information	FPR, FWD, VCE, VMC, VT Entomological Society	SWG, Lintillac Foundation, UVM

Common Name: **Beetles-Carabid Group**
Scientific Name: **Beetles-Carabid Group**
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Scientific Name: **Beetles-Carabid Group**
Species Group: **Invert**

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Common Name: **Beetles-Tiger Beetle Group**
Scientific Name: **Beetles-Tiger Beetle Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Declining

Extirpated in VT? No

Regional SGCN? Yes

Assessment Narrative:

This group includes three state-threatened species, one of which is also federally threatened, and four rare species, three of which are known from only one or two collections and includes:
--Boulder-beach Tiger Beetle (Cicindela ancocisconensis): This rarely observed beetle is known from only single collections on two widely separated rivers. Globally rare (G3), RSGCN*. Species appears to be in decline globally.
--Hairy-necked Tiger Beetle (Cicindela hirticollis): This state-threatened beetle's habitat and range has been greatly reduced and fragmented in Vermont by lakeshore development. It was formerly known from several sites along the northern Lake Champlain shores, but is now reduced to a single site. This habitat is protected by the Winooski Valley Park District.
--Boreal Long-lipped Tiger Beetle (Cicindela longilabris): There are few records of this little known beetle in VT. It is a northern species found in VT at moderately high elevations. More survey work is needed.
--Cobblestone Tiger Beetle (Cicindela marginipennis): There are few records of this state-threatened species scattered around the state in uncommon habitat. It has been studied in VT to a greater degree than other Cicindela. At least one site appears to no longer support the species. Habitat losses along the Connecticut River and possibly other rivers have been significant due to impoundments. Globally rare (G2), RSGCN*.
--Northern Barrens Tiger Beetle (Cicindela patruela): This is a very rare species throughout the Northeast; known in VT from a single historic collection. Globally rare (G3), RSGCN*. It uses restricted habitat (sand plains), which has been extensively destroyed in VT and elsewhere; global occurrences are now highly fragmented. It is now a rare, relict species.
--Puritan tiger beetle (Cicindela puritana): This federally threatened species is known from a single historic VT collection, although other historic records were known along the New Hampshire side of the river. Impoundments along the Connecticut River likely caused the extirpation of this species. Other habitat losses may have also been a factor. Reintroduction could be considered if sufficient habitat improvements are made. Riverside recreational use has had a significant impact on populations at other New England sites. RSGCN*
--Eastern Red-bellied Tiger Beetle (Cicindela rufiventris): Known from a single VT location. Its status is unknown.

*Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states

Distribution

--Boulder-beach Tiger Beetle (Cicindela ancocisconensis): Reported from Underhill historically. More recently from West River and Third Branch of the White River. Biophysical regions: Southern Green Mountains, Northern Green Mountains.

--Hairy-necked Tiger Beetle (Cicindela hirticollis hirticollis): Historically six locations on Lake Champlain, three of which probably represented dispersing individuals. Only a single extant breeding population now known in Colchester. Biophysical regions: Champlain Valley.

--Boreal Long-lipped Tiger Beetle (Cicindela longilabris): Three locations. Restricted to the mountains and northern plateau in VT. Biophysical regions: Northern Green Mountains, Northern Highlands.

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Species Group: **Invert**

--Cobblestone Tiger Beetle (Cicindela marginipennis): Known from West, White, and Winooski rivers. It is reported that populations along the Connecticut River are believed to use islands (NH) for larval sites, though adults will forage on the west (VT) shore. Biophysical regions: Southern Vermont Piedmont, Northern Green Mountains, Champlain Hills.

--Northern Barrens Tiger Beetle (Cicindela patruela): Single historic record from Burlington. Sand plains in and around Burlington have largely been destroyed by urban growth. Biophysical regions: Champlain Valley.

--Puritan Tiger Beetle (Cicindela puritana): On historic location in Hartland. Biophysical regions: Southern Vermont Piedmont.

--Eastern Red-bellied Tiger Beetle (Cicindela rufiventris): One location in Sandgate. Biophysical regions: Taconic Mountains.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Not Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Habitat Types:

Upland Shores
Outcrops and Alpine
Spruce Fir Northern Hardwood
Oak-Pine Northern Hardwood
Open Peatlands
Wet Shores

Current Threats

Habitat Threats:

Conversion of Habitat
Habitat Succession

Common Name: **Beetles-Tiger Beetle Group**
Scientific Name: **Beetles-Tiger Beetle Group**
Species Group: **Invert**

Habitat Alteration

Sedimentation

Inadequate Disturbance Regime

Invasion by Exotic Species

Incompatible Recreation

Climate Change

Description of habitat threat(s): Regular scouring of river shores by high water events helps keep habitat open by reducing vegetation; damming of rivers impacts this process downstream of these structures and may degrade habitat. Replenishment of substrates is also reduced downstream of dams, which can alter substrate composition along shores. Excessive fine sediments that enter streams and rivers can alter the substrate composition along shores, thereby reducing the suitability of habitat. Development along shores of Lake Champlain and rivers has reduced the availability of habitat. Loss of sand plain habitat has probably caused extirpation of one species. Northern species on the southern edge of their range in Vermont may be impacted by climate change. Invasive plants that colonize river shores could eliminate tiger beetle populations.

Non-Habitat Threats:

Genetics

Trampling or Direct Impacts

Description of non-habitat threat(s): Small, isolated populations may be at risk genetically.4-wheelers on rivershores and islands can crush larvae and make habitat unsuitable for sustaining burrows.Use of beaches and sand shores can also cause trampling of areas used by larvae.

Common Name: **Beetles-Tiger Beetle Group**
Scientific Name: **Beetles-Tiger Beetle Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Define particular habitat requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Basic Life History	Medium	Need to rear and describe the larvae of C. marginipennis.
Research	Distribution and Abundance	High	1) Conduct inventories to detect and gather information on new SGCN tiger beetles populations. 2) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Efforts should be focused on particular habitats required by each. Abundance information should be collected at sites of known occurrence. Determine if C. marginipennis colonies are disappearing and/or new colonies appearing.
Research	Threats and Their Significance	High	1) Assess potential and existing impacts of limiting factors to habitat. Such limiting factors as habitat loss and degradation, exotic invasive plants, incompatible recreation, and dams should be examined. 2) Investigate how rivershore tiger beetle populations are being affected by dams, and actions that can be taken to restore or mimic natural processes that maintain habitat.
Monitoring	Population Change	High	Monitor known SGCN tiger beetle populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.
Monitoring	Habitat Change	High	Monitor change in available habitat for each species' specific requirements. Loss, restoration, and other changes to local habitat sites recognized as important to these species should be tracked.
Monitoring	Monitor Threats	High	Recreational use of shoreline habitat needs to be monitored, as it can affect several species.

Common Name: **Beetles-Tiger Beetle Group**
Scientific Name: **Beetles-Tiger Beetle Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Easements	High	Acquisition/easement of high priority SGCN tiger beetle sites	Number of SGCN tiger beetle sites protected	FWD, FPR, USFS, NRCS, VLT, other land trusts	VHCB, SWG, GMNF, EQIP, USFWS
Compatible Resource Use	High	Work with land owners to direct recreational use away from necessary rivershore tiger beetle habitat	Number of monitored sites where trampling of habitat is eliminated	FWD, watershed groups, local landowners	
Compatible Resource Use	High	Work to restrict recreational vehicles from accessing riverbank and lakeshore SGCN tiger beetle habitat	Number of sites that have eliminated motorized access to SGCN tiger beetle habitat	FWD, NRCS, watershed groups, local landowners	

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Common Name: **Butterflies-Grassland Group**
Scientific Name: **Butterflies-Grassland Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

State Rank:

Extirpated in VT?

Global Trend:

State Trend: Declining

Regional SGCN?

Assessment Narrative:

This group consists of four species. The first three are very rare in Vermont and their habitat requirements vary within the general grasslands category. The fourth, Regal fritillary, is extirpated in Vermont and almost all of the Northeast.

--Cobweb Skipper (Hesperia metea): Two recent sight records only; needs further documentation.

--Dusted Skipper (Atrytonopsis hianna): First records from Vermont in 2004. Only in Southern Vermont; highest density populations along I-91 where bluestem grasses planted. May benefit and expand northward from additional plantings in appropriate areas.

--Monarch (Danaus plexippus): On-going and sharp decline of eastern North American population has led to recent proposal to list the Monarch as threatened under the U.S. Endangered Species Law. A large factor in the species decline may be habitat loss, particularly of milkweed (Asclepias), which is the host plant.

--Regal fritillary (Speyeria idalia): Extirpated from Vermont; ability to re-establish uncertain.

Distribution

2002-2007 butterfly survey (VBS) records by biophysical region:

--Cobweb skipper: 2 sight records in Taconic Mountains and Vermont Valley

--Regal fritillary: extirpated. Historically from collections in Southern Vermont Piedmont and Vermont Valley

--Dusted skipper: Taconic Mountains, Southern Vermont Piedmont

--Monarch: Northern Highlands, Northern Vermont Piedmont, Northern Green Mountains, Champlain Hills, Champlain Valley, Taconic Mountains, Vermont Valley, Southern Green Mountains, Southern Vermont Piedmont

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Butterflies-Grassland Group**
Scientific Name: **Butterflies-Grassland Group**
Species Group: **Invert**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

This group consists of three species, the habitat requirements of which vary within the general grasslands category. Regal fritillary is extirpated in Vermont and all of North America east of the Mississippi River except for two populations in PA and WV. The other species are very rare in Vermont or in the case of the Monarch, may still be somewhat common in optimal years..

--Cobweb Skipper (Hesperia metea) Grasslands, old dry fields, and open barrens. Host plants are Little Bluestem (Schizachyrium scoparius) and Big Bluestem (Andropogon gerardi). Adults prefer nectaring on low-growing plants such as Labrador Tea (Ledum groenlandicum), Wild Strawberry (Fragaria virginiana), Blackberry (Rubus allegheniensis), Winter Cress (Barbarea vulgaris), and Red Clover (Trifolium pratense).

--Regal fritillary (Speyeria idalia) In Massachusetts, seems to have preferred extensive open areas with a combination of wetlands and upland fields containing an abundance of nectaring plants. Host plants are violets (Viola sp.).

--Dusted Skipper (Atrytonopsis hianna) Open, dry habitats in far southern Vermont valleys with bluestem grasses. Often found in the same habitat as the Cobweb Skipper. Host plants are Little Bluestem (Schizachyrium scoparius) and Big Bluestem (Andropogon gerardi). Adults nectar from flowers including Japanese Honeysuckle (Lonicera japonica), Wild Strawberry (Fragaria virginiana), Blackberry (Rubus allegheniensis), Phlox (Phlox), Vervain (Verbena) and Red Clover (Trifolium pratense).

--Monarch (Danaus plexippus) Prefers open meadows, weedy areas, marshes, roadsides and disturbed habitats with milkweed. Caterpillars feed on Common Milkweed (Asclepias syriaca), Swamp Milkweed (Asclepias incarnata), and Showy Milkweed (Asclepias speciosa). Blooming later summer/early fall clover fields are important stopover habitat in the Champlain and Connecticut valleys. Monarchs occur in Vermont from as early as mid-May to early November; adults migrate south in the fall to reach overwintering habitat in Mexico. Multiple generations are necessary to reach Vermont in the spring/summer.

Habitat Types:

Oak-Pine Northern Hardwood

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Other Cultural

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Common Name: **Butterflies-Grassland Group**
Scientific Name: **Butterflies-Grassland Group**
Species Group: **Invert**

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Loss of grasslands (anthropogenic and natural) and host plants is a threat to members of this group

Non-Habitat Threats:

Pollution

Trampling or Direct Impacts

Loss of Relationship with Other Species

Loss of Prey Base

Description of non-habitat threat(s): --Loss of and impacts to host plants have a negative impact on these grassland butterflies. Increased use of herbicides in agricultural fields may be reducing host plant (milkweeds) density for Monarch in Midwest; impacts in Vermont are unknown.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Define particular habitat requirements of species for which we still have inadequate information, utilizing current knowledge of researchers and field investigations. This has been completed for most SGCN grassland butterflies.
Research	Threats and Their Significance	High	Assess potential and existing impacts of threats to habitat, host plants, and individual butterflies. Such threats as habitat loss and degradation, exotic invasive plants, disease, and host plant loss should be examined.
Research	Population Genetics	Low	Reintroduction of regal fritillary would need to identify the source populations that are likely most similar to those originally occurring in Vermont.
Monitoring	Population Change	Medium	Monitor known SGCN butterfly populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.
Monitoring	Habitat Change	High	Grasslands are some of the habitats most vulnerable to loss due to development and intensive agriculture. Landscape level changes in this general habitat type should be monitored. Loss, restoration, and other changes to local habitat sites recognized as important to these species should be tracked.

Common Name: **Butterflies-Grassland Group**
Scientific Name: **Butterflies-Grassland Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Workshops	High	Incorporate butterfly SGCN occurrence information into environmental review and technical assistance	Number of sites with butterfly SGCN that received conservation benefits to this group	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Easements	High	Acquisition/easement of high priority SGCN butterfly grassland sites	Number of SGCN butterfly sites protected	FWD, VLT, other land trusts	VHCB, SWG, EQIP, USFWS

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Common Name: **Butterflies-Hardwood Forest Group**
Scientific Name: **Butterflies-Hardwood Forest Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Unknown

Extirpated in VT? No

Regional SGCN? Yes

Assessment Narrative:

.

This group consists of four species, the habitat requirements of which vary within the general hardwood forest category.

--West Virginia white (Pieris virginiensis): Threatened by exotic garlic mustard, disease, and poor weather conditions; colonies easily extirpated; does not recolonize isolated sites well.

--Early hairstreak (Erora laeta): Widely scattered and localized populations. Beech bark disease is killing off large stands of beech in Vermont, often leaving only 1% of trees remaining. The future for the beech and the early hairstreak in Vermont and much of northeastern North America is uncertain. The beaked hazelnut has also been reported as a host plant further west; the extent to which early hairstreak would adapt to this plant in Vermont is unknown.

--Hackberry emporer (Asterocampa celtis): First VT record in 2002. Likely to increase with climate change.

--Tawny emporer (Asterocampa clyton): First VT record in 2002. Likely to increase with climate change.

Distribution

2002-2007 butterfly survey (VBS) records by biophysical region:

--West Virginia white: Champlain Valley, Taconic Mountains, Vermont Valley, Southern Green Mountains, Southern Vermont Piedmont

--Early hairstreak: Champlain Valley, Northern Green Mountains, Northern Vermont Piedmont, Southern Green Mountains

--Hackberry emperor: Champlain Valley, Taconic Mountains, Northern Green Mountains; possibly Southern Vermont Piedmont

--Tawny emperor: Champlain Valley, Vermont Valley, Northern Green Mountains, Southern Vermont Piedmont

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Common Name: **Butterflies-Hardwood Forest Group**
Scientific Name: **Butterflies-Hardwood Forest Group**
Species Group: **Invert**

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

This group consists of several species, the habitat requirements of which vary within the general hardwood forest category.

--West Virginia White (Pieris virginiensis) Requires mature, relatively undisturbed rich hardwood forests with large populations of the host plants, Two-leaved Toothwort (Dentaria diphylla) and Cut-leaved Toothwort (Cardamine concatenata). Adults nectar from Toothworts, Spring Beauty (Claytonia virginica), Violets (Viola), and other spring wildflowers.

--Early Hairstreak (Erora laeta) requires stands of American Beech (Fagus grandifolia), the host plant; failure of the beechnut crop, even for a single year, may seriously impact populations. Adults nectar on fleabane (Erigeron sp.) and Ox-eyed Daisy (Chrysanthemum leucanthemum). Often found on bare ground puddling.

--Hackberry Emperor (Astrocampa celtis) Found in floodplain forests with Northern Hackberry (Celtis occidentalis), the host plant. Also reported from suburban Hackberry plantings in Burlington. Adults feed on sap, mud, rotting fruit, and excrement, which can sometimes take them outside of their regular habitat.

--Tawny Emperor (Astrocampa clyton) Found in floodplain forests with Northern Hackberry (Celtis occidentalis), the host plant. Also reported from suburban Hackberry plantings in Burlington. Adults feed on tree sap, rotting fruit, dung, and carrion.

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Softwood Swamps

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Early hairstreak is limited by the loss of American beech stands due to beech bark disease. Caterpillars feed on the fruits of this tree, which are only produced by individuals 40 years old or more. Invasion of garlic mustard may threaten the West Virginia White, as the adults will lay eggs on it. The plant is toxic to eggs and larvae. West Virginia White will not recolonize an isolated site once extirpated because it doesn't fly across open areas. Logging activities may impact West Virginia White and Early Hairstreak.

Non-Habitat Threats:

Loss of Relationship with Other Species

Disease

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Disease and invasives threaten host plants that are required for egg laying and larval development. Build up of granulosis virus in soil causes premature death of larval West Virginia White. Forest pest control spraying may impact West Virginia White and Early Hairstreak. Beech bark disease poses a significant threat to Early Hairstreak.
--West Virginia White is a poor recolonizer of isolated sites that become extirpated; colonies may be easily lost due to disturbance of habitat.
--Early Hairstreak populations are scattered and highly localized in VT; genetic exchange and recolonization would be unlikely among known sites.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Define particular habitat requirements of species for which we still have inadequate information, utilizing current knowledge of researchers and field investigations. This has been completed for most SGCN hardwood forest butterflies.
Research	Basic Life History	Medium	It is possible that early hairstreak uses beaked hazelnut in Vermont, as well as American beech; but this is unknown.
Research	Threats and Their Significance	High	Assess potential and existing impacts of limiting factors to habitat, host plants, and individual butterflies. Such limiting factors as habitat loss and degradation, exotic invasive plants, disease, and host plant loss should be examined.
Monitoring	Population Change	High	Monitor known SGCN butterfly populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.
Monitoring	Habitat Change	High	Monitor change in available habitat for each species' specific requirements. Loss, restoration, and other changes to local habitat sites recognized as important to these species should be tracked.

Common Name: **Butterflies-Hardwood Forest Group**
Scientific Name: **Butterflies-Hardwood Forest Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Workshops	High	Incorporate butterfly SGCN occurrence information into environmental review and technical assistance	Number of sites with butterfly SGCN that received conservation benefits to this group	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Easements	High	Acquisition/easement of high priority SGCN butterfly hardwood forest sites	Number of SGCN butterfly sites protected	FWD, FPR, TNC, VLT, other land trusts	VHCB, SWG, EQIP, USFWS
Standards	High	Work with foresters to avoid significant impacts to SGCN butterfly populations and habitats during forest management activities	Number of SGCN butterfly locations indicated and protected in forest management plans (including mature beech stands)	FWD, FPR, USFS, private landowners	

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Common Name: **Butterflies-Wetland Group**
Scientific Name: **Butterflies-Wetland Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:
Global Trend:
State Rank:
State Trend:
Extirpated in VT?
Regional SGCN? Yes

Assessment Narrative:

This group consists of six species, the habitat requirements of which vary within the general wetland category. Their caterpillars require specific food plants.

--Bog copper (Lycaena epixanthe): Found only in acidic bogs with cranberries, which are the host plants; few colonies; a weak flier (limited disperal capability); six VBS survey blocks

--Jutta arctic (Oeneis jutta) Only 3 colonies known, all in Northeast Highlands. Restricted to acidic bogs in Northeast Highlands.

--Dion skipper (Euphyes dion): Strong flier; a good short-distance colonizer. Typically low densities in colonies. 12 VBS blocks.

--Black dash (Euphyes conspicua): First VT record in 2002; found in southern-most VT sedge wetlands, except one possible sighting in the Champlain Valley. Nine VBS blocks.

--Two-spotted skipper (Euphys bimacula) Low numbers observed in widely scattered colonies; may disappear from a location for several years, then reappear. Only four colonies known; widely separated.

--Mulberry wing (Poanes massasoit): Known from limited area Taconic Mountains and Vermont Valley, with two possible observations in Champlain Valley and Southern Green Mountains. Eight VBS blocks.

Distribution

Biophysical regions recorded during 2002-2007 butterfly survey (VBS):

--Bog copper: Northern Highlands, Champlain Hills, Northern Vermont Piedmont, Vermont Valley

--Jutta arctic: Northern Highlands

--Dion skipper: Champlain Valley, Northern Green Mountains, Taconic Mountains, Vermont Valley, Southern Vermont Piedmont

--Two-spotted skipper: Northern Highlands, Champlain Valley, Northern Vermont Piedmont, Southern Green Mountains

--Black dash: Taconic Mountains, Southern Vermont Piedmont; possibly Champlain Valley

--Mulberry wing: Taconic Mountains, Vermont Valley; possibly Champlain Valley, Southern Green Mountains

--Broad-winged skipper: 11 survey blocks in Bennington, Grand Isle, Addison, and Rutland counties

Common Name: **Butterflies-Wetland Group**
Scientific Name: **Butterflies-Wetland Group**
Species Group: **Invert**

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☐ General Literature ☑

This group consists of several species, the habitat requirements of which vary within the general hardwood forest category. Caterpillars require specific food plants, which are referenced below.

--Bog Copper (Lycaena epixanthe): Found only in acidic bogs with cranberries (Vaccinium sp.), which are the host plants.

--Jutta Arctic (Oeneis jutta): Restricted to Black Spruce bogs in the Northeast Highlands; host plants are Dense Cottongrass (Eriophorum spissum), Carex geyeri, and C. confine. Adults nectar at bog flowers such as Labrador Tea (Ledum groenlandicum).

--Dion Skipper (Euphys dion): Calcareous sedge wetlands; host plants are narrow-leaved sedges such as Tussock Sedge (Carex stricta); adults nectar on Buttonbush (Cephalanthus occidentalis), jewelweed (Impatiens sp.), And Swamp Thistle (Cirsium muticum).

--Black Dash (Euphys conspicua): Sedge wetlands in southern-most VT, except also one possible sighting in the Champlain Valley. Host plants are narrow-leaved sedges, predominantly Tussock Sedge (Carex stricta), though others are possible. Adults rely on nectar from Buttonbush (Cephalanthus occidentalis), jewelweed (Impatiens sp.) , and Swamp Thistle (Cirsium pumilum). Associated with the Mulberry Wing (Poanes massasoit).

--Two-spotted Skipper (Euphys bimacula): Prefers spruce bogs and sedge wetlands. Larval host plants are sedges, especially Hairy-fruited Sedge (Carex trichocarpa) and Tussock Sedge (C. stricta); adults nectar on Pickerelweed (Pontederia cordata), blue flag iris (Iris sp.), Common Milkweed (Asclepias syriaca), and spireas (Spirea sp.).

--Mulberry Wing (Poanes massasoit): Sedge wetlands in southwestern VT, often with Black Dash and Dion Skipper; sometimes found in bogs, fens, and wet meadows. Known host plant is Tussock Sedge (Carex stricta), but there are likely others. Adults nectar on Swamp Milkweed (Asclepias incarnata), Common Milkweed (A. syriaca), and possibly other wetland flowers..

Common Name: **Butterflies-Wetland Group**
Scientific Name: **Butterflies-Wetland Group**
Species Group: **Invert**

Habitat Types:

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Wetlands are particularly vulnerable to invasive exotic plants. Invasives threaten to replace native flora, including larval host plants of wetland SGCN butterflies. Wetland impacts due to development can also impact these butterflies.

Non-Habitat Threats:

Trampling or Direct Impacts

Loss of Relationship with Other Species

Description of non-habitat threat(s): Loss or reduction of native wetland flora can include SGCN host plants.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Define particular habitat requirements of species for which we still have inadequate information, utilizing current knowledge of researchers and field investigations. This has been completed for most SGCN wetland butterflies.
Research	Threats and Their Significance	High	Assess potential and existing impacts of limiting factors to habitat, host plants, and individual butterflies. Such limiting factors as habitat loss and degradation, exotic invasive plants, disease, pesticides, and host plant loss should be examined.
Monitoring	Population Change	High	Monitor known SGCN butterfly populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.
Monitoring	Habitat Change	High	Monitor change in available habitat for each species' specific requirements. Loss, restoration, and other changes to local habitat sites recognized as important to these species should be tracked.
Monitoring	Monitor Threats	Medium	Monitor the spread (and control) of wetland invasive species that can impact the habitat and host plants of these butterfly species.

Common Name: **Butterflies-Wetland Group**
Scientific Name: **Butterflies-Wetland Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Workshops	High	Incorporate butterfly SGCN occurrence information into environmental review and technical assistance	Number of sites with butterfly SGCN that received conservation benefits to this group	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Easements	High	Acquisition/easement of high priority SGCN butterfly wetland sites	Number of SGCN butterfly sites protected	FWD, TNC, VLT, other land trusts	VHCB, SWG, EQIP, USFWS

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Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority
Global Rank:
State Rank:
Extirpated in VT?
Global Trend:
State Trend:
Regional SGCN? Yes

Assessment Narrative:

Numerous species of moths are considered rare, declining, or extirpated. Very little information is available on the distribution of these species, and there is even less known about their trends throughout the region. This group includes the following 17 species:

--Eacles imperialis pini, Imperial Moth: Thought to be extirpated until collected in 2001. Declined drastically or disappeared from VT in 1950's. Probable cause of decline was pesticide spraying and release of Compsilura concinnata for gypsy moth control.
--Eana georgiella, A tortricid moth: One recent collection from high elevation site. Status unknown.
--Hemileuca lucina, New England Buckmoth: Restricted to New England; found in SE VT. Have increased in abundance globally.
--Lasionycta taigata, A noctuid moth: One collection in 1975. A bog associate. Status uncertain.
--Lemmeria digitalis, A noctuid moth: Several collected in 1991-93. Status uncertain.
--Lithophane franclemonti, Franclemont's Lithophane: One VT collection. Globally rare, with evidence of decline.
--Pachypolia atricornis, An autumnal noctuid moth: Reported from Chittenden Co. (Proctor Maple Research Forest). Very rarely collected throughout range.
--Papaipema sp. 2 nr. pterisii, Ostrich Fern Borer moth: Rare outside of VT. Responsibility species. Metapopulation structure is needed for long-term viability. Globally rare (G3G4).
--Properigea costa, A noctuid moth: Collected in Chittenden Co. Associated with shale, granite, or limestone barrens. More common globally than previously believed.
--Speranza ribearia, Currant Spanworm: Collected Bakersfield, 1991 (Franklin Co). Formerly widespread, now rare through much of range due to eradication of currant in 1920's-'60's (alternate host of white pine blister rust).
--Sphinx drupiferarum, Plum Sphinx or Wild Cherry Sphinx: Severe populations declining in Eastern NA; now uncommon to rare throughout range. Reasons for decline unknown, but may include introduction of parasitoid Compsilura concinnata and historic aerial (DDT) spraying.
--Sphinx luscitiosa, Clemens' Sphinx: Populations declining rangewide. Uncommon or rare throughout Northeast.
--Sthenopis thule, Willow Ghost moth: Single specimen, South Hero in 1992. Only reported from VT and ON.
--Xestia fabulosa, A noctuid moth: Range not well-known. Recorded from VT, NH, and ON. Status uncertain.
--Xestia homogena, A noctuid moth: Found in alpine habitat (high elevation; mountain peaks). Habitat specialist.
--Zale submediana, Gray Spring Zale: Associated with rare, highly impacted habitat. Very rare in VT; single report; probably was previously common in sand plains.
--Zanclognatha martha, Pine Barrens Zanclognatha: Associated with rare habitat. Somewhat rare outside of NJ; single VT report.

Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

Distribution

--Eacles imperialis pini, Imperial Moth: One collected Grand Isle, 2001; Chittenden Co. historically. Also known from northern NY and southern Canada.

--Eana georgiella A tortricid moth: One recent collection from Jay Peak.

--Hemileuca lucina New England Buckmoth: Restricted to New England; found in SE VT.

--Lasionycta taigata A noctuid moth: Reported from Essex Co. '75 (Moose Pond).

--Lemmeria digitalis A noctuid moth: Several collected in Chittenden Co., 1991-93.

--Lithophane franclemonti Franclemont's Lithophane: Known from one Grand Isle specimen.

--Pachypolia atricornis An autumnal noctuid moth: Reported from Chittenden Co. (Proctor Maple Research Forest).

--Papaipema sp. 2 nr. pterisii Ostrich Fern Borer Moth: Several collections along rivers in VT, including Huntington River. Rare outside of VT.

--Properigea costa A noctuid moth: Collected in Chittenden Co.

--Speranza ribearia Currant Spanworm: Collected Bakersfield, 1991 (Franklin Co).

--Sphinx drupiferarum Plum Sphinx or Wild Cherry Sphinx: Reported from Franklin, Chittenden, Bennington, Orleans, and Lamoille counties.

--Sphinx luscitiosa Clemens' Sphinx: VT distribution unknown.

--Sthenopis thule A ghost moth: Single specimen, South Hero in 1992.

--Xestia fabulosa A noctuid moth: Range not well-known. Recorded from VT, NH, and ON.

--Xestia homogena A noctuid moth: Found in alpine habitat (high elevation; mountain peaks).

--Zale submediana Gray Spring Zale: Reported from Jericho Research Forest (Chittenden Co.) in '90. Probably was previously common in sand plains.

--Zanclognatha martha Pine Barrens Zanclognatha: Reported from Jericho Research Forest (Chittenden Co.) in '90.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Probable
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

--Eacles imperialis pini, Imperial Moth: White pine specialist; possibly also pitch pine. Found in coniferous forest.
--Eana georgiella, A tortricid moth: High elevation species. VT specimen collected from summit in a "disturbed area."
--Hemileuca lucina, New England Buckmoth: Found in wet meadows and open fields. May use powerline corridors. Host plants: oak, Prunus serotina, willows, gray birch, Vaccinium; early instars on meadowsweet.
--Lasionycta taigata, A noctuid moth: Bog associate.
--Lemmeria digitalis, A noctuid moth: Reported from wetland habitats in PA. Host plants unknown.
--Lithophane franclemonti, Franclemont's Lithophane: Host plants and habitat unknown.
--Pachypolia atricornis, An autumnal noctuid moth: Found in mesic northern hardwood or mixed forests with non-acidic soils.
--Papaipema sp. 2 nr. pterisii, Ostrich Fern Borer Moth: May occur where there are large areas of ostrich fern, the host plant; particularly along floodplain forests.
--Properigea costa, A noctuid moth: Associated with shale, granite, or limestone barrens.
--Speranza ribearia, Currant Spanworm: Host plants are currant, gooseberry.
--Sphinx drupiferarum, Plum Sphinx or Wild Cherry Sphinx: Found in wooded habitats and suburbs. Host plants: cherry, plum, apple; also lilac and hackberry.
--Sphinx luscitiosa, Clemens' Sphinx: Found in clearings, edges, and meadows in wooded areas. Host plants: willow, poplar, birch, apple, ash. Has been reportedly seen obtaining nourishment from dead fish.
--Sthenopis thule, Willow Ghost Moth: Host plant: reported on willows, but not well known.
--Xestia fabulosa, A noctuid moth: Reported elsewhere from boreal and montane spruce-fir forests, and high-elevation subalpine forests. Host plants: Vaccinium sp.
--Xestia homogena, A noctuid moth: Found in alpine habitat (high elevation; mountain peaks).
--Zale submediana, Gray Spring Zale: probably was previously common in sand plains. Host plants: jack, pitch, red, and probably other hard pines.
--Zanclognatha martha, Pine Barrens Zanclognatha: Found in pitch pine/ scrub oak barrens in PA northward; Jericho population may have colonized pines from a remnant pine barren.

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Open Peatlands

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

Other Cultural

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Inadequate Disturbance Regime

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Hemileuca lucina, New England Buckmoth Habitat loss, habitat succession.
--Papaipema sp. 2 nr. pterisii Ostrich Fern Borer Moth Metapopulation structure is needed for long-term viability (habitat loss, habitat fragmentation, invasion by exotic species).
--Zale submediana Gray Spring Zale Habitat loss and conversion.
--Zanclognatha martha Pine Barrens Zanclognatha Habitat loss and conversion.
--Habitat threats for other species are not known.

Non-Habitat Threats:

Parasites

Reproductive Traits

Trampling or Direct Impacts

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Eacles imperialis pini, Imperial Moth Declined drastically or disappeared from VT in 1950's. Probable cause of decline was pesticide spraying and release of Compsilura concinnata for gypsy moth control. Use of BTK is also potential problem if used wrong time of year (late June or later).
--Speranza ribearia Currant Spanworm Formerly widespread, now rare through much of range due to eradication of currant in 1920's-'60's (alternate host of white pine blister rust).
--Sphinx drupiferarum Plum Sphinx or Wild Cherry Sphinx Introduced parasitoid Compsilura concinnata was probably involved in the decline of this species, but was not the only factor.
--Xestia homogena A noctuid moth Trampling or disturbance of host vegetation in alpine areas is a potential threat.

Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Define Vermont-specific habitat requirements of species for which this information is lacking; utilize field investigations and current knowledge of researchers.
Research	Basic Life History	Medium	Larval host plant requirements need to be studied and described or refined.
Research	Distribution and Abundance	High	1) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Efforts should be focused on particular habitats required by each and, where appropriate, on regions of expected occurrence within the state (e.g., a northern peripheral species might be expected in the northern tier counties). Abundance information should be collected at sites of known occurrence. 2) Conduct inventories to detect and gather information on new SGCN moth populations.
Research	Threats and Their Significance	High	Assess potential and existing impacts of limiting factors to habitat, host plants, and individual moths. Such limiting factors as habitat loss and degradation, exotic invasive plants, diseases, parasitoids, pest control, and host plant loss should be examined.
Research	Taxonomy	Medium	Taxonomic uncertainty of some species, such as Eacles imperialis pini, needs to be resolved.
Monitoring	Population Change	High	Monitor known SGCN moth populations. Many of these species are declining regionally; trends need to be monitored.
Monitoring	Habitat Change	Medium	Monitor change in available habitat for each species' specific requirements. Loss, restoration, and other changes to local habitat recognized as important to these species should be tracked.
Monitoring	Monitor Threats	Medium	Several species have been negatively impacted by gypsy moth control methods, including release of exotic parasitoids. Gypsy moth and other species-targeted control needs to be tracked and considered in managing for SGCN moths. Exotic parasitoid populations and distributions need to be assessed also.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Easements	High	Acquisition/easement/conservation/restoration of high priority SGCN moth sites	Number of SGCN moth sites protected/restored	FWD, FPR, USFWS, NRCS, VLT, other land trusts	VHCB, SWG, EQIP, USFWS
Standards	High	Work with landowners and those who manage forest pests to reduce/eliminate the use of pesticides and exotic species where they may negatively impact SGCN moth species	Area of land where methods detrimental to SGCN moths have been eliminated through management planning	FWD, FPR, USFS, VT Entomological Society, towns, private landowners	SWG

Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

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Common Name: **Moths Group**
Scientific Name: **Moths Group**
Species Group: **Invert**

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Common Name: **Mayflies/Stoneflies/Caddisflies Group**
Scientific Name: **Mayflies/Stoneflies/Caddisflies Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Unknown

Extirpated in VT? No

Regional SGCN? Yes

Assessment Narrative:

This group consists eleven species with all but the Rhyacophila brunnea considered globally rare (G1-G3). Very little information is available on Vermont populations, making status determination difficult.
--A Mayfly (Ameletus browni): This is a globally rare species (G3/G4). Insufficient information is available to determine VT status.
--Tomah Mayfly (Siphlonisca aerodromia): This is a globally rare species (G2G3). Although not yet recorded from VT, insufficient information is available to determine VT status.
--A Mayfly (Siphlonurus demaryi): This is a globally rare species (G2G3). Insufficient information is available to determine VT status.
--Roaring Brook Mayfly (Epeorus frisoni): This is a globally rare species (G1). Known only recently from a single location in VT. To date, only four small stream populations are known worldwide.
--A Mayfly (Eurylophella bicoloroides): This is a globally rare species (G3). Insufficient information is available to determine VT status.
--A Mayfly (Baetisca rubescens): This is a globally rare species (G3/G4). Insufficient information is available to determine VT status.
--A Stonefly (Alloperla voinae): This is a globally rare species (G3) which is rarely collected. Insufficient information is available to determine VT status.
--Appalachian Stone (Hansonoperla appalachia): This is a globally rare species (G3). Insufficient information is available to determine VT status.
--Spiny Salmonfly (Pteronarcys comstocki): This is a globally rare species (G3). Insufficient information is available to determine VT status.
--A Caddisfly (Rhyacophila brunnea): This species is known from fewer than 10 sites in Vermont.
--A Caddisfly (Rhyacophila amicis): This is a globally rare species (G2). Insufficient information is available to determine VT status.

Distribution

--Roaring Brook mayfly (Epeorus frisoni): Known in Vermont only from a Battenkill tributary near Dorset. Globally, known from only from NH, VT, and ME.
--Ameletus browni: This species is not well documented, but has been reported from Bennington County.
--Eurylophella bicoloroides: This species is not well documented, but has been reported from Bennington County.
--Tomah mayfly (Siphlonisca aerodromia): This mayfly has not yet been documented in VT. It is known only from a few sites in NY, ME, QE, and Labrador. Noted as one of the rarest mayflies in the world.
--Baetisca rubescens: Distribution of this species in VT is not known. Only a few U.S and Canadian records.
--Alloperla voinae: Distribution of this species in VT is not known. Otherwise known from NY to NS, south to MA.
--Rhyacophila brunnea: Known from Killington, Shrewsbury, Mendon, Orange, and Stowe.
--Siphlonurus demaryi: This species is not well documented, but has been reported from Bennington County. A regional endemic to northeastern U.S and southeastern Canada.
--Hansonoperla appalachia: This species is not well documented in Vermont.
--Pteronarcys comstocki: This species is not well documented in Vermont.

Common Name: **Mayflies/Stoneflies/Caddisflies Group**
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Species Group: **Invert**

--Rhyacophila amicis: This species is not well documented in Vermont.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

--Tomah mayfly (Siphlonisca aerodromia) This mayfly inhabits rivers with broad, seasonally flooded sedge-dominated floodplains.
--Siphlonurus demaryi Larvae have been collected in lake littoral zones near stream inlets and along margins of larger streams among vegetation.
--Roaring Brook mayfly (Epeorus frisoni) Found in small, first and second order tributaries of high elevation streams. May be associated with conditions of pristine water quality and minimally or undisturbed riparian habitat.
--Ameletus browni Restricted to cold, high elevation, first order streams in undisturbed habitat.
--Eurlophella bicoloroides Found in small (2nd order) streams up to medium sized rivers (6th or 7th order). In large streams, has been reported in reaches below reservoirs with hypolimnetic release.
--Baetisca rubescens A northern species, restricted to cold, high elevation streams.
--Alloperla voinae Habitat is unknown for this species.
--Rhyacophila brunnea This species inhabits small, high-elevation streams; these are acid-sensitive streams.
--Rhyacophila amicis A coldwater montane stream caddisfly.
--Hansonoperla appalachia Occurs in pristine medium-sized streams of the elevated Appalachians. Nymphs were collected in WV from undercut banks of riffle areas where roots of riparian vegetation trapped coarse detritus and caused deposits of sand to accumulate.
--Pteronarcys comstocki Prefers medium-sized to large cold streams. An Appalachian species.

Habitat Types:

Marshes and Sedge Meadows

Aquatic: Fluvial

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Common Name: **Mayflies/Stoneflies/Caddisflies Group**
Scientific Name: **Mayflies/Stoneflies/Caddisflies Group**
Species Group: **Invert**

Habitat Fragmentation

Description of habitat threat(s):

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Several of these species are known globally from very few sites, which are often widely separated. Recolonization may not be possible if individual populations are lost.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Need to determine details of habitat requirements in order to refine distributional searches.
Research	Distribution and Abundance	High	1) Conduct inventories to detect and gather information on SGCN stoneflies, mayflies, and caddisflies. 2) Need statewide surveys to provide basic understanding of distribution for all species.
Research	Threats and Their Significance	Medium	Assess threat of high elevation and headwater stream acidification to mayflies, caddisflies, and stoneflies that occupy these waters.
Monitoring	Population Change	Medium	1) Monitor known SGCN stonefly/mayfly/caddisfly populations. 2) Populations should be monitored for presence/absence now; monitor for population changes after baseline abundance data is available.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Protect and restore habitats on which SGCN stoneflies, mayflies, and caddisflies are dependent through pollution abatement, riparian buffers, flow regulation, easements, etc.	Number of acres of riparian habitat protected and/or restored	FWD, USFS, Trout Unlimited, Watershed groups, Landowners, NRCS	SWG, EQIP, LCLT, VLT

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Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority
Global Rank:
Global Trend:
State Rank:
State Trend: Unknown
Extirpated in VT? No
Regional SGCN? Yes

Assessment Narrative:

Individual species in this group are rare in Vermont; several are regionally or globally rare.

This group consists of 15 species, the habitat requirements of which vary within the general wetland category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species require various nearby terrestrial habitats as well.
--Subarctic Bluet (Coenagrion interrogatum): Bogs, boggy-edged ponds
--Comet Darner (Anax longipes): On northern edge of range in Vermont; one larval record. Vernal pools and semi-permanent ponds (no fish)
--Mottled Darner (Aeshna clepsydra): Boggy/marshy edges of lakes
--Zigzag Darner (Aeshna sitchensis): Boggy ponds, small bog pools, fen puddles
--Subarctic Darner (Aeshna subarctica): Bogs with saturated sphagnum
--Spatterdock Darner (Rhionaeschna mutata): Southern species, could advance north with climate change; vegetated ponds
--Swamp Darner (Epiaeschna heros): Hardwood swamps
--Cyrano Darner (Nasiaeschna pentacantha): Vegetated ponds
--Petite Emerald (Dorocordulia lepida): Boggy ponds and lakes, marshes, cedar swamp streams
--Ski-tailed Emerald (Somatochlora elongata): Marshy ponds, peatlands
--Forcipate Emerald (Somatochlora forcipata): Boggy rills, bogs, and small forested streams
--Delicate Emerald (Somatochlora franklini): Bogs, boggy-edged ponds
--Kennedy's Emerald (Somatochlora kennedyi): Boggy streams; bogs, fens, and swamps often with flowing water.
--Ebony Boghaunter (Williamsonia fletcheri): Bogs, fens
--Black Meadowhawk (Sympetrum danae): Marshy ponds, bogs, fens

Distribution

Distributions by biophysical region for bog/fen/swamp/marshy pond odonates are as follows:

--Subarctic Bluet (Coenagrion interrogatum): Northern Highlands, Southern Green Mountains
--Comet Darner (Anax longipes): Southern Vermont Piedmont
--Mottled Darner (Aeshna clepsydra): Champlain Valley, Taconic Mountains, Southern Green Mountains, Southern Vermont Piedmont
--Zigzag Darner (Aeshna sitchensis): Northern Highlands
--Subarctic Darner (Aeshna subarctica): Northern Highlands, Northern Green Mountains
--Spatterdock Darner (Rhionaeschna mutata): Champlain Valley, Northern Green Mountains, Southern Vermont Piedmont
--Swamp Darner (Epiaeschna heros): Champlain Valley, Northern Green Mountains, Taconic Mountains, Southern Green Mountains
--Cyrano Darner (Nasiaeschna pentacantha): Southern Vermont Piedmont
--Petite Emerald (Dorocordulia lepida): Northern Highlands, Northern Vermont Piedmont, Southern Vermont Piedmont, Vermont Valley
--Ski-tailed Emerald (Somatochlora elongata): Northern Highlands, Northern Vermont Piedmont, Northern

Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

Green Mountains, Taconic Mountains, Southern Green Mountains, Southern Vermont Piedmont
--Forcipate Emerald (Somatochlora forcipata): Northern Highlands, Northern Vermont Piedmont, Vermont Valley, Southern Green Mountains
--Delicate Emerald (Somatochlora franklini): Northern Highlands, Northern Vermont Piedmont
--Kennedy's Emerald (Somatochlora kennedyi): Northern Highlands
--Ebony Boghaunter (Williamsonia fletcheri): Northern Highlands, Northern Vermont Piedmont, Vermont Valley
--Black Meadowhawk (Sympetrum danae): Northern Highlands, Northern Vermont Piedmont, Champlain Valley

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

This group consists of 15 species, the habitat requirements of which vary within the general wetland category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species require various nearby terrestrial habitats as well. Some dragonflies are known to exhibit "hilltopping" behavior, in which they congregate on tops of hills, which may be fairly distant from egg-laying sites. This would increase the home range requirements for such species.

--Subarctic Bluet (Coenagrion interrogatum): Bogs, boggy-edged ponds
--Comet Darner (Anax longipes): Vernal pools and semi-permanent ponds (no fish)
--Mottled Darner (Aeshna clepsydra): Boggy/marshy edges of lakes
--Zigzag Darner (Aeshna sitchensis): Boggy ponds, small bog pools, fen puddles
--Subarctic Darner (Aeshna subarctica): Bogs with saturated sphagnum
--Spatterdock Darner (Rhionaeschna mutata): Vegetated ponds
--Swamp Darner (Epiaeschna heros): Hardwood swamps
--Cyrano Darner (Nasiaeschna pentacantha): Vegetated ponds
--Petite Emerald (Dorocordulia lepida): Boggy ponds and lakes, marshes, cedar swamp streams
--Ski-tailed Emerald (Somatochlora elongata): Marshy ponds, peatlands
--Forcipate Emerald (Somatochlora forcipata): Boggy rills, bogs, and small forested streams
--Delicate Emerald (Somatochlora franklini): Bogs, boggy-edged ponds
--Kennedy's Emerald (Somatochlora kennedyi): Boggy streams; bogs, fens, and swamps often with flowing water.
--Ebony Boghaunter (Williamsonia fletcheri): Bogs, fens
--Black Meadowhawk (Sympetrum danae): Marshy ponds, bogs, fens

Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

Habitat Types:

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Shrub Swamps

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): Many of these wetlands are small, fragile, and could be easily degraded by disturbances within their watershed or groundwater source (e.g., development, clearcutting, hydrologic alterations). There is little specific information available citing negative impacts on these odonates. Several or all of these species utilize a combination of wetland and upland habitat to complete there life cycle; fragmentation of this complex could potential have a negative effect on these odonates. Climate change may affect bog communities and the odonates that reside in them. Exotic plants such as Phragmites and purple loosestrife can dominate the floral community and make odonate habitat less suitable.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Non-point source nutrients can alter water chemistry, nutrient availability, and benthic habitat.

Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Define particular habitat requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Distribution and Abundance	High	1) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Efforts should be focused on particular habitats required by each and, where appropriate, on regions of expected occurrence within the state (e.g., a northern peripheral species might be expected in the northern tier counties). Abundance information should be collected at sites of known occurrence. 2) Conduct inventories to detect and gather information on new SGCN odonate populations.
Research	Threats and Their Significance	Medium	Assess the vulnerability of nymphs of each species to wetland perturbations, such as siltation, temperature and water quality shifts, chemical pollution, and changes in vegetation. Investigate the upland habitat needs of the adults and the effects of such impacts as fragmentation and reduction.
Monitoring	Population Change	High	Population monitoring could be employed to track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.

Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Educate public and improve appreciation of vulnerable odonate habitats	Number of participants at events/workshops	FWD, VCE, town Cons Comms, media outlets	SWG
Technical Assistance, Training, Learning Networks	High	Incorporate odonate SGCN occurrence information into environmental review and technical assistance	Number of sites with odonate SGCN that received conservation benefits to this group.	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Compatible Resource Use	Medium	Manage protected areas (wetlands) for odonate conservation	Number of protected sites with odonate protective strategies in place.	FWD, FPR, USFS, USFWS, DEC, NRCS, VLT, other land trusts, town conservation and planning commission s.	SWG, FPR, USFS
Easements	High	Acquisition/easement of high priority SGCN odonate wetland sites	Number of SGCN odonate sites protected	FWD, FPR, TNC, VLT, other land trusts	VHCB, SWG, EQIP, USFWS

Common Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Scientific Name: **Odonates-Bog/Fen/Swamp/Marshy Pond Group**
Species Group: **Invert**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Odonates-Lakes/Ponds Group**
Scientific Name: **Odonates-Lakes/Ponds Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:
State Rank:
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

This group consists of seven species, the habitat requirements of which vary within the general lakes/ponds category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species depend on various nearby terrestrial habitats as well. Some dragonflies are known to exhibit "hilltopping" behavior, in which they congregate on tops of hills, which may be fairly distant from egg-laying sites. This would increase the home range requirements for such species.

--New England Bluet (Enallagma laterale): Vegetated ponds.

--Slender Bluet (Enallagma traviatum): Lakes and ponds with vegetation

--Lilypad Forktail (Ischnura kellicotti): Ponds with lilypads

--Ringed Emerald (Somatochlora albicincta): Cold ponds

--Lake Emerald (Somatochlora cingulata): Shallow cold lakes, sluggish rivers and streams

--Banded Pennant (Celithemis fasciata): Newly discovered in Vermont. A southern species that may continue to move northward. Vegetated ponds and lakes

--Carolina Saddlebags (Tramea carolina): Newly discovered in Vermont. A southern species that may continue to move northward. Vegetated ponds and lakes.

Distribution

Distribution records by biophysical region for lakes/ponds odonates:

--New England Bluet (Enallagma laterale): Southern Vermont Piedmont

--Slender Bluet (Enallagma traviatum): Champlain Valley, Taconic Mountains, Southern Vermont Piedmont

--Lilypad Fork tail (Ischnura kellicotti): Taconic Mountains, Southern Vermont Piedmont

--Ringed Emerald (Somatochlora albicincta): Northern Highlands, Northern Green Mountains

--Lake Emerald (Somatochlora cingulata): Northern Highlands, Northern Vermont Piedmont, Southern Green Mountains

--Banded Pennant (Celithemis fasciata): Southern Green Mountains

--Carolina Saddlebags (Tramea carolina): Vermont Valley, Southern Vermont Piedmont

Common Name: **Odonates-Lakes/Ponds Group**
Scientific Name: **Odonates-Lakes/Ponds Group**
Species Group: **Invert**

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Probable	Vermont Valley	Confident
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

This group consists of seven species, the habitat requirements of which vary within the general lakes/ponds category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species require various nearby terrestrial habitats as well. Some dragonflies are known to exhibit "hilltopping" behavior, in which they congregate on tops of hills, which may be fairly distant from egg-laying sites. This would increase the home range requirements for such species.

--New England Bluet (Enallagma laterale) Vegetated ponds

--Slender Bluet (Enallagma traviatum) Lakes and ponds with vegetation

--Lilypad Forktail (Ischnura kellicotti) Ponds with lily pads

--Ringed Emerald (Somatochlora albicincta) Cold ponds and lakes

--Lake Emerald (Somatochlora cingulata) Shallow cold lakes, sluggish rivers and streams

--Banded Pennant (Celithemis fasciata) Vegetated lakes and ponds

--Carolina Saddlebags (Tramea carolina) Vegetated lakes and ponds

Habitat Types:

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Common Name: **Odonates-Lakes/Ponds Group**
Scientific Name: **Odonates-Lakes/Ponds Group**
Species Group: **Invert**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Incompatible Recreation

Description of habitat threat(s): Shoreline development and fill can degrade and eliminate suitable aquatic habitat. Exotic invasive aquatic plants such as Eurasian milfoil may change the habitat available to lake and pond odonates.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Wakes caused by boating can wash over and kill emerging adults.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Define particular habitat requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Distribution and Abundance	Medium	1) Conduct inventories to detect and gather information on new SGCN odonate populations. 2) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Efforts should be focused on particular habitats required by each and, where appropriate, on regions of expected occurrence within the state (e.g., a northern peripheral species might be expected in the northern tier counties). Abundance information should be collected at sites of known occurrence.
Research	Threats and Their Significance	Medium	Assess the vulnerability of nymphs of each species to habitat perturbations, such as substrate alteration, temperature and water quality shifts, chemical pollution, and changes in vegetation. Investigate the upland habitat needs of the adults and the effects of such impacts as fragmentation and reduction.
Monitoring	Population Change	High	Monitor known SGCN odonate populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts. Particularly important monitoring sites would include Lily Pond (Windham Co.) and those sites with isolated populations or scattered distributions.
Monitoring	Range Shifts	Medium	Monitor particular northern peripheral species (northern Vermont) to detect shifts in range over time.

Common Name: **Odonates-Lakes/Ponds Group**
Scientific Name: **Odonates-Lakes/Ponds Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Workshops	High	Incorporate odonate SGCN occurrence information into environmental review and technical assistance	Number of sites with odonate SGCN that received conservation benefits to this group	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Compatible Resource Use	High	Develop stewardship program for sites with high priority odonate SGCN	Number of stewardship sites established	FWD, Federation of VT Lakes & Ponds, VCE, DEC, CLF, town Cons Comms	SWG, conservation license plate funds, corporate funding
Awareness Raising and Communications	High	Educate public and improve appreciation of vulnerable odonate habitats	Number of participants at events/workshops	FWD, VCE, Federation of VT Lakes & Ponds, town Cons Comms, media outlets	SWG
Awareness Raising and Communications	High	Raise awareness of Vermont Shoreland Protection Act with landowners	Number of lakeshore landowners contacted	DEC, FWD, ANR, Federation of VT Lakes and Ponds, media outlets	DEC, ANR
Compliance & Enforcement	High	Enforcement of the new (2014) Vermont Shoreland Protection Act	Number of permit requests annually	DEC, ANR	DEC, ANR
Easements	High	Acquisition/easement of high priority SGCN odonate lake and pond sites	Number of SGCN odonate sites protected	FWD, VLT, other land trusts	VHCB, SWG, EQIP, USFWS

Common Name: **Odonates-Lakes/Ponds Group**
Scientific Name: **Odonates-Lakes/Ponds Group**
Species Group: **Invert**

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Common Name: **Odonates-River/Stream Group**
Scientific Name: **Odonates-River/Stream Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Unknown

Extirpated in VT? No

Regional SGCN? Yes

Assessment Narrative:

This group consists of 17 species, the habitat requirements of which vary within the general rivers/streams category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species depend on various nearby terrestrial habitats as well. Riparian vegetation is important to adults as habitat.

--American Rubyspot (Hetaerina americana): Streams and rivers with emergent vegetation
--Blue-fronted Dancer (Argia apicalis): Small to large rivers with sand or mud; occasionally ponds and lakes
--River Bluet (Enallagma anna): First Vermont record in 2014; rivers
--Rainbow Bluet (Enallagma antennatum): Slow streams and big rivers
--Big Bluet (Enallagma durum): Discovered in 2005 in southern Vermont; two known sites; slow rivers
--Spine-crowned Clubtail (Gomphus abbreviatus): Rivers
--Midland Clubtail (Gomphus fraternus): Large rivers
--Rapids Clubtail (Gomphus quadricolor): Large streams and rivers
--Skillet Clubtail (Gomphus ventricosus): Large rivers; mud or sand bottom
--Cobra Clubtail (Gomphus vastus): Large rivers with mud bottom; sometimes large streams and lakes
--Brook Snaketail (Ophiogomphus aspersus): Sandy streams
--Riffle Snaketail (Ophiogomphus carolus): Rapid, rocky or sandy streams and rivers
--Maine Snaketail (Ophiogomphus mainensis): Clear, rocky forested streams
--Rusty Snaketail (Ophiogomphus rupinsulensis): Large streams and rivers
--Riverine Clubtail (Stylurus amnicola): Big rivers
--Zebra Clubtail (Stylurus scudderi): Rivers
--Stygian Shadowdragon (Neurocordulia yamaskanensis): Large rivers and lakes; often rocky

Distribution

Biophysical region records for river/stream odonates:

--American Rubyspot (Hetaerina americana): Champlain Valley, Southern Vermont Piedmont
--Blue-fronted Dancer (Argia apicalis): Champlain Valley, Taconic Mountains, Southern Vermont Piedmont
--River Bluet (Enallagma anna): Southern Vermont Piedmont
--Rainbow Bluet (Enallagma antennatum): Champlain Valley, Northern Green Mountains, Taconic Mountains, Southern Vermont Piedmont.
--Big Bluet (Enallagma durum): Champlain Valley, Taconic Mountains
--Spine-crowned Clubtail (Gomphus abbreviatus): Champlain Valley, Taconic Mountains, Southern Vermont Piedmont
--Midland Clubtail (Gomphus fraternus): Champlain Valley
--Rapids Clubtail (Gomphus quadricolor): Champlain Valley, Champlain Hills, Taconic Mountains, Southern Green Mountains, Southern Vermont Piedmont.
--Skillet Clubtail (Gomphus ventricosus): Southern Vermont Piedmont
--Cobra Clubtail (Gomphus vastus): Southern Vermont Piedmont
--Brook Snaketail (Ophiogomphus aspersus): Northern Highlands, Northern Vermont Piedmont, Northern

Common Name: **Odonates-River/Stream Group**
Scientific Name: **Odonates-River/Stream Group**
Species Group: **Invert**

Green Mountains, Champlain Valley, Taconic Mountains, Southern Vermont Piedmont.
--Riffle Snaketail (Ophiogomphus carolus): Northern Highlands, Northern Green Mountains, Champlain Valley, Taconic Mountains, Southern Green Mountains, Southern Vermont Piedmont.
--Maine Snaketail (Ophiogomphus mainensis): Northern Highlands, Northern Vermont Piedmont, Northern Green Mountains, Southern Green Mountains, Southern Vermont Piedmont.
--Rusty Snaketail (Ophiogomphus rupinsulensis): Northern Green Mountains, Taconic Mountains, Southern Vermont Piedmont
--Riverine Clubtail (Stylurus amnicola): Southern Vermont Piedmont
--Zebra Clubtail (Stylurus scudderi): Northern Highlands, Northern Vermont Piedmont, Northern Green Mountains, Champlain Valley, Taconic Mountains, Vermont Valley, Southern Vermont Piedmont.
--Stygian Shadowdragon (Neurocordulia yamaskanensis): Northern Vermont Piedmont, Champlain Valley, Taconic Mountains, Southern Green Mountains, Southern Vermont Piedmont.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

This group consists of several species, the habitat requirements of which vary within the general rivers/streams category. Habitats given for each species refer primarily to reproduction and nymphal requirements; adults of many species depend on various nearby terrestrial habitats as well. Riparian vegetation is important to adults as habitat.

--American Rubyspot (Hetaerina americana): Streams and rivers with emergent vegetation

--Blue-fronted Dancer (Argia apicalis): Small to large rivers with sand or mud; occasionally ponds and lakes

--River Bluet (Enallagma anna): Rivers

--Rainbow Bluet (Enallagma antennatum): Slow streams and big rivers

--Big Bluet (Enallagma durum): Slow rivers

--Spine-crowned Clubtail (Gomphus abbreviatus): Rivers

--Midland Clubtail (Gomphus fraternus): Big rivers

--Rapids Clubtail (Gomphus quadricolor): Large streams and rivers

Common Name: **Odonates-River/Stream Group**
Scientific Name: **Odonates-River/Stream Group**
Species Group: **Invert**

--Skillet Clubtail (Gomphus ventricosus): Large rivers; mud or sand bottom

--Cobra Clubtail (Gomphus vastus): Large rivers with mud bottom; sometimes large streams and lakes

--Brook Snaketail (Ophiogomphus aspersus): Sandy streams

--Riffle Snaketail (Ophiogomphus carolus): Rapid, rocky or sandy streams and rivers

--Maine Snaketail (Ophiogomphus mainensis): Clear, rocky forested streams

--Rusty Snaketail (Ophiogomphus rupinsulensis): Large streams and rivers

--Riverine Clubtail (Stylurus amnicola): Big rivers

--Zebra Clubtail (Stylurus scudderi): Rivers

--Stygian Shadowdragon (Neurocordulia yamaskanensis): Large rivers and lakes; often rocky.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Energy Infrastructure and Development

Habitat Alteration

Sedimentation

Incompatible Recreation

Description of habitat threat(s): Bank armoring (riprap) and other disturbance that alters the river bed can kill individuals and permanently reduce habitat suitability. New dam construction alters habitat from riverine to impoundment. Dam operation alters water velocity, water level, and other hydrologic factors.

Non-Habitat Threats:

Pollution

Description of non-habitat threat(s): Wakes caused by boating can wash over and kill emerging adults.

Common Name: **Odonates-River/Stream Group**
Scientific Name: **Odonates-River/Stream Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Define particular habitat requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Distribution and Abundance	High	1) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Efforts should be focused on particular habitats required by each and, where appropriate, on regions of expected occurrence within the state (e.g., a northern peripheral species might be expected in the northern tier counties). Abundance information should be collected at sites of known occurrence. 2) Conduct inventories to detect and gather information on new SGCN odonate populations.
Research	Threats and Their Significance	Medium	Assess the vulnerability of nymphs of each species to habitat perturbations, such as siltation, temperature and water quality shifts, chemical pollution, hydropower development and operation, and changes in vegetation. Investigate the upland habitat needs of the adults and the effects of such impacts as fragmentation and reduction.
Research	Other Research	Medium	Conduct cage study of Hetaerina americana during lampricide treatment of Lewis Creek to provide information on vulnerability of the species to these chemicals.
Monitoring	Population Change	High	Monitor known SGCN odonate populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Workshops	High	Incorporate odonate SGCN occurrence information into environmental review and technical assistance	Number of sites with odonate SGCN that received conservation benefits to this group	FWD, USFWS, DEC, ANR, VTrans, NRCS	SWG
Awareness Raising and Communications	High	Educate public and improve appreciation of vulnerable odonate habitats	Number of participants at events/workshops	FWD, VCE, watershed groups, VT River Conservancy, TU, town Cons Comms, media outlets	SWG
Easements	High	Acquisition/easement of high priority SGCN odonate riverine sites	Number of SGCN odonate sites protected	FWD, TNC, VLT, other land trusts, watershed groups	SWG, EQIP, USFWS

Common Name: **Odonates-River/Stream Group**
Scientific Name: **Odonates-River/Stream Group**
Species Group: **Invert**

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Westfall, M.J. and M.L. May. 1996. Damselflies of North America. Scientific Publishers, Gainesville, Florida.

Common Name: **Crustaceans Group**
Scientific Name: **Crustaceans Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:
State Rank:
Extirpated in VT? No

Global Trend:
State Trend: Unknown
Regional SGCN? Yes

Assessment Narrative:

This group includes the following three species:
--An amphipod (Diporeia hoyi): This deep-water species is rarely collected. It has been reported from Lake Champlain and Lake Memphremagog. It may occur in other deep lakes also. This species is cited as being very sensitive to pollution. It is likely to be one of the first species to disappear when a lake is polluted.

--Taconic Cave amphipod (Stygobromus borealis): This state-endangered species is known from only a single cave in Vermont, which is a popular spelunking cave. The status of this population is not known.

--Appalachian Mountain crayfish (Cambarus bartonii): This rare crayfish is only found in small cold water streams and is threatened by development (stormwater sedimentation), acid rain, climate change, and introduction of the rusty crayfish (Orconectes rusticus).

Distribution

--An amphipod (Diporeia hoyi): This species is known in Vermont only from (1) deep water in Lake Champlain from Crown Pt. to Rouses Pt., including Inner Mallets Bay and Missisquoi Bay; and (2) possibly Lake Memphremagog. It may also occur in other large lakes with similar deep water habitat. It was very rare in Lake Champlain 1992-1996 samples.

--Taconic Cave amphipod (Stygobromus borealis): This amphipod is known in Vermont only from Morris Cave in Danby; it may also occur in Dorset (Aeolus) Cave in Dorset, but that record is unclear. Is has also been reported from MA and NY. It appears to be limited to subterranean drainage systems of karst terrain in the Taconic Mountains. Three single locations comprise the entire global distribution known for this species.

--Appalachian Mountain crayfish (Cambarus bartonii): This crayfish is known from the West River, Hudson drainage (Battenkill), and the Champlain Basin. It occurs both in the mountains and in small, valley streams.

Distribution by Biophysical Region:

Champlain Valley
Champlain Hills
Northern Green Mtns
Northern VT Piedmont
Northeastern Highlands
Southern VT Piedmont
Vermont Valley
Southern Green Mtns
Taconic Mtns

Distribution by Watershed:

Known Watersheds	Probable Watersheds
West	St. Francois River
Hudson-Hoosic	

Common Name: **Crustaceans Group**
Scientific Name: **Crustaceans Group**
Species Group: **Invert**

Lake Champlain

Lamoille River

Missisquoi River

Otter Creek

Winooski River

Metawee River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

--An amphipod (Diporeia hoyi) This is a deep-water species of large lakes, where is undergoes vertical migrations. It has been collected as deep as 900 feet in Lake Superior. It requires cold, deep water with a good oxygen supply. It is likely to be one of the first species to disappear when a lake is polluted.

--Taconic Cave amphipod (Stygobromus borealis) In Vermont, this amphipod is found in a cave of marble bedrock with a deep (probably > 9 meters) pool of water with a silt and/or sand bottom. In MA, it was reported from a springhouse.

--Appalachian Mountain crayfish (Cambarus bartonii) This rare crayfish is only found in small cold water streams. It occurs both in the mountains and in small, valley streams.

Habitat Types:

Subterranean

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): D. hoyi is limited by shifts in food web dynamics caused by zebra mussels. The invasive quagga mussel is displacing D. hoyi in the Great Lakes and could cause similar effects if it reaches Lake Champlain. Spiny waterflea now poses a new threat in Lake Champlain. Long-term deposition of silt is likely altering the benthic habitat this amphipod uses.

--S. borealis, due to the nature of its habitat, is vulnerable to hydrologic alterations that may originate away from the occupied site.

--Cambarus bartonii is limited by development (stormwater sedimentation), acid rain, climate change, and introduction of the rusty crayfish (Orconectes rusticus).

Non-Habitat Threats:

Pollution

Reproductive Traits

Trampling or Direct Impacts

Description of non-habitat threat(s): D. hoyi is pollution sensitive, needing clean, cold, well-oxygenated water.

--S. borealis, due to the nature of its habitat, is vulnerable to such problems as pollution and nutrient shift. It is also vulnerable to direct loss of individuals, due to the small size and isolated nature of the population. The reproductive capability of this species is likely much more limited than that of surface-water inhabiting amphipods due to limited food supply. This makes rebounding from population losses or poor reproductive years difficult. The threat posed by cave recreation is uncertain.

--C. bartonii lives in streams which can be greatly affected by acid rain.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	The habitat requirements for S. borealis needs to be studied and refined.
Research	Basic Life History	Medium	The life history of S. borealis is virtually unknown. Study is needed.
Research	Distribution and Abundance	High	The distribution and abundance of all three species has not been sufficiently investigated. Further survey work is needed to accurately determine the extent and status of these species in Vermont.
Research	Threats and Their Significance	High	The potential impacts of recreational and other human uses of caves supporting S. borealis need to be assessed. The potential for negative impacts due to manipulation or contamination of groundwater feeding these cave streams needs to be determined. The affects of fine sediments on the benthic habitat of D. hoyi should be studied. The effects on food web dynamics caused by zebra mussels and spiny waterflea need to be studied with regard to D. hoyi.
Monitoring	Population Change	High	1) Known S. borealis population should be monitored; methods that do not impact individual amphipods will be required. 2) Monitor known SGCN crustacean populations.
Monitoring	Habitat Change	Medium	Water quality and volume in known S. borealis cave stream should be monitored.

Common Name: **Crustaceans Group**
Scientific Name: **Crustaceans Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration	High	Protect and restore habitats on which SGCN crustaceans are dependent through pollution abatement, riparian buffers, groundwater protection, etc.	Number of acres of land protected for river buffers, groundwater recharge, etc.	Watershed groups, USFWS, DEC, FWD, LCLT, VLT, TNC	SWG, EQIP, LCLT, VLT, NRCS, USFWS
Easements	High	Acquisition/easement of any newly discovered Stygobromus borealis sites	Number of newly discovered sites protected	FWD, USFS, TNC, LCLT, VLT, USFWS	VHCB, SWG, GMNF, EQIP, USFWS

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Conservation Assessment

Final Assessment: High Priority

Global Rank:
Global Trend:
State Rank:
State Trend: Declining
Extirpated in VT? No
Regional SGCN? Yes

Assessment Narrative:

This group includes 13 species. Seven are state-endangered species and three state-threatened species One is also federally endangered. Two of the three remaining species are each known from only a single short stretch of river. Freshwater mussels are recognized as one of the most endangered groups in the state
--Eastern pearlshell (Margaritifera margaritifera): State threatened. Regional SGCN*
--Dwarf wedgemussel (Alasmidonta heterodon): State and federal endangered. Regional SGCN*
--Brook floater (Alasmidonta varicosa): State threatened. Only one population, occupying only one river stretch. Regional SGCN*
--Elktoe (Alasmidonta marginata): Very rare. Occupies a single short river stretch. Regional SGCN*
--Alewife floater (Anodonta implicata): Rare. Occupies a single river stretch. Regional SGCN*
--Cylindrical papershell (Anodontoides ferussacianus): State endangered. Regional SGCN*
--Pocketbook (Lampsilis ovata): State endangered. Regional SGCN*
--Fluted-shell (Lasmigona costata): State endangered.
--Creek heelsplitter (Lasmigona compressa): Rare. Regional SGCN*
--Fragile papershell (Leptodea fragilis): State endangered. Regional SGCN*
--Black sandshell (Ligumia recta): State endangered. Probably most endangered Vermont mussel. Regional SGCN*
--Pink heelsplitter (Potamilus alatus): State endangered
--Giant floater (Pyganodon grandis): State threatened

*Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states

Distribution

Eastern pearlshell (Margaritifera margaritifera): Reported from the upper Winooski River and Lewis Creek systems of the Champlain basin, and the Passumpsic River, West River, and Nulhegan River systems of the Connecticut River basin.

--Dwarf wedgemussel (Alasmidonta heterodon): Connecticut River mainstem, and slightly upstream into some large tributaries. Historically found from Bloomfield to Brattleboro. More recently known from Hartland to Springfield, and from Guildhall to Lunenburg.

--Brook floater (Alasmidonta varicosa): Known only from West River (Connecticut River tributary). One historic report from the Connecticut River mainstem.

--Elktoe (Alasmidonta marginata): Known only from a short stretch (~ 5 miles) of the Lamoille River.

--Alewife floater (Anodonta implicata): Occurs in Connecticut River downstream of Bellows Falls.

--Cylindrical papershell (Anodontoides ferussacianus): Known from Missisquoi, Lamoille, and Poultney river systems, and also Stone Bridge Brook (Milton). May occur in other Lake Champlain rivers and the main lake itself. One historic report from the Clyde River.

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--Pocketbook (Lampsilis ovata): Champlain basin species: reported from Lake Champlain, Missisquoi River, Lamoille River, Winooski River, LaPlatte River, Lewis Creek, Otter Creek, and Poultney River. Only found below principal fall line.

--Fluted-shell (Lasmigona costata): Champlain basin species: reported from Lamoille River, Winooski River, Otter Creek, Lewis Creek, and Poultney River. Historically in the Missisquoi River (shells collected), but no live specimens have been observed. Observed above the principal fall line only in Otter and Lewis creeks.

--Creek heelsplitter (Lasmigona compressa): Reported from several small to large tributaries to Lake Champlain. Primarily a headwater to medium-sized creek species, but does occur in larger habitats (e.g., below fall line in Winooski River). One record is from outside the Champlain basin, the Coaticook River.

--Fragile papershell (Leptodea fragilis): Lake Champlain basin only; reported from Lake Champlain, Missisquoi River, Lamoille River, Winooski River,Poultney River, and Otter Creek system. Only found below principal fall line.

--Black sandshell (Ligumia recta): Champlain basin species; reported from Missisquoi River, Otter Creek, Poultney River, and Hospital Creek, and shallow areas in Lake Champlain near the mouths of these rivers. Appears extirpated from Hospital Creek; most recent survey did not find it in Otter Creek. Only found below principal fall line.

--Pink heelsplitter (Potamilus alatus): Champlain basin species; reported from Lake Champlain, Missisquoi River, Lamoille River, Winooski River, Otter Creek, Lewis Creek, Hospital Creek, and Poultney River. Only found below principal fall line.

--Giant floater (Pyganodon grandis): Champlain basin species; reported in Lake Champlain, Missisquoi River, Lamoille River, Winooski River, East Creek, Poultney River, and Otter Creek system. Reported from above the principal fall line only in Otter Creek and Lamoille River. A high elevation pond population in Chittenden Co. is believed to be the result of an unintentional stocking.

Distribution by Biophysical Region:

Champlain Valley
Champlain Hills
Northern Green Mtns
Northern VT Piedmont
Northeastern Highlands
Southern VT Piedmont
Vermont Valley
Southern Green Mtns
Taconic Mtns

Distribution by Watershed:

Known Watersheds

Metawee River
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Lake Champlain
Lamoille River

Probable Watersheds

St. Francois River
Middle Connecticut
West

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Missisquoi River
Otter Creek
Passumpsic
Upper Connecticut
Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

--Eastern pearlshell (Margaritifera margaritifera) This is a coldwater species, found in streams that support trout populations. It inhabits firm sand substrates, often amidst gravel and cobbles, and occasionally tightly packed cobbles and gravel. Salmonids are the fish hosts.

--Dwarf wedgemussel (Alasmidonta heterodon) A large river species, this mussel is found in stable mud, silty sand, sand, or gravel where the current is sufficient to keep the substrate free of surficial silt. Fish hosts may include the tessellated darter and slimy sculpin.

--Elktoe (Alasmidonta marginata) This is a mussel of medium-sized rivers, where it occupies riffles or rapids on stable gravel or rocky bottoms. It burrows securely into the sand-filled spaces between stones.

--Brook floater (Alasmidonta varicosa) This mussel occupies small rivers, where it is found in broad and shallow pools, runs, and glides, in sand and gravel substrates, often among or near cobble and boulder. Mussel beds usually support some submerged aquatic plants.

--Pocketbook (Lampsilis ovata) This relatively mobile mussel is found primarily in stretches of larger rivers from Lake Champlain to the first major waterfall. It also can be found in shallow areas of the main lake near deltas of these rivers. Mussels occupy firmly packed sand, sand and gravel, or silty sand.

--Fluted-shell (Lasmigona costata) This mussel is found primarily in medium-sized creeks to larger rivers from Lake Champlain to the first major waterfall, but also occurs above this fall line in some streams. It inhabits a variety of substrates, including mud, sand, gravel, and aggregates of cobble, gravel, and sand.

--Creek heelsplitter (Lasmigona compressa) This is a mussel of small creeks to small rivers, but occurs in small numbers in large river sections above Lake Champlain as well. It if found in gravel, sand, or mud.

--Pink heelsplitter (Potamilus alatus) This mussel occurs in large rivers only between Lake Champlain and the first major waterfall. It also occupies areas of Lake Champlain near the deltas of these rivers. It is found in clay, clayey silt, sand, gravel and sand, or mixtures of cobble, sand, and silt. Pink heelsplitters usually bury themselves nearly completely into the substrate, their shape anchoring them securely in place.

--Fragile papershell (Leptodea fragilis) This mussel occurs in large rivers only between Lake Champlain and the first major waterfall. It also occupies areas of Lake Champlain near the deltas of these rivers. It is found in sand, clayey silt, silty sand, or gravel and sand. Fragile papershells usually bury themselves nearly completely into the substrate, their shape anchoring them securely in place.

--Black sandshell (Ligumia recta) This mussel occurs only in large rivers between Lake Champlain and the first major waterfall. Substrates include sand, sand and gravel, and mud.

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--Giant floater (Pyganodon grandis) A relatively mobile species of large rivers and lakes, it is found in sand, sand and gravel, silty sand, and clay.

--Cylindrical papershell (Anodontoides ferussacianus) This mussel is found in creeks and rivers, but likely occupies shallow lake habitat as well (Lake Champlain). Substrates include silt and silty sand in slow currents. It is known from both above and below the first waterfall upstream of Lake Champlain.

--Alewife floater (Anodonta implicata) This is a riverine mussel in Vermont found in slow to fast waters. It occurs in a variety of substrates, including sand, sand and gravel, and silt.

POTENTIAL FISH HOSTS REPORTED*:

--Eastern pearlshell: Rainbow trout, Atlantic salmon, brook trout, brown trout

--Dwarf wedgemussel: tessellated darter, slimy sculpin, banded killifish, Atlantic salmon

--Elktoe: white sucker, shorthead redhorse, rock bass

--Brook floater: slimy sculpin, longnose dace, blacknose dace, golden shiner, pumpkinseed, yellow perch, tessellated darter

--Pocketbook: smallmouth bass, white crappie, largemouth bass, bluegill, sauger, yellow perch

--Fluted-shell: common carp, spotfin shiner, longnose dace, creek chub, slimy sculpin, black crappie, yellow perch, bowfin, northern pike, bluegill, pumpkinseed, largemouth bass, walleye

--Creek heelsplitter: slimy sculpin, black crappie, spotfin shiner, yellow perch, yellow bullhead, brook stickleback, brassy minnow, bluegill, smallmouth bass, emerald shiner, mimic shiner, longnose dace, creek chub, bluntnose minnow

--Pink heelsplitter: freshwater drum

--Fragile papershell: freshwater drum

--Black sandshell: sauger, banded killifish, rosyface shiner, bluegill, redbreast sunfish, pumpkinseed, rock bass, American eel, common carp, white perch, white crappie, black crappie, largemouth bass, yellow perch, walleye

--Giant floater: banded killifish, blackchin shiner, blacknose shiner, black crappie, blacknose dace, bluegill, bluntnose minnow, brook silverside, common carp, brook stickleback, common shiner, creek chub, freshwater drum, gizzard shad, golden shiner, largemouth bass, longnose gar, pearl dace, pumpkinseed, rock bass, white crappie, white sucker, yellow bullhead, yellow perch

--Cylindrical papershell: spotfin shiner, black crappie; possibly sea lamprey, mottled sculpin, brook stickleback, white sucker, common shiner, blacknose shiner, bluntnose minnow, fathead minnow, bluegill, largemouth bass

--Alewife floater: American shad, alewife, blueback herring, white sucker, pumpkinseed, white perch
*Primarily from lab studies; this list does not indicate that fish hosts have been demonstrated in natural

environment.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Sedimentation

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): --Zebra mussels are decimating Lake Champlain mussel populations, and are found in the lower portions of some of the lake's tributaries.
--Asiatic clams now occur in Lake George, which is upstream of Lake Champlain; these pose a future threat to Vermont's mussels.
--Bridge construction and road-related river bank stabilization have been common direct impacts Streambank erosion and stormwater runoff can cover mussel habitat in intolerable levels of sediment.
--Dams have been responsible for large losses of habitat, particularly with the Connecticut River. Dams have converted river habitat to reservoirs, altered and degraded downstream habitats, and created barriers to movement. Hydropower dams create unnatural frequency of water level and velocity changes.

Non-Habitat Threats:

Genetics

Pollution

Harvest or Collection

Reproductive Traits

Trampling or Direct Impacts

Predation or Herbivory

Description of non-habitat threat(s): --Loss of specific fish hosts can result in reduced/eliminated reproductive success.
--Low local mussel abundance can reduce success rate of external fertilization.
--Muskrats are mussel predators and can decimate local populations when their numbers are too high or when a mussel species is particularly vulnerable.
--Low mussel densities can have genetic consequences.
--Mussels have been shown to be sensitive to a variety of pesticides and other anthropogenic chemicals.
--Wastewater effluents, stormwater runoff, and agricultural runoff can carry these pollutants into rivers

where mussels reside.
--Use of mussels as bait by anglers has been problematic in some other states. This has not been investigated in Vermont.
--Damage to/death of mussels due to trampling by stream users may occur regularly, but has not been investigated. Thin-shelled species are often found dead due to breakage.
--Fisheries sampling also has the potential of affecting young and adult mussels, where equipment is in contact with the substrate.

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Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Define particular habitat requirements of each species within Vermont, utilizing field investigations and knowledge of researchers.
Research	Basic Life History	High	Determine host fish requirements for each mussel species. This needs to be specific to Vermont populations.
Research	Distribution and Abundance	High	1) Obtain baseline information on distribution and abundance of each mussel species. This should include all existing information sources. 2) Conduct inventories of rivers and appropriate lake habitat to detect and gather information on SGCN mussel populations.
Research	Threats and Their Significance	High	1) Assess limiting factors and their potential impacts to the aquatic habitats of each mussel species. Assessment should be on a watershed scale, including upland sources of potential limiting factors. 2) Research is needed on how to protect native mussel populations that are being impacted by zebra mussels, and also those populations that are vulnerable to further zebra mussel colonization. 3) Determine how dams affect mussel populations, their habitats, and life history requirements. 4) Investigate impacts of Missouri trawl (fisheries sampling) operation on young-of-year and older juvenile SGCN mussels.
Research	Population Genetics	High	1) Certain species (e.g., black sandshell, elktoe, brook floater) are highly isolated from nearest populations. Genetic comparisons with other populations will be needed before reintroduction options can be evaluated. 2) Determine genetic constraints that may be hampering the recovery of isolated SGCN mussel populations (particularly black sandshell and elktoe).
Research	Taxonomy	Medium	There is uncertainty about the species assignment of Lampsilis ovata. Vermont populations may be L. cardium, or more than one species could be here. This needs to be determined.
Research	Other Research	High	Investigate the potential benefits and risks of dam removal to SGCN mussel populations.
Monitoring	Population Change	High	Monitor known SGCN mussel populations. Track population trends at distinct locations. This would follow field surveys and assessments to identify appropriate populations for monitoring. Focusing on large populations would offer greater probability of detecting population shifts. Areas of habitat where species have disappeared need to be tracked.
Monitoring	Habitat Change	High	Changes to habitat due to specific threats (e.g., hydrodams) need to be monitored.
Monitoring	Monitor Threats	High	Zebra mussel detection and monitoring is needed in watersheds that support SGCN mussels. Occupied rivers and boating lakes that occur upstream need to be monitored. The effects of dams on downstream habitat needs to be monitored, including de-watering, temperature regime, and silt releases.

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Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Investigate possibility of developing a freshwater mussel propagation facility for population reintroduction and enhancement. Such a facility could provide research opportunities as well.	Completion of design and plans for a mussel propagation facility	FWD, USFWS, UVM, other Northeast states	FWD, SWG, Endangered Species Section 6, PR
Habitat Restoration	High	Reduce the use of riprap in aquatic habitat as a method of bank stabilization.	Track change in annual number of stream feet impacted by new riprap projects.	FWD, DEC, ANR, NRCS, FEMA, VTrans, FHWA	PR, DJ, NRCS
Natural Processes Restoration	High	Work with regulators and dam operators/owners to reduce the impacts of dam operations on SGCN mussel populations. FERC re-licensing should require run-of-river flows.	Number of operating dams on SGCN mussel rivers that modify operations to run-of-river flows through FERC re-licensing or other negotiations.	FWD, DEC, ANR, FERC, dam operators/owners, USACOE, towns, VNRC	PR, DJ, DEC, USFWS, Hydro funds
Invasive Species Control & Prevention	High	Prevent the introduction and spread of zebra mussels.	Monitor sites of potential occurrence	LCBP, DEC, Towns, FWD, USFWS	VT Watershed Grants, LCBP, DEC
Species Restoration	High	Remove muskrats and potentially other predators where local mussel populations are vulnerable and are likely to be impacted by predation.	Continued surveillance to determine whether muskrats are impacting critical areas.	FWD, Wildlife Services (USDA), TNC, local trappers, USFWS	FWD, SWG, Endangered Species Section 6, PR
Easements	Medium	Acquire conservation easements for the protection of necessary SGCN mussel habitats and maintenance or restoration of ecological functions.	Number of riparian habitat acres acquired/enrolled	LCLT, VLT, FWD, ANR, TNC, NRCS, USFWS	LCLT, VLT, TNC, SWG, NRCS, PR, DJ
Alliance Development	High	Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN mussel requirements and problems.	Number of mussel-pertinent permit and project notifications that bridge between agencies/organizations annually.	ANR, USFWS, COE, FEMA, FHWA, NRCS, Wildlife Services, VTrans, others	PR, SWG

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Habitat Restoration	High	Protect and restore habitats on which SGCN mussels are dependent through pollution abatement, riparian buffers, flow regulation, etc.	Number of acres of riparian habitat protected and/or restored	LCLT, VLT, Watershed groups, USFWS, DEC, FWD	SWG, LCLT, VLT, NRCS

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Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Conservation Assessment

Final Assessment: High Priority

Global Rank:

Global Trend:

State Rank:

State Trend: Declining

Extirpated in VT?

Regional SGCN?

Assessment Narrative:

A diverse group of 15 snail species whose general status ranges from extirpated to declining to rare. Much work is needed to refine status assessment. This group includes
--Fringed valvata (Valvata lewisi): Recorded from four locations in VT: St Catherine, and associated Little Pond, Lake Salem and Berlin Pond. Possibly occurs elsewhere. Only found in low numbers throughout range.
--Mossy valvata (Valvata sincera): Only found at four locations in VT: three in Lake Champlain, and Flagg pond.
--Squat duskysnail (Lyogyrus granum): Only three locations: Lake St Catherine, Connecticut River, Lake Fairlee. An East Coast species.
--Pupa duskysnail (Lyogyrus pupoideus): Only six collections, all in Lake Champlain, may be susceptible to zebra mussel colonization.
--Canadian duskysnail (Lyogyrus walkeri): Only known from Lake St. Catherine.
--Buffalo pebblesnail (Gillia altilis): 12 locations in: Lake Champlain, Missisquoi River, Connecticut River, Crystal Lake, Indian Brook Reservoir, Hinkum Pond. Atlantic drainage species.
--Boreal marstonia (Marstonia lustrica): Found in Lake Champlain, Laplatte River and Joes Pond. Uncommon in northern part of range; more common southward. Reported as abundant at some Massachusetts sites.
--Liver elimia (Goniobasis livescens): Eleven sites, all in Lake Champlain. May be vulnerable to invasives such as Bithynia tentaculata, zebra mussel.
--Sharp hornsnail (Pleurocera acuta): No recent occurrences from Vermont; may be extirpated. Reported historically from VT, QE, and NY in literature.
--Spindle lymnaea (Acella haldemani): Only known from one lake in VT: Beebee Pond, a lake periodically chemically treated and managed for invasive Eurasian Milfoil. Limited and localized in distribution. Appears to be greatly reduced from historical range. Often only one location is reported for a lake, but it is easily overlooked. Reproduction may be a limiting factor.
--Dusky ancylid (Laevapex fuscus): Reproductive traits may be a limiting factor (low colonization rate).
--Mammoth lymnaea (Bulimnaea megasoma): Reported from Lake Champlain and its tributaries in 19th century literature; no recent records. May be extirpated; only VT historic record, a small stream in Burlington area, has since been filled in.
--Country fossaria (Fossaria rustica): Only found in two streams in Champlain Valley: Little Otter and Lewis creeks. Locations have been resampled since 1997 and not found.
--Star gyro (Gyraulus crista): Limited distribution in VT. Found in seven rivers: White River, Calendar Brook tributary, East Branch Passumpsic River, Ranch Brook, Sunny Brook, East Creek-South Fork, Morehouse Brook. Holarctic (northern): distribution. Rare in NY.
--Thicklip rams-horn (Planorbula armigera): Found at four locations; three of these are in urban or agricultural watersheds with degraded water quality.

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Distribution

--Fringed valvata (Valvata lewisi): Recorded from four locations: St Catherine, and associated Little Pond, Lake Salem and Berlin Pond. Possibly occurs elsewhere.

--Mossy valvata (Valvata sincera): Recorded at four locations: three in Lake Champlain, and Flagg pond.

--Squat duskysnail (Lyogyrus granum): Three locations: Lake St Catherine, Connecticut River, Lake Fairlee.

--Pupa duskysnail (Lyogyrus pupoideus): Only six collections, all in Lake Champlain.

--Canadian duskysnail (Lyogyrus walkeri): Only known from Lake St. Catherine.

--Buffalo pebblesnail (Gillia altilis): 12 locations in: Lake Champlain, Missisquoi River, Connecticut River, Crystal Lake, Indian Brook Reservoir, Hinkum Pond.

--Boreal marstonia (Marstonia lustrica): Found in Lake Champlain, Laplatte River and Joes Pond.

--Liver elimia (Goniobasis livescens): Eleven sites, all in Lake Champlain.

--Sharp hornsnail (Pleurocera acuta): No recent occurrences from Vermont; may be extirpated. Reported historically from VT, QE, and NY in literature.

--Spindle lymnaea (Acella haldemani): Only known from one lake in VT: Beebee Pond.

--Dusky ancylid (Laevapex fuscus): Known from two locations: Colchester Pond and Jones Mill Pond.

--Mammoth lymnaea (Bulimnaea megasoma): Reported from Lake Champlain and its tributaries in 19th century literature; no recent records. May be extirpated; only VT historic record, a small stream in Burlington area, has since been filled in.

--Country fossaria (Fossaria rustica): Only found in two streams in Champlain Valley: Little Otter and Lewis creeks. Locations have been resampled since 1997 and not found.

--Star gyro (Gyraulus crista): Limited distribution in VT. Found in seven rivers: White River, Calendar Brook tributary, East Branch Passumpsic River, Ranch Brook, Sunny Brook, East Creek-South Fork, Morehouse Brook.

--Thicklip rams-horn (Planorbula armigera): Found at four locations: Jewett Brook, Indian Brook, Pleasant Brook, and Leicester Sedge Marsh.

Distribution by Biophysical Region:

Champlain Valley
Champlain Hills
Northern Green Mtns
Northern VT Piedmont
Northeastern Highlands
Southern VT Piedmont
Vermont Valley
Southern Green Mtns
Taconic Mtns

Distribution by Watershed:

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Known Watersheds
Middle Connecticut
Waits
West
Black - Ottauquechee
Upper Connecticut - Mascoma
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut
White
Winooski River
Metawee River

Probable Watersheds
Deerfield
Hudson-Hoosic

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

--Boreal marstonia (Marstonia lustrica) Found in well-buffered lakes and streams.
--Liver elimia (Goniobasis livescens) Grazes in shallow water on stones and gravel in lakes and clear rapid streams. In lakes, it burrows into the sand and feeds on algae and bacteria; this is not as good a food source as it is for other pulmonate snails.
--Sharp hornsnail (Pleurocera acuta) Found in a variety of habitats. In lakes, found on boulders on exposed shores or in mud and sand. In rivers, found on stones in rapid current. Snails remain in shallow water up to 1 m deep, where they burrow under the sand and layers of decaying leaves and other organic matter.
--Spindle lymnaea (Acella haldemani) Found on submerged logs, silt, sand, and mud; up to 2 m deep. Often is attached to leaves and stems of aquatic pondweed and other submerged vegetation. Reported to favor eutrophic lakes and ponds. Young don't travel far from where they hatched, leading to a clumped distribution.
--Mammoth lymnaea (Bulimnaea megasoma) Found in ponds, large and small lakes, and quiet embayment of rivers.
--Country fossaria (Fossaria rustica) Occupies rivers and streams, lakes, ponds, and occasionally ditches and canals. Can be in damp mud flats and bodies of water with fluctuations in water level.
--Star gyro (Gyraulus crista) Found in dense aquatic vegetation, water-logged wood, and rotting terrestrial leaves (in water).
--Fringed valvata (Valvata lewisi) A pool/pond/lake species. Found particularly on sand, but also mud and aquatic vegetation down to 7 m.
--Mossy valvata (Valvata sincera) Generally limited to oligotrophic and mesotrophic situations, but occasionally in eutrophic waters. Associated with submerged aquatic vegetation. In MA, however, it is reported as requiring deep lakes with a pH of 7.6 or greater, where it is often associated with rooted vegetation.
--Squat duskysnail (Lyogyrus granum) Found on organic debris and vegetation in standing waters of larger lakes and ponds, oxbows, and major rivers. Highly tolerant of acidic conditions, but limited tolerance to sodium (e.g., road salt).

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

--Canadian duskysnail (Lyogyrus walkeri) Found in sluggish streams and quiet ponds where dead plants accumulate. Occupies lentic waters, ranging from oligotrophic to marl ponds.
--Buffalo pebblesnail (Gillia altilis) Large lakes and rivers. In Hudson River, it is found on mud and aquatic plants in the shallows.
--Pupa duskysnail (Lyogyrus pupoideus) Occurs in small to large ponds and large rivers. Found on organic debris and aquatic plants. Hybridization with A. grana reported.
--Dusky ancylid (Laevapex fuscus) Most commonly found in still waters, such as impoundments, back waters, and ponds; occasionally in temporary waters. Generally absent from mountainous regions. Absent from low diversity habitats and tends to have low colonization rates, but will compete well.
--Thicklip rams-horn (Planorbula armigera) Most likely to be found in slow streams, wetlands, temporary ponds, and ditches.

Habitat Types:

Seeps and Pools

Wet Shores

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Sedimentation

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Invasion by Exotic Species

Climate Change

Description of habitat threat(s): --Sedimentation and chloride from road and impervious surface runoff.
--Lake/reservoir water level manipulation may be a problem to snails.
--Acidification (acid rain) may be a problem for species sensitive to low pH, low calcium.
--Copper sulfate used for treating waters for algae and swimmers itch is a risk to snails (it is a molluscicide).
--Baylicide, used to reduce sea lamprey populations, is a molluscicide.
--Nuisance aquatic plant management can impact snails by removing snails and habitat (plants) and covering lake bottoms.
--Goniobasis livescens is at risk to invasive Bithynia tentaculata.
--Lake species vulnerable to zebra mussels.

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Non-Habitat Threats:

Competition

Pollution

Reproductive Traits

Description of non-habitat threat(s): --Valvata lewisi - only found in very low densities throughout range; this may limit long-term viability of local populations.
--Valvata sincera - low reproductive rate. Only a few eggs (4-12) produced per individual.
--Lyogyrus granum - low tolerance to sodium (e.g., road salt). This may impact populations anywhere they are found (particularly in rivers).
--Lyogyrus pupoideus - reported to hybridize with Amnicola grana. This could jeopardize both species where they co-occur.
--Goniobasis livescens - Likely being impacted by the exotic Bithnia tinticulata (snail) in Lake Champlain. Region mollusc expert Dr. Doug Smith (Umass) believes it will become extirpated from the lake for this reason.
--Acella haldemani - Apparently greatly reduced in distribution and abundance from historical range for unknown reasons. The young don't travel far from where the hatch, which creates limited abiliity to disperse and colonize/recolonize other habitat patches.
--Bulimnaea megasoma - may have been extirpated due to unknown causes.
--Laevapex fuscus - reproductive traits may be a limiting factor (low colonization rate).

--Copper sulfate used for treating waters for algae and swimmers itch is a risk to snails (it is a molluscicide).
--Baylicide, used to reduce sea lamprey populations, is a molluscicide.
--Nuisance aquatic plant management can impact snails by removing snails and habitat (plants) and covering lake bottoms.
--Fisheries reclamation in lakes (rotenone) is known to impact snail communities.

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Define particular habitat requirements of each species within Vermont, utilizing current knowledge of researchers and field investigations.
Research	Distribution and Abundance	High	1) Obtain baseline distributional and abundance data for all species in group by conducting surveys throughout the state. Abundance information should be collected at sites of known occurrence. 2) Conduct inventories to detect and gather information on new SGCN snail populations.
Research	Threats and Their Significance	High	Assess potential and existing impacts of limiting factors to habitat and individual species. Such limiting factors as habitat loss and degradation, exotic invasive snails, and use of pesticides should be examined.
Research	Population Genetics	High	Investigate genetic relationships of isolated populations to their larger population strongholds; potentially addressing taxonomic uncertainties.
Research	Taxonomy	Medium	Taxonomic questions regarding Fossaria rustica need to be resolved.
Monitoring	Population Change	Medium	1) Monitor known SGCN snail populations. 2) Population monitoring could be employed to track population trends at distinct locations. This would follow field surveys and assessments to identify populations judged to be large and viable. Focusing on such large populations would offer greater probability of detecting population shifts. Monitoring populations subjected to specific environmental perturbations should also be considered.
Monitoring	Habitat Change	High	Changes to habitat due to specific threats (e.g., dam removal) need to be monitored.
Monitoring	Monitor Threats	High	Number of waterbodies and areas chemically treated to control snails and algae needs to be tracked and used to assess the significance of this limiting factor to SGCN snails.
Monitoring	Other Monitoring Needs	High	Changes to populations due to specific threats (e.g., dam removal) need to be monitored.

Common Name: **Freshwater Snails Group**
Scientific Name: **Freshwater Snails Group**
Species Group: **Invert**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Work to reduce the problem and impacts of acidification on aquatic habitat		DEC, other state regulators, legislators, governor	
Alliance Development	Medium	Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN snail requirements and threats.		ANR, USFWS	
Invasive Species Control & Prevention	High	Prevent the introduction and spread of invasive exotic species (particularly snails)		FWD, DEC, LCBP, USFWS	
Habitat Restoration	High	Protect and restore habitats on which SGCN snails are dependent through pollution abatement, riparian buffers, etc.	Number of acres of riparian and lakeshore natural vegetation protected and/or restored. Number of acres of lake habitat restored/protected	LCLT, VLT, Watershed groups, USFWS, DEC, FWD	SWG, LCLT, VLT, NRCS
Compatible Resource Use	High	Reduce the use of algicides, molluscicides, and other pesticides in waters where it may impact SGCN snails	Sustained reduction in the number of annual requests for use of pesticides in SGCN waters	FWD, DEC, ANR, lake associations , private landowners	

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Appendix A5

Mammal SGCN Conservation Reports

Vermont's Wildlife Action Plan 2015

Common Name: **Cinereus or Masked Shrew**
Scientific Name: **Sorex cinereus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? NA

Global Trend:
State Trend: Unknown
Regional SGCN? no

Assessment Narrative:

The trend of the cinereus (masked) shrew in Vermont is unknown. Historic records indicate a widespread distribution of the species in the state. Since 2008, during an effort to develop a small mammal atlas, the masked shrew was verified at 28 sites in Vermont further supporting the belief that the species continues to be widely distributed throughout the state. Although it may be the most common of the small shrews, it is still believed to be relatively rare at most locations and there is insufficient data on this species in Vermont to fully assess its status. The masked shrew may be more common at higher elevations but the overall role of elevation on the species distribution remains unclear. It is believed that masked shrews are more common in old growth or late successional forests.

Distribution

Considered rare though broadly distributed.

Distribution by Biophysical Region:

Champlain Valley	Confident
Champlain Hills	Confident
Northern Green Mtns	Confident
Northern VT Piedmont	Confident
Northeastern Highlands	Confident
Southern VT Piedmont	Confident
Vermont Valley	Confident
Southern Green Mtns	Confident
Taconic Mtns	Confident

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☐

Masked shrews are know to favor cool mesic deciduous and coniferous forests often at higher elevations. They are sometimes found in mixed habitat types such as edges of bogs and other cool and wet sites (seeps). The masked shrew uses grasses, rocks, and logs or stumps for cover. They are primarily carnivorous and insectivorous consuming worms, spiders, snails, slugs, and small amounts of vegetable matter. Dampsness of site and depth of leaf litter, seems to be critical factors in determining habitat use. The species is known to utilize down woody debris. Its home range is understood to be less than 0.5ha.

Common Name: **Cinereus or Masked Shrew**
Scientific Name: **Sorex cinereus**
Species Group: **Mammal**

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Climate Change

Description of habitat threat(s): Climate changes, habitat alterations/degradations, and/or habitat conversions resulting in overall drier conditions may significantly limit the species in Vermont. Although it is speculated that the direct impacts of energy infrastructure development (e.g. industrial wind power projects) could result in the reduction of upper elevation spruce fir habitats used by this species, more

Common Name: **Cinereus or Masked Shrew**
Scientific Name: **Sorex cinereus**
Species Group: **Mammal**

research is needed to determine just how severe this impact would be on Vermont's population of maksed shrews.

Non-Habitat Threats:

Competition

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Previous studies indicate that competition from other shrews may pose a significant risk to masked shrews. Furthermore, there is concern that acid rain could alter the ecology of soil invertebrates resulting in adverse impacts to the prey prey base upon which this species depends.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Attempt to narrow down habitat requirements and determine critical habitat needs of the masked shrew.
Research	Basic Life History	Low	Determine basic life history and population demographics
Research	Distribution and Abundance	Medium	Determine distribution and abundance of the masked shrew and maintain a database of known locations.
Monitoring	Population Change	Medium	Analyze habitat conditions and local populations prior to construction of upper elevation wind generating faciiities
Monitoring	Monitor Threats	Medium	Monitor know populations, e.g. Camels Hump spruce-fir zone, to detect any significant population changes related to climate change

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Conduct research to determine impact of warming, especially as it relates to drying of habitats	Amount of forest habitat protected	UVM, Middlebury, Johnson State College	SWG
Compatible Resource Use	High	Minimize habitat fragmentation	Amount of forest habitat protected from development	VFPR, GMP, UVM, TNC	EQIP, SWG
Standards	Medium	Minimize fragmentation (the permanent conversion of habitat as a result of development) between populations in core habitats. Maintain habitat mosaic	Number of travel corridors identified and protected	UVM, Middlebury, Johnson State College	SWG
Standards	Medium	Determine appropriate management strategies to improve and conserve habitat	Number of habitats identified and protected.	VFPR, USFS, Coverts	SWG

Common Name: **Cinereus or Masked Shrew**
Scientific Name: **Sorex cinereus**
Species Group: **Mammal**

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Common Name: **Water Shrew**
Scientific Name: **Sorex palustris**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S3	**State Trend:**	unknown
Extirpated in VT?	no	**Regional SGCN?**	yes

Assessment Narrative:

There is very limited information regarding the water shrew in Vermont. Fifty seven specimens have been taken since 1915 from 21 different localities throughout the state including two specimens collected since 2008 as part of the effort to develop a statewide small mammal atlas. Historic records of this species' occurrence in the state indicate that there may be limited at risk populations.
The species is listed as a high priority because not a lot is known about it in the state and because of its very specific habitat requirements. Although there is no evidence of a decline in the state at this time, a number of potential limiting factors have been identified including changes in natural water flow regimes resulting from climate change, dams/flow regulation, inadequate riparian buffers, atmospheric deposition and acid rain, loss of habitat, and potential loss of prey base. Furthermore, there are taxonomic uncertainties and speculation exist that it may actually be more than one species.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☐

The water shrew is found in undercut banks of streams and beaver dams. It is assumed that wooded buffers on streams are desirable and there is a recognition that wooded wetlands and streams are utilized more often than cattail dominated wetlands. Mesic forests are believed to be important. Although the water shrew has been trapped on dry creekbeds, it may prefer streams that flow year-round. DeGraaf (2001) suggests that coniferous forests are preferred over deciduous forests. Whitiker & Hamilton (1998) found this species on mud flats of sluggish backwaters. It is believed that habitats adjacent to water, particularly fast cold streams, may hold the largest populations. Critical habitat appears to be undercut banks of streams and possibly beaver dams.

Common Name: **Water Shrew**
Scientific Name: **Sorex palustris**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Floodplain Forests

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Aquatic: Fluvial

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Inadequate Disturbance Regime

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Alteration or conversion of riparian buffers as a result of certain forest management and development practices could degrade key habitat requirements of the water shrew and impact its survival and productivity. Similarly, alterations of natural water flow regimes resulting from climate change could pose significant impacts on the species. The lack of baseline data on the distribution, abundance and basic life-history of water shrews in Vermont prevents a comprehensive assessment of the threats facing the species.

Non-Habitat Threats:

Pollution

Loss of Prey Base

Description of non-habitat threat(s): It is believed that the species' prey base could be impacted by the effects of acid rain.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Assess habitat at historical sites and sample for species.
Research	Basic Life History	High	Sample stomach contents to determine prey preferences.
Research	Distribution and Abundance	High	Develop baseline data on distribution and abundance
Research	Threats and Their Significance	High	Identify key limiting factors to this species.
Research	Population Genetics	High	Determine the extent of gene flow in the state.
Research	Taxonomy	High	Determine whether or not this is a single species.

Common Name: **Water Shrew**
Scientific Name: **Sorex palustris**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Minimize trail or road intrusion into wetlands or riparian buffers.	Miles of riparian buffers and acres of wetlands intact and protected	NRCS, USFWS, VLT, FSA, Coverts	EQIP, SWG, CREP,
Habitat Restoration	High	Enhance or restore degraded wetlands and repair buffers	Number of habitats maintained or improved	NRCS, DEC Wetlands, VT Rivers Conservancy	SWG, EQIP
Habitat Restoration	High	Identify and maintain rich wetland habitats and stream buffers.	Number of habitats identified and maintained	FVPR, NRCS, VLT, Coverts	EQIP, SWG

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Common Name: **Smoky Shrew**
Scientific Name: **Sorex fumeus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? Yes

Assessment Narrative:

The smoky shrew is listed as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states. Although the status of the smoky shrew in Vermont is poorly understood, the few records of its occurrence in the state indicate that the species is more limited in numbers than masked shrews. Compared with other relatively abundant shrews, the smoky shrew has more specific habitat requirements.

Distribution

Confident everywhere but Taconic Mountains and the Vermont Valley where it is unknown

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The smoky shrew often occupies damp, boulder-strewn, upland woods (DeGraff and Yamasaki 2001). It is found in cool mesic forests, often conifer, that are shady with deep, loose, leaf litter and is often associated with higher elevation sites with damp, moss covered rocks. Smoky shrews are also typically found along streams with moss covered banks (DeGraff and Yamasaki 2001). The dietary niche of the smoky shrew is broader than that of other shrews. Although it is 80 % insectivorous, it will also eat earthworms, spiders, snails, salamanders, small mammals, and birds. (Brannon 2000). The smoky shrew uses tunnels made by other animals for nesting as well as beneath stumps and rotten logs. It is also known to use downed woody debris for cover and foraging. Loose damp leaf litter may be critical to habitat use.

Common Name: **Smoky Shrew**
Scientific Name: **Sorex fumeus**
Species Group: **Mammal**

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Softwood Swamps

Seeps and Pools

Open Peatlands

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Early Succession Northern Hardwoods

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Description of habitat threat(s): The conversion of forest to non-forest habitat is thought to be a potential impact on smoky shrews. Similarly, the construction of upper elevation wind energy facilities causes major habitat conversion from areas of moist, boulder strewn, and loose humus conditions favored by these shrews to dry warm sites, including roadways, avoided by them.

Non-Habitat Threats:

Competition

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Competition and predation from other shrews (Blarina brevicanda) may be a problem.
Acid rain may reduce invertebrate prey base.

Common Name: **Smoky Shrew**
Scientific Name: **Sorex fumeus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine critical habitat needs in Vermont. Narrow the habitat requirements. Are there areas within available habitats where species are concentrated.
Research	Basic Life History	Low	Determine the basic life history requirements.
Research	Distribution and Abundance	Medium	Determine distribution and abundance in Vermont.
Research	Threats and Their Significance	Medium	Determine the significance of potential impacts resulting from wind industry developments and other disturbances of preferred habitats, competition with other shrews, and pollution.
Monitoring	Population Change	Low	Monitor population changes in high elevation sites planned for wind energy development before and after construction.
Monitoring	Habitat Change	Low	Monitor changes to and availability of identified critical habitats in Vermont.
Monitoring	Range Shifts	Medium	Monitor distribution and abundance in Vermont to assess range shifts.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Protect stream buffers sufficient to maintain a mesic environment	Miles of riparian buffers intact and protected	NRCS, VLT, Coverts	EQIP, SWG
Habitat Restoration	High	Maintain prey base	Identification of prey use, abundance and distribution	UVM, Middlebury, Johnson State College	SWG
Compatible Resource Use	Medium	Identify and maintain rich mesic habitats	Number of habitats identified and maintained	Vermont Forest and Parks Dept., USFS, Coverts	SWG

Common Name: **Smoky Shrew**
Scientific Name: **Sorex fumeus**
Species Group: **Mammal**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Long-tailed or Rock Shrew**
Scientific Name: **Sorex dispar**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G4	**Global Trend:**	
State Rank:	S2	**State Trend:**	unknown
Extirpated in VT?	No	**Regional SGCN?**	yes

Assessment Narrative:

The long-tailed shrew (rock shrew) is listed as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states. It is further listed as an S2 species in Vermont. The long-tailed shrew is currently listed as a C-2 species by the USFWS indicating the species may be endangered or threatened but insufficient information is currently available to allow preparation of rules for listing the species. The total number of known occurrences in the state is 32 (Tumosa 2001, Chipman 1994, Kilpatrick and Benoit 2011, VT Natural Heritage database). Eleven specimens of the long-tailed shrew were obtained between 2008 and 2011 as part of the development of a small mammal atlas in Vermont. Two of the specimens collected during this effort provided the first records of existence in the Northeastern Highlands Biophysical Region and in Orange County. Eleven specimens were collected prior to 1940, one specimen was taken on Camels Hump in 1968, six specimens were obtained between 1972 and 1989, and three long-tailed shrews were captured at sites in the Northern Green Mountains biophysical region in 1994.

It is believed that the long-tail shrew occurs in limited, localized, at-risk populations however current data is to limited to fully assess the species' status. In Vermont, the species is also believed to be primarily associated with talus slopes and is only occasionally found in association with mountain streams and never in large forest openings such as clearcuts (Kilpatrick and Benoit 2011).

Distribution

The long-tailed shrew was historically found in the prominent talus habitat located along the western slopes of the Southern Green Mountains in Mendon and Wallingford (Rutland County) and was further documented to occur on Camel's Hump (Chittenden and Washington Counties) however no recent records of their occurrence in these locations exist. More recently, the species has been reported from the talus dominated habitats found on Mount Mansfield (Chittenden and Lamoille Counties), Wheeler Mountain (Caledonia County), West Mountain (Essex County) and Mount Ascutney (Windsor County). The long-tailed shrew has also been reported from the Champlain Hills since 1990 and was documented in the towns of Jericho and Vershire.

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Confident	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Long-tailed or Rock Shrew**
Scientific Name: **Sorex dispar**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☐

The long-tailed shrew prefers cold, mesic forests and is typically found in close proximity to streams having undercut banks. The species often inhabits cool, talus slopes and moss covered boulders and logs. It is believed that moss covered rocks and logs provide critical shade and protective cover. Similarly, forested talus slopes are also believed to be an important habitat feature where long-tailed shrews spend most of their time in the labyrinth of spaces between rocks about a foot beneath the surface (Kirkland 1981). Although generally associated with coniferous forests, the long-tailed shrew may also be found in deciduous and mixed forest types. May be associated with rock vole.

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Incompatible Recreation

Climate Change

Description of habitat threat(s): Ski trails and associated structures could impact the habitat of the long-tailed shrew. Conversion of habitat as a result of quarrying activities could also destroy critical rocky, talus habitat.
Climate Change may significantly warm and dry the moist talus slopes favored by these shrews. In addition, the upper elevation development of wind energy facilities could result in the conversion of suitable long-tailed shrew habitat to a more open, bare rock and/or grass dominated habitat.

Non-Habitat Threats:

Genetics

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Change in prey base due to acid rain deposition at high elevations. Shrews feed on invertebrates and therefore may accumulate pesticides and heavy metals in body tissue (Tumosa 2001). Mining, mercury deposition, and the application of sewage sludge can all negatively affect long-tailed shrews due to a build up ot toxins in the body. Furthermore, because the species is believed to occur in limited, localized, at-risk populations, there is a risk of reduced survival and fecundity due to inbreeding depression.

Common Name: **Long-tailed or Rock Shrew**
Scientific Name: **Sorex dispar**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Identify habitats critical for the perpetuation of the species
Research	Basic Life History	High	Determine home range and other life history needs.
Research	Distribution and Abundance	High	1) Determine distribution and abundance in a multi year monitoring effort. 2) Re-census historical habitats and survey in other likely habitats. 3) Map confirmed habitats.
Research	Threats and Their Significance	High	Determine significane of environmental toxicity on preferred prey base and survival.
Research	Population Genetics	High	Determine the isolation of existing populations and the need for the protection of movement corridors.
Monitoring	Population Change	Medium	Determine current status of the population and monitor changes to this population through the future.
Monitoring	Habitat Change	High	Monitor populations near or adjacent to high elevation development to determine long range changes.
Monitoring	Range Shifts	High	Monitor current populations to determine any change due to climate change.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Ensure that ski trail development and maintainance and energy development follows best management practices.	Number of habitats protected	VFPR, GMP, Ski Areas	SWG
Privately-Owned Protected Areas	High	Minimize fragmentation (the permanent conversion of habitats as a result of development) between populations in core habitats	Number of travel corridors identified and protected.	TNC, VLT, Coverts, VHCB, VFPR	SWG, VHCB
Habitat Restoration	High	Determine appropriate management strategies to improve and conserve habitat.	Number of Habitats identified and protected	TNC, University of Vermont, Middlebury College, VFPR	SWG

Common Name: **Long-tailed or Rock Shrew**
Scientific Name: **Sorex dispar**
Species Group: **Mammal**

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Common Name: **Pygmy Shrew**
Scientific Name: **Sorex hoyi**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S2
Extirpated in VT? no

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

The pygmy shrew is listed as an S2 species in Vermont. The species appears to be rare in the state based on the scarcity of occurrence records though this could be due to survey methods. The pygmy shrew is hard to catch and difficult to identify so it may be more abundant than records would suggest. Very little is known about the historic population of this species in Vermont.

Distribution

Very few records of occurrence of pygmy shrews exist in Vermont. Furthermore, the species was not detected during a state wide small mammal survey conducted between 2008 and 2010 (Kilpatrrick and Benoit, 2011).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Probable
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Habitat requirements of the pygmy shrew are relatively unknown. It is believed that mesic forests and fields are used but it has also been recorded in swamps and marshes. Critical habitat is often listed as boreal forests where wet and dry areas occur together. Disturbed sites and cultivated areas with leaf litter and downed logs may also be important habitats for pygmy shrews. The species is believed to require moist leaf mold near water (DeGraff and Yamasaki, 2001) and is typically found within 100 yards of water. There is no evidence in the literature that it prefers any particular forest age class. It was found in 4 different age classes of cove hardwood stands in southern Appalachia (Ford et al. 1996 in Tumosa 2001).

Common Name: **Pygmy Shrew**
Scientific Name: **Sorex hoyi**
Species Group: **Mammal**

Habitat Types:

Northern Hardwood

Hardwood Swamps

Marshes and Sedge Meadows

Early Succession Boreal Hardwoods

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): The distribution and abundance of pygmy shrews in Vermont, as well as the species' specific habitat requirements, are poorly understood. Therefore, additional information is required before a comprehensive threat assessment can be completed.

Non-Habitat Threats:

Loss of Prey Base

Description of non-habitat threat(s): It is speculated that changes to habit resulting from succession, alteration and/or conversion could result in the diminishment of the species' prey base.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Collect baseline data on habitat use and identify critical habitats
Research	Distribution and Abundance	High	Collect baseline data on distribution and abundance

Common Name: **Pygmy Shrew**
Scientific Name: **Sorex hoyi**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Protect, through voluntary management practices, habitat from wetland, to grassland to forest.	Monitoring and demonstrating use of these habitats	NRCS, VLT, Coverts, Consulting Foresters	EQIP, SWG,
Habitat Restoration	Medium	Restore any missing habitats identified above.	Shrew restoration and use of restored habitats.	UVM, Middlebury, Johnson State College	SWG
Compatible Resource Use	Medium	Identify and maintain a mosaic of habitats	Number of habitats identified and maintained	VFPR., USFS, Coverts	SWG
Research	High	Determine habitat requirements and distribution	Development and adoption of habitat guidelines for the species	UVM, VFWD	SWG

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Common Name: **Hairy-tailed Mole**
Scientific Name: **Parascalops breweri**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3S4
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? Yes

Assessment Narrative:

The hairy-tailed mole is listed as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states.
Believed to be relatively common, but population status and trends are unknown. The Vermont Small Mammal Atlas verified distributional records in Orleans, Essex, Chittenden, Caledonia, Addison, Washington, Windsor, and Windham counties based on results of surveys (for herps), incidental pick up or photographs of dead specimens, and from voucher specimens at the Zadock Thomson Natural History Collection at the UCMM (Kilpatrick and Benoit 2011). Little is known about this species' status and habitat requirements. Loss of habitat with sandy and sandy loam soils is a concern

Distribution

The Vermont Small Mammal Atlas verified distributional records in Orleans, Essex, Chittenden, Caledonia, Addison, Washington, Windsor, and Windham counties based on results of surveys (for herps), incidental pick up or photographs of dead specimens, and from voucher specimens at the Zadock Thomson Natural History Collection at the University of Vermont (Kilpatrick and Benoit 2011).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Found in all places with well-drained sandy loam soils (e.g. agricultural fields and older forests). Open deciduous woodlands with thick humus are preferred. Hairy tailed moles are also adapted to second growth stands, old fields, and hedgerows. They prefer well-drained, light, moist soil with well-mixed organic matter and minerals and avoid soils that are hard, dry, or with a large clay content. Species is not restricted to any one habitat type or successional stage (Hallett 1978).

Common Name: **Hairy-tailed Mole**
Scientific Name: **Parascalops breweri**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Conversion of Habitat

Unknown Habitat Threats

Description of habitat threat(s): Conversion of required habitats to houses, roads or other development may negatively impact the species..

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Because of human/mole conflicts proximity to humans can result in decline. The application of pesticides/rodenticides may also cause localized population declines, particularly in orchards. The status of the species in forested habitats is unknown.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Collect baseline data on habitat requirements.
Research	Distribution and Abundance	Medium	Collect baseline data on distribution and abundance.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Develop guidelines for pest control professionals for the non-lethal control of the species	Number of trained pest control professionals	Agricultural Extension, Pest Control Professionals	SWG
Research	Medium	Monitor distribution and abundance of species	Distribution map	Agricultural Extension, UVM, Pest Control Professionals	SWG

Common Name: **Hairy-tailed Mole**
Scientific Name: **Parascalops breweri**
Species Group: **Mammal**

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Common Name: **Little Brown Bat/Myotis**
Scientific Name: **Myotis lucifugus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G3	**Global Trend:**	
State Rank:	S1	**State Trend:**	Stable
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

The Little Brown Bat/Myotis has been identified as a Very High Concern Regional Species of Greatest Conservation Need. Before White-nose Syndrome, the little brown bat was considered to be relatively common and was one of the most frequently captured bat species in state-wide surveys. The Little Brown Bat/Myotis relies heavily on human dwellings as maternity sites and less frequently uses trees. Both maternity colony habitat and winter hibernacula are vulnerable and at risk. Every year bats lose hundreds of possible building roosts as a result of exclusion and eviction or the actual removal of old barns and other structures. Although Little Brown Bats/Myotis are known to hibernate in slightly greater than 20 sites in Vermont, the vast majority of the population hibernates in a single cave. This species is also impacted by the removal or killing of bats in structures, as well as recreational spelunking in hibernacula. Little brown myotis have experienced population declines of 90% in Vermont due to White-nose Syndrome (Darling and Smith 2011) and have experienced similar or greater mortality rates region-wide (Turner et al. 2011). The state-wide population is a fraction of what it once was and concentrated gatherings of bats at maternity colonies are particularly vulnerable to incidental mortality as evidenced by citizen reports of up to 23 bats found dead in a furnace in one summer after they flew down the chimney, probably in search of a warm roost. Trend information is needed on this species in the years following White-nose Syndrome to determine whether populations will recover from the disease.

Distribution

Distribution, including both maternity colonies and dispersed males, was historically statewide from spring through early fall before the massive population declines caused by White-nose Syndrome (WNS). Little Brown Bats/Myotis migrate to their winter hibernacula both in Vermont and in neighboring states such as New York. This species has been histrically documented at nearly every known bat hibernacula in the state. In the years following WNS, maternity colonies appear to be concentrated in the greater Champlain Valley and northern Taconic Mountains and a few in the Southern Vermont Peidmont, though males and non-reproductive females likely still exist state-wide according to acoustic survey data.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Little Brown Bat/Myotis**
Scientific Name: **Myotis lucifugus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

During the winter Little Brown Bats/Myotis hibernate in caves with a constant temperature of 40 degrees F and a relative humidity of 80% (Banfield 1974: 42 in DeGraff and Yamasaki, 2001). Little Brown Bats/Myotis often hibernate in large clusters. To prevent dehydration they awaken every ten to fourteen days to consume water. This is thought to act as a buffer against water loss, enabling longer hibernation between arousals (Sanders 2004). During the summer the Little Brown Bat/Myotis often inhabits attics where the temperature may average 100 degrees (Chenger 2004). Females form large nursery colonies that numbered in the hundreds or even thousands of individuals before White-nose Syndrome. Capture data and citizen reports indicate that males spend the summer months scattered around the state, either solitary or in small bachelor groups in buildings or trees. Colonies usually exist close to water because little brown bats seem to prefer to forage over water. When foraging, the bats may repeat a set hunting pattern within a few miles of the roost (Chenger 2004). Little brown bats eat moths, wasps, gnats, crane flies, and beetles. Young are born in May, June, or early July. Average litter size is one (Davis and Hitchcock 1965).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Hardwood Swamps

Marshes and Sedge Meadows

Shrub Swamps

Subterranean

Building or Structure

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Wet Swales and Ditches

Powerlines/RR/Roadsides

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Incompatible Recreation

Common Name: **Little Brown Bat/Myotis**
Scientific Name: **Myotis lucifugus**
Species Group: **Mammal**

Description of habitat threat(s): Disturbance in hibernacula reduces fat reserves and negatively affects reproduction and survivability. In addition, every year Little Brown Bats/Myotis lose hundreds of possible building roosts due to exclusion or the actual destruction of buildings. Direct killing of bats is common due to human fears about rabies, bat bites and histoplasmosis.

Non-Habitat Threats:

Genetics

Disease

Description of non-habitat threat(s): The Little Brown Bat/Myotis has suffered population declines upwards of 90 in Vermont and the Northeast (Turner et al. 2014) and White Nose Syndrome continues to be a threat. Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	Continue the maternity colony location and monitoring program to plot changes in distribution, abundance, and population size in the years following White-nose Syndrome.
Research	Threats and Their Significance	Medium	Research and quantify the effect of evicting from or incidentally taking maternity colonies in structures on reproductive success.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Medium	Research the effectiveness of bat houses for maternity colonies evicted and excluded from buildings.
Monitoring	Population Change	High	Monitor changes in popluation size in the years following White-nose Syndrome.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Investigate observed post-WNS range shifts from state-wide occurences of maternity colonies to concentrations in the Champlain Valley.
Monitoring	Monitor Threats	High	Monitor the continued population effects of White-nose Syndrome and cooperate on research about individual survivors.

Common Name: **Little Brown Bat/Myotis**
Scientific Name: **Myotis lucifugus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Technical Assistance, Training, Learning Networks	High	Train nuisance wildlife control operators (NWCOs) in proper bat exclusion techniques. Work with homeowners/landowners to safely exclude bats and erect bat houses for displaced colonies.	Implemement Best Management Practices and train nuisance wildlife control operators.	Wildlife Rehabilitators, NWCO's, Homeowners associations	USFWS, PR
Habitat Restoration	High	Maintain at least 20 maternity colony sites and a minimum of 10,000 adult females.	Number of maternity sites and bats protected	Coverts, Vermont Woodlands Magazine, NWF, UVM, Mammals subcommittee of ESA,	SWG, PR USFWS, WNS
Habitat Restoration	High	Protect hibernacula containing 100 or more little brown bats	Number of hibernacula protected	Vermont Cavers Assoc., UVM, TNC, VLT, Coverts	USFWS, TNC, VLT

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Van Zyll de Jong, C.G. 1985. Handbook of Canadian Mammals. Volume 2. Bats. National Museums of Canada, Ottawa, Ontario, Canada. 212 pp.

Common Name: **Indiana Bat**
Scientific Name: **Myotis sodalis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G2
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

The Indiana bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. Indiana bats are listed as endangered in Vermont. They have declined range wide by 60% since monitoring began in the 1960's. Historic numbers were estimated at 800,000 in the late 1960's and by 1997 the range wide population was down to 350,000 (USFWS, 1999 in Sanders, 2004). Surveys in the 2000's indicated that regionally the population was rebounding and may have been increasing until the deadly fungal disease, White-nose Syndrome (WNS), was found in the state. Nationally, declines could have been related to disturbance in hibernacula and more recently in the northeast this species has suffered mass mortality from WNS (Turner 2011). Limited dispersal may be a problem for pregnant females. Vermont is the only New England state known to harbor maternity colonies. Radio-transmittered Indiana bats roosting in the Champlain Valley come from hibernacula in New York (Sanders, 2004). Because the majority of Vermont's summer population is believed to hibernate in a single abandoned mine in Essex County, New York, they are especially vulnerable to disturbance and disease transmission. In Vermont in the1940-50s, Indiana bats were reported in the 1000s in hibernacula. Historic hibernacula included the Plymouth Caves, Nickwacket Cave, Dorset Cave, and the Ely Copper Mine. Currently, Vermont has two hibernacula used by Indiana bats: Brandon Silver Mine (3 bats in 2011) and Little Skinner Hollow (53 bats in 2013). This species has high interannual fidelity to roost sites and is vulnerable to habitat fragmentation.

Distribution

The Indiana bat is distributed throughout the lower Champlain valley and northern Taconic Mountains duiring the summer, with populations concentrated around roost trees and maternity colony sites. Small numbers of this species hibernate in Vermont, though most of the Champlain Valley population is knows to hibernate across the Lake in a large abandoned mine in NY state. Hibernacula: Brandon Silver Mine, owned by The Nature Conservancy (TNC); Dorset Cave, gated and owned by TNC. Skinner Hollow, unprotected and privately owned. private ownership. Nickwackett Cave, gated and privately owned.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Historic Record(s) Only
Northern VT Piedmont	Historic Record(s) Only	**Taconic Mtns**	Confident
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Common Name: **Indiana Bat**
Scientific Name: **Myotis sodalis**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Maternity roosts are in large diameter shaggy hardwoods with sloughing bark (maple, shagbark hickory, poplar) or snags. Indiana bats roost under loose or peeling bark or in crevices and require nearby water (within a few hundred meters) to forage over. Colonies typically select one or more primary roost tree that receives direct sunlight for most of the day. Additional alternate roost trees may be shaded or in the open. During the winter months Indiana bats hibernate and require caves with a specific microclimate. Cave conditions that include cool, stable temperatures are preferred. Roost sites that are below 10 degrees Celsius when they arrive and 3-6 degrees in mid-winter allow for population increases (Tuttle and Kennedy, 2002 in Tumosa, 2003). Relative humidity above 78% but below saturation is also important. It appears that there is fidelity to the hibernaculum. Indiana bats in Kentucky travel over 300 miles to maternity areas in Michigan (Kurta and Murray, 2000 in the Vermont bat conservation plan). They have also been documented flying over 20 miles in one hour during migration (Sanders and Chenger, 2001in the Vermont bat conservation plan). Indiana bats are insectivorous, eating mostly flies, moths, beetles, and caddis flies. Mosquitoes, midges, bees and other flying insects are also consumed (USFWS, 1999 in Tumosa, 2001). During the swarming period, the area within 0-2 miles of the hibernaculum is critical for foraging and night roosting; 2-5 miles is important, and 5-10 miles gets used but not as frequently. Connectivity between habitats may be important but is poorly understood.

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Subterranean

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Powerlines/RR/Roadsides

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Common Name: **Indiana Bat**
Scientific Name: **Myotis sodalis**
Species Group: **Mammal**

Habitat Alteration

Incompatible Recreation

Climate Change

Description of habitat threat(s): Disturbance of winter hibernacula is a significant problem to Indiana bats. These bats have been documented to lose 15-20% of their body weight during hibernation in an undisturbed hibernaculum (Johnson et al. 1997, in Sanders, 2004). Disturbance of hibernating bats causes them to awaken and forces them to use additional limited energy reserves (Sanders, 2004). Arousal can use up enough fat to sustain a bat for 10-30 days (Thomas et al. 1990, Thomas 1995). Changes in temperature and light, as well as direct contact, can cause a bat to awaken and deplete stored fat reserves. Alterations to cave and mine openings can change the microclimate of a hibernacula and affect bat survival. Loss of maternity roosts may also be a problem to survivability of young. Maternity roosts can house several hundred individual bats. Felling of a maternity roost tree can impact the survival of both adults and young. Development within close proximity of hibernacula, particularly along travel corridors could also be detrimental to survival. Destruction/development of summer habitats are likely to negatively affect bats if potential roost sites and foraging areas are altered (Tumosa 2003).

Non-Habitat Threats:

Genetics

Disease

Loss of Prey Base

Description of non-habitat threat(s): Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Common Name: **Indiana Bat**
Scientific Name: **Myotis sodalis**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	Refine knowledge of maternity roost tree characteristics.
Research	Basic Life History	Medium	1) Determine the summer range of bats that use VT hibernacula. 2) Assess the degree of local recruitment to determine if are Vermont populations reproducing.
Research	Distribution and Abundance	Medium	Monitor changes in distribution and abundance in the years following White-nose Syndrome.
Research	Threats and Their Significance	Low	Determine what other factors besides habitat loss and White-nose Syndrome influence population trends.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	High	Learn more about the role of Vermont hibernacula in the region
Monitoring	Population Change	High	Monitor population trends in the years following White-nose Syndrome to determine if the species continues to decline.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	High	Investigate range shifts associated with summer habitat and roost tree loss in the Champlain Valley.
Monitoring	Monitor Threats	High	Monitor the continued population effects of White-nose Syndrome and cooperate on research about individual survivors.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Privately-Owned Protected Areas	High	Protect at least four USFWS Level I or II hibernacula in Vermont or New York	Number of hibernacula protected.	UVM, USFS, Cavers Organizations, TNC, NY DEC	SWG, USFWS, NYDEC
Protected Area Management	Medium	Maintain and protect all maternity roost trees that support over 100 adults. Conserve summer foraging habitat that supports 2500 adults.	Number of roost trees identified and protected. Acres of foraging habitat conserved.	UVM, Coverts, Cavers, TNC, NY DEC,	SWG, USFWS, NYDEC
Research	Medium	Collect distribution and abundance data through the Northamerican Bat Monitoring Project (NABat) to contribute to range-wide trend information over time.	Number of NABat randomized grid cells surveyed each year.	USGS, USFWS refuges, USFS, National Parks, FPR	ENDG, PR, USFWS

Common Name: **Indiana Bat**
Scientific Name: **Myotis sodalis**
Species Group: **Mammal**

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Common Name: **Small-footed Bat**
Scientific Name: **Myotis leibii**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G1G3
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend: unknown
Regional SGCN? yes

Assessment Narrative:

The small-footed bat occurs throughout southeast Canada and the eastern United States, but is found in very low numbers. Regionally it seems to be at risk. In New England, this bat is listed as threatened in Vermont, endangered in New Hampshire, and a species of concern in Maine, Massachusetts, and Connecticut as well as in New York State. The small-footed bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. There is a general lack of information about this species. It is found in small numbers (i.e., 2-50 bats) in the major caves in Vermont, with one larger population of 110 individuals observed at Pike Hill Mine in 2013. This bat may be particularly susceptible to disturbance and is known to be associated with dams, exposed cliff faces, and talus during the summer. Three small-footed bats were caught in mist nets in 2003 at the Union Village Dam, North Hartland dam, and Townshend dam (a female, male, and female respectively) by a contractor for the US Army Corp of Engineers (Chenger 2003). Though infrequently captured in the summer and noted for their ability to detect and avoid mist nets, records exist from over a dozen towns around the state. Small-footed bats are susceptible to White-nose Syndrome, but have demonstrated relatively low population declines, as evidenced by regional hibernacula data (Turner et al. 2011). The USFWS was petitioned to evaluate this species for federal listing but concluded in 2013 that the listing was not warranted (USFWS 2013).

Distribution

The small-footed bat is widely, though sparsely, distributed throughout the state, as evidenced by mist net captures from around the state, and is likely associated with dams, exposed cliff faces, and talus. This species is documented at hibernacula in Brandon, Sudbury, Manchester, Stockbridge, Vershire, and Corinth.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

In both winter and summer the small-footed bat is closely associated with rocky habitat such as caves, cliffs, talus piles, quarry faces, and rock outcrops. It hibernates in very cold sites, often in the entrance areas of caves and mines sometimes using small cracks or piles of breakdown on cave and mine floors. Hibernacula surveys probably undercount the species. They may also hibernate in talus piles and cliffs that have deep crevices;

however, the extent of this behavior in Vermont is unknown. No maternity sites have been found in Vermont, however, in other states they use barns and buildings, cliffs and bridges, but are primarily found under exfoliating tree bark (Sanders 2004). Changer (2004) documented small-footed bats using crevices in rocks and large rip-rap on a manmade dam face in New Hampshire. A radio-transmittered small-footed bat was found to use power line corridors (Kilpatrick, pers com). Areas that promote an abundance of insects are crucial to small-footed bat survival (Tomosa, 2003). Beaver ponds with abundant snags may provide roosting and foraging sites. Micro Habitat: outcrops

Habitat Types:

Cliffs and Talus

Northern Hardwood

Oak-Pine Northern Hardwood

Wet Shores

Subterranean

Building or Structure

Mine

Powerlines/RR/Roadsides

Other Cultural

Aquatic: Fluvial

Aquatic: Lacustrine

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Impacts of Roads or Transportation Systems

Incompatible Recreation

Climate Change

Description of habitat threat(s): These bats may be more susceptible to disturbance in the hibernacula. Disturbance of hibernating bats causes them to awaken and forces them to use additional limited energy reserves (Sanders, 2004). Arousal can use up enough fat to sustain a bat for 10-30 days (Thomas et al., 1990; Thomas, 1995; Martin et al, 1966). Changes in temperature and light, as well as, direct contact can cause a bat to awaken and deplete stored fat reserves. Alterations to cave mine openings can change the microclimate of a mine and affect bat survival. Loss of maternity roosts may also be a problem to survivability of young. Little is known about the summer habitat requirements of this bat but destruction/development of summer habitats are likely to negatively affect bats if potential roost sites and foraging areas are altered (Tumosa 2003). Maternity roosts may be present in rock outcroppings along roadsides and could therefore be susceptible to habitat disturbance or alteration during highway work. Warm winters and drought conditions are likely to increase bat body temperatures and corresponding metabolic demands which may influence survivability and reproduction.

Common Name: **Small-footed Bat**
Scientific Name: **Myotis leibii**
Species Group: **Mammal**

Non-Habitat Threats:

Genetics

Reproductive Traits

Loss of Metapopulation Structure

Unknown Non-Habitat Threats

Disease

Loss of Prey Base

Description of non-habitat threat(s): Insecticides and pesticides have been implicated in the deline of several bat species (Belwood 1998 in Tumosa 2003). Environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	1) Determine summer habitat utilization from known hibernacula in NY and Vershire in a telemetry study and 2) research the use of transportation corridor rock outcroppings
Research	Basic Life History	Low	
Research	Distribution and Abundance	High	1) estimate the statewide population by evaluating population densities in summer and winter habitat. 2) Document estimated populations of reproductive females.
Research	Threats and Their Significance	Medium	Research the impacts of transportation corridor naintenance activities on rock outcroppings used by this species.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	
Monitoring	Population Change	Medium	1) Monitor distribution and abundance to determine critical summer and winter habitats as well as population status. 2) Develop a monitoring plan to document the number of reproductive females.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Monitor changes in summer and winter habitat use in the aftermath of White-nose Syndrome and possible effects from population declines of other Myotis species.
Monitoring	Monitor Threats	Medium	Monitor changes in hibernating populations in sites that are gated to limit human entry versus open to visitation.

Common Name: **Small-footed Bat**
Scientific Name: **Myotis leibii**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	High	Protect all VT hibernacula with 5 or more small-footed bats.	Number of hibernacula protected	TNC, VLT, Coverts	TNC, VLT, Forest Legacy, VHCB, USFWS
Research	Medium	Locate summer maternity roost sites and define roost characteristics.	Number of summer roost sites located.	GMNF, USFWS Refuges, VTRANS, Private quarry owners, CRAG Vermont	PR, USFWS

Common Name: **Small-footed Bat**
Scientific Name: **Myotis leibii**
Species Group: **Mammal**

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Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G2G3	**Global Trend:**	
State Rank:	S1	**State Trend:**	Declining
Extirpated in VT?	No	**Regional SGCN?**	Yes

Assessment Narrative:

The Northern Long-eared Bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need and was listed as Federally Threatened on April 2, 2015. This species is extremely vulnerable to White-nose Syndrome, with state-wide surveys indicating declines of 93-100% from this disease (Darling and Smith 2011) and regional hibernacula declines of 98% (Turner et al. 2011). This species is in serious danger of extirpation in Vermont and extinction across its range as the disease continues to spread each winter (Frick et al. 2012 and USFWS 2013). Loss of maternity roosts could be a concern. Little information exists regarding summer roosting needs in VT, although neighboring NH has documented northern long-eared bats using a variety of tree species in close proximity, switching roosts frequently, and using trees that have a larger DBH than the average size in the stand (Sasse 1996). Recreational spelunking could also affect winter survivability. Information is needed on population trends and recruitment to determine if Vermont still has a reproductively viable population of this species.

Distribution

Distribution is statewide as recorded through captures, and hibernacula and acoustic surveys. However, this species has suffered drastic population declines due to White-nose Sydrome and their current distribution is not well known.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Northern Long-eared Bats hibernate in parts of caves and mines that are relatively cool and moist where the air is still. Hibernation may begin in August and may last for 8-9 months in northern latitudes. In the summer Northern Long-eared Bats roost by day in buildings and under tree bark, shutters, bat houses and bridges. At night they use caves to roost. They tend to be more solitary than other bats (Chenger 2004). They are gleaners and Northern long-eared bats forage in forested hillsides rather than in stream associated woodlands and consume a variety of night flying insects. They are well suited to forest interior habitats. Micro Habitat: roost sites

Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Northern Hardwoods

Early Succession Upland Oak

Subterranean

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Fluvial

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Incompatible Recreation

Description of habitat threat(s): Disturbance of hibernating bats causes them to awaken and forces them to use additional limited energy reserves (Sanders, 2004). Arousal can use up enough fat to sustain a bat for 10-30 days (Thomas et al. 1990, Thomas 1995). Changes in temperature and light, as well as, direct contact can cause a bat to awaken and deplete stored fat reserves. Alterations to cave mine openings can change the microclimate of a mine and affect bat survival. Loss of maternity roosts may also be a problem to survivability of young. Felling of a maternity roost tree can impact the survival of both adults and young. Development/roads within close proximity of hibernacula, particularly along travel corridors could also be detrimental to survival. Destruction/development of summer habitats are likely to negatively affect bats if potential roost sites and foraging areas are altered (Tumosa 2003).

Non-Habitat Threats:

Genetics

Disease

Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

Description of non-habitat threat(s): The Northern Long-eared Bat has suffered population declines of 90-99% in Vermont and the northeast (Turner et al. 2014) and White Nose Syndrome continues to be a threat. Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Determine summer habitat and roost tree characteristics.
Research	Basic Life History	High	Determine the spring migratory distance of bats emerging from hibernation and traveling to their summer range.
Research	Distribution and Abundance	High	Investigate the current distribution and abundance of this species in the years following White-nose Syndrome.
Research	Threats and Their Significance	High	Determine which threats secondary to White-nose Syndrome are the most detrimental to the small remaining population.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	
Monitoring	Population Change	High	Monitor population trends in the years following White-nose Syndrome.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	High	Investigate possible range shifts to prime summer or winter habitat in the years following White-nose Syndrome when population size and competition for habitat are extremely low.
Monitoring	Monitor Threats	High	Monitor the continued population effects of White-nose Syndrome and cooperate on research about individual survivors.

Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Privately-Owned Protected Areas	High	Protect all hibernacula containing northern long-eared bats in line with Federal threatened listing.	Number of hibernacula protected	UVM, Middlebury College, Vt. Cavers Assoc, VLT, TNC	SWG, TNC, USFWS
Creating Privately-Owned Protected Areas	High	Protect all roost trees documented as used by northern long-eared bats in line with Federal threatened listing.	Number of roost trees protected	UVM, Middlebury College, Vt., VLT, TNC, Woodland Owners Association	SWG, ENDG, WNS, TNC, USFWS

Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

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Common Name: **Northern Long-eared Bat**
Scientific Name: **Myotis septentrionalis**
Species Group: **Mammal**

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Common Name: **Silver-haired Bat**
Scientific Name: **Lasionycteris noctivagans**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S2B	**State Trend:**	Unknown
Extirpated in VT?	no	**Regional SGCN?**	Yes

Assessment Narrative:

Status of this bat is unknown but presumed to be much lower than historical levels. Many factors could be influencing the decline. Silver-haired bats migrate along the eastern seaboard in winter and could encounter factors that affect its survival. In some parts of the country it is associated with late successional forests with a snag density of more than 21 snags/ hectare. Loss of forest habitat throughout the 1800's probably contributed to the decline of this bat in New England. Other factors such as pesticides, availability of prey, and loss of maternity roosts could also be influencing the status of this bat. The silver-haired bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. Once the most common bat in the region in the 1800s it has experienced a significant decline throughout the Northeast. This species is currently considered rare and difficult to monitor. The silver-haired bat is documented as the shortest-lived (i.e., average 2 years, maximum 12 years), possibly indicating that this species is more sensitive to changes than other bat species. Silver-haired bats are the second most-commonly reported species found dead below turbines in Vermont's operating wind facilities (Sheffield, Lowell, and Georgia) during surveys conducted between April and October. Wind energy development is an increasing threat to this species, especially during fall migration (Leclair et al. 2009).

Distribution

One capture record exists for this species in Springfield and a maternity roost was found in a building in Chittenden. Data from mortality surveys below operating wind turbines in Sheffield, Lowel, and Georgia have provided new occurance data for this migratory species, as well as acoustic data around the state from 2010 to 2014. Silver-haired bats are assumed to be widespread but very little is known about how abundant or how evenly distributed they are in Vermont. This species migrates south for the winter.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Silver-haired bats will range up to 5km from roost tree to forage areas. In summer, they roost under the bark of late-successional and old-growth boreal forests and perhaps along woodland edges. They forage in forest openings, including clear cuts, and over water and sometimes roost in buildings. In other parts of the country they are associated with late successional forests with snag densities of 21 snags/hectare. They form maternity colonies almost exclusively in tree cavities and will periodically switch roosts throughout the maternity season. Like big brown bats, the silver-haired bats feed on many insect pest species such as flies, midges, leafhoppers, moths, mosquitoes, beetles, crane flies, lacewings caddis flies, ants, crickets, and spiders.

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Building or Structure

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Description of habitat threat(s): Conversion of forest habitat as a result of rural development that leads to loss of mature and older forests used as roosting habitat. Because silver-haired bats are migratory, they could be limited by wind and radio towers as well as powerlines. Wind energy development causes significant direct mortality to this species through colisions with turnbine blades and barotrauma. Predators include several kinds of birds including blue jays therefore increased suburbanization could increase loss to

Common Name: **Silver-haired Bat**
Scientific Name: **Lasionycteris noctivagans**
Species Group: **Mammal**

predation.

Non-Habitat Threats:

Genetics

Disease

Description of non-habitat threat(s): Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats. Silver-haired bats are also susceptible to a virulent strain of rabies. This normally solitary species is more vulnerable to population impacts when concentrated in the spring and fall migration.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine habitat requirements in Vermont.
Research	Basic Life History	Low	Research the possibility of food competition and partitioning between red, hoary, silver-haired and eastern pipistrelle bats.
Research	Distribution and Abundance	High	Collect baseline data on distribution, abundance in Vermont.
Research	Threats and Their Significance	High	Collect mortality data from wind energy facilities.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	Research the effects of pesticides on mortality and reproductive success.
Monitoring	Population Change	High	Monitor changes in abundance after the onset of operating wind turbines in the Northeast.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Monitor changes in migratory patterns after habitat conversion of ridgelines and direct mortality due to wind development.
Monitoring	Monitor Threats	High	Research migratory patterns and impacts from power lines, wind towers, and road mortality

Common Name: **Silver-haired Bat**
Scientific Name: **Lasionycteris noctivagans**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	High	Design, standardize, and implement mitigation guidelines, such as curtailment regimes, to decrease the threat of and direct take from wind energy development in Vermont.	Percentage of operating wind turbines that meet minimum mitigation guidelines.	Bat Wind Energy Cooperative, USFWS, USFS, Wind energy companies	Wind industry, USFWS, ENDG

Common Name: **Silver-haired Bat**
Scientific Name: **Lasionycteris noctivagans**
Species Group: **Mammal**

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Common Name: **Tri-colored bat**
Scientific Name: **Perimyotis subflavus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G3
State Rank: S1
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? Yes

Assessment Narrative:

The tri-colored bat is one of six species that overwinter in Vermont. This species occurs in small numbers in Vermont hibernacula and is only infrequently captured in mist net surveys. Its small size and multiple young (i.e., two, versus one for most bats) makes it more vulnerable. The tri-colored bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. This species was formerly known as the eastern pipistrelle, Pipistrellus subflavus (Menu 1984). Little is known about the tri-colored bat in Vermont, where this species is near the northern edge of its summer range (Whitaker 1998). It appears uncommon based on available survey data. Historic summer captures total less than 10 and many hibernacula surveys reveal 2-6 individuals roosting solitarily. By 2011, White-nose Syndrome had caused regional population declines for this species upwards of 75% (Turner et al. 2011) in hibernacula surveys. Tri-colored bats are extremely vulnerable to WNS. Fungal infection rates during late hibernation reach nearly 100% and fungal loads in this species are among the highest documented (Langwig et al. 2014). The tricolored bat was added to Vermont's endangered species list in 2012. The concentration of this species in caves and mines to hibernate makes them particularly vulnerable to human disturbance.

Distribution

Distribution is probably statewide but sparse. Capture records, hibernacula survey records, or acoustic recordings exist from most regions, though little is known about how evenly distributed they are in Vermont. Tri-colored bats have been documented in small numbers in the majority of known hibernacula. However, seven of the hibernacula with tri-colored bats documented before White-nose Syndrome (WNS) revelaed none of this species in post-WNS surveys.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Probable
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The Tri-colored bat forages over wetlands, riparian areas, and forest edges, ingesting ants, moths, small beetles, mosquitoes and other insects. Possibly uses trees for maternity roosts, although in Vermont, the Tri-colored bat has not been found with other tree roosting bats. In Indiana they are found in sugar maple and American elms, as well as tulip and sycamore trees. Tri-colored bat is also found in the dead foliage of oaks.

Common Name: **Tri-colored bat**
Scientific Name: **Perimyotis subflavus**
Species Group: **Mammal**

They hibernate in caves mines and rock crevices where humidity is high and temperatures are around 10 to 15 degrees centigrade.

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Wet Shores

Early Succession Boreal Hardwoods

Early Succession Northern Hardwoods

Early Succession Upland Oak

Subterranean

Mine

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Incompatible Recreation

Description of habitat threat(s): Hibernating bats are limited by degradation, destruction and disturbance of hibernacula (caves and mines). Bats disturbed within the hibernacula use significant stores of fat each time they are awakened. If awakened enough times, bats can deplete their fat reserves and not have enough energy resources to complete spring migration, survive post emergence periods of bad weather or initiate and successfully complete gestation. In some cases, awakening hibernating bats can directly lead to their death. Closure of mines or caves in winter, when bats are present, would lead to the destruction of the entire colony. Slight alterations in cave/mine microclimate as a result of modifications to the opening etc. could also negatively impact hibernating bats. Removal of trees which serve as bat roosts, especially those serving as maternity roosts can directly kill entire colonies of bats. Wind energy turbines located on ridge tops have been found to directly kill bats as well..

Non-Habitat Threats:

Genetics

Loss of Metapopulation Structure

Common Name: **Tri-colored bat**
Scientific Name: **Perimyotis subflavus**
Species Group: **Mammal**

Disease

Description of non-habitat threat(s): Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon levels of the pesticide in the tissue, as well as, the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Collect baseline data on habitat requirements.
Research	Basic Life History	Low	Research possibility of food competition and partitioning between red, hoary, silver-haired and eastern pipistrelle bats.
Research	Distribution and Abundance	High	Collect baseline data on distribution and abundance
Research	Threats and Their Significance	High	Research what threats secondary to White-nose Syndrome are the most detrimental to the small remaining population.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	
Monitoring	Population Change	High	Monitor population trends in the years following White-nose Syndrome to determine if the species continues to decline.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Investigate the characteristics of hibernacula still occupied by this species post-White-nose Syndrome versus abandoned sites.
Monitoring	Monitor Threats	High	Monitor the continued population effects of White-nose Syndrome and cooperate on research about individual survivors.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Creating Privately-Owned Protected Areas	High	Protect all hibernacula containing more than 5 tri-colored bats.	Number of hibernacula protected	UVM, USFS, Cavers Organizations, TNC, Private landowners	ENDG, USFWS

Common Name: **Tri-colored bat**
Scientific Name: **Perimyotis subflavus**
Species Group: **Mammal**

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Common Name: **Big Brown Bat**
Scientific Name: **Eptesicus fuscus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S4
Extirpated in VT? no

Global Trend:
State Trend: Stable
Regional SGCN? Yes

Assessment Narrative:

The Big Brown Bat has been identified as a High Concern Regional Species of Greatest Conservation Need. Because Big Brown Bat maternity sites are most often in human structures such as barns, sheds, houses, and churches, they are frequently in conflict with people. At best, they may be excluded from these structures, forcing a split into several smaller maternity sites. At worst, they may be exterminated by pest control agents or homeowners. This species is also vulnerable to the effects of White-nose Syndrome (WNS), though it has not seen the same drastic declines in Vermont or the northeast as some other hibernating species (Turner et al. 2011). Big Brown Bats are among the first bats to give birth and often have 2 offspring. Before WNS, little brown bat colonies were nearly twice as common as Big Brown Bat colonies in New England (D.S. Reynolds and T. H. Kunz, unpub. data, 1999). Because of the 90% declines of the little brown bat (another structure-dwelling species) experienced from WNS, the VFWD conducted extensive surveys of citizen-reported bat colonies in buildings between 2011 and 2014. By 2014 that ratio had reversed and Big Brown Bats made up 249 of the 283 structure-dwelling maternity colonies identified by the VFWD. Big Brown Bats are commonly captured during mist net surveys and are among the most commonly detected species in acoustic surveys done by neighboring states (Carl Herzog, NYDEC and Kate Moran, CTDEEP, personal communication). However, Big Brown Bats are difficult to survey during the winter because not only do they overwinter in caves and mines, but they also hibernate in structures, cliffs, and wood piles, where they are more difficult to detect. The actual population size of this species in VT is unknown but their long-term conservation is important as they may be one of the few species able to thrive after WNS has spread across the rest of North America and threatened the viability of many other hibernating species.

Distribution

Distribution is statewide as recorded through captures, citizen reports of bats in buildings, wind turbine mortality data, and acoustic survey data. During the winter, the Big Brown Bat is found in small numbers in about half the known bat hibernacula in Vermont, but also hibernates in structures around the state.

Distribution by Biophysical Region:

Champlain Valley	Confident	Southern VT Piedmont	Confident
Champlain Hills	Confident	Vermont Valley	Confident
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Confident	Taconic Mtns	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Big Brown Bat**
Scientific Name: **Eptesicus fuscus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

In summer, Big Brown Bats roost in the attics of churches, houses, and old abandoned structures and deciduous tree cavities. In winter they hibernate in very cold areas (cave entrances and cliff faces) often with temperatures very close to and sometimes below freezing. This is the only bat species in VT known to hibernate in buildings. These low temperatures allow them to drastically slow their metabolism (Sanders 2004). Right now, Big Brown Bats hibernate in fewer than 20 sites in Vermont. Big Brown Bats consume beetles, ants, flies, mosquitoes, mayflies, stoneflies, and other insects. They emerge from their summer roost at dusk and fly a steady, nearly straight course to foraging areas (Chenger, 2004). There may be fidelity to the feeding grounds and some bats use the same grounds night after night. Little is known about where the majority of these bat winter, though reports of 1-6 bats hibernating in buildings are increasingly frequent as citizen reporting of bat activity has increased since White-nose Syndrome.

Habitat Types:

Cliffs and Talus

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Pine and Hemlock

Early Succession Upland Oak

Subterranean

Building or Structure

Mine

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Wet Swales and Ditches

Powerlines/RR/Roadsides

Aquatic: Fluvial

Aquatic: Lacustrine

Common Name: **Big Brown Bat**
Scientific Name: **Eptesicus fuscus**
Species Group: **Mammal**

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Description of habitat threat(s): Every year Big Brown Bats lose hundreds of possible building roosts due to exclusion or the actual destruction of buildings. Direct killing of bats is common due to human fears about rabies, bat bites and histoplasmosis. In addition, alterations or impacts to winter hibernacula also limits the future of this bat.

Non-Habitat Threats:

Genetics

Disease

Description of non-habitat threat(s): Big Brown Bats are one of 6 species in Vermont that are susceptible to White-nose Syndrome, though direct mortality for this species has been lower than for other susceptible species (Turner et al. 2011). The long-term and reproductive effects of this disease are unknown. Citizen reports of abandoned, dying, and dead young found below bat houses, and building roosts increased in VT and other Northeast states in 2012-2014 and is yet unexplained. Big Brown Bats are threatened by direct take when roosting in buildings during the summer and winter due to human fears of bats and rabies, as well as routine building maintenance (e.g., roof replacement), weatherization, and pest control activities. Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon levels of the pesticide in the tissue, as well as, the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At low levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats.

Common Name: **Big Brown Bat**
Scientific Name: **Eptesicus fuscus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Investigate the importance of human-made structures for hibernation.
Research	Basic Life History	Low	
Research	Distribution and Abundance	Medium	Document and map summer maternity colonies and human-made structures used for hibernation.
Research	Threats and Their Significance	Medium	Research long-term population effects of White-nose Syndrome
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	Track changes in abundance, distribution, and colony size over time by locating and monitoring summer maternity colonies
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Investigate the increased use of colony locations (structures) or foraging areas previously dominated by little brown bats and other species in the genus Myotis that have declines drastically since White-nose Syndrome.
Monitoring	Monitor Threats	Medium	Monitor long-term population changes in the years following White-nose Syndrome

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Habitat Restoration		Protect hibernacula that are found to contain 30 or more big brown bats	Number of hibernacula protected	Vermont Cavers Association, TNC, VLT, USFS, ACE, Coverts	SWG, USFWS
Habitat Restoration		Maintain at least 50 maternity sites and a minimum of 5,000 adult female individuals in Vermont	Number of maternity sites protected	NRCS, Coverts, USFWS, ACE, VLT, TNC	USFWS, NRCS, EQIP,
Technical Assistance, Training, Learning Networks		Train nuisance wildlife control operators (NWCOs) in proper bat exclusion techniques. Work with homeowners/landowners to safely exclude bats and erect bat houses for displaced colonies.	Implemement Best Management Practices and train nuisance wildlife control operators.	Wildlife Rehabilitators, NWCO's, Homeowners associations	USFWS, PR

Common Name: **Big Brown Bat**
Scientific Name: **Eptesicus fuscus**
Species Group: **Mammal**

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Common Name: **Eastern Red Bat**
Scientific Name: **Lasiurus borealis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S4B
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? Yes

Assessment Narrative:

Eastern Red Bats spends the winter in the southern U.S. or Mexico. They migrate back and forth along the Eastern seaboard. A study in New York (Fisher 1896) reported red bats to be the second most common bat and reports from the late 1800's and early 1900's talk about "great flights of them during the whole day" (Mearns, 1898). This bat has a larger litter size than most other bats, ranging from one to five young. The Eastern Red Bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. Once one of the most abundant bats in many parts of their range, Eastern Red Bats appear to have declined dramatically over the last 100 years. Little was known about the Vermont population based on traditional survey methods. However, since the development of wind energy facilities in Vermont, data from fatality monitoring below operating turbines has added to population distribution information. Eastern Red Bats are the third most-commonly reported species found dead below turbines in Vermont's operating wind facilities (Sheffield, Lowell, and Georgia) during surveys conducted between April and October. Wind energy development is an increasing threat to this species, especially during fall migration. In addition, this species may be vulnerable to climate change as violent spring and autumn thunderstorms reportedly account for a large percentage of Eastern Red Bat deaths to migrating individuals and to females that are hesitant to separate from young during the birthing season (Leclaire et al. 2009).

Distribution

Capture records exist from around the state. Data from mortality surveys below operating wind turbines in Sheffield, Lowel, and Georgia have provided new occurance data for this migratory species, as well as acoustic data from 2010 to 2014. The eastern red bat appears to be widespread throughout Vermont, though very little is known about how abundant or how evenly distributed they are in the state. This species migrates south for the winter.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Eastern Red Bat**
Scientific Name: **Lasiurus borealis**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The eastern red bat is a solitary rooster which often hangs by one foot from branches in the foliage appearing as dead leaves in the crown of the tree. It prefers older forests with dense canopy foliage and open understory as well as hedgerows with elms and eastern red cedar stands. They are fast flyers that forage in open areas along hedgerows and field edges. Eastern red bats are also frequently observed foraging around lights in rural and suburban areas. The eastern red bats migrate south to Gulf states to hibernate. Tree bats such as the red, silver-haired, and hoary are the least studied of the bats and little is known about their status or habitat needs in Vermont. Eastern red bats feed on moths, crickets, flies, mosquitoes, beetles, cicadas, and other insects. Micro Habitat: red cedar

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Hardwood Swamps

Seeps and Pools

Shrub Swamps

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Powerlines/RR/Roadsides

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Common Name: **Eastern Red Bat**
Scientific Name: **Lasiurus borealis**
Species Group: **Mammal**

Climate Change

Description of habitat threat(s): Problems include conversion/degradation of forest habitat, as well as, rural development leading to loss of mature forest. Loss of American elms, a major roost tree, may be a continuing factor in the decline of the red bat. Because red bats are migratory, they could be limited by wind and radio towers as well as powerlines. Wind energy development causes significant direct mortality to this species through colisions with turnbine blades and barotrauma. this species may be vulnerable to climate change as violent spring and autumn thunderstorms reportedly account for a large percentage of eastern red bat deaths to migrating individuals and to females that are hesitant to separate from young during the birthing season (LeCLaire et al. 2009). Predators include several kinds of birds including blue jays therefore increased suburbanization could increase loss to predation.

Non-Habitat Threats:

Genetics

Disease

Loss of Prey Base

Description of non-habitat threat(s): Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats. This normally solitary species is more vulnerable to population impacts when concentrated in the spring and fall migration.

Common Name: **Eastern Red Bat**
Scientific Name: **Lasiurus borealis**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Collect baseline data on habitat requirements
Research	Basic Life History	Low	Research possibility of food competition and partitioning between red, hoary, silver-haired and eastern pipistrelle bats.
Research	Distribution and Abundance	High	Collect baseline data on distribution and abundance in Vermont
Research	Threats and Their Significance	High	Collect mortality data from wind energy facilities.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	Research the effects of pesticides on mortality and reproductive success.
Monitoring	Population Change	High	Monitor changes in abundance after the onset of operating wind turbines in the Northeast.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Monitor changes in migratory patterns after habitat conversion of ridgelines and direct mortality due to wind development.
Monitoring	Monitor Threats	High	Research migratory patterns and impacts from power lines, wind towers, and road mortality

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	High	Design, standardize, and implement mitigation guidelines, such as curtailment regimes, to decrease the threat of and direct take from wind energy development in Vermont.	Percentage of operating wind turbines that meet minimum mitigation guidelines.	Bat Wind Energy Cooperative, USFWS, USFS, Wind energy companies	Wind industry, USFWS, ENDG

Common Name: **Eastern Red Bat**
Scientific Name: **Lasiurus borealis**
Species Group: **Mammal**

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Saunders, D. Andrew. 1980. Adirondack Mammals. Adirondack Wildlife Program, State University of New York (College of Environmental Science and Forestry - Syracuse). 216 pp.

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Shump, K. A., Jr., and A. U. Shump. 1982. Lasiurus borealis. Mammalian Species, 183:1-6.

Common Name: **Hoary Bat**
Scientific Name: **Lasiurus cinereus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3B
Extirpated in VT? no
Global Trend:
State Trend: unknown
Regional SGCN? Yes

Assessment Narrative:

Hoary Bats are the largest bats of northeastern North America. The range-wide population has declined significantly since 1900. Historically, few records existed for this species in Vermont, due largely to the difficulty in capturing this fast, high-flying species in nets. Due to their solitary nature, we know the least about the three tree bat species in Vermont (red, hoary, and silver-haired). However, capture records, combined with more recent acoustic survey and wind mortality data indicate that this species is wide-spread throughout Vermont. The Hoary Bat has been identified as a Very High Concern Regional Species of Greatest Conservation Need. Add statements about wind mortality. Hoary Bats are the most commonly reported species found dead below turbines in Vermont's operating wind facilities (Sheffield, Lowell, and Georgia) during surveys conducted between April and October. Wind energy development is an increasing threat to this species, especially during fall migration (Leclaire et al. 2009).

Distribution

Capture records from Thetford, Springfield, Orwell, Brandon, Salisbury, and historic record from Rutland. Data from mortality surveys below operating wind turbines in Sheffield, Lowel, and Georgia have provided new occurance data for this migratory species, as well as acoustic data around the state from 2010 to 2014. The Hoary Bat appears to be widespread throughout Vermont, though very little is known about how abundant or how evenly distributed they are in the state. This species migrates south for the winter.

Distribution by Biophysical Region:

Champlain Valley	Historic Record(s) Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

In the summer, during the day, Hoary Bats may stay concealed in the foliage of trees, well-concealed but with an open understory, generally 10 to 17 feet above the ground and often on the edge of a clearing. They emerge after dark to feed and may make round trips of up to 24 miles to forage. They forage over wetlands, openings, lakes and edges. They are fast flyers. Northern populations make long seasonal migrations to and from warmer winter habitats in the southern United States or Mexico. The sexes are segregated throughout most of the summer range. Foods include moths, true bugs, mosquitoes, and other insects. Hoary Bats have two young in mid-May through June or July. Females are solitary roosters and roost exclusively in trees. They may roost in the same tree in subsequent years.

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Powerlines/RR/Roadsides

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Energy Infrastructure and Development

Habitat Alteration

Description of habitat threat(s): Problems include conversion/degradation of forest habitat, as well as rural development leading to loss of mature forest. Because Hoary Bats are migratory, they could be impacted by wind and radio towers as well as powerlines. Wind energy development causes significant direct mortality to this species through colisions with turnbine blades and barotrauma. Predators include several kinds of birds including blue jays therefore increased suburbanization could increase loss to predation

Non-Habitat Threats:

Common Name: **Hoary Bat**
Scientific Name: **Lasiurus cinereus**
Species Group: **Mammal**

Genetics

Disease

Description of non-habitat threat(s): Pesticides and environmental poisons have had negative impacts on, and increased the mortality rates of, bat populations. Bats store some lipophilic pesticides in brown adipose fat tissues. These stores are released as bats use their fat reserves during hibernation. Depending upon tissue levels of the pesticide, as well as the amount of fat used over a given time period, bats can be exposed to both chronic and acute poisoning which can result in death. At lower levels, chronic poisoning may raise a bat's metabolism, burning the limited fat resources more quickly and possibly causing them to starve to death. In addition, broad spectrum insecticides can deplete insect diversity and limit the food sources available for bats. This normally solitary species is more vulnerable to population impacts when concentrated in the spring and fall migration.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	High	Collect baseline data on habitat requirements.
Research	Basic Life History	Low	Research the possibility of food competition and partitioning between red, hoary, silver-haired and eastern pipistrelle bats.
Research	Distribution and Abundance	High	Collect baseline data on distribution and abundance in Vermont
Research	Threats and Their Significance	High	Collect mortality data from wind energy facilities.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Research	Other Research	Low	Research the effects of pesticides on mortality and reproductive success.
Monitoring	Population Change	High	Monitor changes in abundance after the onset of operating wind turbines in the Northeast.
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Medium	Monitor changes in migratory patterns after habitat conversion of ridgelines and direct mortality due to wind development.
Monitoring	Monitor Threats	High	Research migratory patterns and impacts from power lines, wind towers, and road mortality

Common Name: **Hoary Bat**
Scientific Name: **Lasiurus cinereus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	High	Design, standardize, and implement mitigation guidelines, such as curtailment regimes, to decrease the threat of and direct take from wind energy development in Vermont.	Percentage of operating wind turbines that meet minimum mitigation guidelines.	Bat Wind Energy Cooperative, USFWS, USFS, Wind energy companies	Wind industry, USFWS, ENDG

Common Name: **Hoary Bat**
Scientific Name: **Lasiurus cinereus**
Species Group: **Mammal**

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Common Name: **New England Cottontail**
Scientific Name: **Sylvilagus transitionalis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G4	**Global Trend:**	
State Rank:	SU	**State Trend:**	Unknown
Extirpated in VT?	no	**Regional SGCN?**	yes

Assessment Narrative:

The New England cottontail is rare, possibly extirpated in Vermont. The New England Cottontail is the only rabbit native to the northeastern United States east of the Hudson River Valley of New York including New England. It's range has contracted by an estimated 86% since 1960. Outside of Vermont, only five smaller populations occupy its historic New England range. The cottontail is recognized as a SGCN in the Wildlife Action Plans of all New England States and New York. In 2006 it was designated a candidate for listing under the federal Endangered Species Act

The New England Cottontail is listed as a Regional Species of Greatest Conservation Need among the 13 Northeastern states. A regional effort has been mounted to restore the New England Cottontail ((http://www.newenglandcottontail.org/).

The New England cottontail was abundant in Vermont prior to the 1940s, however, the species was last documented in the state in 1946. Widespread introductions of the eastern cottontail (Sylvilagus floridanus) and habitat changes have resulted in apparent competition and possibly hybridization with eastern cottontails. Despite concerted trapping efforts in Vermont, no evidence of New England cottontails has been found since 1991.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Not Probable	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Historic Records Only	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Not Probable		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

New England cottontails are associated with many types of vegetation but are most often found in early successional old fields, 10-25 years post-disturbance with high stem density (9000-10,000 stems/hectare). It is critical that patches of dense hardwood and softwood shrubs, seedlings and saplings at least .5 meters tall and less than 7.5 meters in diameter be closely spaced to facilitate usage. Connectivity between patches is also important. Isolated patches are much less frequently used (Tumosa 2001). New England cottontails seldom

Common Name: **New England Cottontail**
Scientific Name: **Sylvilagus transitionalis**
Species Group: **Mammal**

venture far from dense cover and in winter will inhabit larger patches (greater than 10 ha) (DeGraff and Yamasaki, 2001). They cannot colonize areas already inhabitant by Eastern cottontail. Home ranges can be linear along riparian areas, roadsides etc.

Habitat Types:

Early Succession Boreal Hardwoods

Early Succession Pine and Hemlock

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Invasion by Exotic Species

Description of habitat threat(s): Fragmentation and isolation of patches results in lower survival rates and skewed sex ratios and increases vulnerability to extirpation due to chance events (natureserve.org). Habitat patches less than 3 acres in size increases the risk of predation. Decline in patch size (less than 15-75 ha) and increase in juxtaposition (greater than 500m) reduces survivability of New England cottontails. Loss of 10-25 year post-disturbance habitat due to conversion, succession and fragmentation also negatively influences New England cottontail recovery. Competition from eastern cottontail is also a problem. The eastern cottontail will occupy a habitat first and exclude NE Cottontail.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition with eastern cottontail is widely recognized as a limiting factor for New England cottontail populations.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Determine habitat requirements in Vermont.
Research	Distribution and Abundance	Medium	Continue to monitor for occurrence in likely Vermont habitats.
Research	Taxonomy	Medium	Genetically test trapped rabbits to determine distribution of floridanus vs. transitionalis
Monitoring	Monitor Threats	Medium	Monitor changes in early successional habitats in regards to size, age, and juxtapositon

Common Name: **New England Cottontail**
Scientific Name: **Sylvilagus transitionalis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	High	Support the implementation of the Conservation Strategy for the New England Cottontail (Fuller and Tur 2012)		Other New England states, VLT, TNC, USFWS	SWG, PR
Ex-Situ Conservation		Identify regional refugia until habitat can be developed w/in a state. Maintain isolated populations until a long-term plan is developed.	Number of isolated populations conserved. Number of regional refugia conserved.	Other New England states, VLT, TNC, USFWS	SWG, PR

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Snowshoe Hare**
Scientific Name: **Lepus americanus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? No

Global Trend:
State Trend: Declining
Regional SGCN? no

Assessment Narrative:

The Snowshoe Hare experiences cyclical population changes on a10-year period mostly in the northern parts of its range. Populations near the southern limits of its range, including Vermont, are believed to be less cyclical. Early successional softwood and mixed softwood- hardwood patches are critical habitats. Dense softwood and hardwood understory cover is highly important as it provides feeding, escape, and thermal cover for hares (Carreker 1985, Litvaitis et al. 1985). Forest succession and an overall decrease in active forest management practices in recent decades (Morin et al. 2014) has led to a reduction in suitable habitat and a decline in the state and regional Snowshoe Hare populations. Furthermore, changes in the climate that produce anomalously warm temperatures and decreased snowfall may diminish the hares' competitive advantages leading to higher predation rates and chronic declines in hare abundance (Schmitz et al. 2003). Consequently, lower hare populations may affect other wildlife species that rely on abundant hare populations as a source of prey (Chapman and Feldhamer 1982). The Snowshoe Hare is a keystone species in the northern transitional and boreal forest. If it should disappear, many species of predators would go with it and the structure of the plant community would be altered substantially (Krebs et al. 2001).

Distribution

The Snowshoe Hare was formerly found throughout Vermont with highest populations found in the mountains and lowland swamps (Foote 1946). Clearing of the land for agriculture and the introduction of the eastern cottontail have reduced hare habitat and populations especially in the Champlain and Connecticut River Valleys where hares currently exist only in larger forested blocks away from agriculture and development. The species is currently more commonly found in the Green Mountains, Taconic Mountains, and the northeastern part of the state. Hare populations generally increase from south to north in the state.

Distribution by Biophysical Region:

Champlain Valley	Probable	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Prefers large expanses of forest habitat,with low brushy cover and needs diverse forest size/age classes for feeding and cover.

Common Name: **Snowshoe Hare**
Scientific Name: **Lepus americanus**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Hardwood Swamps

Softwood Swamps

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Current Threats

Habitat Threats:

Habitat Succession

Climate Change

Description of habitat threat(s): The natural succession of forests, particularly with respect to an observed decrease in active forest management across the region, is believed to be the leading cause of snowshoe hare population declines (DeGraaf & Yamasaki 2001). The availability of suitable cover and sufficient quantities of preferred browse plays an important role in hare productivity and survival (DeGraaf & Yamasaki 2001). Although the potential effects of climate change on this species are poorly understood, it is widely speculated that a warming climate could impact the species' ability to persist due to decreased snowfall and commensurate shifts in predator communities.

Description of non-habitat threat(s):

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	High	Collect Snowshoe Hare baseline data on the distribution and abundance in Vermont.
Research	Threats and Their Significance	Medium	Evaluate current forest management trends in Vermont and assess implications for Snowshoe Hare.
Research	Other Research	Medium	Evaluate uneven aged forest management techniques to determine if the habitat needs for snowshoe hare can be achieved and at what population density.
Monitoring	Population Change	Medium	Develop and implement a hare monitoring protocol in the state for evaluating population trends over time
Monitoring	Habitat Change	High	Periodically perform quantitative assessments of hare habitat in Vermont in order to detect trends and evaluate effectiveness of conservation strategies.
Monitoring	Range Shifts	Low	Develop and implement a protocol for monitoring range shifts in carnivores as a result of a changing climate.
Monitoring	Monitor Threats	Low	

Common Name: **Snowshoe Hare**
Scientific Name: **Lepus americanus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Determine snowshoe hare population goal in the state that can sustain Canada Lynx and other carnivores and recreational hunting.		USFWS, WMI, UVM	PR
Policy & Regulations	High	Support and cooperate with regional efforts to curb the effects of climate change via the development and implementation of appropriate policy and regulations.			
Publically-Owned Protected Areas	High	Use even age management methods to increase young softwood and young mixed softwood/hardwood forests on state and federal lands.	Number of acres of early successional habitat in VT Forest Inventory Analysis (USFS).	ANR, USFS, USFWS, Coverts, RGS, WMI	PR,SWG
Conservation Payments/Financial Incentives	High	Encourage private landowners to use even age management methods to increase young softwood and young mixed softwood/hardwood forests through incentive programs (e.g., Current Use, USDA Wildlife Habitat programs).	Number of acres of early successional habitat in VT Forest Inventory Analysis (USFS).	ANR, USFS, USFWS, NRCS, Coverts, RGS, WMI, private landowners	PR, NRCS

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Common Name: **Southern Flying Squirrel**
Scientific Name: **Glaucomys volans**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S4	**State Trend:**	stable
Extirpated in VT?	no	**Regional SGCN?**	no

Assessment Narrative:

Species is listed as S4 and is apparently secure but little is known about this species or population trends in the state. Generally less is known about flying squirrels than other squirrels because of their nocturnal habits. Southern flying squirrels are expanding their range northward and have recently been documented from the Northeastern Highlands (Kilpatrick and Benoit 2011). Although the number of sites where the northern and southern flying squirrels occur in sympatry in the state are limited (Kilpatrick and Benoit 2011), increase competition for nest sites (tree cavities) may occur. While it is expected that the southern flying squirrel will dominate in these situations (Wells-Gosling and Heaney 1984), limited empirical data from field studies are available.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Probable	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

In the eastern United States the southern flying squirrel is usually found at lower elevations in deciduous forests (Dolan and Carter 1977). In the northern areas of its range it also inhabits mixed woodlands of hardwoods and conifers, particularly where hardwoods predominate (Dolan and Carter 1977). Individuals and family groups require several nests; a primary nest (usually a tree cavity) that is used more or less continuously and several secondary nests (often stick nest) that serve as sheltered stations for feeding and defecating (Muul 1968). The availability of nest sites may be a limiting factor of population size (Muul 1968).

Habitat Types:

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Common Name: **Southern Flying Squirrel**
Scientific Name: **Glaucomys volans**
Species Group: **Mammal**

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Climate Change

Description of habitat threat(s): Although little is known about the potential habitat related threats to this species, it is believed southern flying squirrels are vulnerable to the degradation of preferred habitats resulting from climate change, forest pests, and forestry practices. Habitat threats of this nature are of particular concern with respect to the availability of sufficient quantities of large diameter deciduous trees with cavities suitable for use as nesting sites.

Non-Habitat Threats:

Trampling or Direct Impacts

Description of non-habitat threat(s): Southern flying squirrels are known to occupy residential structures with some frequency. Pest control professionals often respond to complaints of nuisance squirrel behavior via lethal control measures.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	High	Determine distribution and abundance by conducting targeted surveys and through collaboration with pest control professionals
Monitoring	Population Change	Medium	Monitor for changes in population by periodically assessing the species distribution and abundance

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Develop guidelines for pest control professionals for the non-lethal control of the species	Change in the number of trained pest control professionals	Pest Control Professionals	SWG
Standards	Medium	Develop guidelines for retention of suitable cavity trees on public and private forest land	Change in the number of suitable cavity trees retained	VFPR	SWG
Research	High	Monitor distribution and abundance of species	Distribution map	UVM, Pest Control Professionals	SWG

Common Name: **Southern Flying Squirrel**
Scientific Name: **Glaucomys volans**
Species Group: **Mammal**

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Common Name: **Northern Flying Squirrel**
Scientific Name: **Glaucomys sabrinus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S4 **State Trend:** stable
Extirpated in VT? no **Regional SGCN?** no

Assessment Narrative:

The Northern Flying Squirrel has a state rarity rank of apparently secure (S4) but little is known about its biology, population and threats within the state. Northern flying squirrels are cavity nesters that frequently nest in woodpecker holes (Wells-Gosling and Heaney 1984). Although they also use non-cavity stick nests, these exposed structures are unsuitable as winter nests, requiring the utilization of cavities during winter months (Cowan 1936). Experimental studies (Weigl 1977) have shown that the smaller southern flying squirrel (Glaucomys volans) is dominant and more aggressive sometimes displacing northern flying squirrels from nest boxes. The northern range expansion of the southern flying squirrel may have several negative impacts on populations of northern flying squirrels. The southern flying squirrel may have a greater ability to locate and dominate tree cavities thus displacing northern flying squirrels from hardwood forest (Wells-Gosling and Heaney 1984). Furthermore, in areas where the two species are sympatric, the earlier breeding southern flying squirrel may have an advantage by being the first to occupy tree cavities as nest sites for their young (Wells-Gosling and Heaney 1984). Additionally, southern flying squirrels have a parasite (Strongyloides sp.) that appears to be debilitating or lethal to northern flying squirrels (Weigl 1977). Finally, the dietary requirements of northern flying squirrels are not understood. These squirrels cannot be maintained on a diet of spruce seed (Brink and Dean 1966). Fungi and lichens may be the predominant or only foods eaten at certain times of the year (Cowan 1936, Connor 1960, McKeever 1960, Wrigley 1969, Maser et al. 1978, Mowrey et al. 1981, Maser et al. 1985, Mayer et al. 2005)

Distribution

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Historic Records
Northern Green Mtns	Confident	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Historic Records
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Known to inhabit a wide variety of woodland habitats including spruce-fir and mixed hemlocks and adjacent mature hardwoods (Weigl 1978). Under experimental conditions, Weigl (1978) found that northern flying squirrels would select for either deciduous or coniferous habitat whereas the southern flying squirrel strongly selected deciduous habitat. Given the southern flying squirrels ability to displace northern flying squirrels from

Common Name: **Northern Flying Squirrel**
Scientific Name: **Glaucomys sabrinus**
Species Group: **Mammal**

tree cavities, northern flying squirrels are likely displaced from hardwood forest in areas where the two species are sympatric. Northern flying squirrels require mature trees with cavities for winter nest sites (Cowan 1936). The species feeds on hypogeous fungi in the summer and arboreal lichens and hypogenous fungi in the winter (DeGraff et al, 1986, Rosentreter et al. 1997, Curran et al. 2000, Vernes et al. 2004).

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Climate Change

Description of habitat threat(s):

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Predicted changes in the climate may allow the southern flying squirrel population to shift northward thereby increasing competition with northern flying squirrels. Increased competition for suitable nesting cavities may be amongst the most significant impact resulting from climate change particularly with respect to the outright loss of nest cavities and/or the displacement from the use of nest cavities. Climate change may also limit northern flying squirrel populations by influencing the abundance of key dietary requirements such as lichen and fungi.

Increased sympatry with southern flying squirrels may result in the spread of parasites to northern flying squirrels. Although the intestinal nematode, Strongylorides robustus, infects both southern and northern flying squirrels, it is more prevalent in southern flying squirrels (Wetzel and Weigl 1994) and appears to be more deleterious to northern flying squirrels (Pauli et al. 2004).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	High	Monitor distribution and abundance of this species.
Research	Threats and Their Significance	Medium	Determine the prevalence of the Strongylorides robustus parasite in flying squirrel populations in Vermont
Monitoring	Range Shifts	High	Monitor changes in the distribution of flying squirrels to determine the degree of sympatry.

Common Name: **Northern Flying Squirrel**
Scientific Name: **Glaucomys sabrinus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Standards	Medium	Develop guidelines for retention of suitable cavity trees on public and private forest land.	Change in the number of suitable cavity trees retained	VFPR	SWG, PR
Research	High	Monitor distribution and abundance of species	Distribution maps	UVM	SWG, PR

Common Name: **Northern Flying Squirrel**
Scientific Name: **Glaucomys sabrinus**
Species Group: **Mammal**

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Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S2
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? No

Assessment Narrative:

Ranked as S2 in Vermont and considered a species of special concern. Talus slopes are the species' refugal habitat. In some locations, rock voles may be found in early successional forest habitat (Kirkland 1977; Martell and Radvanyi 1977) and krumholtz. There is uncertainty as to why the population fluctuates so much and there are relatively few known populations. The relatively narrow habitat requirements of this species make it vulnerable to habitat alterations. Furthermore, because rock voles occur in disjunct populations, it is dependent upon movement corridors. It is also speculated that these disjunct populations could be negatively impacted by landscape changes that favor the meadow vole (Microtus pennsylvanicus) which is a suspected competitor of the rock vole.

Distribution

There are a number of historic records indicating the species' existence and distribution in the state. These records include: 20 specimens from Island Pond at 1400' elevation (1937-1940); two specimens from Brighton on the talus slopes of NW Bluff Mountain (1953); one specimen from near Smugglers cave, Mt. Mansfield (1954); four specimens from Nebraska Notch, Mt. Mansfield (1958-1959); and two specimens (one male and one female) from Nebraska Notch, Mt Mansfield (1966). More contemporary records of the rock vole in Vermont include: Whenlock WMA (Chipman, 1994); West Mountain WMA (Kilpatrick, 2001); East Mountain, East Haven (Kilpatrick, 2005), and East Charleston (Kilpatrick, pers. comm.). The Vermont Small Mammal Atlas also recorded six specimens from four sites in Essex and Caledonia counties between 2008 and 2010 (Kilpatrick and Benoit 2011). Unknown populations were verified inhabiting talus slopes on Brousseau Mountain (Averill, Essex Co.), Umpire Mountain (Victory, Essex Co.) and Wheeler Mountain (Sutton, Caledonia Co.) and the population from West Mountain WMA was verified to still exist (Kilpatrick and Benoit 2011).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Historic Records Only	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Occurs in disjunct populations that are not genetically differentiated so movement corridors may be important. This species is very habitat selective. They use moist talus habitats among mossy rocks and logs in spruce/ fir and northern hardwood forests, cedar swamps, and krummholz. May be naturally rare due to habitat specificity. Rock vole has been reported in three-five year old clearcuts with slash however, not in Vermont. Critical habitat includes cool, moist talus and mossy rocks usually with a stream or other surface water in the immediate vicinity.

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Mesic aspect of habitat is important so the loss of forest cover may dry out the site. Loss of connectivity may be a problem. Habitat is isolated and local populations may go extinct. Repopulation may require habitat corridors of coniferous forests that connect optimal habitats. Activities that destroy or degrade talus habitat would impact rock vole populations.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition from meadow mouse as a result of habitat conversion, particularly near talus areas, could limit the rock vole. Metapopulation structure is not clearly understood but local populations appear to go extinct and then are repopulated. In Massachusetts and West Virginia populations were negatively affected by high levels of deer over the long term (Healey and Brooks 1988).

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: S2
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? No

Assessment Narrative:

Ranked as S2 in Vermont and considered a species of special concern. Talus slopes are the species' refugal habitat. In some locations, rock voles may be found in early successional forest habitat (Kirkland 1977; Martell and Radvanyi 1977) and krumholtz. There is uncertainty as to why the population fluctuates so much and there are relatively few known populations. The relatively narrow habitat requirements of this species make it vulnerable to habitat alterations. Furthermore, because rock voles occur in disjunct populations, it is dependent upon movement corridors. It is also speculated that these disjunct populations could be negatively impacted by landscape changes that favor the meadow vole (Microtus pennsylvanicus) which is a suspected competitor of the rock vole.

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Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Historic Records Only	**Vermont Valley**	Not Probable
Northern Green Mtns	Confident	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Occurs in disjunct populations that are not genetically differentiated so movement corridors may be important. This species is very habitat selective. They use moist talus habitats among mossy rocks and logs in spruce/ fir and northern hardwood forests, cedar swamps, and krummholz. May be naturally rare due to habitat specificity. Rock vole has been reported in three-five year old clearcuts with slash however, not in Vermont. Critical habitat includes cool, moist talus and mossy rocks usually with a stream or other surface water in the immediate vicinity.

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Habitat Alteration

Description of habitat threat(s): Mesic aspect of habitat is important so the loss of forest cover may dry out the site. Loss of connectivity may be a problem. Habitat is isolated and local populations may go extinct. Repopulation may require habitat corridors of coniferous forests that connect optimal habitats. Activities that destroy or degrade talus habitat would impact rock vole populations.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Competition from meadow mouse as a result of habitat conversion, particularly near talus areas, could limit the rock vole. Metapopulation structure is not clearly understood but local populations appear to go extinct and then are repopulated. In Massachusetts and West Virginia populations were negatively affected by high levels of deer over the long term (Healey and Brooks 1988).

Common Name: **Rock Vole**
Scientific Name: **Microtus chrotorrhinus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Basic Life History	Medium	Telemeter to determine home range movements
Research	Distribution and Abundance	High	Determine distribution and abundance as well as corridor needs
Research	Population Genetics	Medium	Research genetics to determine changes in population structure and size.
Research	Other Research	High	Determine appropriate management strategies to improve and conserve habitat.
Monitoring	Population Change	Medium	In a multi year monitoring effort, re-census historical habitats and survey in other likely habitats and map confirmed habitats.
Monitoring	Monitor Threats	Medium	Monitor encroachment by medow mice.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	Medium	Minimize permanent fragmentation between populations.	Amount of habitat between populations protected or conserved.	UVM	SWG

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Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S3
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? no

Assessment Narrative:

The woodland vole is frequently considered a pest in agricultural settings (especially in apple orchards) though much of the reported damage is the result of meadow voles (Microtus pennsylvanicus). Despite appearing to do well in agricultural landscapes, little is known about this species outside this setting or in its native habitat. Fewer than 50 specimens have been collected in the state and is known historically from very few localities .

Distribution

Known historically from very few localities including the flanks of Ide Mountain, West Lyndon Center (Miller, 1964); Island Pond (Miller, 1964); Sherburne (Osgood, 1936); and from Colchester and Duxbury (Kilpatrick, pers. com). Woodland voles occur in orchards in Putney, Mendon, and Bennington (Kilpatrick, 1979). The Vermont Small Mammal Atlas obtained two specimens from two localities in Orleans and Windsor counties from 2008 to 2010; one was trapped in the Skitchewaug WMA (species verified by DNA sequencing) and another collected from a garden in Charleston (Kilpatrick and Benoit 2011). Records were also verified from Addison County and Chittenden County (Kilpatrick and Benoit 2011).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Probable	**Vermont Valley**	Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Probable
Northern VT Piedmont	Confident	**Taconic Mtns**	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Defining habitat characteristic of the woodland vole is well-drained sandy loam soils. Found in all places with these soils (e.g. agricultural fields and older forests). Favors well-drained upland forests, grasslands, meadows, or orchards but can be found in marshes and swamps (DeGraff and Yamasaki, 2001). May require a ground cover of leaves or duff or grass. Forages primarily below ground digging tunnel systems 3 inches to 12 inches below ground. Nests are found under dead and down material, rocks, or in burrows. They are active throughout the year and eat tubers, roots and bulbs, seeds, nuts fruits, bark and leaves (DeGraff and Yamasaki, 2001). Can be a problem in orchards.. Prefers large expanses of forest and grassland habitats,

Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Lawns, Gardens, and Row Crops

Current Threats

Habitat Threats:

Unknown Habitat Threats

Description of habitat threat(s): Habitat requirements unknown.

Non-Habitat Threats:

Trampling or Direct Impacts

Pollution

Description of non-habitat threat(s): Because of human/vole conflicts, the application of rodenticides may cause a decline of this species in orchards and other developed lands. The status of the wooland vole in forested habitats is unknown.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Develop baseline data on habitat requirements outside of agricultural areas.
Research	Distribution and Abundance	Medium	Develop baseline data on distribution and abundance outside of agricultural areas.

Species Strategies

Strategy Type	*Strategy Priority*	*Strategy Description*	*Performance Measure*	*Potential Partners*	*Potential Funding Sources*
Standards	Medium	Develop guidelines for pest control professionals for the non-lethal control of the species.	Number of trained pest control professionals	Agricultural extension, Pest Control Professionals	SWG

Common Name: **Woodland Vole**
Scientific Name: **Microtus pinetorum**
Species Group: **Mammal**

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Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? no

Global Trend:
State Trend: Declining
Regional SGCN? no

Assessment Narrative:

The muskrat has traditionally been one of the most heavily exploited furbearers in North America owing to its abundance, relative ease of capture and highly prized fur (Boutin and Birkenholz 1987). Across its range today, most jurisdictions, including Vermont, maintain regulated trapping and hunting seasons for the species. The muskrat plays an important ecological role serving as a significant prey source for a variety of predators including raptors, river otter and American mink (Holmengen et al 2009). In recent decades, anecdotal evidence indicates a nationwide decline in muskrat populations. Such noted declines have been most prominent in the northeast. Despite much knowledge regarding the biology and management of muskrats, little empirical evidence exists indicating either the magnitude of such declines and/or any possible contributing factors (Roberts and Crimmins 2010).

Distribution

Muskrat harvest records in Vermont indicate well established populations in all major watersheds.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds
Middle Connecticut
West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
Passumpsic

Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

St. Francois River

Upper Connecticut

White

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Muskrats occupy almost every type of freshwater aquatic habitat in eastern North America (Boutin and Birkenholz 1987). Muskrat have flexible habitat requirements as long as there is permanent water and protection through burrows and vegetated lodges. Highest population densities exist where emergent vegetation is at a 1:1 ratio to open water.

Habitat Types:

Marshes and Sedge Meadows

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Invasion by Exotic Species

Unknown Habitat Threats

Description of habitat threat(s): Although the specific effects of habitat alteration on muskrats are poorly understood, the anthropogenic degradation of muskrat habitat is widely recognized as a potential contributing factor to the decline of populations throughout the region. Increased sedimentation and stream flashiness resulting from poorly planned land management and/or excessive development could, for example, alter the ratio of open water to emergent vegetation within watersheds to the detriment of muskrats. Similarly, human activities resulting in the spread of invasive plant species, such as phragmites, can cause a reduction in the abundance and diversity of native taxa, including muskrats, by creating monotypic stands.

Non-Habitat Threats:

Genetics

Loss of Relationship with Other Species

Predation or Herbivory

Description of non-habitat threat(s): Previous studies of contaminant levels in muskrats have shown that muskrats bioaccumulate heavy metals (Halbrook et al. 1993, Stevens et al. 1997). While the direct effects of such contaminants on muskrats remain uncertain, there is continued concern that the long-term persistence of such contaminents in the environment could limit muskrat populations. While the significance and magnitude of other non-habitat threats are poorly understood, it is speculated that changes in predatory communities, diseases and alterations of natural water cycles all potentially contribute to observed declines in muskrat populations regionally.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	High	Continue closely monitoring the distribution and abundance in Vermont
Research	Threats and Their Significance	High	Determine what factors may be influencing population declines, focusing in particular on pollution and habitat degradation.
Research	Other Research	Medium	Conduct a cause specific mortality study to aid in the identifiction of significant mortality factors in Vermont.
Monitoring	Monitor Threats	Medium	Monitor the accumulation of contaminants such as heavy metals and PCBs in the tissues of muskrats throughout all watersheds in Vermont.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Determine causes of observed declines in regional muskrat populations	Number of hypotheses evaluated	UVM, AFWA	SWG, PR
Policy & Regulations	Medium	Support and cooperate with regional efforts to curb pollution via the development and implementation of appropriate policy and regulations	Reduction in the prevalence of contaminants in Vermont's water bodies	DEC, EPA	
Compliance & Enforcement	High	Enforce existing laws with respect to water quality protection	Increased compliance with existing laws	DEC, EPA	
Compliance & Enforcement	High	Enforce existing laws with respect to riparian and wetland habitat protection	Area and/or linear distance of riparian and wetland habitat protected	DEC, EPA, USACE	
Invasive Species Control & Prevention	Medium	Identify and restore muskrat habitat impaired by invasive plants, and develop and implement measures aimed at preventing further introduction of such species	Acreage of habitat restored and number of preventative measures adopted		

Common Name: **Muskrat**
Scientific Name: **Ondatra zibethicus**
Species Group: **Mammal**

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Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S3	**State Trend:**	Fluctuating
Extirpated in VT?	no	**Regional SGCN?**	yes

Assessment Narrative:

Although the southern bog lemming is relatively rare in collections, it is by no means an uncommon animal (Whitaker and Hamilton 1998). A number of historical records are available primarily for southern Vermont (Kirk 1916, Osgood 1938, Godin 1977). When combined with recent records (Brooks et al. 1998, Kilpatrick 2003, Decher and Kilpatrick 2005, Kilpatrick and Benoit 2011) some 268 specimens of the southern bog lemming confirm the occurrence at over 35 different localities throughout the state (see Kilpatrick and Benoit 2011). The species is believed to exist in scattered colonies that often inhabit only a small portion of the suitable habitat. Although little is known about potential threats to this species in Vermont, it is believed southern bog lemmings are vulnerable to changes in habitat, competition with meadow voles and to a variety of disease and parasites.

The southern bog lemming is listed as a Regional Species of Greatest Conservation Need (RSGCN) among the 13 Northeastern states.

Distribution

The southern bog lemming is known from throughout the state with the exception of Grand Isle, Franklin, and Orange Counties

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Historical Records
Champlain Hills	Confident	**Vermont Valley**	Historical Records
Northern Green Mtns	Confident	**Southern Green Mtns**	Historical Records
Northern VT Piedmont	Probable	**Taconic Mtns**	Historical Records
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

The southern bog lemming uses a wide variety of habitats in addition to sphagnum bogs, including wet meadows and marshes, grassy openings in woods, and among mossy boulders in spruce forests (Linzey 1983). In Southern Canada, New York and New England most captures are associated with sphagnum bogs or heavily forested areas (Coventry 1942, Goodwin 1932, Hamilton 1941). The southern bog lemming will use clearcuts and other small forest openings with adequate ground cover (Kirkland 1977). Recent small mammal surveys in Vermont (Kilpatrick and Benoit 2011) found southern bog lemming among small rock outcrop in a mesic spruce forest and in a red pine plantation. Doutt et al. (1973) suggested that the major feature common to Synaptomys habitats was that they were marginal for Microtus and Linzey (1981, 1984) documented

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

competitive exclusion of Synaptomys by Microtus in southwestern Virginia. Southern bog lemmings have been collected from hairy-tailed mole burrows (Eadie 1939).

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Climate Change

Description of habitat threat(s): Although little has been documented about the potential habitat related threats to this species, it is believed southern bog lemmings are vulnerable to the degradation of preferred habitats resulting from climate change, forest succession, and/or direct human impacts. Habitat threats are of particular concern with respect to a potentially drying climate and the direct loss of sphagnum bogs.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition from Microtus (meadow vole) in sites where habitat has been altered and/or forest succession has favored this species. Southern bog lemmings carry a heavy ectoparasite parasite load (Wassel et al. 1978) and several endoparasites have been confirmed (Erickson 1938, Whitaker and Adalis 1971).

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	Medium	Determine baseline information
Research	Distribution and Abundance	High	Determine baseline information
Monitoring	Population Change	High	1) Begin low-level monitoring in appropriate habitats to determine distribution, abundance, and population status and trends. 2) Better understand distribution, abundance and changes in population.

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	High	Monitor distribution and abundance of species	Distribution maps	UVM	SWG, PR

Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

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Common Name: **Southern Bog Lemming**
Scientific Name: **Synaptomys cooperi**
Species Group: **Mammal**

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Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G4
State Rank: SU
Extirpated in VT? no

Global Trend:
State Trend: Unknown
Regional SGCN? No

Assessment Narrative:

Although there are no historical or recent records of the northern bog lemming in Vermont, records are know from surrounding states including a recent specimen from Whiteface Mountain, NY (Sanderson 1988), and three specimens from New Hampshire including two from Coos Co., from Fabyans near the base of Mt Washington (Preble 1899) and Bean's Purchase (Yamasaki 1997) and one from Mt Moosilauke, Grafton Co. (Clough and Albright 1987). Five specimens have been verified from Maine from two localities in Piscataquis Co., one being Mt Katahdin and the other a low elevation site near the western border of Baxter State Park (Clough and Albright 1987). Additional specimens are known from Quebec (Cross 1938, Banfield 1974). The northern bog lemming is among the rarest mammals in New England and eastern Canada and is likely vulnerable to local extirpation (Banfield 1974). The subterranean habits of bog lemmings (Banfield 1974, Godin 1977, Degraff and Yamasaki 2001) likely results in infrequent captures of these rodents by traditional collecting methods. This, combined with the difficulty in identification (Clough and Albright 1987), probably contributes substantially to the rarity of northern bog lemmings in surveys and collections of small mammals. A recent small mammal survey in New Hampshire (Yamaski 1997) employing methods to increase the captures of several rare small mammal species captured a single northern bog lemming at one of the 108 sites surveyed. No northern bog lemmings were captured at the 51 sites recently surveyed in Vermont and none were identified among the southern bog lemming specimens examined (Kilpatrick and Benoit 2011). Despite a lack of evidence of the species in the state, Vermont appears to have viable habitat.

Distribution

Distribution by Biophysical Region:

Champlain Valley	Unknown	**Southern VT Piedmont**	Unknown
Champlain Hills	Unknown	**Vermont Valley**	Unknown
Northern Green Mtns	Unknown	**Southern Green Mtns**	Unknown
Northern VT Piedmont	Unknown	**Taconic Mtns**	Unknown
Northeastern Highlands	Unknown		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The northern bog lemming has been taken at high elevation sites (3700 - 4500 ft.) in spruce-fir forest with dense herbaceous and mossy understory and in alpine sedge meadows containing sphagnum and surrounded by dense spruce-fir Krummholtz (Clough and Albright 1987). At least two records are known from relatively low elevations (1300 - 1600 ft.) in New Hampshire from habitats ranging from a stand of spruce-budworm

Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

killed spruce-fir forest with a shrub and ground layer consisting of a dense covering of raspberry, ferns, and sedges, and having sphagnum moss in scattered damp places (Clough and Albright 1987) to a wet meadow and mossy streamside (Preble 1898). Habitat requirements included moist loose soils of leaf mold with sphagnum present (Banfield 1974, DeGraff and Yamasaki, 2001). Northern bog lemmings feed on grasses and sedges and use burrows several inches below the ground (Banfield 1974). They are active year round, in summer constructing spherical nest of dried grasses in burrows and in winter nesting on the ground (Banfield 1974).

Habitat Types:

Outcrops and Alpine

Spruce Fir Northern Hardwood

Softwood Swamps

Open Peatlands

Current Threats

Habitat Threats:

Conversion of Habitat

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Two hypotheses for the rarity of this species have been proposed by Clough and Albright (1987); northern bog lemmings require a habitat that is scarce and/or the species cannot coexist with other species of small mammals. Neither hypothesis is strongly supported by the available data. However, habitat conversion that results in the elimination of peat lands, sphagnum bogs and moist wooded areas with a solid floor of thick sphagnum could be a problem for the northern bog lemming. Climate change that results in increasing temperatures, could result in dryer habitats that would allow the meadow vole population to increase and thereby compete and displace northern bog lemmings. Development of roads, trails and powerlines could also provide access for meadow vole populations and result in increased competition with the northern bog lemming.

Non-Habitat Threats:

Competition

Description of non-habitat threat(s): Habitat changes that benefit the meadow vole could result in increased competition that negatively affects the northern bog lemming.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Determine habitat requirements. Map appropriate habitat.
Research	Distribution and Abundance	High	Conduct a dedicated search for northern bog lemming using species specific methods (pit fall traps and drift fences) in sphagnum-dominated vegetative communities.
Monitoring	Range Shifts	Medium	

Common Name: **Northern bog lemming**
Scientific Name: **Synaptomys borealis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Research	Medium	Conduct targeted surveys for northern bog lemmings.	Distribution map	UVM	SWG
Research	High	Determine habitat requirements	Map appropriate habitats	UVM	SWG

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Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G4	**Global Trend:**	
State Rank:	SX	**State Trend:**	N/A
Extirpated in VT?	Yes	**Regional SGCN?**	No

Assessment Narrative:

Believed to be extirpated in Vermont and the rest of New England. Based on bounty records, wolves were historically common in Vermont but were eliminated from the state by the mid to late 1800's as the result of a $20.00 bounty and habitat changes. There is uncertainty regarding the genetic ancestry of the wolves that inhabited the northeastern United States historically, including Vermont (Wilson et al. 2003, Koblmuller et al. 2009, Kays et al. 2009). Rigorous DNA analysis of additional historic samples from Vermont and the northeastern United States may help clarify this issue.

The wolf is currently considered extirpated in the Northeast but populations exist in southern Canada with potential for migrants to arrive in Vermont within next 20 years. However, the St. Lawrence River and adjacent agricultural/urban/suburban environments in southern Quebec and Ontario may pose substantial barriers. Additionally, dispersal rates for wolves in southern Ontario and Quebec appear to be relatively low and canids are harvested heavily in these regions, which will likely reduce the number of wolves successfully dispersing into New England (Wydeven et al. 1998). The ability of coyote hunters in the northeast to effectively discern wolves from coyotes in the field may also influence the likelihood of natural wolf recolonization. Recovery/reintroduction efforts are complicated by taxonomic uncertainty about the wolf or wolves that historically occupied the region, by public attitudes towards wolves, and by potential interactions with the eastern coyote. Regardless, populations of gray wolves, eastern wolves, and wolves of mixed ancestry in Ontario and Quebec are within plausible dispersal distance of Vermont (Wydeven et al. 1998, Fuller et al. 2003). Thus, it is possible that eastern and/or gray wolves enter Vermont periodically and the potential for natural recolonization of the state exists

Distribution

It is believed that wolves existed throughout Vermont prior to European settlement. This belief is supported by bounty records which clearly indicate the existence of wolves in nearly all biophysical regions of the state.

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Historic Records Only	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Historic Records Only	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Historic Records Only	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Historic Records Only		

Distribution by Watershed:

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Wolves are considered to be habitat generalists and usually select habitat to maximize predation success rather than for specific vegetation characteristics per se (e.g., Mech et al. 2003). Much of the suitable habitat for wolves in Vermont is likely forested, however wolves would be likely to occupy any patches of undeveloped terrestrial habitat that support adequate prey densities and where they are protected from human-caused mortality. Although wolves use a variety of habitat types across their range, they tend to occupy relatively contiguous patches of forests in remote areas with relatively low human and road densities (Mladenoff et al. 1995, Benson et al. 2012). Wolves require an adequate prey base to persist. Deer, moose, and beaver would likely be the main prey for wolves in Vermont Mladenoff and Sickley (1998) and Harrison and Chapin (1998) estimated that approximately 53, 500 to 58, 500 km2 of suitable habitat remains in northern New England. Mladenoff and Sickley (1998) further suggested that this habitat could support 702 to 1439 wolves. Harrison and Chapin (1998) suggested that 2470 km2 and 1430 km2 of suitable "core" and "dispersal" habitat, respectively, existed in Vermont based on road densities, human densities, and available forested habitat. Fuller et al. (2003) recommended that the smallest demographically viable wolf population might include 2-3 adjacent packs of 4 wolves each that were 40-60 km from other wolves. Thus, the 950 km2 of suitable core habitat estimated to exist in Vermont might support approximately 8 packs of 4 wolves at average ungulate densities (8 deer/ km2) with wolf territories of approximately 300 km2 (Fuller et al. 2003). Some of the core habitat identified by Harrison and Chapin (1998) is somewhat isolated in the central and southwestern portions of the state which might limit connectivity between patches. However, there is considerable evidence of wolves crossing highways and areas used intensively by humans in both Europe and North America (Merrill and Mech 2000, reviewed by Boitani 2003) suggesting that wolves might be able to successfully navigate the fragmented New England landscape. Mech (2006) found that Mladenoff and Sickely's predictive model for wolf recolonization in Wisconsin (and potentially for the Northeast) failed to account for the wolf's adaptability and capacity to colonize areas deemed <50% probable, including 22% of colonized areas with low probability. Additionally, Harrison and Chapin (1998) noted that much of the core habitat in Vermont is in the northeastern portion of the state and is contiguous with an expansive area of suitable habitat in New Hampshire, Maine, and Quebec meaning that wolves in Vermont could be connected with a larger regional population should recolonization occur. Territory size and density of wolves are strongly influenced by the availability of prey. Mean territory size is larger (>1000 km2) and smaller (< 200 km2) in areas with lower and greater prey densities, respectively (Mech and Boitani 2003, Fuller et al. 2003). Thus, the estimates for wolf numbers and territory sizes would likely shift depending on the local densities of deer and moose in areas of suitable habitat within Vermont. Regional corridors and habitat linkages are critical to maintaining wolves in potentially fragmented landscapes. Three important elements to wolf population viability are adequate prey, absence of excessive human exploitation, and relatively undeveloped blocks of habitat (Fritts and Carbyn 1995; Fuller 1997; Haight et al. 1998 in Parson 2003).

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Habitat Types:

Upland Shores

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Human activity associated with roads, vehicles, and houses seem to negatively influence use of an area by wolves. Conversion of forest and other natural habitat to non-forest (development and agriculture) also negatively affects wolf densities. Wolves cannot survive without adequate prey, adequate protection, and adequate public support (Theberge et al, 1996 in Tumosa 2003). Connectivity with other wolf packs in the region is important to recovery of wolves in the northeast. Potential core habitat in southern Vermont appears to be disconnected from core habitat in northeastern Vermont (Harrison and Chapin 1998).

Non-Habitat Threats:

Genetics

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Competition

Parasites

Harvest or Collection

Loss of Prey Base

Trampling or Direct Impacts

Description of non-habitat threat(s): Competition/hybridization with eastern coyotes may influence the probability of successful wolf recolonization of Vermont. Eastern wolves readily hybridize with eastern coyotes where they come into contact (e.g., Rutledge et al. 2010, Benson et al. 2012, Monzon et al. 2014). Hybridization would likely be rampant in Vermont between recolonizing eastern wolves (which would be at low density) and coyotes (which would be much more abundant). Conversely, gray wolves and admixed gray wolves such as those inhabiting Minnesota, Wisconsin, and Michigan have not been documented to hybridize with coyotes in the wild (e.g., Wheeldon et al. 2010). Thus, dispersing gray wolves from Quebec and Ontario may have a higher probability of avoiding genetic swamping from eastern coyotes and establishing a viable population in Vermont. The eastern coyote is now the dominant large canid predator in the Northeast and it is not clear how the existing coyote population would respond to the establishment of a wolf population. A better understanding of the ecological role of the eastern coyote in Vermont would help clarify the extent to which these smaller canids are able to occupy the ecological niche of wolves.

Thiel (1985) found that when wolves were persecuted by humans in Wisconsin populations did not persist where road densities exceeded approximately 1km/km2. However, with sufficient protection from human-caused mortality wolves have been documented persisting at road densities greater than 1km/km2 as public attitudes about wolves shifted (Mech 1989, Fuller et al. 1992, reviewed in Fuller et al. 2003). Thus, protection from hunting and trapping mortality may facilitate viable wolf populations in fragmented habitat with higher human population and road densities.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	Medium	Document and map the distribution of large wild canids based on DNA analysis.
Research	Population Genetics	High	Determine the genetics of large wild canids in Vermont and monitor wolf colonization events.
Research	Taxonomy	High	Determine the species of wolf historically found in Vermont.
Research	Other Research	High	Determine public attitudes towards wolves in Vermont and New England
Monitoring	Other Monitoring Needs	High	Monitor wolf colonization events

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	High	Determine public attitudes towards wolf recovery possibly by partnering with University researchers to conduct a rigorous evaluation of public opinions.		NWF, Keeping Track, Sportsmen's Federation, University researchers, wildlife educators	USFWS, SWG
Policy & Regulations	Medium	Develop statewide protocol to guide state/federal wildlife management actions in response to wolf immigration. Results of the species restoration strategy may provide information that can be used to reevalute the rank for this strategy in the future.	Degree to which partners adopt the protocols	USFWS, USFS, NWF, VTFSC, Agency of Agriculture, NRCS, Farm Bureau, RPCs, Law Enforcement ,	USFWS, SWG
Species Restoration	High	Evaluate VT large canid ancestry via DNA analysis/ morphology to monitor possible recolonization. Obtain tissue samples and morphological measurements from large canids trapped, shot, hit by cars, or otherwise observed in VT.		NWF, Keeping Track, Sportsmen's Federation, VTA,	NWF, USFWS, SWG
Compatible Resource Use	Medium	Develop and distribute outreach and educational materials to help hunters and trappers better distinguish between coyotes for wolves.	Literature, web-videos, public presentations, informational signs, media articles are all necessary for increased public awareness.	USFWs, VFWD, hunting and trapping organizations	VFWD, USFWS

Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

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Common Name: **Wolf**
Scientific Name: **Canis sp?**
Species Group: **Mammal**

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Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? no

Assessment Narrative:

Gray foxes are widespread throughout Vermont and occupy most major habitat types including forests, shrublands, agricultural areas, and the margins of urban environments. Despite being relatively common, little is known about basic characteristics of the species in the state, including distribution, demographics, diet and space use behavior, and interactions with other species. Similarly, little is known about threats facing the species. Gray foxes elsewhere are negatively impacted by competition from larger carnivores such as red foxes, coyotes, and bobcats, and diseases such as rabies and canine distemper. Gray foxes also appear to be expanding their range northward into Quebec.

Distribution

Gray Fox harvest records indicate a widespread distribution of the species in Vermont with records of occurrence in all biophysical regions.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Few studies have been undertaken on gray foxes regionally in New England and even range-wide, despite their widespread distribution and perception as a common species (Fuller and Cypher 2004). Studies elsewhere indicate that foxes occur in densities that range from 0.4/km2 (California) to 1.5/km2 (Florida), and that foxes occupy home ranges that vary in size from 75 ha (West Virginia) to 653 ha (Alabama) (Fritzell and Haroldson 1982, Fuller and Cypher 2004). In Vermont, a radio-telemetry study indicated that average gray fox home range size was 4.43 km2 in the Champlain Valley (n=5, 2 females/3 males, Ingle 1990). Gray foxes in this study occurred primarily in hardwood forested areas and avoided open habitats. Basic demographic estimates, such as density and population size, and home range/habitat use characteristics have not been adequately quantified in Vermont. Gray foxes elsewhere associate mainly with deciduous forest, but use other forest types, shrublands, agricultural lands, fields, and farmlands, and the margins of urban environments (Fritzell and Haroldson 1982). They typically use successional forests, habitat mosaics and managed woodlands.

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Habitat Alteration

Unknown Habitat Threats

Description of habitat threat(s): Unknown, but distribution and abundance appears to be linked to forest habitats. Changes in forest cover, especially deciduous forest, due to development (e.g., residential housing, roads, urban expansion) may impact the species in Vermont.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition and mortality from coyotes, bobcats, and red foxes represent potential threats. These three species have been shown to compete with gray foxes elsewhere (Chamberlain and Leopold 2005, Farias et al. 2005), and may negatively impact the species in Vermont. Diseases such as rabies and distemper represents another potential concern (Fuller and Cypher 2004).

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? No

Global Trend:
State Trend: Stable
Regional SGCN? no

Assessment Narrative:

Gray foxes are widespread throughout Vermont and occupy most major habitat types including forests, shrublands, agricultural areas, and the margins of urban environments. Despite being relatively common, little is known about basic characteristics of the species in the state, including distribution, demographics, diet and space use behavior, and interactions with other species. Similarly, little is known about threats facing the species. Gray foxes elsewhere are negatively impacted by competition from larger carnivores such as red foxes, coyotes, and bobcats, and diseases such as rabies and canine distemper. Gray foxes also appear to be expanding their range northward into Quebec.

Distribution

Gray Fox harvest records indicate a widespread distribution of the species in Vermont with records of occurrence in all biophysical regions.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Few studies have been undertaken on gray foxes regionally in New England and even range-wide, despite their widespread distribution and perception as a common species (Fuller and Cypher 2004). Studies elsewhere indicate that foxes occur in densities that range from 0.4/km2 (California) to 1.5/km2 (Florida), and that foxes occupy home ranges that vary in size from 75 ha (West Virginia) to 653 ha (Alabama) (Fritzell and Haroldson 1982, Fuller and Cypher 2004). In Vermont, a radio-telemetry study indicated that average gray fox home range size was 4.43 km2 in the Champlain Valley (n=5, 2 females/3 males, Ingle 1990). Gray foxes in this study occurred primarily in hardwood forested areas and avoided open habitats. Basic demographic estimates, such as density and population size, and home range/habitat use characteristics have not been adequately quantified in Vermont. Gray foxes elsewhere associate mainly with deciduous forest, but use other forest types, shrublands, agricultural lands, fields, and farmlands, and the margins of urban environments (Fritzell and Haroldson 1982). They typically use successional forests, habitat mosaics and managed woodlands.

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Seeps and Pools

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Current Threats

Habitat Threats:

Habitat Alteration

Unknown Habitat Threats

Description of habitat threat(s): Unknown, but distribution and abundance appears to be linked to forest habitats. Changes in forest cover, especially deciduous forest, due to development (e.g., residential housing, roads, urban expansion) may impact the species in Vermont.

Non-Habitat Threats:

Disease

Competition

Description of non-habitat threat(s): Competition and mortality from coyotes, bobcats, and red foxes represent potential threats. These three species have been shown to compete with gray foxes elsewhere (Chamberlain and Leopold 2005, Farias et al. 2005), and may negatively impact the species in Vermont. Diseases such as rabies and distemper represents another potential concern (Fuller and Cypher 2004).

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Medium	Identify important habitats and quantify patterns of habitat selection.
Research	Basic Life History	Medium	Estimate home range characteristics.
Research	Distribution and Abundance	High	Refine distribution and abundance data.
Research	Threats and Their Significance	Medium	1) Examine how habitat alteration impacts distribution and abundance. 2) Determine the effects of zoontic diseases (distemper and rabies). 3) Determine effects of competition with coyotes and other sympatric carnivores such as fisher.
Monitoring	Range Shifts	Medium	Determine possible range shifts and population changes due to climate change.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote less development of high quality habitats.	Amount of high quality habitat protected or conserved	VTrans, Town Planning Commissions, Town and Regional Cons Comms, VLT, Keeping Track	SWG, Vtrans

Common Name: **Gray Fox**
Scientific Name: **Urocyon cinereoargenteus**
Species Group: **Mammal**

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Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S1	**State Trend:**	Increasing
Extirpated in VT?	Unknown	**Regional SGCN?**	Yes

Assessment Narrative:

Despite having been previously extirpated from Vermont, recent evidence indicates the presence of two distinct populations of American marten in the state (VFWD unpublished data). Although little is known regarding their full extent and distribution, these populations are likely at risk due to their presumed small size and limited distribution. Relative to most other forest-associated mammals, marten have large spatial requirements, low population densities and specific habitat needs (Buskirk and Ruggerio 1994) making populations particularly vulnerable to factors influencing habitat suitability. Forest management practices that fail to consider marten habitat requirements, for example, may result in a decrease in marten density and productivity over the landscape (Gosse et al. 2005, Payer and Harrison 1999, Johnson et al. 2009, Fuller and Harrison 2005). Furthermore, interspecific relations with sympatric carnivores such as fisher and red fox are widely hypothesized to be limiting factors for marten population recovery and expansion (Krohn et al 2004, Siren 2009). Vermont furbearer harvest data indicate widespread and abundant populations of many competing carnivores throughout the state (VFWD unpublished data). Last, the strong correlation between marten occurrence and the annual accumulation of suitable snow depths makes the persistence of this species in Vermont vulnerable to changes in the climate (Krohn 2012, Kelly 2005, Siren 2009, and Carroll 2007).

Distribution

Although believed to have occurred throughout the state prior to European contact, American marten were extirpated from Vermont in the 1800's due to excessive land clearing and unregulated trapping. Since 2000, a total of 25 marten occurrences have been confirmed in Vermont(VFWD unpublished data). The majority of these were reported from the northeast corner of the state in Essex (13), Caledonia (4) and Orleans (1) counties. The remaining marten were reported from the high elevation towns of the southern Green Mountains in Bennington (4) and Windham (3) counties. Additionally, remote camera surveys conducted in 2012 documented the occurrence of two individual marten in the town of Sunderland (Bennington County).

Distribution by Biophysical Region:

Champlain Valley	Not Probable	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Probable	**Southern Green Mtns**	Confident
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

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Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

In general, American marten are associated with forested habitats that provide overhead cover and complex physical structure near the forest floor (Payer and Harrison 2003, Andruskiw 2008, Godbout and Ouellet 2010). Although these forest characteristics are most closely associated with older seral stages, the use of younger, managed forests by marten has also been well documented where previous harvesting practices have favored the retention of course woody debris, and have maintained residual basal areas greater than 18m2/ha and at least a 30% canopy closure in winter (Thompson et al 2012, Payer and Harrison 2003, Fuller and Harrison 2005). In the northeast, suitable marten habitat is provided by a wide range of forest types including mixed coniferous-deciduous forests and forests dominated by deciduous trees (Kelly 2005, Payer and Harrison 1999). Marten avoid open areas such as those occurring naturally on the landscape (e.g. wetland meadows and stands recently disturbed by fire, Gosse et al. 2005) and those resulting from human activities (e.g. clearcutting and infrastructure development; Payer and Harrison 1999, Siren 2009). Jensen et al (2012) documented a significant demographic response of the marten population to fluctuations in annual mast crop production indicating the importance of mast producing trees as a component of suitable marten habitat. Several studies have documented a close association of annual snow fall rates and occupied marten habitat suggesting a strong preference for deep snow where certain morphological adaptions may give marten competitive advantages over sympatric carnivores (Krohn 2004, Kelly 2005, Carroll 2007).

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Softwood Swamps

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Because American marten life history is strongly influenced by adult survival (Buskirk et al. 2012), the recovery and growth of Vermont's marten populations will require favorable environmental conditions over long periods of time. Thus, habitat stochasticity resulting from anticipated changes in the climate (Carroll 2007, Krohn 2012, Kelly 2005), the broadscale implementation of forest management practices that do not adequately account for marten habitat requirments (Thompson et al. 2012, Fuller and Harrison 2005, Payer and Harrison 2003), and further fragmentation of the lanscape (Siren 2009) jeopardizes the persistence of marten in the state.

Non-Habitat Threats:

Harvest or Collection

Competition

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Disease

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Competition with, and predation by, sympatric carnivores such as fisher and red fox could negatively influence the distribution and persistence of marten in Vermont (Krohn et al 1995, Kelly 2005, Siren 2009). The effects of climate change will likely exacerbate the adverse impact of interspecific completion on marten as carnivore communities shift northward into marten range and the species' competitive advantages are diminished as a result of lower snowfall accumulations (Carroll 2007, Krohn et al. 2005). Although the incidental take of marten in fisher traps has been documented in Vermont (VFWD unpublished data), it is not currently known to be a limiting factor of the marten population. In fact, the continued harvest and management of competing carnivores could prove to be an overall benefit to marten despite this infrequent take. Although difficult to assess, the impacts of unregulated take and interspecific competition need to be considered where the maintenance of marten populations is a priority.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Perform a habitat suitability analysis of Vermont in order to identify key marten habitats, to help predict distribution of the speices in the state and to facilitate the developemnt of appropriate conservation actions.
Research	Distribution and Abundance	High	Collect baseline data on marten distribution and abundance in Vermont in order to assess the status of the population and develop appropriate conservation strategies.
Research	Threats and Their Significance	Medium	Examine the affects of interspecific competion with fisher and assess how certain habitat features, fisher harvests and snow depths influence this relationship.
Research	Population Genetics	High	Conduct a genetic analysis of marten in Vermont in order to determine the source of the species in the state, particularly of the southern population.
Research	Other Research	High	Assess the effectiveness and practicality of various trap configurations and trapping techniques for minimizing the incidental take of marten.
Monitoring	Population Change	Medium	Develop and implement a plan for monitoring the marten population in Vermont.
Monitoring	Habitat Change	Medium	Develop and implement a plan for monitoring changes in suitable marten habitat resulting from habitat conversions, forest management practices and climate change.
Monitoring	Range Shifts	Low	Monitor range shifts of competing carnivore populations resulting from climate change.

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Policy & Regulations	Medium	Support and cooperate with larger efforts to curb global climate change.			
Compatible Resource Use	High	Promote forest management practices that provide for the life history requirements of marten	Number of acres of forest land positively influenced	Coverts, UVA, USFS, Industrial forest landowners, VFPR, VLT landowners, Forest Legacy landowners	
Standards	Medium	Develop best management practices for forest management within key marten habitats	The successful development and subsequent dissemination of best management practices	UVM, VFPR	SWG
Standards	High	Develop best management practices for fisher trapping in order to minimize incidental take of marten	Number of trappers employing best management practices and the number of marten taken	Vermont Trappers Association, AFWA, NHFG, MDIFW, NY DEC	Vermont Trappers Association, AFWA, SWG
Compatible Resource Use	High	Continue managing competing carnivores within key marten habitats, particularly fisher, via regulated trapping	Maintenance of healthy furbearer populations	Vermont Trappers Association	
Standards	Medium	Develop and implement guidelines and mitigation strategies for minimizing impacts to key marten habitats from regulated land use activities such as the development of energy infrastructure	Number of acres protected from conversion		

Common Name: **American Marten**
Scientific Name: **Martes americana**
Species Group: **Mammal**

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Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S3S4
Extirpated in VT? no

Global Trend:
State Trend: unknown
Regional SGCN? no

Assessment Narrative:

The distribution and abundance of long-tailed weasels in Vermont are poorly understood and no records of their occurrence were collected during a statewide small mammal survey between 2008 and 2010 (Kilpatrick and Benoit, 2011). Although the extent to which these factors influence the population is poorly understood, the species is vulnerable to current pest control practices and could be potentially impacted by the application of pesticides.

Distribution

Only 22 verified records of the long-tailed weasel are available for Vermont but these confirm a wide spread distibution of this species in Orleans, Essex, Chittenden, Caledonia, Addison, Rutland, Windsor and Bennington counties. No additional records of their occurrence were collected during a state wide small mammal survey between 2008 and 2010 (Kilpatrrick and Benoit, 2011)

Distribution by Biophysical Region:

Champlain Valley	Probable	Southern VT Piedmont	Confident
Champlain Hills	Probable	Vermont Valley	Probable
Northern Green Mtns	Confident	Southern Green Mtns	Confident
Northern VT Piedmont	Probable	Taconic Mtns	Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

The long-tailed weasel inhabits the broadest range of any of the weasels from low elevations to above treeline across the continent (Novak et al, 1987). They occupy a variety of habitats from forest and shrubs adjacent to stone walls to fields, wetlands and standing water. Where it overlaps with the short-tailed weasel, it may occupy more open habitats while the short-tailed weasel is more common in forested or wetland areas. Areas with high prey density are important. The long-tailed weasel feeds on small mammals such as mice, rabbits, voles and ground nesting birds. Water seems to be a critical factor. Hamilton (1933) reported that they can drink 25cc of water per day and therefore, it may be restricted to habitats in close proximity to standing water. The long-tailed weasel is more of a food generalist than the short-tailed weasel. On average, long-tailed weasels will take 1.5 voles per day (Powell 1973 in Wild Furbearer Mgt 1987). The weasel uses excavated burrows or holes and/or crevices for den sites (DeGraff and Yamasaki, 2001).

Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Marshes and Sedge Meadows

Wet Shores

Early Succession Boreal Hardwoods

Early Succession Northern Hardwoods

Early Succession Upland Oak

Grasslands, Hedgerows, Old Field, Shrub, or Orcharc

Aquatic: Man-Made Water Bodies

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Description of habitat threat(s): Although the full extent and nature of impacts are poorly understood, it is suspected that the conversion of habitat via natural succession or anthropogenic degradation could negatively affect weasel populations.

Non-Habitat Threats:

Predation or Herbivory

Description of non-habitat threat(s): Predation on long-tailed weasels by domestic pets, foxes and raptors could be a factor limiting the distribution and abundance of this species. Similarly, when existing in close proximity to humans, exposure to pest control practices and potential for road kill may be a problem. Weasels could be affected directly and/or indirectly by pesticide use.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Distribution and Abundance	High	Determine abundance, distribution, and status of the Vermont population.
Research	Threats and Their Significance	Medium	Examine how current pest control practices, including the use of pesticides, influence long-tailed weasel populations.
Research	Other Research	Low	Examine how predation, particularly by domestic pets, influecnes long-tailed weasel populations.
Monitoring	Population Change	Medium	Develop and implement a plan for monitoring the long-tailed weasel population in Vermont.
Monitoring	Habitat Change	Medium	Examine how forest succession and anthropogenic changes of the landscape influence long-tailed weasel populations.

Common Name: **Long-tailed Weasel**
Scientific Name: **Mustela frenata**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Awareness Raising and Communications	Medium	Develop outreach materials informing the public of the importance of keeping domestic pets under control	Development and dissemination of outreach materials		
Standards	Medium	Develop Best Management Practices for pest control professionals and landowners to follow for minimizing damage by and lethal control of long-tailed weasels	Development and dissemination of BMPs	NWCOs, Pest Control Professionals	SWG

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Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: S5
Extirpated in VT? no

Global Trend:
State Trend: stable
Regional SGCN? no

Assessment Narrative:

The Northern River Otter's pisciviorous diet and high trophic position make it a noteworthy indicator of pollution in aquatic systems (Melquist and Dronkert 1987). Of 20 otter tested for mercury in Vermont in 2001, for example, two had levels higher than that recommended by the EPA (K. Royar, pers. Com). Prey may also be susceptible to pollution and acid rain. Because of their strict aquatic nature, otter populations are susceptible to changes in riverine and lacustrine habitats which alter the physical character of these habitats and/or impact the prey upon which they depend.

Distribution

Otter are annually harvested in every watershed in Vermont during a regulated trapping season.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Known Watersheds

Middle Connecticut
West
Waits
Upper Connecticut-Mascoma
Black-Ottauquechee
Deerfield
Hudson-Hoosic
Mettawee River
Lake Champlain
Lamoille River
Missisquoi River
Otter Creek
Passumpsic
St. Francois River
Upper Connecticut

Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

White

Winooski River

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☐

Otter are adaptable to many different wetland habitats including beaver created wetlands, lakes, streams and ponds. Intact vegetation along the perimeter of streams, lakes and wetlands is an important habitat feature of otter habitat. Beaver bank dens and lodges are also used by otter. Beaver created wetlands provide critical foraging and denning habitat. Log jams resulting from fallen trees also provide shelter and foraging habitat. Otter also require healthy aquatic systems that provide an adequate prey base.

Habitat Types:

Aquatic: Fluvial

Aquatic: Lower CT River

Aquatic: Large Lake Champlain Tribs Below Falls

Aquatic: Lacustrine

Aquatic: Lake Champlain

Current Threats

Habitat Threats:

Habitat Alteration

Sedimentation

Impacts of Roads or Transportation Systems

Description of habitat threat(s): Forested riparian buffers are key components of otter habitat. Loss and/or degradation could influence otter habitat selection and productivity. Historically, otter were limited by human encroachment, habitat destruction, and unregulated harvest. In Vermont, the extirpation of beaver, loss of habitat, and pollution resulted in a much reduced population throughout the 1800's and early 1900's. Otter populations have rebounded with the return of the beaver. Although not strongly supported in recent literature, it is expected that increasing development pressure and pollutants such as mercury could negatively affect future population levels. Despite this potential vulnerability, contemporary harvest records in Vermont indicate a well distributed, abundant population of otter in recent decades. Furthermore, should Vermont's otter population begin experiencing the effects of development, pollution and/or climate stressors, the mechanisms for detecting and addressing such population trends are currently in place.

Non-Habitat Threats:

Pollution

Loss of Prey Base

Description of non-habitat threat(s): Although the effects of pollutants are not believed to be a limiting factor for the otter population in Vermont, contaminants such as PCB's, mercury, and other heavy metals are known to accumulate in the tissue of otter and negatively affect reproduction and survival.

Common Name: **Northern River Otter**
Scientific Name: **Lontra canadensis**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	Medium	Monitor distribution and abundance
Research	Threats and Their Significance	High	Determine the impact of heavy metals and contaminants on otter populations in each watershed.

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Privately-Owned Protected Areas		Maintain riparian buffer strips along streams, rivers, lakes, ponds, and wetland habitats.	Number of linear miles of vegetated riparian buffers	Trout Unlimited, NRCS, USFWS, NWTF, DEC, Vt. F&P	SWG, USFWS, NRCS, FSA, CREP
Species Restoration		Provide a suitable prey base.		Trout unlimited, DEC	TU, DEC, USFWS, SWG
Policy & Regulations		Eliminate acid rain and the input of mercury into otter habitat.	Decrease acid, mercury, and heavy metal deposition into Vermont lakes, rivers, and streams	DEC, EPA,	DEC, EPA
Compliance & Enforcement		Enforce the Clean Water Act	Increase the number of bodies of water that meet class A designation	Trout Unlimited, NRCS, USFWS, USFS, Wild Turkey Federation, DEC, Vt. Forests & Parks	EQIP, SWG, EPA, NWTF

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: High Priority

Global Rank: G5
State Rank: S1
Extirpated in VT? yes

Global Trend:
State Trend: Fluctuating
Regional SGCN? no

Assessment Narrative:

Recovery of lynx in Vermont may be limited by global climate change (Carroll 2007, Hoving et al. 2005). Although the influence of competition from coyote, fisher, and bobcat, which could also be exacerbated by global climate change (Peers et al. 2013), may not be clearly understood (Ray et.al. 2002), there is some indication that lynx populations existing at the margins of their range may be limited by these sympatric carnivores (Peers et al. 2013, Vashon et al. 2012). Harvest records for fisher, bobcat and coyote in northeast Vermont (VFWD unpublished data) and track surveys conducted within Vermont's two largest blocks of unfragmented suitable lynx habitat (Farrell 2012) indicate well-established populations of these competing carnivores. Suitable lynx habitat in Vermont is limited and occurs in relatively small patches distributed over the northeastern portions of the state. As a result of this habitat condition, the effects of fragmentation could result in the isolation of Vermont's lynx population from populations to the north further jeopardizing its ability to persist in the state (Koehler et al. 2008, Murray et al. 2008). Also, because Canada lynx exhibit strong selection for habitats where snowshoe hares are abundant (Fuller et al. 2007, Vashon et al. 2008, Squires et al. 2010), the suitability of Vermont's currently occupied lynx habitat could change markedly with future changes in landscape-level hare densities and changing habitat associated with forest management; thus, successful conservation of lynx populations in Vermont will require the protection and management of large tracts of snowshoe hare habitat (Simons-Legaard et al. 2013, Murray et al. 2008).

Distribution

Historical records of Canada lynx in Vermont are scarce. Prior to this century, lynx were documented in the state on only four occasions (Windham 1928, St. Albans 1968, Calais 1797 and Addison County 1937: Vermont archived bounty records). Since 2003, nine lynx sightings have been confirmed in Vermont. Eight of the sightings were recorded in Essex County and one in Orleans County (unpublished data, VFWD). Since 2012, Intensive snow track and remote camera surveys have successfully detected lynx in the Nulhegan Basin (Bernier 2011 & 2013). Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Bernier 2011).

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Not Probable
Champlain Hills	Not Probable	**Vermont Valley**	Not Probable
Northern Green Mtns	Not Probable	**Southern Green Mtns**	Not Probable
Northern VT Piedmont	Probable	**Taconic Mtns**	Not Probable
Northeastern Highlands	Confident		

Distribution by Watershed:

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☐

Along the southern periphery of their range, lynx prefer a variety of habitat types including mid-successional coniferous forests and edge habitat with moderate to abundant understory cover (Koehler et al. 2008, Maletzke et al. 2008, Vashon et al. 2008b). Lynx tend to avoid open areas and mature forests having little horizontal cover (Vashon et al. 2008b). Lynx select for stands where snowshoe hare are abundant (2.4 hares/ha, Vashon et al. 2008) such as areas of dense softwood in association with 11 - 21 year old regenerating clear-cuts or similarly aged partially harvested stands (Fuller et al. 2007, Simons-Legaard 2013). Organ et al. (2008) identified the "tip up mounds" of blown down trees as features commonly used as natal dens and further found that the presence of within stand structure capable of providing visual obscurity at 5 meters from the den was a significant predictor of den site selection by lynx. Hoving (2005) determined that lynx populations in this region are unlikely to occur in areas of low annual snowfall (<270cm) or areas dominated by deciduous forests.

Habitat Types:

Spruce Fir Northern Hardwood

Early Succession Boreal Conifers

Early Succession Spruce-Fir

Current Threats

Habitat Threats:

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Climate Change

Description of habitat threat(s): Changes in the climate that result in the reduction of annual snowfall could greatly influence the distribution of lynx in the northeast (Hoving 2005). Decreased snowfall can affect lynx through decreased prey vulnerability and decreased competitive advantage over sympatric carnivores (Carroll 2007). Furthermore, although there is evidence that the degree of diet specialization of lynx in the southern parts of their range is less than in their northern counterparts, the long-term persistence of lynx in Vermont could be limited by the availability of suitable snowshoe hare densities (Roth et al. 2007, Simons-Legaard et al. 2013). Thus, the loss of suitable hare habitat from both natural (i.e. forest succession) and human caused disturbances (i.e. forest management favoring deciduous forest composition) could adversely affect lynx in Vermont. In addition, because the viability of lynx populations in the southern part of their range is suspect in the absence of ingress from northern populations (Murray et al. 2008), the maintenance of landscape connectivity with these northern areas of occupancy is of critical importance. Although Farrell (2012) concluded that lynx connectivity across the northeast is expected to remain stable in the coming decades, the long-term persistence of lynx in Vermont remains dependent upon interstate and international commitments to maintaining these connective habitats (Murray et al. 2007).

Non-Habitat Threats:

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Loss of Metapopulation Structure

Competition

Predation or Herbivory

Loss of Prey Base

Description of non-habitat threat(s): Peers et al. (2013) determined that lynx are subjected to niche displacement in areas of overlap with bobcat. In Vermont, bobcat harvest data (VFWD unpublished data) and the results of extensive snow track surveys conducted since 2012 (Bernier 2012 & 2013) indicate a well-established, sympatric bobcat population. Furthermore, the effects of climate change could increase the competitive pressure on lynx by altering the distribution and abundance of competing carnivores populations and by decreasing their competitive advantages over these sympatric species (Carroll 2007). In addition, the primary source of mortality of lynx in Maine was predation, especially by fisher, accounting for nearly 42% of lynx deaths (Vashon et al. 2012). Similar to bobcats, harvest data and track survey results also indicate an abundance of fisher within Vermont's most suitable lynx habitats.

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Distribution and Abundance	High	Collect baseline data on lynx distribution and abundance in Vermont in order to assess the status of the population and develop appropriate conservation strategies.
Research	Threats and Their Significance	High	Examine the affects of competition with sympatric carnivores and assess how certain habitat features such as snow depth, managing furbearer populations, and a changing climate may influence this relationship.
Monitoring	Population Change	High	Continue monitoring for the presence of the species in the state.
Monitoring	Habitat Change	Medium	Develop and implement a plan for monitoring changes in suitable lynx habitat resulting from habitat conversions, forest management practices and climate change.
Monitoring	Range Shifts	Low	Monitor range shifts of competing carnivore populations resulting from climate change.
Monitoring	Monitor Threats	Medium	Identify and monitor impacts to key connective corridors serving to link Vermont's lynx population with core populations to the north.

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote forest management practices that provide for the life history requirements of lynx	# of acres of snowshoe hare habitat available within potential lynx range	Vt. Forest and Parks Dept, Industrial forest landowners, Coverts	EQIP, SWG, USFWS
Compatible Resource Use	High	Maintain connectivity of habitat between Maine, New Hampshire, Quebec and Vermont.	# of acres of corridor habitat conserved	TNC, VLT, NHF&G, Conservation Fund, NWF, Keeping Track, Coverts	TNC, VLT, Conservation Fund, USFWS, Forest Legacy
Compatible Resource Use	High	Continue managing competing carnivores within key lynx habitats, particularly fisher, via regulated trapping	Maintenance of healthy furbearer populations	Vermont Trappers Association	
Policy & Regulations	Medium	Support and cooperate with larger efforts to curb global climate change.			

Common Name: **Canada Lynx**
Scientific Name: **Lynx canadensis**
Species Group: **Mammal**

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Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank:	G5	**Global Trend:**	
State Rank:	S4	**State Trend:**	Unknown
Extirpated in VT?	no	**Regional SGCN?**	Yes

Assessment Narrative:

The bobcat is apparently common and well distributed throughout Vermont although higher densities appear to exist in the Champlain Valley and the Taconics possibly due to higher prey densities. Bobcats have declined since the middle of the 20th century due to land use changes affecting prey densities and to increasing competition from other carnivores such as fisher and coyote. Statewide population estimates are unknown, but carrying capacity has been estimated.

The bobcat uses a variety of habitats and the relative suitability of habitats in the Vermont landscape have been quantified (see below). Bobcat occurrence appears to be positively related to the amount of mixed forest and forested wetland habitats. Critical habitats, such as those used for denning remain largely unquantified.

Landscape change represents a primary threat to bobcats, especially as they appear to depend on connected expanses of undeveloped habitat. Conversion of natural habitat to housing and other forms of development will most likely affect the distribution and abundance of the species in Vermont. Similarly, the impacts of climate change, particularly with respect to changes in prey and sympatric carnivore distribution and abundance, may present significant challenges to bobcats through the future.

Distribution

Bobcats occupy home ranges that include a variety of habitats. Average home range size for bobcats based on a study in the Champlain Valley was 57.3 km2 (Donovan et al. 2011) Male home ranges (n=10) averaged 70.9 km2 while female home ranges (n=4) averaged 22.9 km2. Based on patterns of use in home ranges, bobcats respond positively to shrub, deciduous forest, coniferous forest, and wetland cover types within 1 km of a location and negatively to roads and mixed forest cover within 1 km of a location. Similar results have been found in New Hampshire with bobcats preferring areas with few roads, limited human development, high stream densities, and steep topography (Broman et al. 2014). Another study conducted repeated surveys throughout Vermont and concluded that bobcat probability of occupancy was positively related to the percentage of both mixed forest and forested wetland habitat within 1 km of survey sites (Long et al. 2011). In Vermont, steep, rocky cliffs may be important as winter refuges and breeding habitat.

The size of the bobcat population is uncertain in Vermont. Donovan et al. (2012) estimated the maximum carrying capacity of females in northwestern Vermont (WMU 1, 1,153 km2) as 42. Using a similar approach, carrying capacity across Vermont has been estimated as 1,150 (835 females, 316 males) (J. Murdoch, pers. comm.).

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☑ General Literature ☑

Bobcats occupy home ranges that include a variety of habitats. Average home range size for bobcats based on a study in the Champlain Valley was 57.3 km2 (Donovan et al. 2011) Male home ranges (n=10) averaged 70.9 km2 while female home ranges (n=4) averaged 22.9 km2. Based on patterns of use in home ranges, bobcats respond positively to shrub, deciduous forest, coniferous forest, and wetland cover types within 1 km of a location and negatively to roads and mixed forest cover within 1 km of a location. Similar results have been found in New Hampshire with bobcats preferring areas with few roads, limited human development, high stream densities, and steep topography (Broman et al. 2014). Another study conducted repeated surveys throughout Vermont and concluded that bobcat probability of occupancy was positively related to the percentage of both mixed forest and forested wetland habitat within 1 km of survey sites (Long et al. 2011). In Vermont, steep, rocky cliffs may be important as winter refuges and breeding habitat.

The size of the bobcat population is uncertain in Vermont. Donovan et al. (2012) estimated the maximum carrying capacity of females in northwestern Vermont (WMU 1, 1,153 km2) as 42. Using a similar approach, carrying capacity across Vermont has been estimated as 1,150 (835 females, 316 males) (J. Murdoch, pers. Comm.).

Habitat Types:

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Floodplain Forests

Hardwood Swamps

Softwood Swamps

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Succession

Habitat Alteration

Habitat Fragmentation

Description of habitat threat(s): Bobcats distribution appears to relate mainly to forest cover and forest wetland habitat, both of which positively influence probability of occurrence in the landscape. Changes to these two habitats and others that offer important resources like rocky ledges for denning represent a primary threat to the species. Conversion of habitats due to development like residential housing and roads or even climate change will most likely affect bobcat distribution and abundance (Bettigole et al. 2014).

Non-Habitat Threats:

Competition

Loss of Prey Base

Description of non-habitat threat(s): Bobcat numbers have declined since coyotes became established in Vermont. The specific impacts of coyotes and other carnivores such as fisher remain largely unstudied in the Northern Forest. Prey species have also declined in some areas due to loss of early successional habitat and have presumably impacted bobcat numbers.

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Research	Habitat Requirements	High	Identify and quantify critical habitats for reproduction, such as rocky, ledge areas.
Research	Distribution and Abundance	High	Determine the location of source and sink populations and identify the habitat parameters associated with these populations.
Research	Threats and Their Significance	Medium	1) Examine how habitat loss, conversion, and fragmentation impacts distribution and abundance. 2) Determine competition effects with coyotes and other sympatric carnivores such as fisher.
Monitoring	Range Shifts	Medium	Assess possible range shifts and population changes due to climate change.

Common Name: **Bobcat**
Scientific Name: **Lynx rufus**
Species Group: **Mammal**

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Compatible Resource Use	High	Promote less development of high quality habitats.	Amount of high quality habitat protected or conserved	VTrans, Town Planning Commissions, VLT, Regional and Town Cons Comms, Keeping Track	SWG, AOT
Species Restoration	Medium	Provide important prey base	Number of acres of rabbit and hare habitat protected	Coverts, USFS, VWA, Northern, USFS, VFPR, Ruffed Grouse Society	USFWS, Ruffed Grouse Society, EQIP
Species Restoration	Medium	Identify necessary habitats and develop actions for protection	Number of necessary habitats mapped and protected	Coverts, USFS, VWA, VLT, UVM	UVM, VLT, USFS, USFWS

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Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5
State Rank: SH
Extirpated in VT? yes

Global Trend:
State Trend: N/A
Regional SGCN? No

Assessment Narrative:

The Mountain Lion, also known as Puma, Cougar and Catamount is listed as endangered in Vermont. It is believed to be extirpated in the East (except in southern Florida). The USFWS declared the Eastern cougar (Puma concolor couguar) extinct in 2011 though it remains federally endangered pending delisting. Anecdotal reports of field sightings are fairly frequent; however, both field and incidental evidence is absent. Even in lowest densities, Mountain Lions are hit, shot, snared, wander into towns and cities, and are photographed on cell phones, point & shoot cameras, and random remote wildlife cams. A Black Hills, SD male left field and incidental evidence in four states across 1500 miles before being hit by a car in Milford, CT, June 2011. All North American Mountain Lions are one subspecies genetically, though the taxonomy remains disputed (Culver et al. 2000); which suggests that conservation efforts should be focused on the entire puma Genus. Confirmations of Mountain Lions with both North and South American DNA (former captives or descendants) have been documented in Ontario (Rosatte, 2011), Quebec and New Brunswick (Lang, et al. 2013), There is no evidence of breeding in eastern Canada. The closest breeding colonies to Vermont remain southwest Florida, the Dakotas and Nebraska. Recent research show mountain lions are keystone species for ecosystem functioning (Ripple et al. 2014).

Distribution

Distribution by Biophysical Region:

Champlain Valley	Historic Records Only	**Southern VT Piedmont**	Historic Records Only
Champlain Hills	Historic Records Only	**Vermont Valley**	Historic Records Only
Northern Green Mtns	Historic Records Only	**Southern Green Mtns**	Historic Records Only
Northern VT Piedmont	Historic Records Only	**Taconic Mtns**	Historic Records Only
Northeastern Highlands	Historic Records Only		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☑ Extensive Local Knowledge ☐ Regional Literature ☐ General Literature ☑

Mountain Lions are no longer understood to be wilderness obligates, with the widest range across more habitats, including urban landscapes, of any terrestrial mammal in the western hemisphere. Beier (1993), using simulated population dynamics, estimated that an area of 1,000 to 2,200 square kilometers (372 to 818 square miles, depending on the demographics of a particular population) was needed for a population of 15-20 adult cougars to have a very low risk (<98%) of extinction within 100 years. Area of 600 - 1600 km 2, and smaller (Beier. 1993), might suffice where adequate dispersal corridors allow movement among populations. Smallest documented home range is 39 km2 (Laundre and Loxterman 2006). Mountain Lions are breeding in suburban-exurban-wildland matrix habitat throughout the western US, and have recovered range east to the Dakotas/Nebraska without assistance. Space-use patterns differ little between wildland and residential environments (Kertson et al, 2011), though reproductive behaviors (communication/denning) require greater buffers from development than non-reproductive behaviors (movement/feeding) within the suburban/exurban/wildland matrix (Wilmers et al, 2013) Specific dispersal barriers include roads and nighttime illumination (Beier 1993, 1995); identifying and protecting wildlife corridors can mitigate dispersal mortalities. Male dispersal and settlement patterns based on mating opportunities; fenale patterns based on avoiding other Mountain Lions (Stoner et al. 2013). Mountain Lions are the epitome of a generalist predator (Knopf and Boyce 2014), though they favor and are adapted for medium-sized ungulates. Deer/ Elk wintering habitat is seasonally favored. (Lindzey 1987).

Adirondack Park, an area roughly comparable to the state of Vermont, could support as many as 350 Mountain Lions (Laundre, 2013). Glick (2014) found that the Northeast region east of the Hudson River could support from 322 - 2,535 Mountain Lions.

Habitat Types:

Outcrops and Alpine

Cliffs and Talus

Spruce Fir Northern Hardwood

Northern Hardwood

Oak-Pine Northern Hardwood

Open Peatlands

Marshes and Sedge Meadows

Wet Shores

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Early Succession Upland Oak

Early Succession Other Types

Current Threats

Habitat Threats:

Conversion of Habitat

Habitat Alteration

Habitat Fragmentation

Impacts of Roads or Transportation Systems

Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

Description of habitat threat(s): Where they still exist, Mountain Lions can be found in a multitude of habitas, ranging from closed forest to semi-open shrublands. Human development/disturbance appears to affect little the use of areas by Mountain Lions as they are found in suburban to exurban environments. Human intolerance to their presence in these areas is the main negative impact on their survival. Prey availability and habitat characteristics can affect Mountain Lion distribution and survival. Loss of habitat connectivity between source populations limits dispersal, range expansion, and genetic variability (Ernest et al. 2003).

Non-Habitat Threats:

Harvest or Collection

Trampling or Direct Impacts

Loss of Prey Base

Description of non-habitat threat(s): Negative human attitudes among certain demographics towards Mountain Lions in regards to human safety and perceived impacts on deer populations can impact successful establishment/ maintenance of Mountain Lion populations in the East Florida public attitude surveys found broad public support for Mountain Lion recovery, including residents of a proposed relocation region and among sportsmen (Duda and Young. 1995; Cramer. 1995). However, a successful test-release of Texas Mountain Lions to southern Georgia/north Florida concluded that resistance from just a handful of inviduals can impede recovery efforts (Belden and McCown. 1996). Pending federal delisting could jeopardize any potential for recolonization if eastern state protections are not established, maintained and enforced,

Research and Monitoring Needs

Type	*Need*	*Priority*	*Description*
Monitoring	Population Change	Medium	Continue current low-level monitoring and incidental Mountain Lion evidence documentation (track, scat, kills, photographs, etc.). Consider active pheromone station monitoring (e.g Lang et al. 2013) to detect VT presence. Collect genetic material for testing.

Species Strategies

Strategy Type	*Strategy Priority*	*Strategy Description*	*Performance Measure*	*Potential Partners*	*Potential Funding Sources*
Policy & Regulations	High	Pending federal delisting, maintain and enforce state protections of entire puma Genus.			
Research	Medium	Identify areas within state that could support viable Mountain Lion populations (Glick 2014) and develop a state recovery plan.			
Awareness Raising and Communications	High	Determine public attitudes towards Mountain Lion recovery efforts in VT (e.g. McGovern and Kretser 2014); Provide interpretive and public education material about Mountain Lions.			

Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

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Common Name: **Eastern Mountain Lion**
Scientific Name: **Puma concolor couguar**
Species Group: **Mammal**

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Vermont Department of Fish and Wildlife
Wildlife Action Plan - Revision 2015
Species Conservation Report

Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Conservation Assessment

Final Assessment: Medium Priority

Global Rank: G5 **Global Trend:**
State Rank: S5 **State Trend:** Declining
Extirpated in VT? yes **Regional SGCN?** no

Assessment Narrative:

Moose were extirpated from Vermont by the early 19th century due to forest clearing and no legal protection. Following regrowth of the forest, restoration of beavers, and nearly a century of protection, moose immigrated from New Hampshire in the 1970’s and their numbers and distribution in Vermont grew rapidly in the 1980’s and 90’s. By the time the former WAP was written in 2005, moose numbered over 5,000 animals and were reproducing throughout the state. Moose were recognized in the 2005 WAP as a “special category” species, along with beaver and white-tailed deer, due to their socioeconomic value and potential of having a significant ecological effect on the landscape. SWG funds were not intended to be directed at these three species at that time.

Currently, the statewide moose population is about half of what it was in 2005. Most of this reduction was by design in order to bring numbers in northeastern Vermont down below ecological carrying capacity and allow for adequate regeneration of trees in managed stands. The current population estimate of 2500 moose is below the minimum target of 3,000 as called for in Vermont’s 10-year Big Game Management Plan--the state's guide for moose management. Moose health and nutrition as reflected by body weight and ovulation rate has declined, and warmer weather from spring through autumn has likely contributed to higher incidence of parasites, most notably the winter tick and brainworm, and abnormally high levels of heat stress.

Distribution

Highest densities in the Northeastern Highlands and Northern Vermont Piedmont.

Distribution by Biophysical Region:

Champlain Valley	Confident	**Southern VT Piedmont**	Confident
Champlain Hills	Confident	**Vermont Valley**	Confident
Northern Green Mtns	Confident	**Southern Green Mtns**	Confident
Northern VT Piedmont	Confident	**Taconic Mtns**	Confident
Northeastern Highlands	Confident		

Distribution by Watershed:

Habitat Description

Habitat Information is based on the following:

Limited Local Knowledge ☐ Extensive Local Knowledge ☑ Regional Literature ☑ General Literature ☑

Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Habitat Types:

Spruce Fir Northern Hardwood

Northern Hardwood

Hardwood Swamps

Softwood Swamps

Marshes and Sedge Meadows

Shrub Swamps

Early Succession Boreal Conifers

Early Succession Boreal Hardwoods

Early Succession Spruce-Fir

Early Succession Pine and Hemlock

Early Succession Northern Hardwoods

Current Threats

Habitat Threats:

Habitat Fragmentation

Climate Change

Description of habitat threat(s): Fragmentation from ski area and recreational trail expansions; ridgetop windfarms. Heat stress from warming climate.

Non-Habitat Threats:

Parasites

Description of non-habitat threat(s): Increased levels of parasites, most notably Dermacentor albipictus and Paralaphostrongylus tenuis.

Common Name: **Moose**
Scientific Name: **Alces alces**
Species Group: **Mammal**

Research and Monitoring Needs

Type	Need	Priority	Description
Research	Habitat Requirements	Low	
Research	Basic Life History	Low	
Research	Distribution and Abundance	Low	
Research	Threats and Their Significance	High	Health condition and effects from parasites and disease.
Research	Population Genetics	Low	
Research	Taxonomy	Low	
Monitoring	Population Change	High	
Monitoring	Habitat Change	Low	
Monitoring	Range Shifts	Low	
Monitoring	Monitor Threats	High	

Species Strategies

Strategy Type	Strategy Priority	Strategy Description	Performance Measure	Potential Partners	Potential Funding Sources
Species Restoration	Medium	Keep moose densities below 0.75/sq km and deer densities below 10/2.6sq km in order to reduce winter tick and brainworm infection rates.	Reduced levels of winter tick infestation. Reduced incidence of brainworm cases.	USFWS	PR
Habitat Restoration	Medium	Increase amounts of early successional habitat, especially in the Central and Southern Green Mountains.	Improved Moose body weights and ovulation rates	USFWS	SWG, PR

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Appendix B

Habitat & Community Summaries

Vermont's Wildlife Action Plan 2015

Terrestrial Habitats

Aquatic Habitats

Conservation at Multiple Scales

Introduction

The Conservation at Multiple Scales section of this appendix explains how conservation is organized in this Wildlife Action Plan. This same information is included as chapter 4 of the Wildlife Action Plan. It is also included here for easy reference for users of this section of the report.

Vermont's list of Species of Greatest Conservation Need (SGCN) comprises 133 vertebrate species 200 invertebrate species (such as the Tawny Emperor Butterfly, Cobblestone Tiger Beetle, and Giant Floater mussel) and 813 plants (vascular and bryophytes). Developing individual conservation plans for each of these species would have been exhausting and impractical. Moreover, implementing so many individual plans would be impossible due to insufficient staffing, resources and funds. In short, it would be monumentally inefficient.

Fortunately, an easier and more efficient approach exists. It consists of designing and implementing conservation at multiple scales. This is commonly referred to as the "coarse filter-fine filter" approach and is widely accepted by scientists, wildlife managers and planners. The underlying concept is that if examples of all coarse-filter features are conserved at the scale at which they naturally occur, most of the species they contain—from the largest trees and mammals to the smallest insects—will also be conserved (Hunter 1991; NCASI 2004; Schulte et al. 2006). The coarse-filter approach is well documented in the scientific literature (Jenkins 1985; Noss 1987; Hunter et al. 1988; Hunter 1991; Noss and Cooperrider 1994; Haufler et al. 1996; Jenkins 1996; Poiani et al. 2000; USDA 2004). Habitat management historically practiced by Fish and Wildlife agencies to create young forests and shrublands that benefit dozens of "shrub and early-successional species" including Moose, New England Cottontail, American Woodcock and Ruffed Grouse is an example of a 'habitat-scale' coarse filter.

To best and most efficiently conserve all our SGCN, this Wildlife Action Plan focuses on three scales of conservation:

1. **Landscapes**: Include the features that contribute to ecological function at the state and regional levels, including a network of large, connected habitat blocks and another of aquatic habitats and riparian areas. Species requiring large habitat block, mixes of forest, wetlands and waters and connections between them will benefit most from landscape-level conservation but most other SGCN can also benefit.

2. **Habitats and Natural Communities**: Include the range of naturally occurring and anthropogenic habitats (such as young forest and grasslands). Terrestrial natural communities follow the classification system developed by Sorenson and Thompson (2005) which ties in with the ecological systems classification developed for the Northeast Association of Fish & Wildlife Agencies (Gawler 2008) for the 13 northeastern states. Aquatic communities follow the classification developed by Langdon et.al. (1998).

3. **Species and Groups of Species**: these are the SGCN for which we have identified specific conservation needs that would not be covered by conservation efforts at the other two scales.

Not all species, however, are best conserved by coarse-filters alone. For example, species dependent on multiple habitats at different times during their life cycles, those that occur in small geographic areas, those with highly specialized needs, those that travel across large geographic areas and those that are particularly rare often require focused attention. To ensure that the needs of these species are also addressed, fine filter conservation strategies are also needed. Species-specific conservation reports can be found in Appendices A1-A5.

Efficiency in conservation effort can be realized by first identifying landscape conservation priorities that will effectively capture many natural communities, habitats, and species found within them. Natural community and habitat level conservation can effectively capture many of the remaining species. And finally, species-specific conservation action will be required for those species that are not captured at landscape or habitat/natural community scales. Typically, these are species that are very rare, are declining across their range, aggregate for breeding, and/or require large home ranges.

Given the species focus of the congressional requirements for Wildlife Action Plan development, we began at the species level by assessing SGCN individually (Appendix A). Then SGCN were organized by taxonomic group and by the habitats they use. This resulted in conservation strategies at the three levels listed above (and in table 4.1).

Table B.1 Organization of Conservation Information in this Report

Level	Organization	Location in this Action Plan
1-Species	6 group summaries (amphibians & reptiles, birds, fishes, invertebrates, mammals and plants) 133 individual species and 15 invertebrates group summaries	Chapter 5 Appendix A
2-Habitats & Natural Communities	125 communities & cultural habitats grouped into 24 summaries	Appendix B
3-Landscapes	Statewide and regional conservation strategies Landscapes Landscape Report	Chapter 1 Chapter 6 Appendix F

Selection of Classification Systems

We delineated landscapes based on the following elements: Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, Riparian Areas for Connectivity, Physical Landscape Diversity Blocks, and Wildlife Road Crossings. Landscape conservation is discussed in chapter 6 and Appendix F of this Wildlife Action Plan.

Though great strides have been made in developing vegetation classification systems that function at the site, landscape, region and national scales (Barnes 1979, Allen and Starr 1982, Forman and Godron 1986, Cleland et. al 1997, Grossman et. al 1998), they are incomplete. No system satisfactorily integrates aquatic and terrestrial communities and cultural habitats1 used by wildlife nationwide.

In lieu of a unified habitat classification system, Vermont's Action Plan technical teams selected the best features of five peer-reviewed vegetation classification systems that can be cross-walked with those used in other states to support broader scale conservation efforts—regionally, nationally, and internationally. Forest Cover Types (Eyre 1980) and U.S Forest Service Forest Inventory & Analysis Types (USDA 2003) were used for early successional stage forests. Natural Communities (Thompson and Sorenson 2000) were the basis for most terrestrial vegetation. "A Classification of the Aquatic Communities of Vermont" by Langdon et al. (1998) was adapted for aquatic community designations and cultural habitats1 were adapted from Reschke (1990). Landscape scale communities were adapted from Poiani et.al. (2000).

1 Cultural habitats are communities and sites that are either created and/or maintained by human activities or are modified by human influence to such a degree that the physical condition is substantially different from what existed prior to human influence (adapted from Reschke 1990).

One hundred twenty-five aquatic and natural community types, cultural habitats and land cover types, capturing most of the habitat required by SGCN were selected from the five systems (table 4.2). Each was assigned to one of 22 categories. Because Lake Champlain and the Connecticut River harbor most of the fish diversity in Vermont, these two waterbodies were broken out from the taxonomy to provide for a more targeted assessment. Technical teams then developed assessment summaries for each that include descriptions and general locations; current conditions; desired conditions based on the needs of associated SGCN; priority problems; conservation strategies to address problems (along with the identification of potential conservation partners and funding sources); and a listing of relevant plans and planning processes pertinent to a habitat type.

Our terrestrial classification is designed to roll up to the Northeast Terrestrial Habitat Classification System (Gawler 2008) with standardized terminology and compatible habitat classifications. It allows the Action Plan to describe the aspects of conservation particular to Vermont, while facilitating conservation at a broader regional level. A Companion to the Terrestrial and Aquatic Maps has been published by TNC (Anderson et al. 2013). It includes profiles of each habitat type in the Northeast, distribution maps, state acreage figures, SGCN identification concern, and an assessment of overall conditions in the region.

Habitat Succession, Species of Greatest Conservation Need & the Action Plan

Plant succession produces cumulative change in the types of plant species occupying a given area through time. Succession is complicated by factors such as disturbance (large and small), local conditions, seed banks and soil legacies (Oliver 1981). A highly simplified timeline begins when land is cleared. Pioneer species typically return first followed by other species generally better adapted to the new and changing conditions created by the previous suite of species. Given sufficient time and appropriate conditions the area moves roughly through early, middle, and late successional stages—often referred to as mature or old growth. A disturbance, if sufficiently large, can re-set the clock anytime and succession begins again. The best-known examples are forest succession but it occurs in virtually all vegetated areas. For example, lichen communities on granite mountaintops experience successional changes (Wessels 2002).

Succession can significantly impact habitat for Species of Greatest Conservation Need and other wildlife as in the edge habitat example noted earlier. Generally, as succession moves from early (young forests) to late stages some wildlife will lose out (e.g., Spruce Grouse, American Woodcock, Cottontail Rabbit) and others will benefit (e.g., American Marten, Northern Goshawk). Others still prefer a mix of successional stages in appropriate configurations (e.g., Canada Lynx).

Over the past two centuries the mix of successional stages available to Vermont's wildlife has changed dramatically in both distribution and abundance. Though precise estimates (current and historic) are unavailable, prior to 1800 a significant percentage of Vermont's forests were in late-successional stages (>150-300 years and older). One-hundred years later young forests (early-successional stages of 1-15 years) dominated the state and today mid-successional forests (60-100 years) are most abundant. Wildlife populations have responded in turn. Vermont's SGCN list contains relatively few species requiring mid-successional forests and more that thrive in early and late-successional representations.

Because the loss of late-successional forests in the eastern U.S. occurred prior to the advent of modern wildlife biology and the current scarcity of later-successional stages (particularly northern hardwood forest types) our understanding how wildlife utilized these stages is not as advanced as our knowledge of wildlife in early successional stages. Historic records and research in late-successional areas elsewhere indicate that the distribution and abundance of some wildlife species was much greater when late-successional forests were in greater abundance—even if these species can survive without them. Given the lack of this condition on the landscape it is advisable to increase its availability to wildlife.

The habitat, community and landscape summaries that follow here and in Chapter 6 address the habitat needs of Species of Greatest Conservation Need that use vegetation types in one or more successional stages. Conservation strategies address these needs as well as those of species that prefer a mosaic of successional stages.

Table B.2: Landscape, Community, Habitat & Cover Type Categories

* Categories marked with an asterisk "*" are considered major categories for the purposes of organizing this report (24 in all). Conservation summaries were developed addressing characteristics and location, current and desired condition, SGCN using this habitat category, priority problems impacting this category, conservation strategies to address the problems and a list of other plans and planning entities with significant interest in this area.

*Landscapes

Interior Forest Blocks
Connectivity Blocks
Surface Waters and Riparian Areas
Riparian Areas for Connectivity
Physical Landscape Diversity Blocks
Wildlife Road Crossing

Aquatic Communities

***Riparian Areas**

***Riverine** (Langdon et.al. 1998)
Brook trout
Brook trout-slimy sculpin
Blacknose dace-slimy sculpin
Blacknose dace-bluntnose minnow
Blacknose dace creek chub
Tessellated darter-fallfish
Blacknose dace-slimy sculpin
White sucker-tessellated darter

***Lower Connecticut River**
(Atlantic salmon-American shad community)

***Lower Lake Champlain Tributaries**
(Redhorse-lake sturgeon community)

***Lakes & Ponds**
Dystrophic lakes
Meso-eutrophic lakes
Oligotrophic lakes
High elevation acidic lakes

***Lake Champlain**

Cultural Habitats
(Reschle 1990)

***Building & structures**

***Mine & Gravel Pits**

***Grassland & Hedgerows**
Grasslands
Hedgerow
Old field/shrub
Orchard

*Young Forests
(Successional Stages, Forest Cover Types, Eyre 1980, US Dept of Agriculture 2003)

Stages: Seedling/Sapling Sapling/Pole Timber, Pole Timber

Cover types
Boreal Conifers
- Balsam fir
- Black spruce
- White spruce

Boreal Hardwoods
- Aspen
- Pin cherry
- Paper birch

Spruce-Fir
- Red spruce
- Red spruce-balsam fir
- Paper birch-red spruce-balsam fir

Pine and Hemlock
- Eastern white pine

Table 4.2 continued: Terrestrial Natural Communities (Thompson & Sorenson 2005)

Open or Shrub Wetlands

*Open Peatlands
- Alpine peatland
- Dwarf shrub bog
- Black spruce woodland bog
- Pitch pine woodland bog
- Poor fen
- Rich fen
- Intermediate fen

*Marshes & Sedge Meadows
- Deep bulrush marsh
- Deep broadleaf marsh
- Shallow emergent marsh
- Sedge meadow
- Cattail marsh
- Wild rice marsh

*Wet Shores
- Calcareous riverside seep
- River cobble shore
- Lakeshore grassland
- Riverside sand or gravel shore
- Outwash plain pondshore
- River mud shore
- Rivershore grassland

*Shrub Swamps
- Buttonbush basin swamp
- Alder swamp
- Alluvial shrub swamp
- Sweet gale shoreline swamp
- Buttonbush swamp

Forested Wetlands

*Floodplain Forests
- Silver maple-ostrich fern riverine floodplain forest
- Lakeside floodplain forest
- Silver maple-sensitive fern riverine floodplain forest
- Sugar maple-ostrich fern riverine floodplain forest

*Hardwood Swamps
- Red maple-black ash swamp
- Red maple-northern white cedar swamp
- Calcareous red maple-tamarack swamp
- Red or silver maple-green ash swamp
- Red maple-black gum swamp
- Red maple-white pine-huckleberry swamp

*Softwood Swamps
- Northern white cedar swamp
- Spruce-fir-tamarack swamp
- Black spruce swamp
- Hemlock swamp

*Seeps & Vernal Pools
- Vernal pools
- Seeps

Open Upland Communities

*Upland shores
- Riverside outcrop
- Lake sand beach
- Lake shale or cobble beach
- Erosional river bluff
- Sand dune

*Outcrops & Upland Meadows
- Alpine meadow
- Boreal outcrop
- Serpentine outcrop
- Temperate acidic outcrop
- Temperate calcareous outcrop

*Cliffs & Talus
- Boreal acidic cliff
- Boreal calcareous cliff
- Temperate acidic cliff
- Temperate calcareous cliff
- Open talus

Upland Forests & Woodlands

*Spruce-Fir Northern Hardwood Forest
- Subalpine krummholz
- Montane spruce-fir forest
- Lowland spruce-fir forest
- Montane yellow birch-red spruce forest
- Boreal talus woodland
- Cold-air talus woodland
- Red spruce-northern hardwood forest
- Red Spruce-Heath Rocky Ridge Forest

*Northern Hardwood Forest
- Northern hardwood forest
- Rich northern hardwood forest
- Mesic red oak-northern hardwood forest
- Hemlock forest
- Hemlock-northern hardwood forest
- Northern hardwood talus woodland

*Oak-Pine-Northern Hardwood Forest
- Limestone bluff cedar-pine forest
- Mesic maple-ash-hickory-oak forest
- Mesic Clayplain Forest
- White pine-red oak-black oak forest
- Dry oak forest
- Dry Red Oak-White Pine Forest
- Pine-oak-heath sandplain forest
- Dry oak-hickory-hophornbeam forest
- Red cedar woodland
- Red pine forest or woodland
- Pitch pine-oak-heath rocky summit
- Dry oak woodland
- Sand-Over-Clay Forest
- Temperate Hemlock Forest
- Temperate Hemlock-Hardwood Forest
- Transition Hardwoods Limestone Forest

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Northern Hardwood Forest Summary

Characteristics and Location

The Northern Hardwood Forest is typically best developed at Vermont's middle elevations and these are widespread in the state. Beech, sugar maple, and yellow birch are the predominant tree species, but hemlock, red oak, red maple, white ash, basswood, and white pine can be common as well, and red spruce makes an occasional appearance.

These are the dominant communities in nearly all biophysical regions, excepting the higher elevations of the Green Mountains and the warmer regions of the Champlain Valley, Taconic Mountains, and Southern Vermont Piedmont. Where the natural communities serve as landscape level habitat (i.e., matrix), they should be represented in large blocks of contiguous forest (1,000 acre to 20,000-acre blocks or larger) of various successional stages, elevations, and soils.

The natural communities that comprise Northern Hardwood forest formation habitat are found in every biophysical region of the state.

Natural communities of the Northern Hardwood Forest

Northern Hardwood Forest: A variable community, generally dominated by beech, sugar maple, and yellow birch. This community occurs as a landscape natural community type (i.e., matrix) throughout the state.

Rich Northern Hardwood Forest: High diversity hardwood-dominated forests of sugar maple, white ash, basswood, and hophornbeam, with excellent productivity and high herb diversity. These forests are closely associated with limestone and other calcium-rich bedrock types. Maidenhair fern, blue cohosh and wood nettle are characteristic herbs. This community occurs as a landscape natural community type (i.e., matrix) in the Taconic Mountains.

Mesic Red Oak-Northern Hardwood Forest: Northern hardwood species and red oak co-dominate. In the northern parts of Vermont this occurs on warm south-facing slopes, especially near major rivers. In southern Vermont, it occurs in cooler settings such as north-facing mid elevation slopes as well and can be common or sometimes the matrix.

Hemlock Forest: Small forest patches dominated by hemlock, often on shallow soils and cool sites. Found throughout Vermont.

Hemlock-Northern Hardwood Forest: Mixed forest of hemlock and northern hardwoods. This community occurs as a landscape natural community type (i.e., matrix) in at least the Southern Vermont Piedmont and the Taconic Mountains.

Northern Hardwood Talus Woodland: A small patch community with characteristic species including yellow birch, mountain maple, red berried elder, rock polypody, and Virginia creeper.

Northern Hardwood Forest Condition

Historical Perspective: Northern Hardwood Forests have dominated the Vermont landscape for at least the last 4,500 years, a period over which there was a gradual cooling of the climate. These past forests are believed to have closely resembled the composition of forests of today. Notable differences in the presettlement northern hardwood forests were the predominance of beech, making up over 40% of the trees (Siccama 1971) and the lower abundance of sugar maple. Although red spruce has decreased in abundance since presettlement times at mid-elevations, it has increased in abundance in valleys due to regeneration in old fields (Hamburg and Cogbill 1988). Similarly, white pine is now more abundant due to its regrowth in abandoned fields (Cogbill 2000). Presettlement forests also likely had much less red maple, white birch, and poplars than the forests of today, as these species are associated with younger forests (Cogbill 2000).

Current Condition: Vermont's Northern Hardwood Forest has become more widespread as farmland on the slopes and in the valleys has reverted to forest. However, human population growth and economic development result in forestland conversion and fragmentation that yield smaller blocks of contiguous Northern Hardwood Forest. While much of the Northern Hardwood Forest has been cleared or logged at one time, current land management trends will likely yield less early successional habitat in the future.

Desired Condition (SGCN Needs): Northern Hardwood Forest should be represented in both large blocks of contiguous forestland that contribute to the full complement of landscape level habitat for wide-ranging species and interior forest dwelling species, as well as in the natural community types that serve specific SGCN associated with that type. The large, contiguous forest blocks of Northern Hardwood Forest should exist in 1,000 to 20,000-acre blocks and should include representation of all successional stages, elevations, and soils should be well represented within each biophysical region. Prey wildlife species supported by northern hardwoods are an important component to maintaining several of the wide-ranging wildlife. In addition, the value of hard mast as wildlife food (i.e., nuts and acorns) from northern hardwoods is important for many SGCN with stands of bear-scarred American beech being a classic example. Interior forest conditions that occur in larger unfragmented forest blocks are critical for many species.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Northern Hardwood Forests since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust (VLT), the Forests, Parks & Recreation Department (VFPR), The Nature Conservancy (TNC), Audubon Vermont, and Green Mountain National Forest (GMNF). The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain in Rutland County and Athens Dome in Windham County. From 2005-2013, the Department acquired 41 separate parcels (excluding fishing access areas) in fee totaling more than 4,100 acres to be added to WMAs or to create new WMAs. VFWD also acquired more than 2,300 acres under conservation easement during the same period. These projects either directly or indirectly benefit SGCN. Partner organizations including the VFPR, TNC, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Beginning in 2008, the Wildlife Management Institute led the implementation of the Woodcock Conservation Plan in the northeast. Audubon Vermont's Forest Bird Initiative and Foresters for the Birds, in partnership with the Vermont Parks & Recreation Department, provides technical assistance to landowners and foresters to support forest management and policies benefitting a suite of responsibility birds (include Wood Thrush, Black-throated Blue Warbler and Canada Warbler). The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

Species of Greatest Conservation Need in Northern Hardwood Forest

High Priority
Canada Warbler (Wilsonia canadensis)
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpata)
Butterflies-Hardwood Forest Group (4 species)
Silver-haired Bat (Lasionycteris noctivigans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Woodland Vole (Microtus pinetorum)
Long-tailed or Rock Shrew (Sorex dispar)
Pygmy Shrew (Sorex hoyi)
Water Shrew (Sorex palustris)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Black-throated Blue Warbler (Dendroica caerulescens)
Wood Thrush (Hylocichla mustelina)
American Woodcock (Scolopax minor)
Chestnut-sided Warbler (Dendroica pensylvanica)
Ruffed Grouse (Bonasa umbellus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)
Common Gray Fox (Urocyon cinereoargenteus)

SGCN Note: Vascular plant SGCN not listed here: 32 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of large blocks of forestland to housing development, commercial development, and roads	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths	High
Impacts of Roads and Transportation Systems	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas)	High
Distribution of successional stages	Lack of appropriate landscape level approach to management resulting in a lack of either late or early successional habitat in appropriate size and juxtaposition.	High
Climate Change	May affect species composition	Low
Pollution	Acid rain, sulfur and mercury deposition	High
Invasive Exotic Species	Introduction of exotics species such as sudden oak death, hemlock wooly adelgid, beech bark disease, emerald ash borer, and garlic mustard could affect survival of species such as marten, black bear, Edwards hairstreak, West Virginia white, small mammals, songbirds, etc.	High
Incompatible Recreation	Inappropriate location of ski, hiking, snowmobile trails, illegal ATV use, rock climbing.	Medium
Habitat Degradation	Loss of key feeding areas (beech stands, riparian areas, snags, cavity trees, etc.). Loss of dead and down material, fragmentation of contiguous forests.	High
Herbivory	Excessive deer and moose browsing alters tree regeneration, composition, and ability to compete with invasive exotics	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Expand the Vermont Conservation Design (2015) to address finer scale elements (e.g., natural communities, habitats, SGCN).	Adoption of conservation targets (numeric and distributional goals) for natural communities, habitat, species.	TNC, VLT, FPR, DEC, CHC	SWG PR, NRCS, USFWS
Encourage long-term conservation efforts to keep forests forested including supporting Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and Vermont Housing and Conservation Board projects to protect intact forests.	Number of acres conserved, by type and quality	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to improve forest structure and manage for SGCN including, SGCN associated with early successional and late successional habitat and Ecologically Sensetive Treattement Areas.	Number landowners managing for SGCN. Acres of forest managed to improve forest structure.	NRCS, TNC, ANR, SAF, VWA, Coverts, Audubon	SWG
Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)		NRCS, TNC, ANR, SAF, VWA, Coverts, Audubon	SWG/PR
Provide financial incentives for private landowners minimize fragmentation to SGCN habitats and to restore and enhance degraded habitats.	Number of acres affected/restored	VFWD, NRCS	EQIP, FSA
Provide technical assistance to realtors, engineers, and licensed designers to help landowners shape their land use to better maintain habitat and to legal advisors to help with succession planning	Number programs presented	VNRC	VFWD
Provide technical assistance to town and regional planning organizations, distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004) and *Community Strategies for Vermont's Forests and Wildlife* (VNRC 2013)	Number of towns contacted; Number of towns incorporating wide-ranging species into planning	VFWD, RPCs, AVCC, VFS	VFWD
Provide technical assistance to state and federal land management agencies	Number of state and federal land management plans that include SGCN conservation.	ANR, USFWS, USFS	ANR, USFWS, NRCS
Work with VTrans to identify and maintain wildlife highway/road crossings and with recreational user groups to avoid road and trail placement in sensitive habitats	Number functional linkages across highways/roads	VFWD, VTrans, VAST, GMHA	SWG, PR, VTrans
Manage deer and moose populations at levels that provide suitable harvest opportunities, but do not impair forest regeneration	Number of deer and moose/square mile.	VFWD	PR
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	DEC, FPR, USFWS, GMNF, NRCS,	ANR, NRCS, FSA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
species. Develop plants at landscape-scale.		municipal & watershed groups, foresters	
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
Partners in Flight	Bird conservation plan	PIF, VCE, VFWD, Audubon, USFWS
Vermont Forest Resources Plan (2015 Update Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	VFPR
Vermont Transportation & Habitat Connectivity Guidance Document.	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Spruce-Fir-Northern Hardwood Forest Summary

Characteristics and location

These forests characterize our coldest regions. At higher elevations and in low cold, moist areas, red spruce and balsam fir may dominate the canopy. Warmer or better drained sites have significant amounts of hardwoods (yellow birch, sugar maple, and beech) along with softwoods in the canopy. Human or natural disturbance can also lead to temporary dominance by hardwood species.

These forests occur where growing seasons are short, summers are cool, and winters are harsh. The conifer-dominated forests blanket our highest peaks above 2,500 feet as well as occurring in cold lowland pockets within large areas of Northern Hardwood Forest. The mixed forests of red spruce and northern hardwoods are more widely distributed.

Natural communities of the Spruce-Fir-Northern Hardwood Forest

Subalpine Krummholz: Low, dense thickets of balsam fir and black spruce at high elevations. Generally shallow to bedrock.

Montane Spruce-fir Forest: Dominated by red spruce and balsam fir, with occasional heartleaf birch, paper birch, and yellow birch. Higher elevations of the Green Mountains and other ranges generally above 2,500 feet.

Lowland Spruce-Fir Forest: Dominated by red spruce and balsam fir, with occasional white spruce, black spruce, paper birch, and yellow birch. Lowlands of Northeastern Highlands and cold valleys elsewhere.

Montane Yellow Birch-Red Spruce Forest: Mixed forest of mountain slopes at elevations typically from 2,000 to 2,900 feet, dominated by yellow birch and red spruce.

Red Spruce-Northern Hardwood Forest: Mixed forest of red spruce, yellow birch, sugar maple, beech, and balsam fir found on generally cooler and drier sites than Northern Hardwood Forest, generally below 2,400 feet elevation.

Red Spruce-Heath Rocky Ridge Forest: A forest of red spruce and heath shrubs (low blueberries) that occurs on ridgelines, low summits, and exposed ledges where there are thin, well-drained soils over acidic bedrock. It is uncommon, but forms small to large forest patches at 1,500' to 2,500' elevations in all but Vermont's lowest elevations.

Boreal Talus Woodlands: Rockfall slopes in cold settings dominated by heart-leaved paper birch with occasional red spruce. Appalachian polypody, skunk currant, and mountain maple are often abundant.

Cold-Air Talus Woodland: Rare. Found where cold air drains at the bases of large talus areas. Characteristic plants are black spruce, abundant mosses and liverworts, foliose lichens, and Labrador tea.

Spruce-Fir-Northern Hardwood Forest Condition

Historical Perspective: In recent geologic time, forests dominated by spruce and fir became established in eastern North America only as recently as 8,000 years ago (Webb 1987). A warming trend, known as the hypsithermal interval, occurred from about 6,000 to 4,000 years ago, at which time spruce and fir dominated forests were greatly reduced in distribution. There has been a general expansion of spruce and fir since this time associated with a general cooling of climate (Klyza and Trombulak 1999).

Balsam fir has increased substantially when compared to presettlement forests, likely the result of its competitive advantage over spruce after heavy cutting (Whitney 1994). Red spruce has decreased in abundance at mid-elevation because of natural climate warming after the "little ice age" and forest harvesting, whereas it has increased in abundance in valley settings because of regeneration in old fields (Hamburg and Cogbill 1988).

Current Condition: Many of the natural communities within the spruce–fir–northern hardwood formation exist at high elevations and are often on shallow, acidic, infertile soils. They are, therefore, particularly susceptible to global climate change and acid rain. Montane Spruce-Fir Forest is commonly considered one of the landscape forest types most vulnerable to expected climatic warming. In addition, fragmentation through permanent conversion of forest blocks to roads, houses, ridgeline development, and ski trails pose the most significant problems to this forest type and the species that depend on it.

Desired Condition (SGCN Needs): Many of the below listed SGCN depend upon large, contiguous, interconnected, forest blocks. Where they exist within a biophysical region, examples of large, intact blocks of appropriate natural communities should be conserved to ensure the long-term viability of the associated SGCN (i.e. Montane Spruce-Fir Forest: Blackpoll Warbler, Olive-sided Flycatcher, Bicknell's Thrush, Bay-breasted Warbler; Lowland Spruce Fir Forest: Black-backed Woodpecker, Gray Jay, Bay-breasted Warbler), and Spruce Grouse. Contiguous forest blocks will ideally exist in 1,000-20,000-acre blocks at various elevations and of various soil types. Conservation of these blocks should incorporate SCGN distribution and habitat needs.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Spruce-Fir-Northern Hardwood Forest's since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust, the Forests, Parks & Recreation Department, The Nature Conservancy, Audubon Vermont, and Green Mountain National Forest. The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Spruce-Fir-Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain in Rutland County and Athens Dome in Windham County. These projects either directly or indirectly benefit SGCN. Partner organizations including the Forests, Parks & Recreation Department, The Nature Conservancy, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Parks & Recreation Department in 2008, provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report (Action Plan Appendix F) identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

SGCN in Spruce-Fir Northern Hardwood Forest

High Priority
Bicknell's Thrush (Catharus bicknelli)
Spruce Grouse (Falcipennis canadensis)
Canada Warbler (Wilsonia canadensis)
Jefferson Salamander (Ambystoma jeffersonianum)
Wood Turtle (Glyptemys insculpta)
Beetles-Tiger Beetle Group (7 species)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Lynx (Lynx canadensis)
American Marten (Martes americana)
Rock Vole (Microtus chrotorrhinus)
Woodland Vole (Microtus pinetorum)
Long-tailed or Rock Shrew (Sorex dispar)
Water Shrew (Sorex palustris)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys

Medium Priority
Northern Goshawk (Accipiter gentilis)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Olive-sided Flycatcher (Contopus cooperi)
Black-throated Blue Warbler (Dendroica caerulescens)
Bay-breasted Warbler (Dendroica castanea)
Blackpoll Warbler (Setophaga striata)
Gray Jay (Perisoreus canadensis)
Black-backed Woodpecker (Picoides arcticus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Wolf (Canis ?)
Mountain Lion (Puma concolor couguar)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Note: Vascular plant SGCN not listed here: 16 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of large blocks of forestland to housing development, and commercial development including: quarries, wind farm, roads, and recreational development	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths	High
Impacts of Roads and Transportation Systems Incompatible Recreation	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas) Conversion of habitat to roads and trails may interrupt movement corridors and provide habitat for competing species.	Medium
Distribution of successional stages	Lack of appropriate landscape level approach to management resulting in habitat degradation (lack of either late or early successional habitat in appropriate size and juxtaposition).	Medium
Climate Change	Expected to alter species composition of many Montane-Spruce-Fir Northern Hardwood Forest types and communities and stress sensitive SGCN associated with these forests.	High
Pollution	Acid rain, sulfur and mercury deposition may affect prey base and vernal pool chemistry	High
Habitat Degradation	Loss of concentrated food, cover, breeding habitats (deer wintering areas, vernal pools, conifer wetlands, coarse woody debris etc.).	High
Incompatible recreation	Inappropriate location of ski, hiking, snowmobile trails, illegal ATV use, rock climbing.	Medium
Herbivory	Excessive deer and moose browsing alters native tree regeneration, composition, and resistance to invasive exotics.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Expand the Vermont Conservation Design to address finer scale elements including similar analyses and mapping to set conservation goals for all-natural community types, habitats, SGCN and other species for which these serve as coarse filters, and to identify the SGCN and other rare species not "captured" by a coarse filter. Identify and establish habitat for climate adaptation refugia	Numeric and distributional goals for landscape and natural community scale elements.	TNC, VLT, FPR, DEC	SWG
Encourage long-term conservation efforts to keep forests forested (e.g., support Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and VT Housing & Conservation Board projects)	Number of acres conserved	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups, consulting foresters and forest managers to improve forest structure and maintain and enhance SGCN habitat in Spruce-Fir NHF and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number landowners/user groups/forest managers managing for Spruce-Fir SGCN. Acres of Spruce-Fir forest managed to improve forest structure	NRCS, TNC, VFWD, FPR, Coverts, SAF, VWA, Keeping Track	SWG/PR
Financial incentives for private landowners to maintain and enhance SGCN habitat in Spruce-Fir NHF	Number of acres affected/restored	VFWD, NRCS	EQIP
Technical assistance to town and regional planning organizations to maintain and enhance SGCN habitat in Spruce-Fir NHF. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns contacted; Number of towns incorporating the needs of SGCN in Spruce-Fir NHF into planning	VFWD, RPCs, AVCC, VFS	VFWD
Technical assistance to state and federal land management agencies to maintain and enhance SGCN habitat in Spruce-Fir NHF	Number of state and federal land management plans for Spruce-Fir NHF providing for lynx and marten habitat. Number of state and federal land management plans for Spruce-Fir NHF that include SGCN in their management objectives.	ANR, USFWS, USFS, SAF	ANR
Maintain forested buffers along stream and rivers (See ANR buffer policy)	Number of miles of streams with intact buffers	ANR, VLT, TNC, NWF, Coverts	SWG, EQIP, Trout Unlimited, NRCS
Work with VTrans to identify and maintain wildlife highway/road crossings	Number functional linkages across highways/roads	VFWD, VTrans	SWG, PR, VTrans
Work with recreational groups to reduce the number of trails in sensitive habitats	Number of sensitive habitats with limited disturbance	GMC, VAST, VT Ski Area Association	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Increase cooperation/coordination between adjacent states and provinces to support and encourage trans-jurisdictional actions to address issues such as global climate change, acid rain and other pollutants.	Implementation of trans-jurisdictional actions.	USFWS, USFS, ANR, other states, TNC, Quebec,	USFWS, IAFWA
Manage moose populations at levels that provide suitable prey, but do not impair forest regeneration	Number of moose/square mile	ANR	PR
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

Plan or planning entity	Goal/Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
Spruce Grouse Recovery Plan	Spruce grouse reintroduction	VFWD
Partners in Flight	Bird conservation plan	PIF, VFWD, Audubon, USFWS
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
2015 Update Vermont Forest Resources Plan (Draft)	Conservation and Management of VT Forests	VFPR
Vermont Transportation & Habitat Connectivity Guidance Document	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Oak-Pine-Northern Hardwood Forest Summary

Characteristics and Location

The Oak-Pine-Northern Hardwood Forest is best developed in the warmer regions of Vermont—the Southern Vermont Piedmont, Champlain Valley, and the lower elevations in the Taconic Mountains. Forest communities in this formation generally occur as large patches or locally as small patches within Northern Hardwood Forests and on dry, south-facing slopes and ridgetops. An exception to this is the Clayplain Forest of the Champlain Valley, which prior to European settlement occurred as a landscape scale (matrix) forest, but now has been reduced to forest fragments due to extensive agricultural use of the valley's clay soils. In the Oak-Northern Hardwood Forest Formation, hardwoods such as sugar maple, beech and white ash may be present, but warmer climate species such as red oak, shagbark hickory, and white oak are dominants of the forest canopy. White pine is also a prominent part of these forests.

The natural communities that comprise the Oak-Pine-Northern Hardwood forest type are diverse in their species composition, but all have species that occur in warmer climates, or on dryer sites such as south-facing slopes and ridges.

Natural communities of the Oak-Pine-Northern Hardwood Forest

Red Pine Forest or Woodland: Maintained by fire, these small areas are dominated by red pine, have very shallow soils, and have blueberries and huckleberries in the understory. They are widespread, and often surrounded by Northern Hardwood Forests.

Pitch Pine-Oak-Heath Rocky Summit: These are fire-adapted communities on dry, acidic ridgetops where red oak, white oak, pitch pine, scrub oak, and white pine are characteristic trees. Heath shrubs (blueberries and huckleberries) are abundant.

Limestone Bluff Cedar-Pine Forest: Northern white cedar dominates these areas of shallow soils over calcareous bedrock usually on the Lake Champlain shoreline. Red pine, white pine, hemlock, and hardwoods are also present. Characteristic herbs are ebony sedge and rock polypody. This community has suffered high degree of loss from historic levels due to shoreline development.

Red Cedar Woodland: These are open glade-like communities on ledge crests, where red cedar is native and persistent, and grasses and sedges dominate the ground layer.

Dry Oak Woodland: These are very open areas with trees of low stature on dry, south facing hilltops. Grasses and Pennsylvania sedge are dominant on the forest floor.

Dry Oak Forest: These forests occur on rocky hilltops with very shallow, infertile soils. Red oak, chestnut oak and white oak can all be present; usually other tree species are absent. Heath shrubs dominate the understory.

Dry Oak-Hickory-Hophornbeam Forest: These forests occur on till-derived soils, but they are often found on hilltops and bedrock exposures are common. Soils are well drained, but are more fertile than in Dry Oak Forests. Red oak, sugar maple, hophornbeam, and shagbark hickory are variously dominant. Sometimes sugar maple is the dominant tree, sometimes it is oak and hickory. Pennsylvania sedge forms lawns.

Mesic Maple-Ash-Hickory-Oak Forest: Sugar maple, white ash, hickories and red and white oak are present in varying abundances. This community needs better documentation.

Transition Hardwoods Limestone Forest: occurs in warm climate regions of Vermont where calcareous bedrock is close to the soil surface. Trees may be stunted and typical include sugar maple, white ash, shagbark hickory, basswood, hophornbeam, butternut, white oak, yellow oak (Quercus muehlenbergii), and bladdernut (Staphylea trifolia). A diverse community with a carpet of herbs reflecting calcium-rich conditions.

Mesic Clayplain Forest: Found on the Vergennes clay soils of the Champlain Valley, this forest is typically dominated by white oak, red maple, bur oak, swamp white oak, hemlock, and shagbark hickory. Maple-leaved viburnum is a typical shrub. Clayplain forests in Vermont have declined by 87.9% since pre-European settlement (Lapin 2003) due primarily to agricultural land use.

Sand-Over-Clay Forest: This large patch forest type occurs on specific soil types of the Champlain Valley where there is a sandy layer overlying clay. Hemlock, red maple, red oak, white oak, and black birch are all typical tree species and witch-hazel is a common shrub.

White Pine-Red Oak-Black Oak Forest: These forests are found on coarse-textured soils. Red and black oak co-dominate along with white pine. Beech and hemlock are also common. Heath shrubs are common in the understory.

Pine-Oak-Heath Sandplain Forest: This is a rare community type, found on dry sandy soils in warmer areas. Characteristic species are white pine, pitch pine, black oak, and red oak with an understory dominated by heath shrubs. Due to high development pressure, only 5% of the original 15,000 acres of sandplain forest in Chittenden County remain (Engstrom 1991).

Temperate Hemlock Forest: Similar to Hemlock Forest, but these dark, hemlock-dominated, small patch forests of warmer regions of the state have white oak, red oak, black birch as canopy associates, instead of northern hardwood species.

Temperate Hemlock-Hardwood Forest: Found in warmer climatic regions of Vermont, this mixed forest is co-dominated by hemlock, white oak, red oak, and black birch.

Transition Hardwood Talus Woodland: These talus woodlands are found in warmer areas, often on limestone but occasionally on slate, schist, granite, gneiss, or other rock. Some characteristic species are red oak, basswood, white ash, sweet birch, bitternut hickory, northern white cedar, hackberry, bulblet fern, and American yew.

Oak-Pine-Northern Hardwood Forest Condition

Historical Perspective: The natural communities that we recognize now are not static – they have changed dramatically over time as component species have migrated across the landscape in response to climatic change. The Oak-Pine-Northern Hardwood Forest Formation (and its characteristic species: pines, oaks, and hickories) provides a good example of how species migrations are independent of each other. After the retreat of the glaciers to the north, pine became well established in the northeastern United States by about 12,000 years ago, while oak was not well established until about 8,000 years ago, and hickory arrived in New England 2,000 to 3,000 years after the first increase in oak populations (Jacobson et al. 1987; Prentice et al. 1991).

It is often thought that white pine dominated the presettlement landscape of Vermont, but evidence from early land surveys indicates that it had a variable and restricted distribution (Cogbill 2000). Pine was abundant only in scattered areas of the Champlain and Connecticut River valleys, and was generally uncommon elsewhere. White pine has more than doubled in frequency since presettlement times, apparently due to its establishment and growth in abandoned agricultural fields (Cogbill 2000).

Current Condition: Of the three landscape level forests in Vermont, the Oak-Pine-Northern Hardwood Forest has been the most altered by human activities. The primary reason is that this forest type is most closely associated with the Champlain and Connecticut River Valleys – Vermont's most populated and prized agricultural regions. The Oak-Pine-Northern Hardwood Formation occurs in the warmest regions of the state that are generally the most desirable for settlement and agriculture. Human alteration of the landscape has most significantly altered two of natural community types of this formation: Mesic Clayplain Forest and Pine-Oak-Heath Sandplain Forest are now both considered rare forest types. In fact, in the southern Champlain Valley 87.9% of the Clay Plain Forest has been lost or degraded (Lapin 2003), primarily because of conversion to agricultural uses. One of Vermont's rarest and most threatened natural communities is the Pine-Oak-Heath Sandplain Forest of the northern Champlain Valley. Because of its high value for residential development, it has been estimated that only 5% of the original 15,000 acres of sandplain forest now remain in Chittenden County (Engstrom 1991). Many of the rarest SGCN are directly associated with these communities.

Many of the other natural communities of this forest formation are small and often found in isolated settings. Several are found along drier ridgetops that make them less vulnerable to forestland conversion. However, fire suppression over the past 200 years or more has taken away one of the more important natural disturbances vital to regenerating some of the oak-pine forest types. Without fire, regenerating oak following timber removal is difficult in some settings, particularly when under the influence of herbivory (i.e., deer browsing, hare and rabbit girdling). Invasive plants (e.g., honeysuckle, buckthorn) and exotic insects (e.g., gypsy moth) can have significant effects on the quality of the wildlife habitat.

Desired Condition (SGCN Needs): Oak-Pine-Northern Hardwood Forest should be represented in both large blocks of contiguous forestland that contribute to the full complement of landscape level forest for wide-ranging species, as well as in the natural community types that serve specific SGCN associated with that type. Although contiguous forest blocks are limited in size and availability for the rarer forest types, where they exist, large, contiguous forest blocks of Oak-Pine-Northern Hardwood Forest will ideally exist in blocks 1,000 acres or more of various elevations and soils. The oak component of this forest serves as important fall foods for numerous mammals, including some key prey species (e.g., deer, small mammals) for wide-ranging wildlife. Because much of the rarer Oak-Pine-Northern Hardwood Forest types have been converted to agriculture and development, the remaining fragmented blocks of these types will ideally be maintained, if not enlarged, as well as interconnected through forested or riparian corridors.

Implementing the 2005 Wildlife Action Plan

Actions by the Vermont Fish & Wildlife Department and partners to implement the Wildlife Action Plan in Oak-Pine Northern Hardwood Forest's since 2005 include:

Contiguous forest/habitat blocks and associated linkages were identified and prioritized as part of the "habitat block project" conducted from 2007 to 2014. Using GIS analysis of existing data, this projected identified 4,055 unfragmented forest blocks in Vermont and ranked each block for its biological and physical landscape diversity values. The project also identified a modeling tool for identifying likely wildlife corridors in Vermont. Partners included Vermont Land Trust, the Forests, Parks & Recreation Department, The Nature Conservancy, Audubon Vermont, and Green Mountain National Forest. The project results are now used extensively in VFWD technical assistance to towns. The project report is "Vermont Habitat Blocks and Habitat Connectivity: An Analysis using Geographic Information Systems."

VFWD has been inventorying Oak-Pine-Northern Hardwood Forest types throughout Vermont since 2007 with the goal of identifying the most important forest blocks that are dominated by this forest formation. Approximately 100 sites have seen ecological and wildlife inventories so far.

In 2013, VFWD and The Nature Conservancy, and working with other partners, completed an inventory and prioritization of clayplain forest fragments in the Champlain Valley. The high priority examples of all clayplain forest types, including Wet Clayplain Forest and Wet Sand-Over-Clay Forest, were entered into the Department's Natural Heritage Database to be used for conservation planning.

VFWD has acquired in fee and through conservation easements many high priority sites that include landscape scale Oak-Pine-Northern Hardwood Forests and provide critical landscape connectivity. These include Bird Mountain and North Pawlet Hills, both in Rutland County). Partner organizations including the Forests, Parks & Recreation Department, The Nature Conservancy, The Trust for Public Land, Vermont Land Trust and many local land trusts acquired and managed lands similarly benefitting SGCN.

VFWD provided technical assistance to private landowners, user groups and forest managers to manage for SGCN including, species associated with early successional and late successional habitat through the Natural Resources Conservation Service-funded WHIP and EQIP programs. Over the period from 2003-2013, the Department has worked on approximately 986 WHIP and 220 EQIP projects representing a total of 1,206 new wildlife habitat enhancement projects with as many private landowners throughout Vermont. Within each of these projects the following practices are the most common: Early Successional

Habitat Development (Patch Cuts), Upland Wildlife Habitat Development (Mast and Apple Tree Release), and Invasive Species Control (in the form of Herbaceous weed control, and Brush Management).

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Vermont Forest Roundtable was first convened in 2006 as a venue for information exchange on keeping Vermont's forests as forests. Organized by the Vermont Natural Resources Council, the Roundtable regularly hosts consulting foresters, professional planners, state agency officials (including VFWD and VFPR), landowners, sportsmen, forest products industry representatives, conservation groups, biomass energy organizations and academics. The Roundtable formed with an initial focus on parcelization and forest fragmentation issues. It's since facilitated discussions on trends in Vermont's real estate market and rising forestland values, property tax policy, land use and conservation planning, estate planning, landowner incentive programs such as the Current Use Program, and the long-term sustainability of the forest products industry.

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat. Staff also work with consulting and county foresters to help them learn about treatment areas.

VFWD and the Vermont Agency of Transportation (VTrans) established a joint Wildlife-Transportation Steering Committee in 2007 to guide and support interagency cooperation to make Vermont's transportation system safer for both people and wildlife. VTrans published its Vermont Transportation & Habitat Connectivity Guidance Document in 2012. Together they currently support three wildlife camera and road tracking projects to advance our understanding of wildlife's use of transportation infrastructure. These studies are providing VTrans with improved infrastructure design criteria and VFWD with an enhanced understanding of wildlife movement at key locations in the state.

The Staying Connected Initiative was established in 2008 to maintain and improve landscape connectivity across the Northern Appalachian/Acadian region of the eastern U.S. and Canada (NY, VT, NH, ME, MA and the eastern provinces) through research, land use planning, land management, land protection and road barrier mitigation. The comprehensive approach of the partnership allows the targeting of specific wildlife movement pinch points and coordinated action and affords some assurance that expensive state investment in wildlife-friendly transportation infrastructure is not undone by conflicting land uses in the near vicinity beyond the transportation right-of-way. Partners include VFWD, TNC, VNRC, VTrans, NWF, Wildlife Conservation Society, and the fish and wildlife and transportation agencies of partner states). VFWD has also worked closely with the North Atlantic Landscape Conservation Cooperative on a pilot conservation design for the Connecticut River watershed.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Parks & Recreation Department in 2008, provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

In 2014-2015 VFWD and partners including Vermont Land Trust, Vermont Forests, Parks & Recreation, The Nature Conservancy, and the Northwoods Stewardship Center produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape" (Sorenson et al. 2015). This report (Action Plan Appendix F) identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, wildlife and landscape connectivity, and physical landscape diversity that are necessary to effectively conserve many finer scale conservation elements in the face of climate change and habitat loss, including natural communities, rare species, and SGCN.

In 2015, VFWD, in collaboration with VFPR and NRCS developed the Landowner's Guide--Wildlife Habitat Management for Lands in Vermont which provides technical assistance on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production.

SGCN in Oak-Pine Northern Hardwood Forest

High Priority
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpata)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Butterflies-Hardwood Forest Group (4 species)
Beetles-Tiger Beetle Group (7 species)
Indiana Bat (Myotis sodalis)
Silver-haired Bat (Lasionycteris noctivigans)
Eastern Red Bat (Lasiurus borealis)
Northern Long-eared Bat (Myotis septentrionalis)
Hoary Bat (Lasiurus cinereus)
Woodland Vole (Microtus pinetorum)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Northern Goshawk (Accipiter gentilis)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-throated Blue Warbler (Dendroica caerulescens)
American Woodcock (Scolopax minor)
Chestnut-sided Warbler (Dendroica pensylvanica)
Ruffed Grouse (Bonasa umbellus)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Masked Shrew (Sorex cinereus)

SGCN Note: Vascular plant SGCN not listed here: 128 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Habitat Conversion	Permanent conversion of forestland to housing development, commercial development, agriculture, and roads	High
Habitat Fragmentation	Break up of large forest blocks, riparian corridors, and migration paths. Wider ranging reptiles and birds depend upon contiguous habitat mosaics of 1000 ha or more.	High
Impacts of Roads and Transportation Systems Incompatible Recreation	Human and motorized disturbance from new roads and trails in sensitive habitats (e.g., denning sites, breeding sites, feeding areas)	High
Inadequate Disturbance Regime	Fire Suppression: many habitats depend upon fire.	Medium
Climate Change	May affect species composition.	Medium
Pollution	Acid rain affects on amphibians.	Medium
Habitat Degradation	Alteration of tree composition and loss of large, dead trees for cavities and roosts	Medium
Herbivory	Excessive deer browsing alters tree regeneration and composition	High
Invasive Exotic Species	Fragmented forest blocks encourage invasive plant species. Gypsy moth infestations affect oak productivity and survival.	High

Priority Conservation Strategies

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop a strategy and design that identifies the coarse-filter conservation values of landscape scale features (blocks of all forest types, connectivity, physical landscape diversity) and which SGCN and other rare species are expected to be captures by these coarse filters. Conduct a similar analysis and mapping to set conservation targets for all-natural community types and the SGCN and other species for which these serve as coarse filters.	Conservation targets (numeric and distributional goals) for landscape and natural community scale elements.	TNC, VLT, FPR, DEC	SWG
Encourage long-term conservation efforts to keep forests forested (e.g., support Use Value Appraisal, Forest Legacy, State Lands Acquisition and Management and VT Housing & Conservation Board projects)	Number of acres conserved	ANR, FPR, VLT, TNC, TPL, VHCB, Local Land Trusts	VHCB, VLT, Forest Legacy
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to improve forest structure and manage for SGCN in Oak-Pine NHF and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number of landowners managing land for SGCN Number of acres of Old-Pine forest managed to improve forest structure	NRCS, TNC, ANR, SAF, VWA, VT Coverts	SWG/PR
Financial incentives for private landowners to maintain and enhance SGCN habitat in Oak-Pine NHF	Number of acres affected/restored	VFWD, NRCS	EQIP
Technical assistance to town and regional planning organizations. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns & RPC's considering SGCN in their planning	VFWD, RPC's, AVCC, SAF, VWA, Coverts, VFS	VFWD

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Technical assistance to state and federal land management agencies	No. state and federal land mgmt plans providing for SGCN, including use of prescribed fire	ANR, USFWS, USFS	ANR
Manage deer populations at levels that provide suitable harvest opportunities, but do not impair forest regeneration	Number of deer/square mile. Level of browse. Change in the # of wildlife road mortalities	ANR	PR
Continue working with VTrans and towns to identify and improve wildlife-highway/road crossings	Number of functional linkages across highways/roads	VFWD, VTrans	SWG, PR, VTrans
Increase cooperation/coordination among adjacent states/provinces. Develop trans-jurisdictional actions to address issues such as climate change, acid rain and connectivity.	Implementation of trans-jurisdictional actions.	USFWS, USFS, ANR, other states, TNC, Quebec, VTA	USFWS, IAFWA
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Investigate the impact of invasive earthworms on Vermont forest habitats: survey the extent of infestations, and develop education and technical assistance programs, best management practices and rules as needed.		VFWD, VFPR, UVM	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal / Scope of plan	Lead
Bat Conservation Plan	Bat habitat conservation	VFWD
ANR Long Range Management Plans	Management activities on ANR Lands	ANR
Green Mountain Forest Plan	Management activities on GMNF	USFS
Partners in Flight	Bird conservation plan	PIF, VFWD, Audubon, USFWS
The Nature Conservancy Champlain Valley Ecoregional Plan	Land conservation targets for the Champlain Valley Ecoregion	TNC
Champlain Basin Plan	Conservation of Champlain Basin resources	LCBP
Watershed Management Plans	Watershed plans for the Lake Champlain Basin	DEC
2015 Update Vermont Forest Resources Plan (Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	FPR
Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change	Maintaining and improving forest resiliency	VFPR
Vermont Transportation and Habitat Connectivity Guidance Document.	Informs transportation planning, design, construction, operations and maintenance activities and related wildlife and ecological systems monitoring	VTrans

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Young Forests, Old Forests and Shrub Habitat Summary

This section augments the preceding forest summaries (Northern Hardwood, Spruce Fir and Oak Pine Northern Hardwood).

Characteristics and Location

Old forests are biologically mature forests, typically in late successional stages of development and showing minimal evidence of human disturbance. In general, old forests have: some trees exceeding 150 years old for most forest types (100 years old for balsam fir forests); dominated by native tree species characteristic of the forest type; trees of multiple ages; complex structural diversity that includes a broad distribution of tree diameters, vegetation layers, and canopy gaps; abundant coarse woody material in all stages of decay; and evidence of past natural disturbance, such as pit-and-mound micro-topography resulting from trees blowing over in wind storms. Old forests have complex soil structure compared to younger forests of the same type. The relative stability of old forests, the abundance of coarse woody material, the complex vegetation and soil structure provide preferred habitat for many species, including herbaceous species, lichens, mosses, fungi, and some species of insects, amphibians, birds, and mammals. Vermont currently has very few areas of old forest, probably less than one percent of the state, with most of the known small patches occurring in remote or inaccessible areas that have escaped past logging or clearing. Other areas of old forest are known from forested swamps, montane forests, and some rare natural community types such as Limestone Bluff Cedar-Pine Forests that have stunted trees on very shallow soils. No comprehensive inventory of Vermont's old forests has been conducted.

Young Forests are comprised of tree species seedlings and saplings between 1 and 15 years of age. The importance of these forests to wildlife, however, is more often related to forest structure than the actual age of the woody vegetation. In Vermont, most young forests are found in recently harvested forest stands, although abandoned fields and pastures that have reverted to young trees also contribute to the needs of SGCN that are dependent on this habitat type. Young forest species composition varies with the natural community that occurs at the site, but also with the land-use history, land management practices, and forest/natural community type. Natural disturbance caused by windstorms, floods, beaver activity, and fires result in stand-replacing events that develop into young forests through natural succession. The size and distribution of young forest patches is important in determining their wildlife habitat function and currently is more easily controlled through management activities than by allowing natural disturbance events to occur. No comprehensive inventory of Vermont's young forests has been conducted.

Shrublands are areas in which shrubs, woody plants with many stems arising at or near the ground, are the dominant vegetation. Typical shrubs include speckled alder, dogwoods, hazelnut, blueberries, wild cranberry, mountain holly, choke cherry, and blackberry. Shrublands occur as relatively stable natural communities in some wetland types, such as Alder Swamp, Alluvial Shrub Swamp, and Buttonbush Swamp (see the Shrub Swamp Summary in later in this chapter). In these shrub-dominated wetland natural communities, periodic flooding or other hydrologic conditions result in ongoing natural disturbance that maintains the shrub cover and retards succession to a forested community. In Vermont, shrublands also occur in areas that are specifically managed for this habitat type through periodic mowing, along managed utility corridors, and in abandoned agricultural lands. The location and extent of shrub-dominated natural communities are relatively well-known though USFWS National Wetlands Inventory and statewide natural community inventory work. The extent of managed shrublands and abandoned agricultural lands currently in a shrub-dominated state are not currently well-inventoried.

Forest Condition

Historical Perspective: Glaciers retreated from what is now Vermont approximately 12,500 years ago. This set the stage for recolonization of the landscape by plants. Pollen records reveal that the first colonizers of the barren, post-glacial landscape were cold-tolerant, small plants that we now associate with arctic and sub-arctic tundra. Trees such as black spruce and paper birch began to appear in Vermont about 11,000 years ago, with closed canopy forests developing in many areas. Tree species migration continued over thousands of years with warmer climate species arriving in Vermont according to their individual cold-tolerances and migratory rates. By approximately 4,500 years ago, the forest composition closely resembled that of the forests present in Vermont at the time of European settlement. (Klyza and Trombulak 1999)

Native American peoples have been present in Vermont for at least 11,000 years. The size of the Native American populations in Vermont were always small. Early Paleoindians that inhabited the tundra and open woodlands had a population estimated to be less than 2,500. At the time of European settlement (1600), an estimated 4,200 Abenaki were in the Champlain Valley and as many as 3,800 in the upper Connecticut River Valley. (Klyza and Trombulak 1999) Their effect on the landscape was significant in the localized areas of vegetation management and agriculture along the river valleys and Champlain Valley. There is no evidence of widespread use of fire or other forest management in Vermont as there is for southern New England (Whitney 1999), so most of Vermont's forests were under the influence of disturbance regimes associated with wind storms. It remains uncertain if the extinction of 35 to 40 large mammal species that occurred 12,000 to 9,000 years ago was the result of climate change or Native American hunting. The alteration of the Vermont and New England landscape was much more dramatic because of European settlement. Forest that covered approximately 95 percent of the Vermont landscape in 1600 was reduced to an estimated 37 percent of the landscape in 1880. The forests were cut and cleared to provide firewood, charcoal, building materials, and agricultural land for crops and livestock. The human population of Vermont decreased around 1860s because of the Civil War, disease, emigration to the highly productive agricultural lands of the Midwest, and other factors. Since the maximum deforestation in Vermont in 1880, forests have rebounded in Vermont and now are estimated to cover 75 percent of the state (Morin et al. 2015).

It has been estimated that old forests occupied from 70 to 89 percent of the regional presettlement landscape dominated by northern hardwood forest and from 29 to 78 percent of the landscape in conifer dominated forests and swamps (Lorimer and White, 2003). The same study estimates that young forest (1-15-year age class) occupied from 1.1 to 3.0 percent of the regional presettlement landscape in areas of northern hardwood forest and 2.4 to 7.1 percent of the regional landscape in areas of spruce-northern hardwood forest. These estimates of presettlement forest conditions provide a useful background on the areas occupied by old forest and young forest but are not necessarily considered targets for each habitat type that should be created through management activities.

We do not have accurate estimates on the extent of natural shrublands in Vermont prior to European settlement. However, we do know that beaver populations were much higher than they are today. Therefore, the extent of alder swamps, shallow marshes, and wet meadows would also have been greater than they are today, as these wetland communities are all part of the natural dynamics of beaver activity.

The percentage of early successional forest in Vermont and the region increased dramatically because of farm abandonment and young forest regeneration in the mid-1800s. Wildlife species that favor young forest increased in numbers in Vermont in response to this increase in regenerating forest. As forest cover has increased and matured in Vermont over the past 150 years, there has been a resulting decline in some species that are dependent on young forests (e.g., woodcock). Many of these declining species are listed below as SGCN.

Current Condition: Land use history has resulted in most Vermont's forests being "middle-aged". The following graph (fig 1) from Forests of Vermont and New Hampshire 2012 (Morin et al. 2015) is based on plot data across Vermont and shows the distribution forest land by age class and stocking class. This clearly shows the low percentage of land area occupied by both old forests and young forest, with most of forests in the three age classes of middle-aged forests (41-60, 61-80, and 81-100). These middle-aged forests provide many substantial functions for wildlife habitat, landscape connectivity, and ecological services, but the poor representation of old forests and young forests on the current landscape is a concern for conserving SGCN and representing biological diversity.

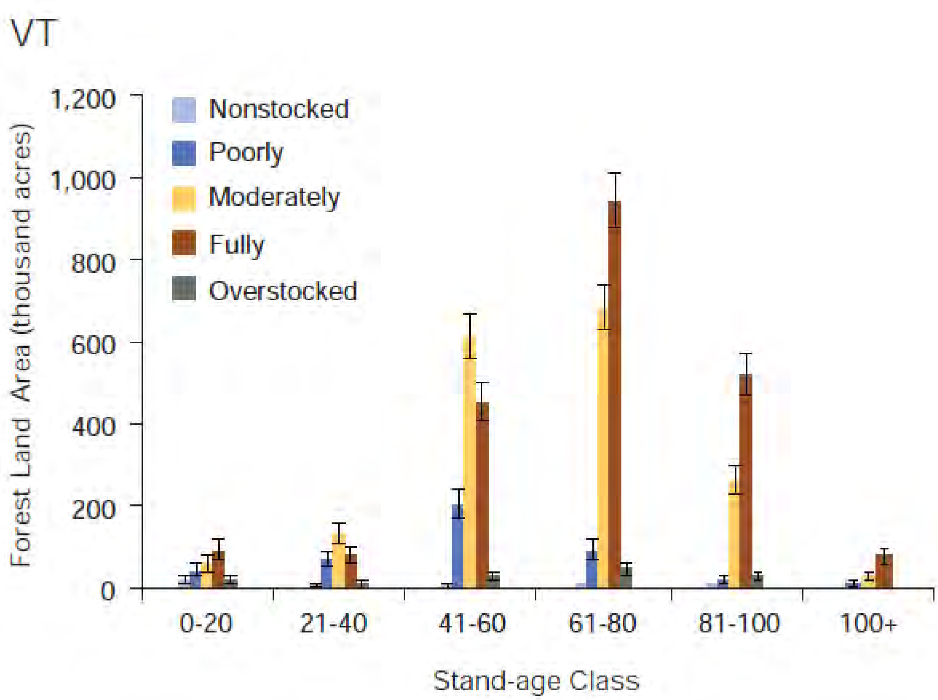

Figure 1 Vermont forests classified by age class shows that there is relatively small area of young and old forests compared to middle-aged forest.

Desired Condition (SGCN Needs): There is a clear need in Vermont to establish conservation targets for the land area and geographic distribution of old forests, young forests, and shrublands. Setting conservation targets for these habitat types should be based on estimated presettlement conditions as well as the specific needs of SGCN and other species that rely on these habitats. Although young forest and shrublands may have been a relatively minor component of the Vermont landscape in presettlement conditions, there are currently many species in Vermont that rely on these habitats now and targeted land conservation and management will be needed to ensure their continued survival in the state. Old forests will develop over time in areas that have been designated as ecological reserves or wilderness areas, but the locations of these designated areas are biased toward high elevation and northern climate areas and the full range of natural communities and physical landscapes should be represented in old forest conditions as part of maintaining an ecologically functional landscape into the future. Some ecological characteristics of old forests can be encouraged by specific forest management techniques, but this does not replace the need for establishing old forests in which little or no active management occurs. Old forests support a high diversity of species and provide ecologically stable conditions under which evolution and natural disturbance events can occur. Over the next two years, Vermont Fish and Wildlife Department (VFWD) will be working specifically on using the best available science to set conservation targets for old forest, young forest, shrublands, and other habitats as part of the Vermont Conservation Design project.

Implementing the 2005 Wildlife Action Plan

Young forest management is a priority on VFWD's Wildlife Management Areas (WMAs). Since the adoption of the Wildlife Action Plan in 2005, an estimated 1,350 acres of Young Forest habitat has been created on WMAs. A 464-acre Young Forest Demonstration site was created on Groton State Forest, and 40 acres of Young Forest and a 4-acre woodcock courtship area have been created thus far.

Audubon Vermont's Foresters for the Birds program, developed in partnership with the Vermont Forests, Parks & Recreation Department (VFPR) in 2008, and provides foresters and landowners with education and technical assistance to manage forest lands for bird habitats. The program is proving to be an excellent mechanism to bring forest landowners with an interest in bird conservation into being active forest stewards.

Landowner's Guide--Wildlife Habitat Management for Lands in Vermont provides tips on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber production. This publication was the result of a partnership of VFWD, VFPR and the USDA's Natural Resources Conservation Service.

Beginning in 2008 the Wildlife Management Institute led the implementation of the Woodcock Conservation Plan in the Northeast and published two reports on shrubland and young forest SGCN (Gilbert 2011 and Gilbert 2012).

The Environmental Quality Incentives Program (EQIP) and the former Wildlife Habitat Incentives Program (WHIP) are administered and funded by the National Resources Conservation Service (NRCS) with technical aid from VFWD Department. These programs help private landowners with the resources and expertise needed to manage their land for the benefit of fish, wildlife and overall environmental quality—be it by releasing mast or apple trees for wildlife, creating early successional habitat for nesting song birds, or controlling invasive species, these programs have helped Vermonters manage their land for wildlife. When the Wildlife Action Plan was adopted in 2005, the Vermont NRCS office quickly adopted it as a guide for its work on these programs. Over the last 10 years of this agreement, Department staff has worked with landowners on approximately 986 WHIP projects and over 220 EQIP projects throughout Vermont, resulting in the creation of nearly 3,000 acres of Young Forest habitat. This agreement is ongoing and the continued partnership is improving habitat throughout Vermont.

Species of Greatest Conservation Need in Young Forests

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
North American Racer (*Coluber constrictor*)
Eastern Ratsnake (*Pantherophis alleghaniensis*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Wood Turtle (*Glyptemys insculpta*)
Whip-poor-will (*Caprimulgus vociferus*)
Bicknell's Thrush (*Catharus bicknelli*)
Common Nighthawk (*Chordeiles minor*)
Rusty Blackbird (*Euphagus carolinus*)
Spruce Grouse (*Falcipennis canadensis*)
Gray Jay (*Perisoreus canadensis*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Brown Thrasher (*Toxostoma rufum*)
Canada Warbler (*Wilsonia canadensis*)
Blackpoll Warbler (*Setophaga striata*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Canada Lynx (*Lynx canadensis*)
Pygmy Shrew (*Sorex hoyi*)
New England Cottontail (*Sylvilagus transitionalis*)

Medium Priority
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
American Woodcock (*Scolopax minor*)
Bay-breasted Warbler (*Dendroica castanea*)
Prairie Warbler (*Dendroica discolor*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Moose (*Alces alces*)
Snowshoe Hare (*Lepus americanus*)
Bobcat (*Lynx rufus*)
Long-tailed Weasel (*Mustela frenata*)

Species of Greatest Conservation Need in Old Fields/Shrubs

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
North American Racer (*Coluber constrictor*)
Timber Rattlesnake (*Crotalus horridus*)
Eastern Ratsnake (*Pantherophis alleghaniensis*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Wood Turtle (*Glyptemys insculpta*)
Whip-poor-will (*Caprimulgus vociferus*)
Chimney Swift (*Chaetura pelagica*)
Common Nighthawk (*Chordeiles minor*)
Northern Harrier (*Circus cyaneus*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Vesper Sparrow (*Pooecetes gramineus*)
Eastern Meadowlark (*Sturnella magna*)
Brown Thrasher (*Toxostoma rufum*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Bumble Bee Group (*Bumble Bee Group*)
Butterflies-Grassland Group (*Butterflies-Grassland Group*)
Moths Group (*Moths Group*)
Woodland Vole (*Microtus pinetorum*)
New England Cottontail (*Sylvilagus transitionalis*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Eastern Red Bat (*Lasiurus borealis*)
Hoary Bat (*Lasiurus cinereus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)
Pygmy Shrew (*Sorex hoyi*)

Medium Priority
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Short-eared Owl (*Asio flammeus*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Purple Martin (*Progne subis*)
American Woodcock (*Scolopax minor*)
Field Sparrow (*Spizella pusilla*)
Prairie Warbler (*Dendroica discolor*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Beetles-Carabid Group (*Beetles-Carabid Group*)
Long-tailed Weasel (*Mustela frenata*)
Hairy-tailed Mole (*Parascalops breweri*)
Southern Bog Lemming (*Synaptomys cooperi*)
Gray Fox (*Urocyon cinereoargenteus*)
Big Brown Bat (*Eptesicus fuscus*)
Masked Shrew (*Sorex cinereus*)

Species of Greatest Conservation Need in Shrub Swamps

High Priority
Fowler's Toad (*Anaxyrus fowleri*)
Boreal Chorus Frog (*Pseudacris maculata*)
Timber Rattlesnake (*Crotalus horridus*)
Eastern Ribbonsnake (*Thamnophis sauritus*)
Spotted Turtle (*Clemmys guttata*)
Wood Turtle (*Glyptemys insculpta*)
American Black Duck (*Anas rubripes*)
Red-shouldered Hawk (*Buteo lineatus*)
Whip-poor-will (*Caprimulgus vociferus*)
Black Tern (*Chlidonias niger*)
Common Nighthawk (*Chordeiles minor*)
Rusty Blackbird (*Euphagus carolinus*)
Eastern Towhee (*Pipilo erythrophthalmus*)
Pied-billed Grebe (*Podilymbus podiceps*)
Vesper Sparrow (*Pooecetes gramineus*)
Brown Thrasher (*Toxostoma rufum*)
Blue-winged Warbler (*Vermivora pinus*)
Bumble Bee Group (*Bumble Bee Group*)
Butterflies-Wetland Group (*Butterflies-Wetland Group*)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (*Odonates-Bog/Fen/Swamp/Marshy Pond Group*)
Water Shrew (*Sorex palustris*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Eastern Red Bat (*Lasiurus borealis*)
Little Brown Bat/Myotis (*Myotis lucifugus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)

Medium Priority
Blue-spotted Salamander (*Ambystoma laterale*)
Spotted Salamander (*Ambystoma maculatum*)
Four-toed Salamander (*Hemidactylium scutatum*)
Common Watersnake (*Nerodia sipedon*)
Smooth Greensnake (*Opheodrys vernalis*)
DeKay's Brownsnake (*Storeria dekayi*)
Common Musk Turtle (*Sternotherus odoratus*)
Ruffed Grouse (*Bonasa umbellus*)
Black-billed Cuckoo (*Coccyzus erythropthalmus*)
Chestnut-sided Warbler (*Dendroica pensylvanica*)
Black-crowned Night-heron (*Nycticorax nycticorax*)
American Woodcock (*Scolopax minor*)
Lesser Yellowlegs (*Tringa flavipes*)
Beetles-Carabid Group (*Beetles-Carabid Group*)
Moose (*Alces alces*)
Wolf (*Canis sp?*)
Snowshoe Hare (*Lepus americanus*)
Bobcat (*Lynx rufus*)
Eastern Mountain Lion (*Puma concolor couguar*)
Masked Shrew (*Sorex cinereus*)
Gray Fox (*Urocyon cinereoargenteus*)
Big Brown Bat (*Eptesicus fuscus*)

Species of Greatest Conservation Need in Old Forests*

High Priority
Early Hairstreak (*Erora laeta*)
Northern Goshawk (*Accipiter gentilis*)
American Marten (*Martes americana*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Hoary Bat (*Lasiurus cinereus*)
Small-footed Bat (*Myotis leibii*)
Little Brown Bat/Myotis (*Myotis lucifugus*)
Northern Long-eared Bat (*Myotis septentrionalis*)
Indiana Bat (*Myotis sodalis*)

Medium Priority
Hackberry Emperor (*Asterocampa celtis*)
Northern Goshawk (*Accipiter gentilis*)
Wolf (*Canis sp?*)
Northern Flying Squirrel (*Glaucomys sabrinus*)
Eastern Mountain Lion (*Puma concolor couguar*)
Big Brown Bat (*Eptesicus fuscus*)

*Except for some young forest-dependent species, most of the forest dwelling wildlife historically found in Vermont' are expected to do well or thrive in old forests.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/ Information Need Category	Problem/ Information Need Detail	Rank
Inadequate Distribution of Successional Stages	Lack of appropriate landscape level approach to management resulting in a lack both old and young forest in appropriate size and juxtaposition. Most of VT's forests are 'middle-aged' and lack the needed forest structural diversity and biological diversity	High
Information Gap	An inventory of old and young forests statewide is needed; and a monitoring/tracking system is needed for both	High
Information Gap	Land managers need geographic distribution and area targets for conservation and management	High
Invasive Exotic Species	Young forests are particularly susceptible to colonization by non-naïve invasive species (in certain parts of the state, particularly warm regions and areas with calcium rich substrates).	High
Habitat Fragmentation	Parcelization of forests making it more difficult to manage broader landscapes. Fragmentation of habitat by development, roads and trails.	High
Habitat Conversion	Conversion of habitat to urban/suburban development	High
Inventory of SGCN	Better information is needed on the distribution of young forests, old forests and shrub species (especially herps and mammals) and the relative values of the various types and sizes of young and old forests and shrublands to SGCN.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Inventory the distribution and abundance of young forests, old forests and shrublands statewide	Number of acres positively affected by management. Population response to management	ANR, USFWS, USFS	USFS, SWG, PR
Refine our understanding of the species that utilize and/or depend on old forests, young forest and shrublands	Completion of the species phase of the Vermont Conservation Design.	ANR, GMNF, UVM	SWG, PR,
Determine targets for young and old forests and shrublands on state lands based on SGCN needs, current distribution levels by biophysical region, presettlement estimates, public demand and legal constraints and objectives of parcel ownership,	Number of state land parcels with target habitats. Number of state lands parcels meeting targets	ANR, USFS, USFWS,	USFS, ANR, PR
Work with partners and willing landowners to promote a sustainable range of forest age, structure, and composition that benefits SGCN and encourages a diverse assemblage of native plants and organisms within the landscape. Young forest habitat should be strategically located, recognizing the importance of interior forest habitat, and providing the full suite of habitat characteristics for SGCN			

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Promote conservation easements and incentives to landowners managing young and old forests and shrublands for SGCN.	Number of maintained or enhanced sites on private land	ANR, VFB, VWA, Coverts, NRCS, VLT, VHCB	EQIP, FSA
Provide technical assistance to private landowners, user groups consulting foresters and forest managers to manage for SGCN including, SGCN associated with early successional and late successional habitat and Ecologically Sensetive Treattement Areas. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number landowners managing for SGCN.	NRCS, TNC, ANR, SAF, VWA, Covert	NRCS, SWG
Manage power line right-of-ways to support SGCN that depend on young forests and shrublands and enhance surrounding areas by creating and maintaining young forests and shrublands where feasible.	Number of sites and total area designated for young forests and shrublands management	ANR, VETCO, GMP	SWG, VETCO, GMP
Develop education and outreach program to provide information about young forest SGCN and management options to enhance their populations in Vermont.	Number of maintained or enhanced sites on private land	ANR, NRCS, Coverts, VWA	SWG, EQIP, PR,
For old forests, develop education and outreach program and BMPs emphasizing long rotations and strategies producing a varied 3-dimensional stand with extensive development of vertical diversity and canopy gaps.	Number of maintained or enhanced sites on private land. Acres of appropriate habitat enrolled in UVA's ESTA program	ANR, Covets, VWA	SWG

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Partners in Flight	Regional Bird conservation	VFWD, USFWS,PIF,NABSCI
Region 5 Woodcock Management Plan	Woodcock conservation	WMI, VFWD, USFWS
Public Lands Long Range Plans	Species Conservation	ANR, GMNF, Conte Refuge
Wildlife Habitat Improvement Program, LIP	Species Conservation	NRCS

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Floodplain Forest Summary

Characteristics and Location

Floodplain forests are usually dominated by silver maple or occasionally sugar maple, with abundant ostrich fern or sensitive fern. They are closely associated with river and lake floodplains and have exposed mineral soils of alluvial origin.

Natural communities of the Floodplain Forest include: Silver Maple-Ostrich Fern Riverine Floodplain Forest, Silver Maple-Sensitive Fern Riverine Floodplain Forest, Sugar Maple-Ostrich Fern Riverine Floodplain Forest and Lakeside Floodplain Forest.

Natural communities of the Floodplain Forest:

Silver Maple-Ostrich Fern Riverine Floodplain Forest: This forest is found generally in the floodplains of moderate-gradient rivers. Silver maple and ostrich ferns are the dominant species and the soils are typically well drained sandy alluvium. Boxelder may be abundant in young forests.

Silver Maple-Sensitive Fern Riverine Floodplain Forest: These forests occur generally in the floodplains of large, low-gradient rivers. Silver maple is the dominant tree, but green ash and swamp white oak may be present. Sensitive fern and false nettle are characteristic. Soils are moist, typically mottled, silty alluvium.

Sugar Maple-Ostrich Fern Riverine Floodplain Forest: This uncommon floodplain forest type occurs along small to moderate sized high gradient rivers in areas of calcium-rich bedrock. Sugar maple, white ash, basswood, boxelder, and ostrich fern are common. There can be a diverse herbaceous layer. Soils are well drained sandy alluvium. Many examples of this community are uplands.

Northern Conifer Floodplain Forest: This rare floodplain forest occurs along small to moderate-sized rivers, primarily in northeastern Vermont. The silty alluvial soils typically support balsam fir, northern white cedar, white spruce, black cherry, and black ash.

Lakeside Floodplain Forest: These forests occur primarily within the flooding zone of Lake Champlain. Silver maple and green ash are the dominant trees. Herbs include sensitive fern, false nettle, marsh fern, white grass, and Tuckerman's sedge. Surface organic layers are present in the moist silty soils and there are mottles near the surface.

Floodplain Forest Condition

Historical Perspective: Although there is little specific information on distribution and composition of floodplain forests prior to European settlement in the region (Siccama 1971), it is expected that they covered large areas and were likely continuous bands of forest extending unbroken for miles along all our major rivers. Forests of towering silver maple and American elm likely covered many of the active floodplains, with more diverse forests of sugar maple, red oak, and other species on higher terraces of former floodplains. (Sorenson et al. 1998). Although their total numbers were relatively small, evidence suggests that the Abenaki people that lived in Vermont concentrated their villages and agriculture on and adjacent to the floodplains of the Connecticut River, other major rivers, and Lake Champlain (Klyza and Trombulak 1999).

Current Condition: High quality floodplain forests are now uncommon in Vermont because the majority of the floodplain forest in Vermont and the region has been converted to agricultural use. Floodplains have been prized as agricultural lands because of their high soil fertility associated with annual flooding and deposition and because of the absence of stones. Because of their high value as agricultural lands, floodplain forests are now limited to fragments of their original size. The small percentage of riverine floodplains remaining in a forested condition is illustrated for Franklin County by a comparison made between the area of alluvial soils identified by the Natural Resources Conservation Service (USDA 1979) and the area of floodplain forests identified in a Vermont Fish and Wildlife Department floodplain forest inventory project (Sorenson et al. 1998). Although approximate, this comparison indicates that as little as 11% of the floodplains in Franklin County remain in a forested condition.

Significant changes to the flooding regimes of floodplain forests results from dam operation and the construction of roads, bridges, and culverts along rivers and in floodplains. Furthermore, the disturbed nature of many of the floodplain sites makes them vulnerable to invasive exotic plant species, such as goutweed (*Aegopodium podograria*), garlic mustard (*Alliaria petiolata*), dame's-rocket (*Hesperis matronalis*), honeysuckle (*Lonicera* spp.), and Japanese knotweed (*Polygonum cuspidatum*) (Sorenson et al. 1998).

Desired Condition (SGCN Needs): Floodplain forest is essential to those SGCN that require habitat mosaics of aquatic and riparian areas and upland forest. Several of the species associated with floodplain forests require a riparian mosaic that depends upon functioning floodplain wetlands (e.g., pied-billed grebe, Odonata, American black duck); many of which are most abundant in the floodplains of larger river systems. Other species such as the water shrew and spotted salamander use floodplain forest directly adjacent to the stream or river. Lastly, there are some species that require large (10-1000ha) contiguous blocks of forested habitat along stream and rivers—these range from the bald eagle to the wood turtle. In all, floodplain forest provides habitat for a total of 49 wildlife SGCN and 28 plant SGCN. Desired conditions include functional floodplain forests in healthy examples (mature, unfragmented) distributed across their range. High water quality is also an essential element of floodplain forest quality. Focus should be given to the largest examples.

Implementing the 2005 Wildlife Action Plan

VFWD continues to focus conservation work on floodplain forests due to their high habitat functions, as well as being critical for river stability. An example is the acquisition of the Johnson Farm in the northeastern corner of Vermont, in the towns of Lemington and Canaan. Acquired in 2012, the Department now owns 283 acres and manages public access on an additional 130 acres of eased land on the adjacent farm conserved by the Vermont Land Trust. The Johnson Farm Wildlife Management Area supports over eight miles of river and stream frontage, including 6.1 miles along the Connecticut River. Most of this shoreline area has well established riparian habitat or was subject to an extensive buffer restoration project in 2005-2006 through the USDA's Conservation Reserve Enhancement Program. The wetland natural community types found on the WMA includes floodplain forest, alder swamp, sedge meadow, shallow emergent marsh, deep broadleaf marsh, cattail marsh, poor fen and river mud shore.

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Floodplain Forests

High Priority
American Black Duck (Anas rubripes)
Bald Eagle (Haliaeetus leucocephalus)
Canada Warbler (Wilsonia canadensis)
Fowler's Toad (Anaxyrus fowleri)
Wood Turtle (Glyptemys insculpata)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Freshwater Snails Group (15 species)
Butterflies-Hardwood Forest Group (4 species)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Cerulean Warbler (Dendroica cerulea)
Black-crowned Night-heron (Nycticorax nycticorax)
Pied-billed Grebe (Podilymbus podiceps)
Spotted Salamander (Ambystoma maculatum)
DeKay's Brownsnake (Storeria dekayi)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here include 24 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Categories	Problem/Info Need Detail	Rank
Habitat Conversion	Agriculture and development	High
Habitat Fragmentation	Wider ranging birds, mammals, and reptiles require unfragmented habitat mosaics of 10-1000 ha or more	High
Inadequate Disturbance Regime	Dams, drainage ditching, filling, and runoff that affect flooding, erosion, and deposition	High
Habitat Degradation	Altering forest conditions along streams and rivers	High
Climate Change	Increased flood severity could increase erosion	Medium
Distribution of successional stages	Loss of mid-story forest cover due to lack of disturbance or active management.	Medium
Invasive Exotic Species	Loosestrife and common reed	High
Trampling or direct impacts	Human activity proximate to nesting birds	High
Inventory	Determine the location, distribution and condition of floodplain forests throughout their range.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Locate additional floodplain forests not already mapped by FWD and assess management practices for these forests.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Identify riparian areas that are high priority for restoration of floodplain forest and other natural communities to increase river stability, water quality, wildlife habitat, and connectivity.	Number of sites located and on which restoration is successfully completed.	ANR, NRCS	SWG, WRP, EQUIP
Identify areas within the state with the largest matrix of floodplain forest for inclusion in conservation opportunity area.	Number of opportunity areas identified	ANR, UVM, NRCS	WRP, SWG
Consider protection of opportunity areas via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC, NRCS	VHCB, WRP, TNC
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, GMNF, FPR, NRCS, municipal & watershed groups, foresters	ANR, NRCS, FSA
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring	ANR, NEPCoP, TNC, NRCS	EQIP, SWG
Technical assistance to private landowners, NGOs and government agencies to maintain and enhance floodplain forests for SGCN	Number of acres of floodplain forest managed for SGCN maintained, enhanced or restored. Number landowners incorporating SGCN into their land management.	NRCS, TNC, VFWD, FSA	EQIP, WRP, CREP, CRP, SWG
Technical assistance to towns and regional planning organizations to maintain and enhance floodplain forests for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of acres of floodplain forest managed for SGCN maintained, enhanced or restored. Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning.	NRCS, TNC, VFWD	SWG, WRP, CREP
Financial incentives for private landowners to maintain and enhance floodplain forests for SGCN	Number of acres conserved/restored	VFWD, NRCS	EQIP, WRP
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Manage or remove dams to restore more natural flooding regimes	Number sites with adequate flooding regimes	ANR, CT River Watershed Council	ACOE

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Floodplain Forests of Vermont	Natural Community Inventory	ANR
Draft VT Bat Conservation Plan	Bat conservation	ANR
Bald Eagle recovery plan	Bald eagle recovery	NWF, ANR
Partners in Flight	Bird conservation plan	ANR, VT Audubon, USFWS
2015 Update Vermont Forest Resources Plan (Draft)	Conservation of healthy forests and the sustainable use and management of Vermont's Forests	FPR
North American Waterfowl Plan	Waterfowl populations	USFWS, ANR, DU
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR

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Hardwood Swamps Summary

Characteristics and Location

Hardwood dominated swamps are the most common swamp type in the state. They are especially common in the warmer regions of the state on flatter topography and so reach their largest size and greatest abundance in the Champlain Valley and are least frequent in the Northeast Highlands. While two of the seven types are widely distributed, two others are restricted to a few biophysical regions, and the remaining three occur primarily in only a single biophysical region.

Hardwood swamps provide many functions, including flood storage, water quality protection, and fish, wildlife, and endangered species habitat. Because of their more open, deciduous canopy, hardwood swamps have more significant understory development than do softwood dominated swamps. This feature, along with their characteristic hummock and hollow topography, creates a landscape mosaic that provides an abundance of microhabitats.

Hardwood Swamp Natural Communities

The hardwood swamp formation includes the nine following natural community types:

Red Maple-Black Ash Seepage Swamp: This is the most common hardwood swamp type in the state. It occurs in all biophysical regions as either small or large patches. Although they occur in various settings, this natural community type is closely associated with groundwater seepage and does not typically experience surface flooding of long duration. While red maple is typically the dominant tree, black ash is very characteristic of this community. There are also other tree species present and well-developed shrub and herbaceous layers.

Red Maple-Sphagnum Acidic Basin Swamp: This is another common swamp type that is widely distributed throughout the state. Typically, it occurs in poorly drained basins with deep organic soils. Groundwater seepage is absent and the permanently saturated soils tend to be quite acidic. Since they occur in basins, most of these basin swamps are small and typically have no inlet or outlet streams. Red maple is the dominant tree, often with a co-dominance of yellow birch and various softwoods. The shrub layer is well developed, but the herb layer is less diverse, often with dominance by cinnamon fern. Moss cover typically approaches 100%.

Red Maple-Northern White Cedar Swamp: This uncommon community type exists as large patches mostly in the western part of the state. This community is limited to areas of calcareous bedrock and is often associated with floodplains, especially in the Champlain Valley. Although it can also occur in isolated basins, it can form huge wetland complexes where it is associated with larger rivers. Red maple, white cedar, and black ash typically dominate the canopy. Both the shrub and herbaceous layer tend to be sparse depending upon the degree of shading and the abundance of water-filled hollows.

Calcareous Red Maple-Tamarack Swamp: This is a rare community type that is restricted to areas of calcareous groundwater seepage. It is mostly restricted to the Vermont Valley with only a few examples in other biophysical regions. It typically occupies small isolated basins, but may also occur as part of a large wetland complex. Red maple and tamarack dominate the canopy that can range from nearly closed to very open. In the latter situation, especially, a diversity of shrubs, herbaceous, and bryophyte species flourish.

Red or Silver Maple-Green Ash Swamp: This uncommon natural community type is largely restricted to the Champlain and Vermont Valleys. It occurs as large patches mostly associated with Lake Champlain. This swamp type typically undergoes extensive spring flooding that often results in saturated soils throughout the growing season. Although silver maple typically dominates, red maple and green ash may be very abundant. Both the shrub and herbaceous layer are well developed.

Red Maple-Black Gum Swamp: This rare community type occurs as small patches. It is mostly restricted to the southeastern part of the state with a few outliers in other regions. It occurs in small basins that are isolated from surface waters and that contain deep, saturated organic soils. Red maple and black gum co-dominate, but hemlock, yellow birch, and red spruce are also common.

Red Maple-White Pine-Huckleberry Swamp: This is a very rare natural community type that is restricted to the Champlain Valley. All known examples occur near the center of much larger wetland complexes. The canopy is dominated by red maple and white pine, but the most striking feature is the dense cover of huckleberry below. Typically, cinnamon fern dominates the herbaceous layer.

Wet Clayplain Forest: A wet forest occurring on the very poorly drained clay soil types of the Champlain Valley. These forests have a diversity of tree species, including swamp white oak, red maple, black ash, green ash, shagbark hickory, and hemlock. Due to their wetness, many Wet Clayplain Forests are the only forest fragments remaining in highly agricultural areas of the Champlain Valley.

Wet Sand-Over-Clay Forest: Similar to Wet Clayplain Forest, but occurring on wet soils with a sand layer overlying clay. Green ash, swamp white oak, and white pine are all common and there is typically a dense tall shrub layer.

Hardwood Swamps Condition

Current Condition: Although still relatively common in the state, hardwood swamps were formerly even more abundant. The primary activities resulting in loss of hardwood swamps were commercial and residential road development and road construction. Presently, agricultural conversion results in the greatest loss of swamps. Although protected by the Vermont Wetland Rules, many smaller examples are not mapped and therefore not protected under the regulations. Since many of these swamp types are most abundant in the lower, warmer regions of the state, they are subject to hydrologic impairment and incremental loss along the edges as the area around them is developed.

The primary problems to SGCN include agricultural conversion, invasion by exotics, altered hydrology, development and unrestricted logging.

Desired Condition: Forested wetlands provide habitat for several SGCN in the state. Hardwood dominated examples are especially diverse since they tend to be at lower elevations and in warmer areas of the state than coniferous swamps. A total of 36 SGCN animals and 43 plant SGCN rely on one or more of these natural communities to provide habitat. Several of the species associated with hardwood swamps also require a habitat mosaic that depends on functioning swamps. Desired conditions include functional hardwood swamps in healthy examples (mature, unfragmented) across the distribution of their range High water quality is also essential to habitat quality. Focus should be given to the largest examples.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD and The Nature Conservancy, and working with other partners, completed an inventory and prioritization of clayplain forest fragments in the Champlain Valley. The high priority examples of all clayplain forest types, including Wet Clayplain Forest and Wet Sand-Over-Clay Forest, were entered into the Department's Natural Heritage Database to be used for conservation planning.

Species of Greatest Conservation Need in Hardwood Swamps

High Priority
American Black Duck (Anas rubripes)
Canada Warbler (Wilsonia canadensis)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Eastern Ratsnake (Pantherophis alleghaniensis)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Pygmy Shrew (Sorex hoyi)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Rusty Blackbird (Euphagus carolinus)
Black-crowned Night-heron (Nycticorax nycticorax)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here 44 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Conversion	Agriculture, road building, development	High
Hydrologic alteration	Sedimentation, development in watershed, road building, dams	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Degradation	Selective removal of cedar or black gum, logging on non-frozen ground, heavy cutting	High

Habitat Fragmentation	Roads, agriculture, and development break swamps into smaller patches	High
Inventory	Statewide inventory has been completed, but not all sites have been evaluated	Low

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide wetland data to ANR Wetlands Office and EPA	Number of sites added to Natural Heritage Database	DEC, EPA	SWG, EPA
Locate hardwood swamps and assess their management practices.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Provide support and technical information to DEC Wetlands Office for designation of Class 1 wetlands	Number of wetlands reclassified to Class 1	ANR (FWD and DEC)	SWG, PR (technical assistance)
Identify areas within the state with the largest matrix of hardwood swamps for inclusion in conservation opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Consider protection of large hardwood swamps via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	NEPCoP, TNC, NRCS	SWG
Provide technical assistance to private landowners, NGOs and government organizations to plan and manage for SGCN in hardwood swamps. Distribute *Landowners Guide - Wildlife Habitat Management for Lands in Vermont* (VFWD 2015)	Number of acres maintained, enhanced or restored. Number landowners incorporating SGCN into their land management.	NRCS, TNC, VFWD, FSA	SWG, CREP, EQIP, CRP
Provide technical assistance to towns and regional planning organizations to plan and manage for SGCN in hardwood swamps. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of acres maintained, enhanced or restored. Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning.	NRCS, TNC, VFWD	SWG, CREP
Financial incentives for private landowners	Number of acres conserved/restored	VFWD, NRCS	EQIP, WRP
Conservation easements on higher quality sites with greatest number of SGCN.	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Programs	Recovery of various plant species in New England	ANR
North American Waterfowl Plan	Waterfowl conservation and management	ANR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Sorenson, E.R., B. Engstrom, M. Lapin, R. Popp and S. Parren. 1998. Northern White Cedar swamps and Red Maple-Northern White Cedar Swamps of Vermont: Some Sites of Ecological Significance. NNHP, VT. Fish and Wildlife Department.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Softwood Swamps Summary

Characteristics and Location

Most softwood swamps in Vermont are situated at higher elevations in the cooler regions of the state. The one exception are hemlock swamps which behave more like hardwood swamps and are in the lower, warmer portions of the state. Because of the dense shading in softwood swamps, the understory shrub and herbaceous layers are generally quite sparse. Conversely due to these same moist shady conditions, bryophyte cover tends to be quite abundant. All the natural communities in this formation occur as small patches on the landscape except for spruce-fir tamarack swamps which occur as large patch communities.

Eight natural communities included within the softwood swamp group

Northern White Cedar Swamp: This is an uncommon natural community type that is associated with calcareous bedrock and groundwater seepage that makes the dissolved minerals available to the plants. Although it occurs in most of the state's biophysical regions, this community is more abundant in the northern half of the state since white cedar declines to the south. In addition to white cedar, balsam fir may be abundant, but the dense shading results in a sparse shrub and herb layers. Only bryophytes attain abundance in these swamps.

Northern White Cedar Sloping Seepage Forest: An uncommon type of cedar swamp known only from northeastern and northcentral Vermont and closely associated with calcium-rich bedrock. Northern white cedar dominated over a sparsely vegetated and gently sloping ground with mineral-enriched ground water flows just below the surface.

Boreal Acidic Northern White Cedar Swamp: An uncommon swamp of northeastern and north central Vermont found in landform settings with swamp watersheds and no inlet or outlet streams. Northern white cedar dominates the closed canopy over a carpet of wet Sphagnum mosses. Spruce-Fir-Tamarack Swamp: This uncommon natural community is totally absent from the warmer parts of the state. They typically occupy basins that are isolated from surface water movement and have deep organic soils. The canopy is dominated by red or black spruce, fir, and tamarack in varying abundance. Generally, more tamarack is indicative of more mineral rich conditions while more black spruce is indicative of deeper peat and less enriched conditions. Despite the deep shade, several tall shrubs persist here, especially mountain holly and wild raisin. Herbs are sparse whereas bryophytes proliferate in the cool, moist conditions.

Red Spruce-Cinnamon Fern Swamp: This uncommon swamp type is most abundant in the southern Green Mountains, although it occurs throughout Vermont. Red spruce is dominant over a ground cover of cinnamon fern and Sphagnum mosses. Organic soils may be deep, but there is little mineral enrichment from groundwater.

Black Spruce Swamp: As the peaty soils become deeper and increasingly acidic and saturated, black spruce begins to replace the less tolerant red spruce. This community is restricted to only the coldest locations where they occupy basins that have gradually accumulated peat over the millennia. Black spruce dominates the canopy which is generally rather low and sparse. These swamps have low shrub and herbaceous diversity due more to the cold, wet, acidic conditions than shading. In openings, low shrubs characteristic of bogs may be common, but bryophytes are ubiquitous throughout the community.

Hemlock-Balsam Fir-Black Ash Seepage Swamp: This uncommon swamp is found throughout Vermont at lower elevations. It is closely associated with mineral enrichment from groundwater seepage. Hemlock and/or balsam fir are dominant and black ash is typically present. Herbaceous plants and mosses are abundant and diverse, reflecting the mineral-enriched groundwater.

Hemlock-Sphagnum Acidic Basin Swamp: This rare swamp type occurs in the warmer regions of Vermont and only in landform settings with small watersheds. There are no inlet or outlet streams and peat accumulations are typically several feet or more. Hemlock is dominant over a moist swamp floor carpeted by Sphagnum mosses.

Softwood Swamps Conditions

Current Conditions: Softwoods swamps have been less impacted than either hardwood swamps or floodplain forest communities due to their location in the colder regions of the state and their generally saturated peat soils. As with the other two wetland types, softwood swamps also receive some protection from the Vermont Wetland Regulations. Nonetheless, they are still limited by habitat degradation and alteration, hydrologic impairment, and sedimentation from development on the fringes and in the watershed, road construction, and poorly planned logging. Exotic species, and herbivory, especially by moose, are also a concern. A potentially major problem for hemlock swamps is the presence in southern Vermont of the hemlock wooly adelgid, an introduced insect that could devastate the Vermont's hemlocks.

Desired Conditions: The eight natural communities in softwood swamp formation provide habitat for 26 SGCN animals. This includes many birds, but also some turtles and salamanders. A total of 33 plant SGCN occur in softwood swamps; not surprisingly, the majority of which are bryophytes which thrive in the cool, moist, shady conditions. Only spruce-fir-tamarack swamps occur as large patches; however, this community and northern white cedar swamps are often included within much larger wetland complexes. Three of the four community types exist as small patches, they are more easily protected; however, protection would need to extend beyond the wetland boundary to include at least a portion of the watershed and should include connectivity to softwood swamps. In such situations protection would need to apply to the entire complex. Desired conditions include functional softwood swamps in healthy examples (mature, unfragmented) across the distribution of their range. High water quality is also essential to habitat quality.

Implementing the 2005 Wildlife Action Plan

In 2010, VFWD completed a statewide inventory of softwood swamps which included assessment of 162 sites. Because of this project and data collected, the natural community classification was revised to include new types. Breeding bird and amphibian surveys were conducted so that animal species could be more closely associated with the natural community types. Information was provided to landowners on the importance of their swamps for the habitat they provide and recommendations for management.

Species of Greatest Conservation Need in Softwood Swamps

High Priority
American Black Duck (Anas rubripes)
Spruce Grouse (Falcipennis canadensis)
Canada Warbler (Wilsonia canadensis)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
American Marten (Martes americana)
Rock Vole (Microtus chrotorrhinus)
Northern Long-eared Bat (Myotis septentrionalis)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Great Blue Heron (Ardea herodias)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Rusty Blackbird (Euphagus carolinus)
Black-crowned Night-heron (Nycticorax nycticorax)
Gray Jay (Perisoreus canadensis)
Black-backed Woodpecker (Picoides arcticus)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Notes: Vascular plant SGCN not listed here 19 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Conversion	Development, road construction	High
Habitat Fragmentation	Roads and development fragment the habitat into smaller patches or from larger habitat mosaics for the wider-ranging species (e.g., wood turtle, American marten)	High
Hydrologic Alteration	Sedimentation, development in watershed, road building, dams	Medium
Invasion by Exotic Species	Non-native species (e.g., wooly adelgid) can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Degradation	Selective removal of cedar, logging on non-frozen ground, heavy cutting, lack of mature and over mature stands	High
Herbivory	Moose can eliminate regeneration in some community types	Medium
Inventory	Distribution, location and condition of these communities are not known. The ongoing statewide inventory needs to be completed to identify and protect the best examples	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide information to State Wetlands Office and EPA	Number of sites added to the Natural Heritage Database	DEC, EPA	SWG, EPA
Provide support and technical information to DEC Wetlands Office for designation of Class 1 wetlands	Number of wetlands reclassified to Class 1	ANR (FWD and DEC)	SWG, PR (technical assistance)
Locate additional softwood swamps of high significance and assess their management practices.	Number of sites located and assessed	ANR, FSA, UVM, FPR	SWG
Identify areas within the state with the largest matrix of softwood swamps for inclusion in conservation opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Consider protection of large softwood swamps via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Manage exotic species on state owned sites and provide technical assistance to other landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	ANR, NEPCoP, TNC, NRCS	SWG
Technical assistance and/or financial incentives to private landowners, NGOs and government organizations to maintain and enhance softwood swamps for SGCN,	Number landowners incorporating SGCN into their land management, Number of acres conserved/restored	NRCS, TNC, VFWD, FSA	SWG, EQIP, CREP, CRP, WRP
Technical assistance and/or financial incentives to towns and regional planning organizations to maintain and enhance softwood swamps for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning for softwood swamps. Number of acres conserved/restored	NRCS, TNC, VFWD	SWG, WRP, EQIP, CRP, CREP
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC, NRCS	VHCB, VLT, WRP

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
American Marten Recovery Plan	Recovery of American Marten in Vermont	ANR
North American Waterfowl Plan	Waterfowl conservation and management	ANR

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Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Vernal Pools & Seeps Summary

Vernal pools are small, open-water wetlands that are filled by rain and snowmelt in spring or fall and are typically dry during the summer months. Such a pool is usually contained within a small forested basin, has no permanent inlet or outlet, and does not support fish. Forested swamps may also contain vernal pools in small depressions. During wet growing seasons, temporary pools may persist without drying completely. Years of filling and drying result in a unique type of set of conditions that supports a variety of wildlife specialized to take advantage of these conditions. Vernal pools are often rich in unique insects, molluscs, and other invertebrates, as well as amphibians. Vernal pools and adjacent forested uplands are critical breeding habitat for mole salamanders and wood frogs.

Seeps are small wetlands that occur on slopes or at the bases of slopes in upland forests. Groundwater discharge is evident at the seep margin. Scattered trees may be present but canopy closure is usually from the adjacent forest. Certain species are adapted to the living in these conditions, including some invertebrate and plant SGCN.

Vernal Pools & Seeps Condition

Current Condition: Vernal pools and the wildlife that use them face many problems, including direct loss of pools, degradation of pool quality, and alteration of the surrounding upland habitat that is critical for many amphibians non-breeding life stages. Hikers, their pets, and recreational vehicles that enter vernal pool risk destroying amphibian eggs and larvae and invertebrate SGCN. In addition, recreational vehicles that enter vernal pools can destroy the soil structure that is so important to maintaining these pools and the species that depend on them. Alterations within the forested basin that surrounds a pool can have significant impacts on the pool's hydrology and its species. Reduction in the volume of water that fills the pool means that drying will occur sooner. Loss of the adjacent canopy trees increases the solar energy reaching the pool, causing water temperature to rise more rapidly and drying the pool earlier in the warm season that usual. Premature drying has a negative impact on the invertebrates and young amphibians that require a minimum length of time (up to 4 months or more) to complete critical life stages. Removal of too many mature trees and downed logs in the surrounding upland habitat can impair the forest floor used by pool-breeding salamanders and frogs. Ditches and vehicle ruts in the surrounding forest often intercept spring migrating adults, luring them to lay eggs in spots that can dry well before the young can leave the water. Road construction or increased road traffic that bisects the upland amphibian habitat surrounding a vernal pool often results in the death of many of these animals as the make their annual migrations between the terrestrial and aquatic environments.

Seeps face problems like those of vernal pools. Activities that alter the hydrology of a seep to even a minor degree can eliminate the characteristics required by some wildlife species. The ecological significance of seeps (and vernal pools) is often not recognized during development planning, with the result being direct loss of these features.

Desired Condition (SGCN Needs): Functional vernal pools are those examples that are intact, well-buffered and interconnected to ensure productivity and movement of species associated with vernal pools. Spotted salamanders, blue-spotted salamanders, Jefferson salamanders, and wood frogs all use vernal pools for breeding. They spend almost their entire lives in the surrounding upland forests, moving up to 300 meters or more from the pool. The adults return for a brief period in the spring to leave their eggs. Water depth must be great enough to cover the egg masses (generally 30cm or more) and provide continuous aquatic habitat until the young leave the pool (3-4 months, depending on the species and location). The terrestrial adults and juveniles can be found under cover material (logs, rocks, stumps) and in animal burrows in moist forest soils that have adequate leaf litter. Spotted turtles are seasonal users, foraging in vernal pools in the early spring. They require large wetland complexes and move between wetlands through the warm season. There are several insects, snails, fingernail clams, fairy shrimp, and other invertebrates that use vernal pools for their entire life cycle. During the dry months, these animals or their eggs remain on or under the soil surface, awaiting the return of water to the pool depression. Many other SGCN use vernal pools seasonally but do not require them.

Seeps are home to a few specialized SGCN as well as many more common species. The gray petaltail is a rare dragonfly that lays its eggs in forested seeps, where the nymphs remain and feed until reaching adulthood. Eastern Jacob's ladder is a threatened plant that is closely associated with seeps in Vermont.

Implementing the 2005 Wildlife Action Plan

VFWD contracted with the Vermont Center for Ecostudies and Arrowwood Environmental to map and inventory of vernal pools in Vermont. Approximately 5,000 vernal pools were mapped and approximately 1,200 were visited by project organizers and volunteers. The resulting mapping and database is used by the DEC Wetlands Office for regulatory purposes and has been the basis for conservation action.

VFWD has drafted conservation and management guidelines for vernal pool-breeding amphibians to provide the scientific justification for the critical nature of these pools and two "life zones "extending 100 feet and 600 feet from the pool edge. These guidelines are expected to be finalized soon and will provide the basis for site-specific vernal pool conservation and management.

Vernal pools are one of the 95 types of natural communities recognized in Vermont. Ranking specifications were developed for all-natural communities, including vernal pools, to evaluate individual examples for their relative ecological significance and importance for amphibian breeding habitat.

Species of Greatest Conservation Need in Seeps and Vernal Pools

High Priority
Whip-poor-will (Caprimulgus vociferus)
American Woodcock (Scolopax minor)
Jefferson Salamander (Ambystoma jeffersonianum)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Freshwater Snails Group (15 species)

Medium Priority
Great Blue Heron (Ardea herodias)
Ruffed Grouse (Bonasa umbellus)
Red-shouldered Hawk (Buteo lineatus)
Prairie Warbler (Dendroica discolor)
Pied-billed Grebe (Podilymbus podiceps)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeus)

SGCN Notes: Six vascular plant SGCN are found in seeps and vernal pools (Appendix I). See individual species conservation reports in Appendices A1-A5 for information about specific Species of Greatest Conservation Need listed here.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
1. Habitat Alteration	Thermal and hydrologic alterations that reduce the quality or usability of pools and seeps; modification of surrounding upland habitat needed to maintain dependent wildlife; creation of ditches and ruts that lure amphibians to unsuitable breeding habitat	High
2. Habitat Conversion	Direct loss of pool and seep habitat due to hydrologic manipulation, filling, draining, etc.; loss of associated upland habitat due to development or conversion	Medium
3.Impacts of Roads and Transportation Systems	Roads located too close to vernal pools kill amphibians as they attempt to migrate between the pools and upland habitat; loss of animals increases with traffic volume	Medium
4. Trampling or direct impacts	Destruction of and damage to amphibian eggs and invertebrate SGCN due to people and their pets entering vernal pools	medium
5. Incompatible recreation	Damage to habitat and loss of SGCN due to recreational vehicles entering vernal pools. Trails leading to sensitive vernal pools bring recreational hikers and their pets	High
7. Pollution	Stormwater directed into pools carries sediments and contaminants that have a negative impact on this habitat and its aquatic populations	Medium
8.Disease	West Nile Virus control: Vernal pools may be annual targets of mosquito control, including the use of chemical and biological pesticides.	Medium
9. Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
10. Monitoring	Monitor SGCN population trends to determine whether populations can persist; evaluate long-term effects of development near these habitats	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations and evaluate effects of development	Number of known SGCN sites monitored	ANR, EPA	SWG, EPA
Continue field investigation of vernal pools identified in statewide inventory of vernal pools and seeps important to SGCN	Number of completed field inventories	ANR, EPA	SWG, EPA
Identify areas within the state with the largest examples of seep and vernal pools for inclusion in conservation opportunity area.	Number of opportunity areas identified	ANR, VHCB, TNC	SWG
Promote conservation easements where appropriate	Number of acres of habitat protected and/or restored	ANR	VFWD, VHCB
Manage access at sensitive sites	Number of selected sites with managed/restricted access in place	ANR, USFWS, Green Mt. Club	
Educate foresters, landowners, developers, and municipalities about the value of vernal pools and seeps and encourage behavior that conserves wildlife dependent on these features and the necessary surrounding habitat	Number of parties contacted	ANR, Audubon, VFF, VCE, RPCs, towns	SWG, EPA
When appropriate, re-vegetate area surrounding pool or seep and restore hydrology	Number of sites restored; number of acres restored	ANR	EPA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop and distribute forestry guidelines for the protection and management of vernal pools and seeps	Number of forest management activities meeting vernal pool guidelines	ANR, USFWS, SAF, VWA, NRCS,	USFWS, USFS, SWG, EQIP
Technical assistance to towns and regional planning organizations to maintain and enhance vernal pools for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering vernal pools and seeps in their planning.	VFWD	SWG
Develop recreational management plans for state lands where vulnerable, sensitive vernal pools and seeps occur	Number of recreational management plans adopted for state lands identified as having vulnerable vernal pools and seeps	ANR, VOGA, VASA,	
Work with VTrans and Federal Highway Administration to encourage protection of vernal pool, seep, and associated upland habitat when designing future roads; encourage the use of well-designed animal passage structures or other methods to allow safe passage for animals across existing roads	Number of cooperative projects that have avoided potential wildlife conflicts or restored safe passage	VFWD, VTrans, FHWA	

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR
Vermont Vernal Pool Mapping Project	Remote and field-based mapping of vernal pools	VFWD, VCE, Arrowwood
Conserving Pool-Specialist Amphibian Habitat	Vernal pool management guidelines	VFWD

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Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Open Peatlands Summary

Characteristics and location

Open peatlands are wetlands that accumulate peat, a type of soil which consists of partially decomposed organic matter. These wetlands are permanently saturated with a stable water table at or near the soil surface, creating a nearly anaerobic soil environment. Seasonal flooding is generally lacking in these wetlands and mosses and liverworts are abundant. With the exceptions of Black Spruce Woodland Bogs and Pitch Pine Woodland Bogs, trees are generally absent or sparse due to the very low availability of dissolved oxygen and minerals in the soil and the saturated soil conditions. Bogs are a type of peatland with slightly raised surfaces that receive most of their water from precipitation, have acidic waters poor in minerals and nutrients, and are dominated by sphagnum mosses, heath shrubs, and in some areas black spruce. Fens, on the other hand, have slightly acidic to slightly basic mineral-rich waters from groundwater discharge and seepage, may be flat or gently sloping, and are dominated by sedges, grasses, and non-sphagnum mosses. Water in fens generally has higher oxygen concentrations than in bogs resulting in greater peat decomposition. There is a continuum, however, in the variations between bogs and fens.

Open Peatlands Natural Communities

The different natural community types in this group are all considered rare:

Dwarf Shrub Bog: These are open, acid wetlands with few trees and are dominated by heath shrubs and sphagnum moss. Size ranges from one to 600 acres in isolated kettlehole basins and as inclusions in larger wetland complexes. They occur throughout Vermont but are more common in the cooler regions.

Black Spruce Woodland Bog: Stunted black spruce trees cover 25 to 60 percent of the ground over heath shrubs and sphagnum moss. Found in cold climate areas. These bogs are generally less than 50 acres in size in Vermont and are found in the cooler regions of Vermont, including the Southern Green Mountains.

Pitch Pine Woodland Bog: Pitch pine covers 25 to 60 percent of the ground over heath shrubs and sphagnum moss. This community is known only from Maquam Bog at the mouth of the Missisquoi River. Small patches of this community are scattered across this larger wetland matrix.

Alpine Peatland: This community has characteristics of both bog and poor fen, but is distinguished by its high elevation and the presence of particular plants. It is found only on the highest peaks of the Green Mountains, particularly Mount Mansfield. By their nature, these communities are limited in size to very small patches.

Poor Fen: These are open, acid peatlands dominated by sphagnum moss, sedges, and heath shrubs. There is some mineral enrichment of surface waters. Poor fens are scattered in all biophysical regions of Vermont.

Intermediate Tall Sedge Fen: These open, slightly acid to neutral fens are dominated by tall sedges, non-sphagnum mosses, and a sparse to moderate cover of shrubs. Most examples are only several acres in size, with all known sites being less than 50 acres.

These fens are found only in areas with calcium-rich bedrock, which may occur in all regions outside of the Green Mountains.

Rich Fen: These fens are similar to Intermediate Fen but typically have shallower sedge peat and more mineral-enriched surface waters. Sedges and non-sphagnum mosses dominate, and shrubs are present. All documented examples are 6 acres or less in size. Rich Fens are restricted to areas with calcium-rich bedrock in the Piedmont, Vermont Valley, and limited areas of the Taconic Mountains.

Open Peatlands Condition

Current Condition: Open peatlands occur in a variety of situations across the Vermont landscape, from small, hydrologically-isolated basins to components of large wetland matrices. The primary problems to SGCN in open peatlands include recreation, exotic species, hydrologic alterations, climate change, and habitat conversion and degradation. Peatlands are popular destinations for outdoor recreationalists interested in experiencing unique natural areas, an activity that can prove detrimental to these fragile communities and their associated SGCNs if not properly managed. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. Nutrient enrichment of runoff waters due to agriculture can lead to invasion by exotic plants as well as replacement of rare plant species by more generalist species. The integrity of bogs and fens can be limited by significant changes in adjacent land use, such as development and clear-cutting, that result in increases in runoff and changes in water quality. Activities that alter the quality and quantity of water received from the groundwater recharge zone can be devastating to fen communities. Climate change is especially a concern with the Alpine Peatlands due to rising temperatures and expansion of forest cover at high elevations. Alteration of precipitation quantity and timing patterns associated with climate change puts the peatlands at risk resulting from peat decomposition rates – a fine balance in peatlands between temperature, soil saturation, and dissolved oxygen levels, and microbial activity. Development of broadcasting facilities on mountain ridgelines also impacts this community type. Alteration of natural water level fluctuations in lakes, ponds, and streams associated with peatlands can also impact these wetlands. Prevention of natural disturbance regimes, including lightning-ignited fires, may limit the Pitch Pine Woodland Bog community.

Desired Condition (SGCN Needs): Many SGCN associated with open peatlands, particularly some invertebrates and plants, are habitat specialists found only in these natural community types. Several SGCN dragonflies and damselflies require breeding and rearing habitat that is commonly described as bogs, fens, fen puddles, boggy ponds, boggy sloughs, and boggy streams. Many plants are found only in the wet, acid soils of bogs. Some vertebrates, such as bog lemmings (*Synaptomys* sp.) and spruce grouse are closely tied to bogs. Others, such as the blue-spotted salamander, four-toed salamander, spotted turtle, and water shrew, may rely on peatlands for habitat locally. Many of the other SGCN may utilize Open Peatlands but are not dependent on its specific characteristics (e.g., wood turtle, spruce grouse, and DeKay's Brownsnake).

Implementing the 2005 Wildlife Action Plan

Field work for a statewide inventory of Dwarf Shrub Bogs and Poor Fens and data is currently being analyzed. When analysis complete it will greatly expand our understanding of these rare natural community types and the birds associated with them.

The first statewide assessment of Vermont dragonfly and damselfly populations (collectively known as odonates) was completed in 2009. This survey (Pfeiffer, 2009) provides vital species distribution and occurrence information which has broadened our understanding of rare habitat-specialist dragonfly and damselfly SGCN. Habitat data collected as part of the study provides a comparative baseline for future population trend monitoring. Future efforts toward odonate SGCN conservation will continue to rely on the information resulting from this and future field studies.

Species of Greatest Conservation Need in Open Peatlands

High Priority
American Black Duck (Anas rubripes)
Spruce Grouse (Falcipennis canadensis)
Vesper Sparrow (Pooecetes gramineus)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Moths group (17 species)
Tiger Beetle group (7)
Butterflies-Wetland Group (6 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Water Shrew (Sorex palustris)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-backed Woodpecker (Picoides arcticus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
DeKay's Brownsnake (Storeria dekayi)

SGCN Notes: Vascular plant SGCN not listed here: 61 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem & Info Needs Category	Problem & Info Need Detail	Rank
Habitat Degradation	Significant land-use changes in adjacent areas can result in increases in runoff and changes in water quality (e.g. development, clear-cutting)	High
Habitat Conversion	Development of broadcasting facilities near alpine peatlands	Medium
Incompatible Recreation	Trampling of plants and soil in wetlands and on mountain tops	Medium
Hydrologic Alteration	Activities affecting the quantity and quality of ground water input and surface water runoff, or alter natural hydrologic regimes of associated water bodies	High

Problem & Info Needs Category	Problem & Info Need Detail	Rank
Impacts of Roads and Transportation Systems	Trails leading to sensitive peatlands bring recreational hikers	Medium
Pollution	Water quality is easily altered in peatlands and can bring about shifts in species composition (e.g., agriculture near rich fens)	High
Climate Change	Shifts in community composition in peatlands	Medium
Inadequate Disturbance Regime	Fire suppression inhibits pitch pine germination and results in shift in species composition	Medium
Statewide inventory of Open Peatland natural communities	Need to identify and locate best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of Open Peatland natural communities (Dwarf Shrub Bog and Poor Fen completed by 2015)	Number of sites inventoried	VFWD, EPA	SWG, EPA
Manage access at sensitive sites	Number of selected sites with managed/restricted access in place	ANR USFWS, Green Mt. Club	
Manage for natural disturbance regime at Maquam Bay	Work with USFWS to develop and implement a fire plan to promote this natural process	VFWD, USFWS	USFWS
Technical assistance to private landowners to maintain and enhance open peatlands for SGCN.	Number landowners incorporating SGCN into their land management.	ANR, EPA, USFWS, Landowners	VFWD
Technical assistance to town and regional planning organizations to manage open peatlands for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning	ANR, EPA, Regional Planning Comm.	SWG, EPA, VT Watershed Grants
Develop recreational management plans for state lands where vulnerable, sensitive open peatlands occur	Number of recreational management plans adopted for state lands identified as having vulnerable peatlands	ANR, VOGA, VASA	
Financial incentives for private landowners	Number of acres conserved	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Acquisition/easement of high priority sites and their groundwater recharge areas	Number of acres acquired/enrolled	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Increase enforcement of access restrictions at alpine peatlands	Number of hours of increased patrol	ANR, Green Mt. Club	
Increase cooperation/coordination among states and provinces and develop trans-jurisdictional actions to address issues such as climate change and acid rain		State of VT, other states, CA provinces, US and CA federal governments	

Coordination with other plans

See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Plan or planning entity	Goal/Scope of plan	Lead
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR

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Marshes and Sedge Meadows Summary

Marshes and Sedge Meadows provide some of the largest natural openings to be found in Vermont. These natural communities and the streams and ponds with which they are associated provide critical habitat for many species of wildlife. Often called emergent marshes, these open wetlands have less than 25 percent shrub or tree cover, and in many cases woody plants are absent. Hydrology is the single most important factor controlling these wetlands.

Marsh and Sedge Meadow Natural Communities

Six different natural community types are included in this group:

Shallow Emergent Marsh: This is a common and variable marsh type with mineral or shallow organic soils that are moist to saturated and only seasonally inundated. Several grasses, bulrushes, and Joe-pye weed may be abundant. This community is commonly associated with old beaver impoundments. This is a widespread natural community found throughout Vermont.

Sedge Meadow: These wetlands are permanently saturated and seasonally flooded. Soils are typically shallow organic muck, although mineral soils may be present in some wetlands. Tussock sedge or other sedges are dominant plants here. This common community is found throughout Vermont, most often along stream and pond margins and in beaver meadows.

Cattail Marsh: Common cattail or narrow-leaved cattail dominates these marshes. The muck or mineral soils are typically inundated with shallow standing water throughout the year, although the substrate may be exposed in dry years. Cattail Marshes range in size from less than an acre to over 500 acres along the shores of Lake Champlain. These common wetlands occur throughout the state but are most common at lower elevations.

Deep Broadleaf Marsh: Water depth in these marshes is typically over one foot deep for most of the year, although some may have only saturated soils in dry summers. Soils are organic. Common plants include pickerelweed, broad-leaved arrowhead, and giant bur-reed. This common community type is found throughout Vermont on the sheltered margins of lakes and ponds, on the slow-moving backwaters of larger rivers, and in isolated basins. The largest examples occur in lowland areas.

Wild Rice Marsh: These uncommon marshes are dominated by wild rice, with an organic soil substrate that is inundated with one to two feet of water throughout the summer. Wild Rice Marshes are found in wave-sheltered coves and on river deltas of Lake Memphremagog and Lake Champlain, and in the slow-moving backwaters of our larger rivers (Connecticut River and lower Champlain tributaries).

Deep Bulrush Marsh: These are marshes of open water along the shores of larger lakes and ponds where there is strong wave action. They are found throughout Vermont. Water depths can range from one to six feet. Soft-stem bulrush and hard-stem bulrush dominate most of these marshes, although marsh spikerush and other bulrushes may be abundant.

Marshes & Sedge Meadows Condition

Current Condition: These natural community types are not considered rare, but do provide critical habitat to many wildlife species, including SGCN. Sedge Meadows are often successional stages that would lead to forested wetlands if left undisturbed. Although they may occur in isolated basins, Marshes and Sedge Meadows are most commonly associated with water bodies (lakes, ponds, rivers) and other wetlands and, therefore, are subject to the same problems (e.g., pollution) as these associated communities. Even small examples of marshes that provide significant wildlife habitat or other functions and values are protected under Vermont Wetland Rules. Invasive exotic species are a major problem for some of these community types. Common reed and purple loosestrife can easily become established in Shallow Emergent Marshes, and water chestnut can crowd out native species in Deep Broadleaf Marshes. Alteration of the natural hydrologic regime by dam operation or creation of impoundments can significantly impact deeper water communities. Greater inventory information is needed for all these natural community types as well as further study on the identification and significance of problems.

Desired Condition (SGCN Needs): Marshes and Sedge Meadows support a host of wildlife species. A variety of SGCN are marsh specialists. Among others, these include many plants, dragonflies, damselflies, butterflies, and birds. Several dragonflies and damselflies require breeding and rearing habitat that is commonly described as marshy ponds, marshy edges of lakes, and marshes. Black terns, least bitterns, and soras spend the nesting season raising their young within marshes. Some other SGCN, such as spotted salamanders, and northern water snakes are commonly associated with these wetland types and may rely on them locally, but do not specifically require marshes to complete their life cycles. Pygmy shrews, smooth greensnakes, and chimney swifts are examples of more casual users that may be found foraging in marshes and sedge meadows.

Species of Greatest Conservation Need in Marshes and Sedge Meadows

High Priority
American Black Duck (Anas rubripes)
Black Tern (Chlidonias niger)
Northern Harrier (Circus cyaneus)
Sedge Wren (Cistothorus platensis)
Least Bittern (Ixobrychus exilis)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Boreal Chorus Frog (Pseudacris maculata)
Butterflies-Wetland Group (6 species)
Freshwater Snails Group (15 species)
Mayflies/Stoneflies/Caddisflies Group (14 species)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/ponds Group (7 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Pygmy Shrew (Sorex hoyi)
Water Shrew (Sorex palustris)

Medium Priority
Short-eared Owl (Asio flammeus)
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Bobolink (Dolichonyx oryzivorus)
Pied-billed Grebe (Podilymbus podiceps)
Sora (Porzana carolina)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Long-tailed Weasel (Mustela frenata)
Muskrat (Ondatra zibethicus)
Southern Bog Lemming (Synaptomys cooperi)

SGCN Notes: Vascular plant SGCN not listed here: 27 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problems/Info Need Categories	Problem & Info Need Detail	Rank
Habitat Conversion	Loss or fragmentation, particularly in small, unmapped (NWI) wetlands; ditching and plowing for agricultural use	High
Habitat Degradation	Cattle grazing	Medium
Hydrologic Alteration	Manipulation of the natural hydrologic regimes of associated water bodies through dam operation or impoundment can drastically impact deep water marshes in particular	High
Exotic Invasive Species	Crowding out of native plants and wildlife habitat by purple loosestrife, common reed, water chestnut, etc.	High
Pollution	Pollutants entering wetlands from runoff and tributaries can impact species and can bring about shifts in community composition	High
Statewide inventory of Marshes and Sedge Meadows	Inventory is needed for all-natural community types, as well as further study on the identification and significance of problems	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of Marshes and Sedge Meadows	Number of sites inventoried. The number of high quality examples identified containing SGCN	VFWD, EPA	SWG, EPA
Protect wetlands not on NWI maps through alternative regulations (e.g., Act 250)	Number of acres conserved	ANR, Regional Planning Comm, ACOE	
Provide technical assistance and/or financial incentives to private landowners, towns and RPC's to maintain and enhance mash and sedge meadows for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning. Number of acres conserved	ANR, EPA, NRCS, TNC, RPC's, towns, VLCT, private landowners	NRCS, SWG, EPA, LCBP, VT Watershed Grants
Identify, prioritize and control problematic native and invasive species deleterious to SGCN and prevent introduction of these species.	Acres surveyed/mapped; acres with dominant native vegetation protected or restored	USFWS, DEC, NRCS, municipal & watershed groups	USFWS, ANR, NRCS, FSA
Financial incentives for private landowners	Number of acres conserved	NRCS, VFWD, USFWS	NRCS, other USFWS grants
Acquisition/easement of high priority sites	Number of acres acquired/enrolled	NRCS, VFWD, USFWS	NRCS, other USFWS grants, Land trusts
Use existing/new regulations to prevent damage of SGCN-important lake/pond-side and river-side wetlands caused by dam operation	Number of acres conserved	ANR, COE, Hydro operators, FERC	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Prevent loss of SGCN-important lake/pond-side and river-side wetlands caused by new impoundments	Number of acres conserved	ANR, COE, Hydro operators, FERC	

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Carle, F. C. 1994. Dragonflies and damselflies (Odonata) known to or likely to occur in Vermont. Report prepared for the Nongame & Natural Heritage Program, Vermont Fish & Wildlife Department. Waterbury, VT.

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Wet Shores Summary

Characteristics and Distribution

All the natural communities contained within the upland shore formation occur as small patches scattered irregularly over the landscape. Four of the natural communities are widely distributed while the three rarest types are restricted to one or more biophysical regions. All the community types in this formation are non-forested and maintained in this early successional state by a combination of flooding, ice scour, and erosional processes. This makes wetland shores perhaps our most dynamic and changeable group of natural communities.

Wet Shores Natural Community Types.

This formation includes the seven following types:

Outwash plain pondshores: This is among the rarest natural communities in the state and is found only in the Southern Vermont Piedmont Biophysical Region. It occurs only on sloping shorelines that are seasonally exposed due to fluctuating water levels in the gravelly soils. The vegetation is characterized by sedge, rush, and herbaceous species, many of them annuals.

River mud shore: This is a common natural community type that occurs in all eight biophysical regions. It is restricted to slow moving rivers whose shorelines are exposed during times of low flow. This community type tends to be sparsely vegetated, primarily by annuals since the shore is often exposed late in the growing season.

River sand or gravel shore: This is a common natural community type that occurs in all eight biophysical regions. It is restricted to the swifter rivers where moving water creates sand and gravel deposits. Because of their dynamic nature they are sparsely vegetated, mostly by grasses and herbs but often with a woody component consisting of willows and cottonwood.

River cobble shore: This common natural community is widely distributed across the state along high-energy waterways. Due to their dynamic nature, this community is sparsely vegetated, mostly by grass and sedge species, but often with a woody component of willows and cottonwood.

Calcareous riverside seep: This is a rare natural community type that is known mostly from the Connecticut Valley. They are restricted to areas where calcareous groundwater seeps on to exposed bedrock on rivershores. The natural processes of flooding and ice scour serve to keep the community open while the limy seepage sustains a unique flora that includes many rare species of sedges, herbs, and bryophytes.

Rivershore grassland: This is a widely distributed natural community that occurs in more sheltered, and hence more stable, portions of our larger rivers. Since the natural river processes needed to maintain their open condition occur less frequently, this community tends to have more of a woody component of shrubs and low trees mixed in with the more abundant grasses.

Lakeshore grassland: This rare natural community type is restricted to the shores of Lake Champlain and Lake Memphremagog where it occurs on gently sloping shorelines that are kept open by waves, flooding, and ice. They tend to be very narrow in width, but may extend for considerable distances along the shore. The community is dominated by grasses, sedges, and forbs with a varying amount of woody species depending upon the frequency and intensity of the natural disturbance.

Wet Shores Condition

Current Condition: All the natural communities within the wet shore formation are dependent upon the natural processes of flooding, wave action, and ice scour. As such, they all occur as small patches that are restricted to areas where these processes are focused. Since they are maintained in an open state, these natural community types provide a specialized habitat for animals and plants. Spiny softshell, spotted, and wood turtles, Fowler's toad, and tiger beetles all depend on one or more of these communities. Outwash plain pondshores and calcareous riverside seeps provide the unique habitat for plants and contain a disproportionate number of rare or Threatened species.

The primary problems to SGCN in this formation include hydrologic alteration, recreation, exotic species, and habitat conversion and degradation. Since all seven community types are dependent upon periodic disturbance by water, ice or wind, anything that prevents these natural processes from occurring would jeopardize the integrity and continued existence of the SGCN they harbor. These community types also support heavy recreational use, and trampling of vegetation is a major concern especially near urban centers and at the more accessible sites. The continual natural disturbance at these sites also provides excellent opportunity for invasive plants to become established, and recreational use adds to this potential. The river cobble shore and the two grassland types are especially subject to habitat conversion or degradation to create marinas, docks, and bathing beaches.

Desired Conditions: Although all the natural communities comprising the wet shore formation occur as small patches on the landscape, they all provide critical habitat to SGCN that utilize both the aquatic and terrestrial environment or require unfrosted areas for basking, nesting, or foraging. A total of 22 animal and 31 plant SGCN are known to utilize the wet shore communities. To protect these sites, we recommend the following activities:

Species of Greatest Conservation Need in Wet Shores

High Priority
American Black Duck (Anas rubripes)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Freshwater Snails Group (15 species)
Tiger Beetle Group (7 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Smooth Greensnake (Opheodrys vernalis)
Long-tailed Weasel (Mustela frenata)

SGCN Notes: Vascular plant SGCN not listed here 54 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Categories	Problem/Info Need Detail	Rank
Habitat Conversion	Construction of marinas, docks, bathing beaches, and other activities that remove shoreline vegetation	High
Hydrologic Alteration	Communities dependent upon wind, wave, and ice action	High
Incompatible Recreation	Intense use of shore disturbs wildlife, tramples rare plants, and introduces exotic species.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Fragmentation	Roads and development fragment habitat along wet shores for species such as the wood turtle and Smooth Greensnake	High
Inventory	Distribution, location, and condition of this habitat are not known: A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of wet shores	Number of sites inventoried. The number of high quality examples identified containing SGCN	FPR	SWG
Provide technical assistance to private landowners to prevent or mitigate hydrologic and recreational impacts to wet shores.	Number landowners incorporating SGCN into their land management	NRCS, TNC, VFWD	SWG
Manage exotic species on state owned sites and provide technical assistance to landowners regarding control of exotics	Number of sites with control activities and/or invasive monitoring. Number of acres conserved.	ANR, NRCS, TNC, EPA	NRCS, USFS
Technical assistance to town & regional planning organizations to help maintain and/or enhance SGCN habitat, and to maintain natural processes and hydrologic conditions. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/RPC's including SGCN in their planning	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with state and municipal managers to reduce and focus recreational impacts		ANR, VOGA	VFWD,

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London

Shrub Swamps Summary

Characteristics and Distribution

All of Vermont's shrub dominated natural communities are wetlands, and most are thought to be retained in this early successional state by periodic flooding. Some of the community types, however, are likely to be more transitional and will eventually become forested. These transitional types are believed to have arisen following some type of disturbance either natural, such as a catastrophic flood or beaver activity, or artificially from past agricultural use. If beaver activity and natural flooding continue, examples of this community should continue to replace themselves on the landscape.

Of the four natural community types included within this formation two occur as small patches while the remaining two occupy larger areas on the landscape. Only one of the communities, buttonbush swamp, is thought to be rare in the state and restricted in its distribution to four of the state's eight biophysical regions. The other three communities are distributed throughout the state.

The shrub swamp formation includes the following four natural community types:

Alluvial Shrub Swamp: This uncommon natural community type is found on alluvial soils in the floodplains of small rivers. This is a high energy, dynamic environment that receives regular flooding and ice scour. As the stream channel naturally wanders across the floodplain, the community also migrates. Senescent channels succeed to floodplain forest while alluvial shrub swamps thrive in newly established natural levees and other such floodplain settings. While speckled alder is the dominant species here, black willow and boxelder can be very abundant under certain conditions. Ostrich fern typically dominates the ground layer although some grasses, herbs, and vines can also be common in more sheltered areas.

Alder Swamp: This is a common, widely distributed community type that occurs in a variety of settings including lakes and pond margins, backwater floodplains of rivers and streams, beaver flowerages, and poorly drained basins. Depending upon the frequency and duration of flooding, some examples may become more forested over time while others may remain shrub dominated. While speckled alder is the dominant shrub, shrubby willows, dogwoods, and young red maple may be locally abundant. Sedges and grasses along with sensitive fern and Joe pye weed typically dominate the ground layer.

Sweet Gale Shoreline Swamp: This uncommon natural community occupies shorelines of ponds and slow-moving streams. This swamp typically occurs as a narrow floating mat, but the shrubs may also be rooted directly into the peaty shore. Sweet gale dominates this community, but meadow-sweet is usually also abundant. Leatherleaf may be co-dominant in more acidic, boggy conditions. Various sedge species typically dominate the ground layer.

Buttonbush Swamp: This rare natural community occurs in two different settings: on the edges of larger lakes and ponds and in poorly drained, isolated depressions – both settings in which water is retained through much of the growing season. Buttonbush is one of the few woody plants that can tolerate seasonally flooded conditions. While in some examples buttonbush may grow so dense that nearly all other vegetation is excluded, in other situations leatherleaf and meadow-sweet may be common. Depending upon the shrub density and degree of flooding, various herbs and grasses may become established.

Shrub Swamps Condition

Current Condition: Shrub swamps are a common wetland type and occur in a variety of situations that are either too wet or too frequently disturbed to allow trees to become established. Although some examples of Alder Swamps are becoming forested, new examples continually arise due to natural disturbance. If the natural processes of flooding, ice scour, and beaver activity continue unabated, shrub swamps will remain common in our landscape.

The primary problems to the communities and SGCN in this formation include habitat loss and fragmentation, suppression of the natural disturbance regime, hydrologic alteration, and invasive exotic species.

Desired Condition: Providing habitat for 30 SGCN makes shrub swamps among the more valuable community types for wildlife of concern is state. Especially notable is the high number of amphibians included in this total. There are few plant SGCN associated with shrub swamps, however; they provide habitat for only six vascular plants and three bryophytes. Many types of shrub swamps are commonly associated with larger wetland complexes along river and streams. Maintaining the natural flooding regimes and other natural processes including beaver activity of these shrub swamps and associated forested swamps and marshes is critical to their long-term function. Maintaining upland buffers for shrub swamps are especially important for amphibian SGCN as well as for other species.

Species of Greatest Conservation Need in Shrub Swamps

High Priority
American Woodcock (Scolopax minor)
American Black Duck (Anas rubripes)
Black Tern (Chlidonias niger)
Vesper Sparrow (Pooecetes gramineus)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Spotted Turtle (Clemmys guttata)
Wood Turtle (Glyptemys insculpta)
Boreal Chorus Frog (Pseudacris maculata)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Freshwater Snails Group (15 species)
Butterflies-Wetland Group (6 species)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Water Shrew (Sorex palustris)

Medium Priority
Red-shouldered Hawk (Buteo lineatus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Rusty Blackbird (Euphagus carolinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blue-spotted Salamander (Ambystoma laterale)
Spotted Salamander (Ambystoma maculatum)
Four-toed Salamander (Hemidactylium scutatum)
Smooth Greensnake (Opheodrys vernalis)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)

SGCN Notes: Vascular plant SGCN not listed here: 12 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Development, road construction, docks, marinas	High
Habitat Fragmentation	Agriculture, roads	High
Hydrologic Alteration	Sedimentation, development in watershed, road building, dams, artificial lake fluctuations	High
Distribution of successional stages	Woodcock are negatively affected by maturing alder stands and adjacent openings.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Inadequate Disturbance Regime	Suppression of natural processes such as eliminating beaver activity, limiting flooding, etc.	High
Inventory	Distribution, location and condition of these communities are not known. A statewide inventory needs to be conducted to identify and protect the best examples	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of shrub swamp natural communities	Number of high quality examples identified containing SGCN		
Provide information to State Wetlands Office & EPA	Number of sites discussed	DEC, EPA	SWG, EPA
Provide technical assistance and/or financial assistance in maintaining natural processes and hydrologic conditions to landowners, especially to municipal and private owners concerned with beaver activity.	Number landowners incorporating SGCN into their land management, Number of towns considering SGCN in their planning	USFWS, NRCS, TNC, VFWD, RPC, VLCT	NRCS, USFWS
Acquisition and conservation easements on higher quality sites with greatest number of SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT, DEC
Manage invasive species on state lands, provide technical assistance to landowners to control invasives	Number of sites with control activities and/or invasive monitoring	ANR, NEPCoP, TNC, NRCS	SWG

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
Partners in Flight Plan	Bird conservation	ANR, Audubon

Literature Cited

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland—A guide to the natural communities of Vermont. University Press of New England, Hanover and London.

Upland Shores Summary

Characteristics and Distribution

All the natural communities contained within the upland shore formation occur as small patches scattered irregularly over the landscape. Both the riparian associated natural communities occur in all eight biophysical regions of the state. In contrast, the three lakeshore natural communities are more restricted with both lake or shale cobble beach and sand dunes occurring in a single biophysical region and lake sand beach in three regions. Since all the upland shores are naturally kept open, all five natural community types provide specialized habitat for animals and plants. Riverside outcrops and sand dunes provide habitat for some plants that occur nowhere else in the state. Generally, SGCN have the best potential for persisting at sites with the most intact natural processes. These same sites likely provide the best and most abundant habitat for SGCN.

The upland shores formation includes the six following natural community types:

Acidic Riverside outcrop and Calcareous Riverside Outcrop: These uncommon to rare natural community types occurs throughout the state wherever bedrock is exposed along waterways, but one occurs on acidic bedrock like granite and one occurs on calcareous bedrock like limestone. They are dependent upon natural hydrologic processes that typically keep the sites open via either flooding or ice scour. These community types are sparsely vegetated, primarily by herbaceous species with only a few shrubs and vines able to withstand the regular disturbance regime – the species composition varies with the two types, reflecting the available calcium from the bedrock.

Erosional river bluff: This is a rare natural community type with a statewide distribution that is restricted to steep banks where soil is actively eroding. Both the nature of the soils and the intensity of the erosional action greatly influences the vegetative cover of these communities, but rarely are woody species frequent.

Lake or shale cobble beach: This uncommon natural community can occur on any large lake in the state, but the only significant examples occur on Lake Champlain. Due to the constant wave action and seasonal flooding and ice scour, they tend to be sparsely vegetated. Although the vegetation is mostly herbaceous, willows, cottonwood, silver maple, and ash can become established at their upper reaches.

Lake sand beach: This is a rare natural community with the most extensive examples on the shore of Lake Champlain, and only scattered examples occurring in other regions of the state. Their formation and sustenance depends upon a regular source of material this is subsequently transported and deposited by waves and/or wind. Due to the constant wind and wave action and seasonal flooding and ice scour, this community is largely kept open. Typically, herbs, grasses, and low sedges dominate although willows, cottonwood, box elder, and ash often becomes established at their higher reaches.

Sand dune: This extremely rare natural community is restricted to the present and previous shoreline of Lake Champlain where dunes are situated on the leeward side of sand beaches. They are dependent upon a continual supply of depositional sand and will be adversely affected by anything that inhibits this process. Because of the shifting nature of the substrate and the dry windy conditions, they are sparsely vegetated mostly by grasses, low sedges, and viney herbs. Cottonwoods, aspen, and gray birch eventually become established and make the dune system more stable.

Upland Shores Condition

Current Condition: All five community types within this formation are dependent upon continual disturbance by water, ice and wind and therefore occur near lakes and rivers. They all reach their best development on the shores of Lake Champlain or other larger lakes and rivers in the state. Because they are desirable places to be, recreational use has impacted many our upland shores. The three lake associated shores are especially subject to habitat conversion or degradation to create marinas, docks, and bathing beaches. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. The continual natural disturbance at these sites provides excellent opportunity for invasive plants to become established.

Desired Condition: Functional upland shores are primarily undeveloped sites where natural processes operate and human disturbance of SGCN is limited. Although upland shores occur as small patches on the landscape, they provide a very specialized habitat that is utilized by a few SGCN and that may not be available elsewhere. Eight SGCN animals and one suite of species (tiger beetles) utilize upland shores. In addition, 33 SGCN plants are dependent upon this formation. To protect the natural communities contained within this formation we would do the following:

Species of Greatest Conservation Need in Upland Shores

High Priority
Common Tern (Sterna hirundo)
Spiny Softshell (Turtle) (Apalone spinifera)
Fowler's Toad (Anaxyrus fowleri)
Beetles-Tiger Beetle Group (7 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Chimney Swift (Chaetura pelagica)
Masked Shrew (Sorex cinereus)

SGCN Notes: Vascular plant SGCN not listed here 40 (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Construction of marinas, docks, bathing beaches, retaining walls, rip-rap	Medium
Hydrologic Alteration	Communities dependent upon wind, wave, and ice action and supply of substrate	Medium
Incompatible Recreation	Intense use of beaches tramples rare plants, degrades dunes and introduces exotic species.	Medium
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of upland shore natural communities to identify the best sites and those with SGCN	Number of sites inventoried. Number of sites with SGCN identified	FPR	SWG
Technical assistance to private landowners to prevent or mitigate hydrologic alteration and recreational impacts and to conserve SGCN	Number landowners implementing conservation practices for SGCN	NRCS, TNC, VFWD	SWG
Technical assistance to town and regional planning organizations to prevent or mitigate hydrologic alteration and recreational impacts and to conserve SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/organizations planning for SGCN conservation	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with state and municipal managers to reduce recreational impacts on these sites and to focus recreational impacts elsewhere.	Number of sites where recreational impacts are managed successfully.	ANR, VOGA	VFWD
Manage exotic species on state owned sites and provide technical assistance to private landowners to control exotics	Number of sites with control activities and/or invasive monitoring	ANR, NRCS	NRCS, FSA

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan (SCORP)	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London,

Outcrops & Upland Meadows Summary

Characteristics and Distribution

Outcrops and upland meadows are naturally un-forested because of several factors: little or no soil, high winds, cold temperatures, and drought. Many of these factors are inter-related and work together in combination to limit tree growth. Outcrops and upland meadow are generally restricted to ridgetops and ledges where bedrock is exposed or close to the surface, and thus all the natural community types occur as small patches. They are often flat or gently sloping, but by definition, have slopes less than 60 degrees.

There are five outcrop and upland meadow natural community types:

Alpine Meadows: This very rare natural community is restricted to the highest elevations in the state where the harsh growing conditions severely restrict vegetative growth. There are only a few known examples, all restricted to the Northern Green Mountains Biophysical Region. Low herbaceous vegetation, primarily grasses and sedges, dominate although stunted fir and black spruce and various heath shrubs occur in more sheltered locations.

Boreal Outcrop: This relatively common natural community occurs at mid to high elevations and is distributed widely in the cooler areas of the state. It occurs in the Northern and Southern Green Mountains, Northern Piedmont, Northeastern Highlands, and Taconics Biophysical Regions. They are sparsely vegetated by scattered low trees, including fir, red spruce, yellow birch, red maple, heath shrubs, and grasses. In some examples, however, mosses and lichens can be abundant and even dominate.

Serpentine Outcrop: One of the rarest natural communities in the state, serpentine outcrops are restricted to the Northern and Southern Green Mountains where this rock type is exposed. Serpentine rocks and the soils derived from them are very low in most plant nutrients, instead containing high amounts of heavy metals that can reach levels that are toxic to plants. The result is a sparse flora, but also one that has adapted to these extremely harsh conditions.

Temperate Acidic Outcrop: This is a relatively common natural community that is absent from only the higher elevations and colder regions of the state. Trees, especially paper and gray birch, white and pitch pine, and red maple are frequent here although they are stunted and slow growing. Beneath then typically grow low heath shrubs, grasses, and various herbs. Mosses and lichens can also be very abundant.

Temperate Calcareous Outcrop: This is an uncommon natural community that is restricted to the warmer regions of the state; generally, the Champlain and Connecticut River Valleys, the Taconics and the Vermont Valley. The community is limited to areas with calcareous bedrock and thus support a characteristic flora of lime-loving plants. Despite their exposure and resulting doughtiness, the availability of nutrients makes these outcrops more diverse than their more acidic counterparts.

Outcrops & Upland Meadows Condition

Current Condition: All the natural communities contained within the outcrop and upland meadow formation are the result of specific conditions, and as such, they occur as small patches and are scattered irregularly over the landscape. Only temperate acidic outcrops occur in all eight biophysical regions of the state. In contrast, alpine meadows are restricted to a single biophysical region and serpentine outcrops to two regions. Since they all are open communities within a generally forested matrix, all five natural community types provide a specialized habitat for animals and plants. They are important basking sites for reptiles, and alpine meadows, serpentine outcrops, and temperate acidic outcrops provide habitat for many plants that occur nowhere else in the state.

The primary problems to SGCN in this category include recreation, exotic species, climate change, and habitat conversion and degradation. Since all five community types provide vistas, they are often a destination for hikes, skiers, and climbers. Trampling of plants is a major concern especially near urban centers and at the more accessible sites. Invasion by exotic plants, especially at the lower elevation temperate outcrops and all communities with major trail access, is increasingly a concern. Alpine meadows are affected by ski area development while both serpentine and temperate calcareous outcrops continue to be limited by mining operations. Climate change is especially a concern with the colder alpine meadows and boreal outcrops.

Desired Condition: Outcrops and upland meadows are very specialized natural communities in Vermont since they are relatively permanent openings within a forested landscape. As such they provide specific habitat requirements for a small number of SGCN, especially some species of snakes which utilize these openings as basking sites. Although they provide significant habitat for only nine SGCN and two suites of species (moths and tiger beetles), these openings are utilized by many additional wildlife species. The number of SGCN plants (95) that rely on this formation speaks to its importance in the state despite the small area that it covers. To protect these sites, we would do the following:

SGCN in Outcrops & Upland Meadows

High Priority
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Moths group
Beetles-Tiger Beetle Group (7 species)
Northern bog lemming (Synaptomys borealis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Chimney Swift (Chaetura pelagica)
Masked Shrew (Sorex cinereus)
Smoky Shrew (Sorex fumeux

SGCN Notes: Vascular plant SGCN not listed here: 104 (Appendix I). For more information about a specific SGCN Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Quarrying activity, development, and ski area development	Medium
Climate Change	Species generally have no higher elevations to move to	High

Incompatible Recreation	Rock climbing, hiking disturbs wildlife, tramples rare plants, and introduces exotic species.	High
Invasion by Exotic Species	Non-native species can spread and degrade the habitat for wildlife and eliminate some plant species	Medium
Habitat Fragmentation	Some species require large expanses of forestland surrounding their denning sites	High
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct a statewide inventory of outcrop and meadow natural communities to identify the best sites and those with SGCN	The number of high quality examples identified containing SGCN	FPR	SWG
Provide technical and financial assistance to private, municipal and federal landowners to control invasive species and to minimize the impact of recreation on SGCN	Number landowners managing for SGCN. Number of acres conserved	NRCS, TNC, VFWD	SWG, NRCS
Technical assistance to town and regional planning organizations to maintain and enhance outcrops and upland meadows for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns including SGCN in their planning	VFWD	VFWD
Develop conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with hiking and rock/ice climbing groups to avoid sensitive sites. Limit hiker use and new trails on high quality state-owned sites		ANR,	VFWD,

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
New England Plant Conservation Program – various Conservation Plans	Recovery of various plant species in New England	ANR
State Outdoor Recreation Plan	A comprehensive recreation plan for state lands	FPR

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

Thompson, E. H., and E. R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England, Hanover and London.

Cliff & Talus Summary

Characteristics and location

Cliffs are areas of exposed bedrock, with slopes greater than 60 degrees. Examples range from very small and shaded by surrounding forests to extensive sites greater than one hundred acres. Vermont's cliffs are divided based on their climatic affinities and their bedrock. Climate is the factor separating boreal cliff types from temperate cliff types. The boreal types are found in the cooler regions of the state, the Northeast Highlands and the Green Mountains, though a few are found in generally warmer regions, in especially cool situations such as at high elevations or in cold valleys. The temperate types are found either at middle to low elevations or in the warmer regions of the state. Bedrock is the factor separating acidic cliff communities from calcareous cliff communities. Granites, some quartzites, and sandstones are typically acidic, whereas limestones, dolomites, calcareous schists, and some quartzites are calcareous. [Thompson and Sorenson 2000]

Talus slopes are areas of rockfall below cliffs and are characterized by an accumulation of many rocks broken off a cliff face through physical forces including freezing and thawing.

Types of Cliff and Talus Communities:

Boreal Acidic Cliff: These are high elevation cliffs, generally above 2,000 feet, found on acidic bedrock such as granite, gneiss, quartzite, or non-calcareous schist. Vegetation is usually red spruce, balsam fir, American mountain-ash, bush-honeysuckle, three-toothed cinquefoil, and hairgrass. Eastern Hemlock is absent from these cliffs. Found primarily in the cooler regions of the state, the Northeast Highlands and the Green Mountains.

Boreal Calcareous Cliff: These are high elevation cliffs, mostly above 2,000 feet, where calcareous bedrock (usually calcareous schist, but occasionally limestone or marble) combined with seepage creates conditions that favor certain calciphilic plants, some of which are quite rare statewide.

Temperate Acidic Cliff: These are lower elevation cliffs, generally below 2,000 feet, found on acidic bedrock. Characteristic vegetation includes eastern hemlock, white pine, red maple, paper birch, harebell, and heart-leaved aster. Found primarily either at middle to low elevations or in the warmer regions of the state.

Temperate Calcareous Cliff: These are low elevation cliffs in warmer areas on limestone, marble, dolomite, or calcareous quartzite. They may be moist or dry, depending on the situation, but usually do not have abundant seepage. Some characteristic species are northern white cedar, purple clematis, smooth cliff-brake, purple-stemmed cliff brake, harebell, and herb robert. Found primarily either at middle to low elevations or in the warmer regions of the state.

Open Talus: This broadly defined community type includes all areas of open rockfall. These rockfall areas usually occur below cliffs, and can be comprised of granite, quartzite, gneiss, shale, or less commonly limestone or marble.

Cliff & Talus Condition

Current Condition: Generally, cliffs and talus communities are not directly vulnerable to habitat degradation simply because they tend to be inaccessible and limited in timber or development potential. Recreational activities and intensive quarrying may be the greatest impacts to these communities where such activities occur.

Desired Condition (SGCN Needs): Cliffs and talus are often host to habitat specialists, many of which are plants directly linked to the natural community type. In general, the larger the site, the greater the likelihood that numerous SGCN plant species will exist and that they will persist. Many of the animal species associated with this community types; however, do require accessible, unfragmented habitat mosaics. Several of the animal species require the cliff and talus for nesting or hibernation, but range as far as 1000 ha from the site. Three of the species (North American Race, rock vole, and five-lined skink) specifically benefit from active management for early successional features or small openings around the sites to provide solar radiation. The North American Race is found on only one site in Vermont. The five cliff and talus community types provides the habitat for 100 SGCN.

Species of Greatest Conservation Need in Cliffs & Talus

High Priority
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Rock Vole (Microtus chrotorrhinus)
Small-footed Bat (Myotis leibii)
Long-tailed or Rock Shrew (Sorex dispar)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Eastern Ribbonsnake (Thamnophis sauritus)

SGCN Notes: Vascular plant SGCN not listed here 65 species (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Quarrying activity and poorly designed ski trails	High
Habitat Fragmentation	Wider ranging reptiles require unfragmented habitat mosaics of 1000 ha or more	High
Climate Change	Species generally have no higher elevations to move to	High
Incompatible Recreation	Rock climbing disturbs falcons and tramples rare plants	High
Distribution of successional stages	Active management for early successional openings (North American Race), young forest (rock vole), and forest openings for solar radiation (five-lined skink).	Medium
Pollution	Acid rain threatens higher elevation habitats	Medium
Research & Inventory needs	Distribution, location, and condition of this community type are not known.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of cliff and talus and identify and locate the best examples of these community types that support the most SGCN	Number of sites inventoried	FPR	SWG
Provide technical assistance and/or financial assistance private landowners to maintain and enhance cliff and talus for SGCN.	Number landowners incorporating SGCN into their land management	NRCS, TNC, FWD	SWG
Technical assistance to town and regional planning organizations for conservation practices that maintain and/or enhance habitat for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns/RPCs considering SGCN in their planning	VFWD	VFWD
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC	VHCB, VLT
Work with hiking and rock/ice climbing groups to avoid sensitive sites	Number of sensitive sites with programs implemented to limit encroachment	ANR, GMC, VOGA	VFWD, Access Fund

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon plan	Remove peregrine from ESA list	ANR
Draft VT Bat Conservation Plan		ANR
ANR Land Conservation Plan	ANR land acquisition	ANR
VT Recreation Plan (SCORP)	Recreation priorities throughout the state	ANR, GMC, VOGA

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Grassland & Hedgerows Summary

Characteristics and location

Grasslands are landscapes dominated by grasses, sedges and forbs with little to no tree or shrub cover. Most of the larger examples of this community type are the result of current or past agricultural practices. Grassland habitats are also commonly maintained at airports, fairgrounds, landfills and industrial complexes. Smaller grasslands are found in fallow beaver flowages, seasonally flooded areas adjacent to rivers, and sandplain communities, and are covered under separate summaries.

Hedgerows are linear patches of trees or shrubs, often lining field borders or roadsides. Hedgerows enable some species to more fully utilize adjacent grassland communities (for perching, nesting, sheltering or escaping predators), while other species may occupy annual or seasonal home ranges solely within hedgerows. Hedgerows also often serve as travel or dispersal corridors connecting disjunct habitat patches.

Types of Grassland & Hedgerow Communities:

Hayfields, pastures, old fields, power line and RR rights-of-way, mowed interstate medians, airports, industrial complexes. Treed and/or brushy hedgerows lining field edges and roads.

Grassland & Hedgerow Condition

Historical Perspective: Grasslands in Vermont are primarily a result of land clearing for agriculture since European settlement of the area. It has been estimated that early successional forest (1-15-year age class) occupied from 1.1-3.0% of the regional presettlement landscape in areas of northern hardwood forest and 2.4-7.1% of the regional landscape in areas of spruce-northern hardwood forest (Lorimer and White 2003).

Current Condition: Most of Vermont's grasslands occur in the Champlain Valley and to a lesser extent the Connecticut River Valley and the area around Lake Memphremagog. There are also numerous grasslands of various types and sizes scattered across the rest of the state. Most grasslands are associated with current or past agricultural practices. There are, however, grasslands that are the result of other human activities and are maintained for specific purposes. These include grasslands associated with airports (commercial and private), landfills, fairgrounds, military reservations and industrial complexes (e.g., IBM, Husky, etc.). Most of Vermont's grasslands are in private ownership, although the state and federal governments own and manage some of these areas. The counties with the highest percentages of land in agriculture and open land are Addison (35.5%), Franklin (29.5%), Grand Isle (25%) and Orleans (22%, primarily in the area surrounding Lake Memphremagog) (U.S. Department of Agriculture. 1997).

Although agriculture practices create and maintain valuable grasslands, recent intensification of these practices has had negative impacts on their quality and availability. Small diversified farming which provided a range of suitable habitat types has given way to larger, more intensively managed farms because of improved agricultural techniques. Advances in equipment, fertilizers and extensive use of potent pesticides and herbicides have resulted in greater management of hayfields (early and frequent cutting which disrupts nesting activity), conversion of hayfields to row crops or legumes, and intensive grazing (LaBarr et al. 2004).

Urban and suburban development has also resulted in a loss of grasslands. This loss comes in two forms, the direct loss of grasslands as structures and lawns replace fields, and fragmentation of large grassland areas into smaller parcels rendering them insufficient for use by some breeding grassland bird (e.g., Upland Sandpiper). In Vermont, the urban and suburban growth of Chittenden County is expanding into Franklin and Grand Isle counties to the north and Addison county to the south. As a result, there is increasing pressure to develop agricultural lands important to grassland species (LaBarr et al. 2004).

Other factors contributing to loss of quality grasslands include incompatible management of grasslands in non-agricultural settings (i.e., airports). Although airport construction and management has provided suitable habitat for grassland species, mowing regimes, many of which are required by the Federal Aviation Administration (FAA) often disturb nesting activity. Also, a lack of airport expansion planning (new hangers, airplane parking, etc.) which considers grassland species has led to the loss of important grassland habitat at these sites (LaBarr et al. 2004).

More is known about the effects of current conditions on grassland bird species than other SGCN taxa that use grasslands and/or hedgerows. Grassland bird species have declined steadily throughout their range. Reported results from the U.S. Fish and Wildlife Service Breeding Bird Survey show that declines of grassland birds have been consistently steeper and more widespread than any other assemblage of birds (Askins 1993, Sauer et al. 2011). In Vermont, Upland Sandpiper populations have declined precipitously (Peterson 1999) and Grasshopper Sparrows are considered rare and uncommon (Ellison 1985, Record of Vermont Birds). Both Sedge Wren and Henslow's Sparrow populations have declined to where they may no longer be breeding in the state. Other obligate grassland species, although relatively abundant (i.e., Bobolink and Eastern Meadowlark) have also show significant declines in recent years (LaBarr et al. 2004).

Desired Condition (SGCN Needs): A variety of grasslands and hedgerows are needed to conserve the suite of species dependent on these habitat types. For example, Bobolinks utilize large expanses of grassland or fallow hay fields with little or no alfalfa, high litter cover and scattered broad-leafed forbs for nest-site cover (Martin and Gavin 1995). Northern Harrier habitat includes marshy meadows, wet, lightly grazed pastures, old fields, mesic grasslands, and drained marshlands. Densest populations are typically associated with large tracts of undisturbed habitats dominated by thick vegetation (MacWhirter and Bildstein 1996). Upland Sandpipers prefer large grassland areas (20-40 ha) with a mosaic of grassland types as areas of short grass are used for feeding while areas of taller grass (10-30 cm) are used for nesting. All three of these species benefit from grasslands that are not subjected to early (before July 15) mowing. American Kestrels nest in cavities or nest boxes in most open areas (< 30% canopy cover; Smallwood and Bird 2002). Gray Fox, New England Cottontail, Eastern Ratsnake, Smooth Greensnake and DeKay's Brownsnake all utilize hedgerows for foraging, denning or nesting, and/or as movement corridors.

Implementing the 2005 Wildlife Action Plan

Over the past decade, VFWD maintained an estimated 340 acres of permanent openings as old field shrub cover by brush mowing and burning an average of 105 acres annually to maintain this vegetation type on WMAs. Such permanent shrub openings have been shown to be extremely important to shrubland birds; Smetzer et al. (2014) estimated that "maintaining the current population size of shrubland birds under a management strategy based entirely on silviculture would require a 50–300% increase in silvicultural openings, depending on the species."

The Champlain Valley Bird Initiative, a partnership of Audubon VT, the Natural Resources Conservation Service and the University of Vermont similarly provides landowner with technical and financial assistance to protect and manage grassland and shrubland habitat (benefitting many species including the Eastern Towhee, Golden-winged Warbler, Field Sparrow and Bobolink).

Species of Greatest Conservation Need in Grasslands & Hedgerows

High Priority
Grasshopper Sparrow (Ammodramus savannarum)
Upland Sandpiper (Bartramia longicauda)
Northern Harrier (Circus cyaneus)
Sedge Wren (Cistothorus platensis)
Vesper Sparrow (Pooecetes gramineus)
Fowler's Toad (Anaxyrus fowleri)
Wood Turtle (Glyptemys insculpta)
North American Race (Coluber constrictor)
Timber Rattlesnake (Crotalus horridus)
Eastern Ratsnake (Pantherophis alleghaniensis)
Butterflies-Grassland Group
Moths Group
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Northern Long-eared Bat (Myotis septentrionalis)
Woodland Vole (Microtus pinetorum)
Pygmy Shrew (Sorex hoyi)
New England Cottontail (Sylvilagus transitionalis)
Southern Bog Lemming (Synaptomys cooperi)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Short-eared Owl (Asio flammeus)
Chimney Swift (Chaetura pelagica)
Black-billed Cuckoo (Coccyzus erythropthalmus)
Bobolink (Dolichonyx oryzivorus)
American Kestrel (Falco sparverius)
Purple Martin (Progne subis)
Field Sparrow (Spizella pusilla)
Eastern Meadowlark (Sturnella magna)
Lesser Yellowlegs (Tringa flavipes)
Blue-winged Warbler (Vermivora pinus)
Smooth Greensnake (Opheodrys vernalis)
DeKay's Brownsnake (Storeria dekayi)
Eastern Ribbonsnake (Thamnophis sauritus)
Long-tailed Weasel (Mustela frenata)
Hairy-tailed Mole (Parascalops breweri)
Common Gray Fox (Urocyon cinereoargenteus)

SGCN Notes: Vascular plant SGCN not listed here: 159 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need/Category	Problem/Info Need Detail	Rank
Habitat Degradation	Widespread early hay harvest (early June) and heavy grazing rotations in pastures.	High
Habitat Conversion	conversion of agricultural habitat to urban/suburban development	High
Distribution of successional stages	Abandonment and forest succession of former agricultural land.	High
Habitat Degradation	Removal of hedgerows to accommodate larger tractors and farm machinery.	High
Habitat Fragmentation	Fragmentation of habitat by roads and trails and increase use of roads and tails by motor vehicles, including ATV's, and mountain bicycles.	High
Inventory	Distribution and condition of this habitat are not well known. Better information is necessary regarding the timing of hay mowing in landscapes with various proportions of agriculture throughout VT.	Medium
Inventory	Better information is needed on the distribution of SGCN within grasslands habitats and the relative values of the various types and sizes of these habitats to the SGCN.	Medium

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Locate grassland and assess management practices on those grasslands.	Number of sites located and assessed	ANR, FSA, UVM	SWG
Identify areas within the state with the largest matrix of grasslands for inclusion in grassland bird opportunity areas.	Number of opportunity areas identified	ANR, UVM	SWG
Ensure protection of opportunity areas via acquisition of conservation easements, management leases and fee title acquisition	Number of sites conserved	ANR, VHCB, TNC	VHCB, TNC
Develop education and outreach program to provide information about grassland/hedgerow dependent species and management options to enhance their populations in Vermont.	Number of maintained or enhanced sites on private land	ANR, FSA, VFB	SWG, EQIP, GRP, VDA
Promote conservation easements or incentives to landowners managing grasslands/hedgerows for SGCN.	Number of maintained or enhanced sites on private land	ANR, FSA, VFB	SWG, EQIP, GRP, VDA
Develop conservation plans at state airports where SGCN are regularly found.	Number of sites with conservation agreements	ANR, VTRANS, FAA	SWG, VTRANS
Continue to work with Vermont National Guard staff at Camp Johnson to manage grasslands to benefit grassland species.	Number of SGCN conserved at Camp Johnson	VNG, ANR	SWG
Maintain and manage grasslands and hedgerows on state and federal lands (wildlife management areas, state parks, National Wildlife Refuges, GMNF)	Number of sites reclaimed and/or managed	ANR, USFWS, USFS	SWG, PR
Manage power line ROW, road margins and related lands known or suspected to support SGCN that depend on grasslands and enhance surrounding habitat by creating and maintaining open habitat.	Number of sites reclaimed and/or managed	ANR, VELCO, GMP	SWG, VETCO, GMP
Support current efforts and develop new efforts to study distribution, productivity, and survivorship of grassland bird species in Vermont.	Number of hypothesis tested	ANR, UVM, Audubon, VCE	SWG, PR
Develop safe road crossings to limit road kill of snakes and turtles which use grassland habitats	Number of safe crossings developed	ANR, Towns, VTRANS,	SWG, PR, VTRANS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
VT Grassland Bird Management Plan	Maintain and enhance grassland bird populations	VFWD, NRCS, Audubon
Partners in Flight	Regional Bird conservation	VFWD, USFWS, PIF, NABCI
VTRANS Transportation Plans	Manage airports grounds which contain a significant amount of VT's grasslands	VTRANS, VFWD

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Mines and Quarries Summary

Characteristics and location

Mines may provide many or all the habitat qualities of natural caves and can even provide better habitat in some instances. Similarly, quarries may mimic natural cliffs, outcrops, and talus slopes. These human-created cultural habitats, due to the history of Vermont are found statewide and may augment the natural habitats available to wildlife.

Types of Mines and Quarries:

Mines in Vermont include gold, silver, iron, asbestos, and talc mines.

Quarries in Vermont include marble, granite, and slate quarries

In some cases, gravel pits and road cuts may provide habitat

Mines & Quarries Condition

Current Condition: Mines and quarries occur throughout the state. Some are long abandoned, some more recent, and others currently used to lesser or greater extents. The sites vary in their structural stability and some are very dangerous (large sections of the Elizabeth Mine have collapsed) Bats are known to use some mine sites as hibernacula. Peregrine falcons may nest or roost on the walls of some rock cuts. Mine vents and other vertical rock structure may provide nesting habitat for swifts. Small-footed bats might seek shelter in between and under large rock talus created by mining or quarrying operations. In some instances, the sites are toxic due to leaching of mine tailings. Some sites have the entrances blocked, become dumping areas, or recreational vehicle parks.

Desired Condition (SGCN Needs): Some mines and quarry site provide conditions that certain species select. A mine that has appropriate temperatures and humidity may provide good wintering habitat for bats. Like caves, if the conditions change or if disturbances occur, the site may no longer be suitable habitat and can even cause the death of bats using the mine. Some rattlesnake reports historically have been from slate quarries in proximity to existing or historical den sites. Quarries could provide foraging and basking habitat as well as escape cover. Rock piles with abundant spaces that extend below the frost line could even provide denning sites. Sites providing necessary habitat for SGCN are important and should be conserved.

Species of Greatest Conservation Need using Mines and Quarries

High Priority
Chimney Swift (Chaetura pelagica)
Timber Rattlesnake (Crotalus horridus)
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana Bat (Myotis sodalis)
Small-footed Bat (Myotis leibii)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Closure of mine entrances and filling of quarries.	High
Habitat Alteration	Modification of mine entrances or interiors that either exclude wildlife or create unsuitable conditions	High
Habitat Conversion	External surface changes to drainage patterns or tree cover that render the mine or quarry unsuitable for wildlife use.	High
Pollution	Poisonous gasses that can infiltrate a mine or runoff that contaminate a site	High
Trampling or Direct Impacts	Direct persecution of wildlife	High
Habitat conversion	Reopening an abandoned mine or cave for extraction of mineral resources	High
Incompatible recreation	Recreational use of mines or caves used by wildlife.	High
Inventory	Distribution, location, and condition of this habitat are not fully known. A statewide inventory would add to our knowledge of sites that support the most SGCN	Med

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of mines and quarries important to SGCN.	Number of sites surveyed that have SGCN that are dependent on mines and quarries	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Identify those mines or quarries important to SGCN and at risk of loss, then take actions to conserve them with priority given to structures with most vulnerable species, largest concentration of a SGCN, or the greatest number of SGCN present.	Number of protected occurrences of each SGCN using mines and quarries.	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Raise awareness and acceptance of the need to provide cultural habitat for some SGCN that depend on mines and quarries and modify recreational and other activities.	Number of audiences reached.	Environmental Educators	
Promote conservation easements or agreements for important sites for SGCN	Number sites having conservation agreements	ANR, BCI	VHCB, VLT
Consider direct purchase of a mine or quarry if that is the most effective manner to manage for SGCN	Number of conserved SGCN that are dependent on mines and quarries	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Provide technical assistance and economic incentives for property owners to manage mines and quarries for SGCN while protecting the health and safety of humans.	Maintained or enhanced condition of SGCN using a mine or quarry (numbers of individuals, reproductive success, survival rate)	VFWD	VFWD

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Work with landowners to provide fencing and/or appropriately designed gates that exclude human intrusion and reduce liability to landowner, while maintaining SGCN using a mine or quarries	Maintained or enhanced condition of SGCN using a mine or quarry (numbers of individuals, reproductive success, survival rate)	VFWD	VFWD
Educate users of mine and quarry sites and encourage avoidance of important sites when SGCN are vulnerable (e.g., bats fall through spring).	Increased understanding and acceptance of mine/quarry conservation by the public	VFWD, BCI, School programs, media	Marketing? Section 6
Encourage use of alternative sites that do not harbor SGCN	Increased understanding and acceptance of mine/quarry conservation by the public	VFWD, BCI, School programs, media	Marketing? Section 6

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon federal monitoring plan and state recovery plan	Peregrine monitoring and management	ANR/Audubon
VT Bat Conservation Plan	Conservation of all bats, especially those currently listed in Vermont	ANR/VFWD
Rattlesnake Recovery Plan	Maintain and enhance rattlesnake populations in VT and move them toward recovery	VFWD

Literature Cited

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Blodgett, D. 2015. Vermont Timber Rattlesnake Recovery Plan. Vermont Fish & Wildlife Department. Montpelier, VT. http://www.vtfishandwildlife.com/common/pages/DisplayFile.aspx?itemId=503500

Subterranean Summary

Characteristics and Location

Subterranean areas area are defined as below-surface natural features (mines are addressed under Cultural Habitats) that consist of both aquatic and terrestrial conditions. Because these areas are below ground, there is limited human access to locate and inventory these sites. Consequently, there is little information on their abundance, distribution, and condition.

Some of the best information on subterranean areas comes from the caving community. Members of the Vermont Cavers Association have interest in locating, exploring, and even surveying these areas. Some of the earlier documentation of Vermont caves is from John Scott (1959) and, more recently, Peter Quick (1994).

Most of Vermont's caves are relatively small, ranging from less than 100 feet underground to several hundred feet. Some caves contain passages that may continue far beyond what has been accessed. Most Vermont caves are solutional, meaning they have been formed through erosion from moving water.

While caves are found throughout Vermont, most of the known caves are in southern Vermont, particularly the Taconics and Southern Green Mountains regions. These areas also are known to have the geologic features most associated with underwater springs and streams that would provide subterranean aquatic habitats.

Subterranean Condition

Current Condition: Due to the geologic nature of the habitat type, caves remain in much of their original structure. Many of the more accessible caves do exhibit signs of graffiti and evidence of the destruction or removal of cave formations such as stalagmites and stalactites. Historic accounts of some caves document the loss of beautiful formations by visitors. Currently, 3 caves are gated and locked to control human visitation.

Subterranean areas provide a very consistent environment of temperature, relative humidity, and air flow. While these variables are likely important to the overall condition, there is very limited information on these variables. Changes in structure and hydrology could greatly affect these habitats provided by subterranean areas.

There are 6 species of bats known to hibernate in Vermont caves. Bats are one of the better studied wildlife species associated with subterranean areas, and have been surveyed in caves going back into the 1930s (Trombulak et al. 2001). Trend data from hibernacula surveys does provide for some evaluation of the value of specific caves to bat species and populations. Recent surveys indicate that caves may hold as few as less than 10 bats to as many as over 23,000. Interest and understanding in the invertebrate community associated with caves is just beginning.

Little is known about the condition of the subterranean aquatic habitats.

The primary activities resulting in the loss or degradation of subterranean areas involve either human disturbance to either the cave structure (thereby affecting temperature, humidity, or air flow) or the species using the area and pollutants to the aquatic elements of the subterranean areas.

Desired Condition: Subterranean areas provide habitat for a small number of SGCN in the state. However, subterranean areas provide a critical habitat component for the survival of these species. Subterranean areas should remain intact, with limited human alteration or influence from above-ground pollutants. Many of the SGCN associated with subterranean areas use the sites for denning or hibernation, but also spend a disproportionate amount of the year in the surrounding area (e.g., fall swarming for bats or breeding and birthing for rattlesnakes).

A total of 8 SGCN are associated with subterranean area.

Species of Greatest Conservation Need in Subterranean Landscapes

High Priority
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana Bat (Myotis sodalis)
Tri-colored bat (Perimyotis subflavus)
Small-footed Bat (Myotis leibii)
Northern Long-eared Bat (Myotis septentrionalis)
Timber Rattlesnake (Crotalus horridus)

Medium Priority
Chimney Swift (Chaetura pelagica)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Hydrologic alteration	Sedimentation, development in watershed, road building	Medium
Habitat Conversion	Roads, development, and agriculture remove SGCN habitat surrounding subterranean sites	High
Habitat Degradation	Alteration of cave structure, thereby influencing temperature, humidity, or air flow	High
Incompatible recreation	Disturbance to hibernating bats or denned rattlesnakes	Medium
Pollution	Aquatic pollutants	Medium
Inventory	Statewide inventory has been completed, but not all sites have been evaluated	Low

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Gate subterranean sites experiencing risk from unlimited human visitation	Number of sites gated	USFWS, TNC, VCA	SWG, USFWS
Conservation easements on higher quality sites with greatest number of SGCN or T&E listed SGCN	Number of acres conserved for SGCN	ANR, VLT, TNC, NCC	VHCB, VLT

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical assistance and/or financial incentives to private landowners, towns and RPC's to maintain and enhance Subterranean habitat for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number landowners incorporating SGCN into their land management, Number of towns including SGCN in their planning. Number of acres conserved	NRCS, TNC, FWD, RPC, VLCT, USFWS	NRCS programs, USFWS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Draft Bat Conservation and Recovery Plan	Conservation and recovery of Vermont bat species	ANR
Cave Management Plans	Management plans for specific caves in Vermont	ANR, VCA, NCC

Literature Cited

Austin, J.M. C. Alexander, E. Marshall, F. Hammond, J. Shippee, E. Thompson. VT League of Cities and Towns. 2004. Conserving Vermont's Natural Heritage. A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife and Biological Diversity. Vermont Fish & Wildlife Department and Agency of Natural Resources. Waterbury, VT.

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Buildings & Other Structures Summary

Characteristics and location

Buildings and structures may provide habitat for wildlife, generally in the form of shelter, when they provide appropriate conditions (i.e., temperature and humidity) and are relatively secure from disturbance. Sometimes the structures provide habitat for prey species (mice) that attract the foraging SGCN (snakes). In other cases the structures may simply become an extension of the natural landscape, such basking and foraging sites for skinks. Structures used by wildlife are located throughout Vermont, but are not always known or appreciated as habitat for wildlife.

Types of Buildings and Other Structures Providing Habitat for SGCN

Barns and other outbuildings, Abandoned or little used buildings, House attics, Bridges, Dams, Power poles and other vertical structures (possibly) and Towers or tall buildings that mimic cliffs.

Condition of Buildings & Other Structures

Current Condition: Buildings and other structures may be used by wildlife under a variety of circumstances. Bats may roost in abandoned building attics, the attics of occupied dwellings, or in outbuildings or covered bridges. Peregrine falcons may nest on ledges of tall buildings, tower, or bridges although we don't have any currently nesting in such locations at present. Small-footed bats might seek shelter in between and under large rock talus used to armor dams. Osprey may nest on power poles near water and chimney swifts may build their nests inside chimneys.

Desired Condition (SGCN Needs): Some buildings and other structures provide conditions that certain species select. If the site is relatively undisturbed and secure over time, large number of some species may come to depend on the site (e.g., large bat maternity colony). Change the light regime or air circulation, and the conditions may no longer be as suitable. In some cases the surrounding area, or even the specific geographic location, may determine if a structure is used by a SGCN. Only barns located near existing skink populations will be used by that species and a power pole used by osprey for nesting has to be within flying distance of fishable waters.

SGCN Using Buildings & Other Structures

High Priority
Chimney Swift (Chaetura pelagica)
Eastern Ratsnake (Pantherophis alleghaniensis)
Five-lined Skink (Plestiodon fasciatus)
Little Brown Bat (Myotis lucifugus)
Northern Long-eared Bat (Myotis septentrionalis)
Indiana bat (Myotis soldalis)
Small-footed Bat (Myotis leibii)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Purple Martin (Progne subis)
Big Brown Bat (Eptesicus fuscus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories cited here.

Problem/Info Need Category	Problem/Info Need Detail	Rank
Inventory	Distribution, location, and condition of this habitat are not known. A statewide inventory is needed to identify and locate the best examples of these habitats that support the most SGCN	Medium
Habitat Conversion	Loss of old buildings that provide shelter for wildlife	High
Habitat Conversion	Modification of structures that exclude wildlife or create unsuitable conditions	High
Habitat Conversion	Changes to structures that may trap or kill animals (including deliberate exclusions)	High
Pollution	Use of chemicals that may poison or kill wildlife	High
Trampling or Direct Impacts	Direct persecution of wildlife using structures	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories cited here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct statewide inventory of buildings and structures important to SGCN.	Number of conserved sites with SGCN that are dependent on buildings and other structures	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Identify those buildings or other structures important to SGCN and at risk of loss, then take actions to conserve or replace.	Number of protected occurrences of each SGCN using buildings and other structures.	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Promote conservation easements or agreements for important sites for SGCN	Number sites having conservation agreements	ANR, BCI	VHCB, VLT
Consider direct purchase of a structure if that is the most effective manner to manage for SGCN (e.g., PA bat maternity colony in old church).	Number of conserved SGCN that are dependent on buildings and other structures	VFWD, Town Conservation Commissions, AVCC	SWG, Section 6
Provide appropriately designed structures in suitable locations to replace buildings and structures no longer available to SGCN. In some cases these need to be provided in conjunction with an exclusion	Number of protected occurrences of each SGCN using buildings and other structures.	VFWD, Town Conservation Commissions	SWG, Section 6
Provide technical assistance and economic incentives for property owners to manage their structures for SGCN while protecting the health and safety of humans.	Maintained or enhanced condition of SGCN using a building or structure (numbers of individuals, reproductive success, survival rate)	VFWD Wildlife Services	VFWD
Provide education programs and materials that improve the public's understanding of SGCN needs and perceptions of wildlife that utilize buildings and structures.	Audiences reached, Number of people attending program.	VFWD, NWF, enviro educators	SWG, PR

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Encourage coexistence with SGCN using buildings and structures	Increased understanding and acceptance of building/structure conservation by the public	VFWD, BCI, School programs, media	VFWD, USFWS

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Peregrine falcon federal monitoring plan and state recovery plan	Peregrine monitoring and management	ANR, Audubon
VT Bat Conservation Plan	Conservation and restoration of bat population	ANR
Osprey Recovery Plan	Osprey monitoring and management	ANR

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Riparian Summary

Vermont's aquatic and shoreline landscape includes all surface waters and their adjacent streambanks, floodplains, river corridors, and/or lakeshores. This landscape includes lacustrine (lake) formations, fluvial (stream and river) formations, floodplain forests, and shores and marshes. This landscape also includes thousands of miles of streambank areas that are comprised of upland communities adjacent to surface waters. The aquatic and shoreline landscape is described as an interconnected system of the lacustrine, fluvial, floodplain, marsh, shore, and upland communities that comprise it for the purpose of identifying and conserving the common habitat functions these communities provide at the landscape level.

Riparian (riverbank) areas, if maintained in continuous, sufficiently wide, interconnected corridors throughout a watershed, serve as movement corridors for many of Vermont's wildlife species. Maintaining intact terrestrial communities adjacent to surface waters also serves to protect aquatic habitats. Riparian areas help protect water quality, provide organic inputs, regulate water chemistry and physical properties (such as temperature), and provide physical aquatic habitat structure (e.g., undercut banks, large woody debris). Again, because aquatic communities are often inter-connected throughout the landscape, maintaining intact riparian areas is essential to protecting aquatic communities from the headwaters to downstream receiving waters.

> "It is a well known fact that the best fishing is where a forest is near the shore, and best of all where the limbs overhang the water. Not only do the trees afford shelter, furnish food and prevent evaporation, but at the same time they keep the water clear and cool in the summer. In the winter the forests afford protection by lessening the severity of the winter frosts, and in all forest regions the changes of temperature are not so severe as in treeless countries and on the open plain: and the effect upon the water is even greater….But the forests not only regulate the flow of water, as above stated, but they purify the water."
> **- Frank H. Carleton, from the Fifteenth Biennial Report of the Commissioners of Fish and Game of the State of Vermont, 1899-1900.**

Vermont State statute (10 V.S.A. Chapter 32 § 752. Definitions) defines *River Corridor* as "the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in section 1422 of this title, and for minimization of fluvial erosion hazards…). River corridors include both the channel and adjacent land such that the river has access to its floodplain and accommodates both existing and future meander features resulting from the forces of fluvial dynamics. The river corridor may consist of floodplain forests, marshes and other wetlands. Maintaining or restoring river corridor processes and function enables longitudinal and horizontal connectivity between aquatic and terrestrial landforms and associated biota.

Habitat requirements, problems, and conservation strategies have been assessed and developed for both the landscape level, and the individual aquatic and terrestrial species' habitats that are associated with it. Many SGCN meet most of their habitat needs within the aquatic-terrestrial interface that the aquatic and shoreline landscape provides. These species, in particular, are discussed in this section.

Characteristics and location

Aquatic and shoreline landscapes are comprised of streams, rivers, lakes, wetlands, shorelines and floodplains that form a complex and interrelated hydrological system. This hydrological system extends up and down streams and along lakeshores from the bottom of the water table to the top of the vegetation canopy, and includes land that is directly affected by surface water (Verry 2000). Riparian areas are known for their high biological diversity. They are "characterized by frequent disturbances related to inundation, transport of sediments, and the abrasive and erosive forces of water and ice movement that, in turn, create habitat complexity and variability…resulting in ecologically diverse communities" (Verry 2000).

The landscape level includes both the terrestrial-aquatic interface and the aquatic areas found throughout Vermont, from the mountain streams to the large valley rivers and the lakes and ponds scattered throughout the landscape. The following aquatic and terrestrial areas are associated with the aquatic and shoreline landscape (for details see the following summaries in Appendix B):

- Lakes
- Lake Champlain
- Lake Champlain Tributaries
- Connecticut River
- Floodplain Forests
- Upland Shores
- Wet Shores
- Swamps and Marshes

Landscape Condition

Current Condition: Nationwide an estimated 70% to 90% of natural riparian vegetation, vital to maintaining the integrity of riparian and aquatic habitats, has already been lost or is degraded due to human activities (Doppelt 1993). In Vermont, some of our rivers, streams, lakes, and wetlands still have intact riparian areas, while many others no longer have functioning riparian areas due to more than 200 years of intensive human use of the land.

In general, riparian areas in Vermont are most affected by habitat conversion, alteration, and fragmentation. Typically, steeper mountainous streams and high elevation lakes and ponds, less suited for human development, have well forested riparian areas with cold, clean water and stable stream channels and shorelines. Recreational activities and their associated development and forestry are the land uses most common in these areas that may affect riparian and aquatic species. Mid and low elevation waterbodies and their adjacent riparian areas are more likely to be impacted by human land uses, including clearing of riparian vegetation, alteration of stream channels and lakeshores, and direct inputs of toxins, excess nutrients, and sediments. These impacts are related primarily to roads, residences, commercial development, and agriculture, with agriculture being especially extensive in the lower valleys of the Champlain and Connecticut tributaries. Lacustrine areas and their associated shorelines are particularly impacted by lakeshore development, such as seasonal and permanent residences, marinas and docks, and public and private beaches. In many instances these developments have altered natural lakeshore and littoral zones resulting in the direct loss of habitats for SGCN through the addition of fill materials (sand, bottom barriers) and the removal of native aquatic vegetation.

The fragmentation of riparian habitat is extensive in Vermont, due primarily to Vermont's roadways paralleling the stream, rivers, and lakeshores, and use of rich floodplain areas for agriculture. Historic settlement and transportation patterns and ease of construction have resulted in roads paralleling the majority of Vermont's major waterbodies and thousands of associated bridges and culverts. This results in removal of riparian vegetation and fragmentation, both longitudinally and laterally between the waterbody and adjacent upland communities.

Desired Condition (SGCN Needs): Aquatic and shoreline areas provide several habitat functions for the species that inhabit them. Some species rely directly on both the aquatic and terrestrial components of the riparian-aquatic interface. For example, otter use aquatic areas within 100 meters of water's edge for feeding and riparian areas for denning and as travel corridors. These species move daily between terrestrial and aquatic areas to fulfill their life needs. Other species move seasonally between the aquatic and terrestrial components of the aquatic and shoreline landscape. For example, the wood turtle uses streams and rivers for overwintering, and uses adjacent riparian areas up to 300 meters from the water's edge for foraging, breeding, nesting, and dispersal. For those species that are strictly aquatic, the adjacent terrestrial riparian areas function to protect the aquatic areas, providing shade, organic inputs, filtering and storage of overland runoff, and bank stability.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity.

VFWD provided technical assistance to every Vermont Regional Planning Commission and nearly every town on a variety of wildlife and land planning related issues, including SGCN conservation, habitat blocks, and wildlife corridors. Conserving Vermont's Natural Heritage (Austin et.al. 2004) was reprinted and distribution of this planning document continues.

The Partners for Fish & Wildlife program of the U.S. Fish & Wildlife Service, which organizes and supports community-based habitat restorations, partnered with more than 600 landowners on more than 550 projects to restore 294 miles of riparian habitat, 5,476 acres of wetland habitat, 976 acres of upland habitat and 1,200 acres of habitats impacted by invasive species. Partners also reopened 1,438 miles of stream to fish passage; and completed 11 miles of in-stream restoration.

Species of Greatest Conservation Need in Aquatic and Shoreline

High Priority

Bald Eagle (Haliaeetus leucocephalus)
Wood turtle (Glyptemys insculpata)
Common Mudpuppy (Necturus maculosus)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Water Shrew (Sorex palustris)
Odonates-Bog/Fen/Swamp/Marshy Pond Group
Freshwater Mussels Group
Freshwater Snails Group
Lakes/ponds Odonata group
Mayflies/Stoneflies/Caddisflies Group
River/stream Odonata group
Elktoe (Alasmidonta marginata)
American Brook Lamprey (Lethenteron appendix)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Blacknose Shiner (Notropis heterolepis)
Northern Brook Lamprey (Ichthyomyzon fossor)
Stonecat (Noturus flavus)

Medium Priority

Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus
Mottled Sculpin (Cottus bairdi)
Redfin Pickerel (Esox americanus)
Brook Trout (naturally reproducing populations) (Salvelinus fontinalis)
American Eel (Anguilla rostrata) Lake Champlain and Connecticut River populations.
Silver Lamprey (Ichthyomyzon unicuspis)
Sea Lamprey (Petromyzon marinus) CT River
Redbreast Sunfish (Lepomis auritus)
Atlantic Salmon (Salmo salar) naturally reproducing populations in Lakes Champlain & Memphremagog

SGCN Notes: Vascular plant SGCN not listed here include 7 species (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Floodplain forests, lakeshores and other riparian communities converted to agriculture, roadways, and residential/commercial development. Habitat conversion is most prevalent in low and mid elevation areas.	High
Habitat Degradation	Removal or alteration of vegetative community, ground disturbance, and manipulation of shorelines and streambanks; can lead to degradation of water quality, and loss of physical habitat structure. Habitat degradation occurs primarily in upper elevation areas, in contrast to complete habitat conversion, which is more common in mid and low elevation areas.	High
Habitat Fragmentation	Interruption of movement corridors to and from breeding, feeding, and seasonal habitats via conversion, degradation, and road mortality (herps). Habitat is fragmented both longitudinally (up and down river and stream channels) and laterally (horizontally) from lake shores and stream banks connecting to upland terrestrial habitats.	High
Inadequate Disturbance Regime	Dams, drainage ditching, floodplain filling, and channel incision (floodplain abandonment) that affect flooding, erosion, and deposition processes	High
Invasion by Exotic Species	Habitat alteration from invasive plant species (e.g., Japanese knotweed, Purple loosestrife); plant inter-species competition for habitat.	High
Harvest or Collection, Trampling/Direct Impacts	Collection and harvest pressures; increased human activity disturbing breeding, nesting and movement.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Develop a plan to identify and prioritize existing contiguous floodplains, riparian corridors and associated wildlife habitat linkages	Increase in number of riparian habitat linkages identified and conserved	ANR, TNC, NWF, NRCS, FSA	EQIP, CRP, CREP
Technical assistance to private landowners to maintain and enhance SGCN habitat in riparian areas and floodplains.	Increase in number of acres of riparian habitat restored and/or conserved by private landowners	NRCS, ANR, USFWS, FSA, TU, watershed associations	EQIP, CREP
Financial incentives for private landowners to maintain and enhance SGCN habitat in riparian areas and floodplains.	Increase in number of acres of riparian habitat restored and/or conserved by private landowners	NRCS, ANR, USFWS, FSA, TU, watershed associations	EQIP, CREP, CRP
Technical assistance to town and regional planning organizations to maintain and enhance SGCN habitat in riparian areas and floodplains. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Increase in number of towns incorporating riparian conservation into planning and zoning	ANR, ACCD, VLCT, AVCC, NRCS, FSA	ANR, NRCS
Technical assistance to state and federal land management agencies on floodplain and riparian habitat management goals/strategies	Change in the number of state and federal land management plans providing for riparian conservation	ANR, VTrans, USFWS, USFS	

Work with VTrans, towns, and private landowners to identify and maintain (or restore) floodplain and riparian habitat connectivity and improve aquatic organism passage	Change in the number of road crossings that do not impede riparian corridor movement – longitudinally and laterally	VTrans, ANR, NRCS	EQIP, VTrans, SWG
Provide technical assistance to landowners and conservation groups on invasive exotic management and eradication		USFWS, TNC, ANR, NRCS, FSA	CRP, CREP,
Pursue funding to enable floodplain and riparian restoration and enhanced protection.	Necessary funding provided.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake/ Watershed Associations	Vermont legislature

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
ANR State Lands Management Plans	Management practices for ANR-owned lands	FPR, VFWD
Floodplain Forests of Vermont	Natural Community Inventory	ANR
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR
Conserving the Eastern Brook Trout: Action Strategies (2011)	Conserve, enhance or restore brook trout populations that have been impacted by habitat modification or other population level threats.	ANR
ANR River Corridor Planning Guide, 2nd edition	Planning, designing & protecting river corridors	ANR
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (Version 1.2, April 2015).	To allow reasonable development of shorelands along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR

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Streams & Rivers Summary

Characteristics and location

There are more than 7,000 miles of rivers and streams in Vermont draining 4 major watersheds: Connecticut, Lake Champlain, Hudson, and Memphremagog. The headwater streams of the western Green Mountains drain to the large rivers of the lower Champlain Valley and eventually into Lake Champlain. The eastern slopes of the Green Mountains drain primarily to the Connecticut River. Portions of the Northeastern Highlands and Northern Piedmont drain north into Lake Memphremagog. The Taconic Mountains and southern Green Mountains drain into the Batten Kill, Deerfield, Walloomsac, and Hoosic rivers. These rivers, with the exception of the Deerfield, eventually drain into the Hudson River in New York. The Deerfield drains to the Connecticut River. Despite this diversity of landscape over which Vermont's streams and rivers flow, fluvial ecosystems can be described by three general categories based on physical stream characteristics. There are various biotic communities associated with each of these physical stream types, depending on both the physical stream characteristics and the geographic location of the waterbody. For example, the large rivers of the lower Lake Champlain watershed are similar in physical characteristics to the large tributaries feeding Lake Memphremagog, but some of the species found in these two settings differ due to the repopulation patterns of aquatic species into freshwater ecosystems post-glaciation. This summary does not include discussion of the lower Connecticut River tributaries and the lower Lake Champlain tributaries below the fall-line and/or below 150 feet elevation, as these areas are covered under separate summaries.

General types of Streams & Rivers communities:

High-elevation Headwater Streams: These streams are typically located in high elevation mountainous areas. They are small in size, having small drainage areas, and are located in steep valleys (typically > 4% slope). Valleys are confined, meaning the stream channel has little or no floodplain, and upland forest communities are adjacent to the channel, typically with no distinct riparian vegetative community present. Channel bed form is usually cascade over bedrock and boulders or step-pools over boulders and cobbles. Stream flow is fast and turbulent with white water common. Stream temperatures are typically very cold. Forest canopy completely shades the stream, and the food web of the system is based on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches). Large trees falling into the stream channel also provide important habitat features and channel bed stability, acting as cover and causing localized scour and deposition of stream sediments. Species that typically inhabit these streams include brook trout, slimy sculpin, northern spring salamander, northern dusky salamander, two-lined salamander, and numerous aquatic insects, including stoneflies and mayflies. SGCN species uniquely associated with these ecosystems include the water shrew, some specific mayfly and Odonata species and naturally reproducing populations of brook trout.

There are some headwater streams in high elevation areas that do not meet the above description. Small, low gradient streams are often found in ridgeline saddles and bowls. These streams are typically meandering, with alternating riffles and pools and gravel and sand substrates. Adjacent wetlands are often associated with these streams. These are typically still cold water systems, due to abundant groundwater feed and cooler climatic conditions influenced by high elevation, and therefore often host many of the same species as the high gradient headwater streams. Invertebrate communities, however, are likely to be distinct from the higher gradient systems (Burnham 2005).

Mid-elevation Streams and Rivers: These streams are typically located in mid elevation areas where the steep mountains transition to the low gradient valleys. Stream channels are small to moderate in size, and are located in moderately steep valleys (typically 2-4% slope). Valleys are semi-confined, resulting in narrow floodplains. These floodplains may have narrow bands of distinct riparian vegetation, but quickly transition into upland forest communities. Channel bed form is typically step-pool or plane bed. Step-pool channels have short vertical drops over boulders and cobbles with channel spanning pools in between, which are typically dominated by cobbles and gravels. Plane bed systems lack distinct pools, and are primarily riffles, runs, and rapids over a mix of boulders, cobbles, and gravels. Stream flow is fast and somewhat turbulent with whitewater common. Stream temperatures are typically cold to cool. Forest canopy usually shades the stream but may not form a complete canopy over the channel. The aquatic food web in these channels is based largely on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches), though some mosses and algae are also present, providing primary production in the waterbody. Large trees falling into the stream channel and transported from upstream provide important habitat features and channel bed stability, acting as cover and causing localized scour and aggradation of the channel bed. Species that typically inhabit these streams include brook trout, slimy sculpin, blacknose dace, white sucker, longnose dace, northern dusky salamander, two-lined salamander, and numerous aquatic insects. SGCN species uniquely associated with this habitat potentially include naturally reproducing populations of brook trout, as well as American eel, wood turtle, river otter, water shrew, muskrat and some specific mayfly and Odonata species.

Low-elevation Large Valley Rivers: These rivers are located at low elevations in Vermont's large river valleys, such as the Winooski, Lamoille, Missisquoi, Barton, Otter, and Batten Kill. This description does not include those portions of the large Lake Champlain tributaries located below the fall-line. These river channels are moderate to large in size, and are located in low gradient valleys (typically <2% slope). Valleys are unconfined, and floodplains are broad and flat. Adjacent wetlands are common in the floodplains. These floodplains have extensive distinct riparian vegetation and often include unique natural communities, such as floodplain forest, marsh, and shoreline communities. The channel bed undulates vertically, being composed of alternating riffles and pools or dune-ripple formations. Riffle-pool systems are dominated by gravels and sands, where dune-ripple systems are usually dominated by sands and silts. Stream flow is slow and flat with whitewater rarely present. Stream temperatures are typically cool to warm. Forest canopy shades the near-bank area of the channel but does not form a complete canopy over the channel. The aquatic food web in these channels is based on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, and branches) and transported from upstream, as well as instream aquatic vegetation. Large trees falling into the stream channel and transported from upstream provide important habitat features, especially since coarser streambed substrates are typically lacking in these systems. Woody debris provides cover and substrate for aquatic biota, as well as helping to maintain channel bed stability and enhancing habitat complexity with localized scour and aggradation of the channel bed. Numerous cool and warmwater fish species inhabit these streams, including bluntnose minnow, fallfish, blacknose dace, creek chub, tessellated darter, and white sucker, as well as several mussel species. SGCN species uniquely associated with this habitat include American eel, blackchin shiner, bridle shiner, blacknose shiner, redfin pickerel, stonecat, giant floater, cylindrical floater, elktoe, brook floater, wood turtle, river otter, muskrat, bald eagle, and some specific species of freshwater snails and Odonata.

Low Elevation Small Streams: These streams are small in size, but located in low gradient valleys (<2% slope) at low elevations (but above the Lake Champlain fall-line and 150 feet in elevation), and typically drain directly into a large waterbody (e.g., Lake Memphremagog, large tributaries of Lake Champlain). Valleys are unconfined, and floodplains are broad, relative to stream size, and flat. These floodplains have distinct riparian vegetation on the valley floor, and transition into upland forest communities on the valley side slopes. Adjacent wetlands are common in the floodplain. The channel bed undulates vertically, being composed of alternating riffles and pools or dune-ripple formations. Riffle-pool systems are dominated by gravels and sands, where dune-ripple systems are dominated by sands and silts. Stream flow is slow and flat. Stream temperatures are typically cool to warm. Streamside vegetation shades the channel, usually forming a closed canopy over the channel. The aquatic food web in these channels is based primarily on inputs of organic material from the adjacent vegetation (e.g., leaves, twigs, branches). Large trees falling into the stream channel provide important habitat features, especially since coarser streambed substrates are typically lacking in these systems. Woody debris provides cover and substrate for aquatic biota, as well as helping to maintain channel bed stability and enhancing habitat complexity with localized scour and aggradation of the channel bed. Typically cool and warmwater fish species inhabit these streams, such as blacknose dace and creek chub. SGCN species uniquely associated with this habitat include American eel, blackchin shiner, bridle shiner, redfin pickerel, stonecat and some specific species of Odonata.

Landscape Streams & Rivers Condition

Current Condition: In general, fluvial ecosystems in Vermont are most affected by conversion, alteration, and fragmentation. Typically steeper mountainous streams at high elevations, less suited for human development, have well forested riparian areas with cold, clean water and stable stream channels. Recreational activities and their associated development, such as ski resorts, and forestry are the land uses most common in these areas that may affect stream habitats. Mid and low elevation streams and rivers are more likely to be impacted by human land uses, including clearing of riparian vegetation, alteration of stream channels, and direct inputs of toxins, excess nutrients, and sediments. These impacts are related primarily to roads, residences, commercial development, and agriculture, the latter being especially extensive in the lower valleys of the Lake Champlain and Connecticut River tributaries.

The fragmentation of fluvial ecosystems is extensive in Vermont. A recent inventory of more than 200 culverts in the White River watershed showed more than half of the culverts inventoried were barriers to the upstream movement of all fish species present in the waterbody all of the time, and the other half of the culverts inventoried were barriers to some species and/or barriers some of the time (i.e. under certain stream flows when species movement is likely to occur) (Vermont Fish and Wildlife 2004). In addition, most of Vermont's major rivers have large flood control and/or hydroelectric dams on them, with numerous smaller dams found throughout Vermont's smaller streams. Such structures influence local habitat conditions, restrict movement of aquatic species, and alter downstream flood and sediment transport processes.

Some aquatic habitat degradation is due to lasting effects of historic land uses. During the last two centuries land use in Vermont has been dominated by extensive land clearing for forestry and agriculture, aggressive stream clearing of boulders and coarse woody debris for stream log driving and flood control, and by dam construction and railroad and road building. Such activities have resulted in the relocation and straightening of stream and river channels throughout Vermont, resulting in an overall decrease in available fluvial habitat. For example, a recent assessment of the upper White River watershed between Granville and Stockbridge shows that 93% (17.8 of 19.1 miles) of the length of the mainstem White River has been channelized in the past, 13 miles of which are still in channelized form (Vermont Department of Environmental Conservation 2004). In addition, the extensive removal of natural substrates, such as boulders and coarse woody debris, has reduced overall stream habitat complexity throughout the Northeast (Verry 2000). The hard armoring of channels combined with the construction of flood control dams means that many of Vermont's river channels have not regained their historic sinuosity. Furthermore, the slow regrowth of the Northeast's forests means that large woody debris contribution to stream and river channels has yet to reach historic levels (Verry 2000). Zadock Thompson, who served as Vermont's Assistant State Geologist and State Naturalist in the mid 1800's, offers first-hand insight on the impacts Vermont's intensive land use history has had on the streams and rivers of the state.

> "Before the country was cleared, the whole surface of the ground was deeply covered with leaves, limbs, and logs, and the channels of all the smaller streams were much obstructed by the same. The consequence was that, when the snows dissolved in the spring, or the rains fell in the summer, the waters were retained among the leaves, or retarded by the other obstructions, so as to pass off slowly, and the streams were kept up, nearly uniform as to the size during the whole year. But since the country has become settled, and the obstructions, which retarded the water, removed by freshets, when the snow melts or the rains fall, the waters run off from the surface of the ground quickly, the streams are raised suddenly, run rapidly, and soon subside. In consequence of the water being thus carried off more rapidly, the streams would be smaller than formerly during a considerable part of the year, even though the quantity of water be the same. It is a well known fact that the freshets in Vermont are more sudden and violent than when the country was new."
> **Zadock Thompson, Natural History of Vermont, 1853**

Desired Condition (SGCN Needs): Most of Vermont's aquatic species rely on streams and rivers that provide clean water, a diversity of in-channel habitat, and unobstructed movement upstream and downstream between habitats.

Characteristics of water quality vary in streams from clear and cold with little buffering capacity in most mountain streams to somewhat turbid and cool or warm with greater buffering capacity in the large valley rivers. Species found in the mountain headwater and mid-elevation streams are typically dependent on cold well-oxygenated waters. Some species found in the headwater streams, such as brook trout, are fairly acid tolerant. Low-elevation rivers and streams typically support species with warmer water temperature requirements and tolerance to some turbidity and nutrient enrichment.

Whether in the mountain streams or large valley rivers, most aquatic SGCN require instream cover and/or substrates for protection and colonization. Most fish species seek cover for predator avoidance and to reduce metabolic (energy) demands. Mussels need firm substrates for colonization, as do most aquatic insect species. Substrates utilized may vary from rock to sand to instream aquatic vegetation, depending on the species, but all species can suffer from excessive fine sediments in the channel that can bury instream substrates. Loss of complexity and solid substrates for cover and colonization reduces overall habitat availability and quality. In addition, many species use instream substrates for reproduction. For example, brook trout deposit eggs in gravels on the channel bottom, whereas many shiner species utilize aquatic vegetation to spawn. Embedding of substrates, destabilization of substrates due to chronic channel instability, and direct removal of substrates all impact aquatic habitats and species. The mammal and bird species associated with streams and rivers, such as bald eagle, river otter, muskrat, and water shrew, are also impacted when aquatic species are affected, as these species rely on aquatic species as prey. In addition, muskrat, otter, and particularly water shrew, utilize undercut streambanks and other stable bank areas for denning. Chronic channel instability that results in substantial streambank erosion may reduce potential denning areas for these species.

Some of the SGCN uniquely associated with streams and rivers have extensive movement requirements, such as the Atlantic salmon and American eel, migrating from freshwater streams and rivers to the Atlantic Ocean and back again. Other species move shorter distances, but still require habitat connectivity to be able to access spawning, rearing, and seasonal habitats. There are also species, such as wood turtle and river otter, that move back and forth between the aquatic and nearby terrestrial habitats both daily and seasonally. Thus, it is important to maintain habitat connectivity both longitudinally along the river channel and adjacent riparian lands, as well as laterally between the aquatic habitat and the riparian habitat.

Ideally, Vermont's rivers and streams would provide an interconnected network of habitats in which species can move upstream and downstream as needed to fulfill seasonal and diurnal habitat needs. Instream structure would provide an abundance and diversity of habitat niches and be naturally maintained by physical stream processes over time (e.g., flooding, balanced sediment transport). Streams and rivers would be connected to the adjacent riparian habitats, which in turn function to protect and provide for fluvial habitat components, such as instream coarse woody debris and pollutant removal from surface runoff.

It is difficult to quantify the number of miles of intact fluvial and riparian habitat needed to conserve SGCN as the exact distribution of all SGCN associated with fluvial habitats is not known at this time.

Implementing the 2005 Wildlife Action Plan

In 2013, VFWD and partners completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity.

The Vermont Department of Environmental Conservation's Rivers Program completed Phase 2 mapping for most of Vermont rivers, has acquired river corridor easements, and has supported the passage of new legislation aimed at protecting river geomorphic processes.

The Partners for Fish & Wildlife program of the U.S. Fish & Wildlife Service, which organizes and supports community-based habitat restorations, partnered with more than 600 landowners on more than 550 projects to restore 294 miles of riparian habitat, 5,476 acres of wetland habitat, 976 acres of upland habitat and 1,200 acres of habitats impacted by invasive species. Partners also reopened 1,438 miles of stream to fish passage; and completed 11 miles of in-stream restoration.

Streams and Rivers provides habitat for 75 Species of Greatest Conservation Need.

Species of Greatest Conservation Need in Streams & Rivers Habitat

High Priority
Bald eagle (Haliaeetus leucocephalus)
Fowlers toad (Anaxyrus fowleri)
Wood turtle (Glyptemys insculpata)
Odonates-River/Stream Group (17)
Freshwater Mussels Group (13)
Freshwater Snails Group (15)
Mayflies/Stoneflies/Caddisflies Group (14)
Bridle shiner (Notropis bifrenatus)
Blackchin shiner (Notropis heterodon)
Blacknose shiner (Notropis heterolepis)
Stonecat (Noturus flavus)

Medium Priority
Northern river otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Water shrew (Sorex palustris)
Redfin pickerel (Esox americanus)
Brook trout (Salvelinus fontinalis)
Northern Pearl Dace (Margariscus nachtriebi)
American Eel (Anguilla rostrata) Lake Champlain and Connecticut River populations.
Sea Lamprey (Petromyzon marinus) CT River
Atlantic salmon (Lake Champlain & Memphremagog basins naturally reproducing populations) (Salmo salar)

SGCN Notes: Lake sturgeon is addressed in the Lake Champlain tributaries summary. For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Channel straightening and maintenance of such that reduces overall stream/river miles, loss of floodplain connectivity, impoundment of river channels	High
Habitat Alteration	Floodplain and stream channel manipulation (e.g., riprap); degradation of water quality, loss of physical habitat structure, temperature alteration	High
Habitat Fragmentation	Interruption of movement to and from breeding, feeding, and seasonal habitats via alteration and conversion; roadways, and impassable dams and culverts	High
Sedimentation	Alteration of habitat (e.g., spawning areas); smothering of organisms	High
Pollution	Acid rain threatens higher elevation habitats, nutrient overloading is common in lower elevation areas, other toxins are suspected but data is unavailable to assess impacts	High
Pollution	Catastrophic spills: toxic chemicals (e.g., chlorine) and contaminants limit mid and lower elevation habitats, especially where roadways and development are in close proximity to stream channels	High
Invasion by Exotic Species	inter-species competition for habitat and food; predation on native species, loss of native riparian vegetation community from invasive competition.	High
Hydrologic Alteration	Stream flow regulation at dams, watershed development, and withdrawals alter hydrographs and instream flows	High
Inventory need	Minimal data is available on the distribution in Vermont of many fluvial-associated SGCN	Med

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Conduct inventories of known and potential SGCN sites		ANR, USFS, USFWS, TU	SWG, TU, EPA, NRCS
Provide technical assistance to anglers and other conservation groups on invasive exotic management and eradication	No new introductions of invasives exotic species that impact fluvial habitats	TNC (plants), angler groups, baitfish dealers	NRCS, LCBP
Provide technical assistance to private landowners and watershed organizations on riparian, floodplain and fluvial habitat conservation	Increase in number of stream/river miles in "reference" condition, as per VTANR Stream Geomorphic Assessments	ANR, NRCS, FSA, USFWS	Clean Water Fund, LCBP, CRP, WRP, EQIP
Provide financial incentives to private landowners for conservation and protection of SGCN and their riparian and fluvial habitats and floodplains	Increase in number of stream/river miles and associated riparian areas that are conserved and/or restored	ANR, NRCS, USFWS, FSA	EQIP, USFWS, CRP, CREP, WRP
Provide technical assistance to town and regional planning organizations. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Increase in number of towns incorporating riparian and aquatic habitat conservation into planning and zoning. Increase in number of stream/river miles under regulated development that are in "reference" condition, per VTANR Stream Geomorphic Assessments	ANR, ACCD, VLCT, AVCC, TNC, watershed organizations	ACCD planning grants, LCBP, SWG
Monitor, protect and restore water quality from excessive nutrient sediment loading, other pollutants.	Miles of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, USFS, Lake & Watershed Associations	ANR, Clean Water Fund
Support efforts to reduce the long range transport of acid rain pollutants to Vermont.	Reduction in acidity levels in monitored high elevation waterbodies	ANR, USFS, AG office, Legislature, Congress.	
Identify pollutant sources posing risks of catastrophic spills to SGCN populations and implement programs to minimize those risks		ANR, Agency of Agric., VTrans, wastewater facilities, town road managers	
Technical assistance to state and federal land management agencies to ensure consistency in program implementation and sensitivity to SGCN requirements	Change in the number of state and federal land management plans that provide for fluvial and riparian habitat conservation	ANR, USFS, USFWS, ACOE, VTrans	
Support efforts to manage flow regulation projects to minimize impacts on SGCN	Decrease in number of river miles with altered flow regimes	ANR, ACOE, VT Dam Task Force, USFWS, watershed orgs	LBCP, USFWS, ACOE, SWG
Provide technical assistance to VTrans, towns, and private landowners to identify and maintain (or restore) aquatic habitat connectivity	Change in the number of road crossings that do not impede aquatic organism movement	ANR, VTrans, Better Back Roads, USFWS, USFS, AVCC	SWG, USFWS, LCBP, VTrans

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
ANR State Lands Management Plans	Management practices for ANR-owned lands	FPR, VFWD
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR
Opportunities for Action – LCBP	Aquatic resource conservation for the Lake Champlain Basin	LCBP
Conserving the Eastern Brook Trout: Action Strategies (2011) http://easternbrooktrout.org/reports/ebtjv-conservation-strategy	Conserve, enhance or restore brook trout populations that have been impacted by habitat modification or other population level threats.	ANR
ANR River Corridor Planning Guide, 2nd edition http://www.watershedmanagement.vt.gov/rivers/docs/rv_rivercorridorguide.pdf	Planning, designing & protecting river corridors	ANR
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR

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Lake Champlain Tributaries Summary

These waters include the lower-most portions of tributaries that empty into Lake Champlain. On many rivers and streams this is defined at its upstream end by the first major waterfall or cascade, called the principal fall line. On streams which do not have this abrupt elevation change, the upstream limit for is roughly at elevation 150 feet above sea level. The SGCN supported in these waters are numerous, with many found nowhere else in the state but in these tributaries and Lake Champlain. There are several factors accounting for the unique aquatic assemblages found here, including: glacial history and ancient routes of colonization from the west and south; the barrier to upstream migration presented by the principal fall line; and the generally warmer water temperatures and finer substrates found here compared to those in higher elevation areas of Vermont. Unique species include many fishes and freshwater mussels, the common mudpuppy, and the spiny softshell. Key features include riffles, runs, and long pools with a variety of dominant substrate types. Small gravel, sand, and finer substrates are more dominant in the lowest reaches of these streams and rivers. Woody debris is prevalent, especially in deep holes in pool sections.

Lake Champlain Tributaries Condition

Current Condition: Some of the most heavily human-populated areas of the state occur adjacent to river sections included in this community type. While the larger volumes of water carried by the large rivers in Lake Champlain tributaries do afford a greater diluting potential than found in smaller rivers and streams, these Champlain tributaries are located in an area of the state where the intensity and frequency of insult to the aquatic habitat from human use is expected to be greater. For example, stormwater runoff reaching the lower Winooski River from developed lands is much greater than in most other Vermont fluvial communities. Stormwater runoff from developed lands increases the amount of sediments, nutrients, and contaminants that reach rivers instead of being trapped by the soil and vegetation. Floodplains function, in part, to absorb runoff and deliver it slowly to rivers through the soil. Paving of land sends water more directly to streams and rivers, in essence bypassing the floodplain. This creates a scouring effect on riverine habitat, due to the more extreme fluctuations in velocity of stormwater runoff.

Pollutants enter these rivers from various non-point sources as well. Agricultural lands located adjacent to rivers within these watersheds can contribute excessive amounts of silt, nutrients, and pesticides to the systems when adequate riparian buffers are not maintained. In such instances, excessive sediments can cover coarser river-bottom substrates needed by many SGCN, as well as covering some of these species themselves. Also, salt from roadways makes its way into rivers, degrading the water quality. These and other sources of non-point pollution are likely the greatest contributors of contaminants to these systems. These pollutants comes not only from adjacent lands, but from the entire watershed.

Accidental contaminant spills are rare, but can have immediate and devastating effects on the aquatic environment and the SGCN that live there. Chemicals, manure, industrial waste, and other potential contaminants stored in areas where they could reach these rivers or their tributaries if released are significant problems. Bridges and riverside roads and railways also present long stretches where accidental spills into rivers and streams can occur. A catastrophic contaminant spill could (and has) easily wipe out entire SGCN populations. As with other sources of pollution, this problem comes from the watershed upstream as well as adjacent lands.

Direct loss of habitat occurs when fill material is placed on the river bottom. Examples of this include riprapping to stop toe erosion along streambanks, placement of piers or causeways to accommodate bridges, and construction of boating access facilities. Direct mortality of freshwater mussels, which live on the river bottom, is sometimes the result of these activities within lower Champlain rivers. The replacement of natural substrates with large stone provides reduced or unsuitable habitat for recolonization by bottom-dwelling animals. The construction of buildings and roads adjacent to rivers creates a hazard for the structures, increasing the potential that bank stabilization will be pursued.

Two dams on major rivers within the Lake Champlain tributaries (the Peterson Dam on the Lamoille and the Swanton Dam on the Missisquoi) have cut off migration for fishes and mussels, and have resulted in the loss of spawning habitat for some species. Impoundments created by these structures have altered the natural habitat from riverine to more lake-like water bodies. "De-watering" of the aquatic habitat that sometimes occurs due to atypical "hydro-peaking" dam operations leaves many benthic SGCN, particularly mussels, out of the water and exposed to the elements and predators. This can occur upstream or downstream of these structures. Existing dams located on fall lines may significantly alter the natural physicochemical regime of waters flowing downstream. The altered hydrologic regimes found below dams degrades the quality of habitat here for SGCN.

Zebra mussels that have devastated the Lake Champlain freshwater mussel community are a problem for rivers in this Lake Champlain tributaries. Adult zebra mussels have been found in the lower reaches of Otter Creek, Little Otter Creek, Lewis Creek, LaPlatte River and the Winooski River in past years. They are also present in Lake Bomoseen, whose outlet stream feeds into the Poultney River.

Desired Condition (SGCN Needs): These waters, along with Lake Champlain, support the greatest diversity of aquatic species found in the state. The larger rivers support the highest number of SGCN. Allowing these rivers to meander freely within their natural floodplains and maintaining and/or restoring natural vegetation to all or a portion of the rivers' floodplains would significantly improve the ecological integrity of these systems, improve water quality, and significantly improve the habitat provided for many aquatic SGCN, as well as the diversity of wildlife species that rely on riparian cover movement or other habitat functions. Species include both year-round residents and those that use the rivers and streams primarily for spawning, development of young, or feeding. Minnows, freshwater mussels and snails, benthic fishes, and mammals are among those that utilize the Lake Champlain tributaries year-round, and often require a variety of habitats. Lake sturgeon, mooneye, greater redhorse, and possibly common mudpuppy are among those that depend on these rivers seasonally for reproduction. Others, such as map turtle, spiny softshell, northern watersnake, wood turtle, and bats use these waters for foraging, winter shelter, or other seasonal purposes.

Gravel/cobble substrates that are free of loose silt are required by many of the riverine species that spawn here. Eggs in contact with excessive silt are not able to adequately absorb oxygen for development. The eastern sand darter requires silt-free sand for this purpose. Substrates also need to be stable in order to support many SGCN, particular benthic organisms like freshwater mussels, darters, hibernating spiny softshells, and nesting mudpuppies. This is often affected by stream hydrodynamics; that is, streams that are hydrodynamically imbalanced can have substrates that shift frequently and do not provide a firm footing or shelter for aquatic organisms that occur there. Small invertebrates are less abundant in silted-in or unstable stream bottoms, thus providing a reduced food source for their predators. Woody debris is an important habitat component in lower Lake Champlain tributaries, especially for aquatic insects. Historically, people removed trees and branches that fell into streams. Unfortunately, this removed the structure and habitat needed for many invertebrates and their predators, as well as basking habitat for turtles.

Two aquatic SGCN, the American eel and the Atlantic salmon, were historically able to ascend the fall line from downstream. The American eel did so to reach smaller waters upstream where the young eels would grow for several years before migrating back out to sea to spawn. Atlantic Salmon jumped the falls to reach the clean, coarse gravel substrates located upstream where they would spawn their eggs. With the construction of dams at or below the falls on all the major Lake Champlain rivers, much of the habitat needed for these two species was made unavailable to them. Reconnection of these fishes with this habitat would likely be beneficial to their long-term survival. River otter is susceptible to heavy metals and PCB's.

Implementing the 2005 Wildlife Action Plan

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Lake Champlain Tributaries

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Lake Sturgeon (Acipenser fulvescens)
Eastern Sand Darter (Ammocrypta pellucida)
American Brook Lamprey (Lethenteron appendix)
Northern Brook Lamprey (Ichthyomyzon fossor)
Silver Redhorse (Moxostoma anisurum)
Greater Redhorse (Moxostoma valenciennesi)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Blacknose Shiner (Notropis heterolepis)
Stonecat (Noturus flavus)
Channel Darter (Percina copelandi)
Sauger (Sander canadense)
Spiny Softshell (Turtle) (Apalone spinifera)
Common Mudpuppy (Necturus maculosus)
Wood Turtle (Glyptemys insculpta)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Freshwater Mussels Group (13 species)
Freshwater Snails Group (15 species)

Odonates-River/Stream Group (17 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Mottled Sculpin (Cottus bairdi)
Mooneye (Hiodon tergisus)
Silver Lamprey (Ichthyomyzon unicuspis)
Shorthead Redhorse (Moxostoma macrolepidotum)
Atlantic salmon (Lake Champlain & Memphremagog basins naturally reproducing populations) (Salmo salar)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Alteration	Input of sediments and nutrients from surface and stormwater runoff, and from small tributaries; caused by human land use nearby	High
Habitat Conversion	Loss of benthic habitat due to riprapping, bridge construction, boat access construction, etc. Loss of riverine environment due to impoundment.	High
Hydrologic Alteration	Changes in hydrologic and physicochemical regime due to dams and stormwater runoff. Direct loss of SGCN due to dewatering.	High
Habitat Fragmentation	Migration barriers created by dams	High
Pollution	Vulnerability to Catastrophic Spills: Bordering roadways, bridge crossings, adjacent industry, and manure pits are examples of high risk points of entry for large-scale contaminant spills	High
Invasion by exotic species	Zebra mussels are currently high risk threat to SGCN; other exotics may also be displacing native SGCN	High
Sedimentation	Alteration of habitat (e.g., spawning areas); fine sediments can embed of substrate and smother invertebrates, incubating eggs and the young of many fish species.	High
Pollution	Water quality degradation due to contaminants from agricultural fields, stormwater runoff, other point and non-point sources	High

Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
Monitor	Detect SGCN population trends to help guide conservation actions and to track the effectiveness of current management	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations	Number of known SGCN sites monitored	USFWS, ANR, TNC, Universities, EPA	SWG, VFWD, VT Watershed Grants, EPA
Conduct inventories of rivers to detect and gather information on new SGCN populations	Number of sites/rivers with completed inventories	USFWS, ANR, TNC, Universities, EPA	SWG, VFWD, VT Watershed Grants, EPA
Protect and restore habitats on which SGCN are dependent through pollution abatement, substrate improvement, riparian buffer and, floodplain enhancement, flow regulation, etc.	Number of acres of floodplain and riparian habitat protected and/or restored	LCLT, VLT, Watershed groups, USFWS, ANR, Army Corps, EPA	EPA, SWG, LCLT, VLT, NRCS, EPA, Clean Water Fund
Restore migration corridors for SGCN by removal of artificial barriers or construction of effective fish passage facilities at dams	Number of artificial SGCN migration barriers removed or provided with passageways Number of adult fish passed migrating to upstream spawning habitat (e.g., lake sturgeon, greater redhorse)	Hydro operators, FERC, ANR, Municipalities, VNRC	USFWS, NRCS
Provide for the safe and expeditious out-migration of SGCN from upstream of dams	Number of artificial SGCN migration barriers removed or provided with out-migration passageways	Hydro operators, FERC, ANR, Municipalities, VNRC	ANR, Army Corps
Prevent the introduction and spread of invasive exotic species, particularly zebra mussels	Number of sites with control activities and/or invasive monitoring. Number sites where invasive species are eliminated or controlled	LCBP, ANR Municipalities, USFWS, EPA	VT Watershed Grants, LCBP, Clean Water Fund
Provide technical outreach and financial assistance to private landowners, watershed groups and other partners to maintain or enhance habitat and tributary functions for SGCN.	Number of actions implemented to maintain or enhance tributary function for SGCN.	USDA, USFWS, EPA, NRCS, VFWD, TNC, LCBP, LCI, RPC's. Municipalities, Watershed groups	EPA, USFWS, EQIP, CRP, CREP, VT Watershed Grants, LCBP, SWG, Clean Water Fund
Provide technical outreach to towns and regional planning commissions to maintain or enhance Lake Champlain tributary habitat and tributary functions for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of actions implemented to maintain or enhance tributary function for SGCN.	USDA, USFWS, EPA, NRCS, VFWD, TNC, LCBP, RPC's. Municipalities, Watershed groups	EPA, USFWS, EQIP, VT Watershed Grants, LCBP, SWG, Clean Water Fund
Acquire conservation easements for the protection of critical SGCN habitats and maintenance or restoration of ecological functions	Number of riparian habitat acres acquired/enrolled	LCLT, VLT, ANR, TNC, NRCS	LCLT, VLT, EPA, TNC, SWG, NRCS

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN requirements and problems to SGCN		ANR, USFWS, COE, FEMA, FHWA, NRCS, LCI, Wildlife Services, VTrans	EQIP, USFWS, EPA, Clean Water Fund
Enhance substrate quality to benefit SGCN via research, technical and financial assistance and regulatory review.		DEC, USFWS, NRCS	EQIP, CREP, Clean Water Fund

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Lake Sturgeon Recovery Plan	Lake Sturgeon restoration	VFWD
Vermont’s Clean Water Initiative	Water quality improvement	VDEC
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
DEC Water Quality Division	Water quality and stream protection and restoration	DEC
Quebec Ministère de l’Environnement	Shared watershed for Missisquoi River	Quebec Ministère de l’Environnement
Conserving Lake Champlain’s Biological Diversity 6/102005	Strategic plan focused on conserving Lake Champlain's biological diversity	TNC
Various watershed planning efforts	Watershed protection and restoration; river and lake restoration and protection	VTDEC; local/regional watershed groups
Riparian Management Guidelines for Agency of Natural Resources Lands (Draft 2015)	Informs the development of recommendations for Act 250-regulated projects	ANR
ANR Stream Geomorphic Assessments	Stream and riparian condition inventories	ANR

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Lower Connecticut River Summary

Characteristics and Location

The Lower Connecticut River encompasses approximately 130 miles of the main stem from the Massachusetts state line upstream to its confluence with the Wells River and occurs almost exclusively within the Southern Vermont Piedmont biophysical region. Additionally, this summary includes the lower sections of its Vermont tributaries that are directly influenced by or have physical and/or biological similarity to the Connecticut River. The presence of a readily identifiable geological feature, such as a fall line, is not evident on all tributaries. Where the fall line is apparent, typically within a short distance from the tributary mouth (e.g., as on the Williams, Black, Ottauquechee, Waits and Wells rivers), this feature delineates the upstream extent of the Lower Connecticut River. On other tributaries (e.g., the West and White rivers), artificial structures (e.g., the lowermost dam) are used to define the upstream limit. Rivers and streams located within the Connecticut River basin but upstream of the habitat boundary are covered under the Fluvial (Stream) Summary. To a limited degree the historic distribution of several anadromous fish species native to the Connecticut River basin, namely sea-run Atlantic salmon, American shad and sea lamprey, as well as current management goals for the restoration of these fishes to the basin also define the bounds of the Lower Connecticut River.

Lower Connecticut River Condition

Current Condition: Prior to European settlement and subsequent industrial development of the Connecticut River basin, rivers and streams were free-flowing systems subject to natural flow regimes and processes. Waters ran free of pollutants, and the landscape, including riparian lands, was predominantly forested. These conditions provided habitat for both aquatic and terrestrial plant and wildlife assemblages native to the Lower Connecticut River. However, over the past 200 plus years, the river and its tributaries have been altered extensively fragmenting historic migration routes, changing natural habitats and ecological functions, as well as the current composition of the plant and wildlife communities.

Dams constructed for waterpower and flood control have greatly altered river and streams throughout the Connecticut River basin. Historic migration corridors used by Atlantic salmon, American shad, blueback herring, and American eel to gain access to critical spawning and nursery habitats have been obstructed. Long sections of the main stem and tributaries have been transformed from free-flowing waters to impoundments; and natural flow regimes are now regulated in ways that are not compatible with the habitat requirements of many aquatic species, including SGCN. Impoundments and artificial flow regimes have significantly influenced sediment transport and deposition, which in turn have altered the character, quantity and quality of various habitat types found throughout the Lower Connecticut River. Waters above and below dams are managed in ways, which result in fluctuating impoundment levels and tail water discharges. Frequently, flows released from dams are not adequate in volume or fluctuate in magnitude and duration so as to create habitat conditions unsuitable for SGCN. While water management within impoundments and free-flowing river segments may benefit habitat for a few SGCN (e.g., expose mudflats and shorelines used by feeding lesser yellowlegs during migration), fluctuating water levels can be detrimental to strictly aquatic SGCN (e.g., Redbreast Sunfish, Dwarf Wedgemussel).

The extensive conversion of the Connecticut River from a free-flowing system to one dominated by impoundments has created habitats suitable to a variety of aquatic exotic plants and animals. Shorelines and wetlands associated with these impoundments have been invaded by phragmites, Eurasian milfoil and purple loosestrife, which have established dominant stands degrading nesting habitats needed by waterfowl, songbirds and muskrats. Water chestnut, an exotic aquatic plant has been a significant environmental problem on Lake Champlain demanding large expenditure of funds and labor to keep it under control. In recent years water chestnut was discovered in North Springfield Reservoir, which is on the Black River, a tributary of the Connecticut River. An early control-rapid response effort was able to eliminate water chestnut from this waterbody. Several fish species not indigenous to the Connecticut River, including predatory largemouth bass, northern pike, bluegill, crappie and rock bass, were introduced during the 1800s and early 1900s and have benefited from habitat formed within the impoundments. These species have altered the composition of the natural fish community of the river and have influenced ecological relationships at all trophic levels. At the present time, zebra mussels have not been found in the Connecticut River.

Prior to the federal Clean Water Act (amended in 1977) and subsequent implementation of water pollution abatement programs, a 1951 government report described the Connecticut River as the "best landscaped sewer in New England" (CRJC 2009). Over the past three decades water quality in the river and its tributaries has vastly improved habitats for aquatic SGCN. Nonetheless these waters continue to receive point and non-point source pollution (sediments, nutrients, toxic chemicals), which remain problems to aquatic habitats and the ability of the environment to support healthy, sustainable populations of SGCN, such as the Bald eagle, fishes, freshwater mussels, and other aquatic invertebrates. Healthy aquatic systems are important to maintaining food webs not only for aquatic SGCN but also terrestrial species (eagle, bats, otter).

Development and logging along the river and tributaries has had a significant impact on riparian areas functions and benefits to SGCN. The loss of naturally vegetated (forested) riparian areas have led to increased inputs of sediment and other pollutants to streams, increased water temperatures, channel instability, and loss of in-stream habitat structure created by the recruitment of large wood. Removal of living and dead trees (snags) from riparian lands has reduced sites for eagle nesting, roosting and perching.

Unique to the Lower Connecticut River is the existence of the Vermont Yankee Nuclear Power Station. While it ceased power generation at the end of 2014, it still uses the river as a source of reactor cooling water and by state permit is allowed to discharges waste heat within specified thermal limits to the river. Excessive heat discharged to the river can potentially limit the temperature regime of the river within vicinity of the power plant to the detriment of aquatic SGCN intolerant of warm water. On a larger scale is the effects of climate change on aquatic habitats critical to many SGCN.

Desired Conditions (SGCN Needs): Eventual restoration and maintenance of sustainable populations of migratory native fishes to the Connecticut River basin is dependent on eliminating or mitigating artificial barriers which currently do not allow fish access to critical habitats, whether freshwater spawning and nursery areas or seawater (e.g. American Shad, Sea Lamprey, American Eel). Dam removal would open river migration corridors, as well as restore natural flow regimes, sediment transport and other fluvial processes essential to creating and maintaining instream aquatic habitat. Where dam removal is not feasible, fish passage should be restored by retrofitting structures with fish ladders, lifts or similar devices. Existing fishways demand continued operation and maintenance to assure their effectiveness. New dam construction should be avoided. Establishing flow regimes below dams and water level management within impoundments that mimic natural systems would benefit many of the aquatic SGCN.

The reduction of sediment inputs to the Lower Connecticut River from land development and chronic streambank erosion is important to maintaining SGCN populations, many of which depend on habitats consisting of coarse river bottom substrates (i.e., gravels and cobbles) that are not embedded by finer substrates. Riparian vegetation contributes to the reduction of these fine sediment inputs to surface waters by obstructing and slowing down overland runoff, while also reinforcing streambanks against the erosional forces of running water. Riparian areas also provide several habitat functions for species that inhabit them. Mature trees in the riparian zone provide necessary nesting sites for eagle. These trees eventually may be recruited to the river channel, creating instream habitat such as refuge cover required by the Redbreast Sunfish.

Allowing these rivers to meander freely within their natural floodplains and maintaining and/or restoring natural vegetation to all or a portion of the rivers' floodplains would significantly improve the ecological integrity of these systems, improve water quality, and significantly improve the habitat provided for many aquatic SGCN, as well as the diversity of wildlife species that rely on riparian cover movement or other habitat functions.

The potential for new non-indigenous invasive organisms (e.g., zebra mussel, Asiatic clam, hydrilla) becoming established in the Connecticut River is a persistent problem for the native biota and habitats.

Implementing the 2005 Wildlife Action Plan

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a map of all aquatic features and the riparian areas/valley bottoms in which rivers and streams occur and the identification of these areas as critical conservation components for wildlife habitat, rare species, aquatic system health, and wildlife/landscape connectivity. The project mapping results for aquatic features, valley bottoms, and riparian connectivity together provide a tool for prioritizing restoration of riparian areas, including floodplain forests.

Species of Greatest Conservation Need in Lower Connecticut River

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Common Mudpuppy (Necturus maculosus)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)
Freshwater Mussels Group (13 species)
Odonates-River/Stream Group (17 species)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Pied-billed Grebe (Podilymbus podiceps)
Lesser Yellowlegs (Tringa flavipes)
Blueback Herring (Alosa aestivalis)
American Shad (Alosa sapidissima)
American Eel (Anguilla rostrata)
Redbreast Sunfish (Lepomis auritus)
Northern River Otter (Lontra canadensis)
Muskrat (Ondatra zibethicus)
Masked Shrew (Sorex cinereus)

SGCN Note: For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat conversion	Loss of riparian and in-stream habitats from land and water development projects and activities, including impoundments.	High
Habitat alteration	Alteration and degradation of riparian and in-stream habitats from land and water development projects, including streambank rip rapping.	High
Hydrologic alteration	Replacement of natural flow cycles and processes with regulated flow regimes (e.g., inadequate minimum flows, fluctuating flows) rendering riverine habitats unsuitable to certain SGCN.	High
Sedimentation	Habitat degradation resulting from land development and uses; dams disrupting natural sediment transport; flushing sediments from impoundments; excessive bank erosion from inadequate riparian vegetation.	High
Habitat fragmentation	Interruption of migration corridors to and from breeding/spawning/wintering habitats via alteration and conversion of home range; construction of dams and culverts.	High
Invasion by exotic species	Displacement or restructuring of native aquatic plant and animal communities by invasive organisms impacting habitat and community structure and processes.	Med
Pollution	Nutrient overloading and other pollutants.	High
Pollution	Vulnerability to catastrophic spills: Bordering roadways, bridge crossings, adjacent industry and urban centers pose high risk points of entry for large-scale contaminant spills.	High
Monitoring	Population and habitat monitoring: Improved data on known SGCN populations is needed to track changes in species abundance and habitat quantity and quality as may be affected by natural processes and anthropogenic factors; habitats with potential for having existing SGCN populations or SGCN restoration potential should be investigated.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor, protect and restore floodplains, riparian and in-stream habitats limited or impacted by development.	Number of SGCN sites (habitats) monitored; acres/miles of undisturbed habitats protected; acres/miles of disturbed habitats restored.	ANR, USFWS, NRCS, CRJC, TNC, Power Companies	EPA, NH Charitable Foundation
Monitor, protect and restore river and stream water quality from excessive nutrient and sediment loading and other pollutants.	Miles of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, CRJC, TNC	EPA, NH Charitable Foundation
Monitor, protect and restore migration and travel corridors limited or impacted by dams, culverts and roads.	Number of identified artificial migration barriers removed or mitigated; miles of critical habitat restored by removal of barriers.	ANR, CRASC, USFWS, CRJC, VTrans, , Utilities	EPA, USACE
Monitor the Connecticut River and its tributaries for invasive species; prevent the introduction or spread of invasive species; implement control measures which take into account SGCN and their habitat requirements.	Number of SGCN habitats monitored for invasive species; number of SGCN habitats with plans in place designed to control invasive species and restore or enhance SGCN.	ANR, USFWS, CRJC, VY, TNC	EQUIP, USFWS Conte Grants, EPA
Support policies and programs designed to reduce climate change.	Number of climate change policies and programs established or supported.	ANR, EPA, Other NE States	EPA
Conduct inventories to detect and gather information on new SGCN populations and their habitats.	Number of potential SGCN habitats surveyed.	ANR, USFWS, TNC, USGS, EPA	EPA

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical and financial assistance to private landowners, towns, watershed and lake associations, regional planning commissions, and other partners to increase their awareness of problems to SGCN.	Number of actions implemented to maintain or enhance river function for SGCN.	ANR, USFWS, NRCS, CRJC, TNC	Farm Bill, Conte Grants, EPA, NH Charitable Foundation
Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004) to town and Regional Planning Commissions.	Number of towns and RPC considering SGCN in their planning. Number of actions implemented to maintain or enhance river function for SGCN.	AVCC	SWG, VFWD
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of their ecological functions.	Number of SGCN habitats acquired or enrolled in land conservation easement programs.	ANR, USFWS, TNC	EPA
Enhance coordination between government agencies/partners to ensure consistency in respective program implementation and increase sensitivity to problems and requirements for SGCN.	Number of agencies and private conservation organization, which recognize and address problems to SGCN.	ANR, USFWS, USFS, NRCS, USACE, VTrans, CRJC, TNC	EPA, NH Charitable Foundation

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Connecticut River Corridor Plan	"That plants, migratory birds, anadromous fish, and other native birds, fish, and wildlife continue to find the Connecticut River corridor and watershed hospitable to their unique needs for clean water and connected, protected open lands and forests;"	CRJC
A Plan to Restore the Aquatic Ecosystem in the Connecticut River Watershed	"Restore aquatic ecosystem so as to recover and support migratory and native fish populations and promote natural reproduction in the Connecticut River and its tributaries."	NRCS
Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River.	"Protect, conserve, restore and enhance the Atlantic salmon population in the Connecticut River for the public benefit, including recreational fishing."	CRASC
A Management for American Shad in the Connecticut River Basin.	"Restore and maintain a spawning shad population to its historic range in the Connecticut River Basin and to…"	CRASC
Management Plan for Blueback Herring in the Connecticut River Basin.	"Restore and maintain a spawning blueback herring population within its historic range in the Connecticut River basin."	CRASC
Plan for the Restoration of Migratory Fishes to the Ashuelot River Basin, New Hampshire.	"Protect, conserve, restore, and enhance the migratory fish populations in the Ashuelot River system for both public and ecological benefits."	NHFG

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Lake Champlain Summary

Lake Champlain includes the main body of the lake and its bays and river deltas. These waters are shared with New York and Quebec. At about 120 miles in length and a maximum depth over 400 feet, this is Vermont's largest waterbody. Aquatic habitats found here are many and extensive. Among these are expansive sand-bottomed shallows, shale/cobble littoral shorelines and bays, and deep limnetic environments. Other natural communities, such as large tributaries, emergent marshes, and floodplain forests, are integral to Lake Champlain and provide a critical habitat component for many SGCN found here. This is, in general, an oligo-mesotrophic lake, with nutrient levels in different parts of the lake dependent on local soil and bedrock types, as well as the type and extent of human land use within the surrounding watershed. This lake supports the highest lacustrine diversity of any of our lakes, which is due mainly to its large size and connections (current and historical) with the Great Lakes-St. Lawrence River and the Hudson River.

Lake Champlain Condition

Current Condition: The most outstanding concerns facing this large system are water quality and habitat degradation, and invasive exotic species. The lake is within the largest watershed in Vermont and is fed by many large tributaries that drain extensive agricultural and developed lands. A significant portion of the excessive nutrients, contaminants, and fine sediments that enter streams and rivers eventually reach Lake Champlain. Water and benthic habitat quality are affected, particularly in delta areas and along the shoreline, but also within the open and deeper waters over time. SGCN that are sensitive to contaminants and those that depend on consolidated (firmly-packed) substrates may be impacted by these changes to their habitat. Development along Lake Champlain's shoreline and within smaller watersheds immediate to the lake is ever-increasing, and with it the amount of contaminants entering directly into the lake. Excessive nutrients that reach the lake from various land uses within the watershed can cause eutrophication, reducing water quality and altering food webs. Zebra mussels have had a dramatic and devastating impact on the biotic community of Lake Champlain, including populations of many SGCN. These exotic pests foul the shells of native freshwater mussels, decreasing their ability to move about and obtain food and oxygen, resulting in a slow death. Populations of native mussels have been eliminated from large areas, a scenario that has repeated itself throughout most of the lake. The only areas where native mussels have not been seriously impacted by zebra mussels are Mallets Bay, the Inland Sea, and Missisquoi Bay. Water chestnut is an invasive that has impacted aquatic communities in the lake by forming huge, dense masses that cover the water surface and crowd out species. The exotic faucet snail *Bithynia tentaculata* now dominates much of the shale/cobble habitat in Lake Champlain, likely reducing native snail populations and altering the food web. Other invasive exotics in Lake Champlain include the alewife, and rusty crayfish. In 2014 the Spiny waterflea (*Bythotrephes longimanus*) was found in the lake. On the horizon are the round goby, quagga mussel. Additional problems to Lake Champlain include habitat conversion and vulnerability to catastrophic contaminant spills.

Desired Condition (SGCN Needs): These waters, along with Lake Champlain tributaries, support the greatest diversity of aquatic species found in the state. SGCN supported by Lake Champlain include mid- to deep-water species like cisco and lake whitefish that require cold, well-oxygenated waters. Shallow-water species such as mooneye and sauger utilize upper portions of the lake where temperatures are often much warmer. Near-shore and benthic species like bridle shiner, pink heelsplitter, giant floater, and spiny softshell are often found in bays or in the shallows of deltas.

The lake offers a variety of habitats that provide for the many needs of aquatic species, such as refuge, food, thermal protection, and spawning substrate. The great majority of freshwater mussel species remain buried in the substrate most of their lives, where they grow, feed, produce offspring, and seek refuge from the elements. Lake sturgeon feed on lake-bottom invertebrates, only entering rivers for brief periods to spawn. Different fishes can be found occupying different strata of the lake where they find the temperatures and oxygen levels they prefer. Degradation of water quality through nutrient input, thermal shifts, or other changes can cause significant alterations in food webs and habitat availability. Similarly, excessive fine sediments entering the lake from the shoreline and tributaries blankets and degrades the benthic substrate used by many SGCN. Improvement and protection of Lake Champlain's water quality, including reduction of nutrient and fine sediment inputs, is paramount to ensure that the SGCN populations found here remain viable. Control of exotic species, including preventing new species from invading, is also of great importance to the survival of these native species.

Many SGCN utilizing Lake Champlain depend on closely associated aquatic, wetland, and terrestrial habitats to complete their life cycles. Many fish, such as lake sturgeon, greater redhorse, and mooneye are found in the lake most of the year, but spawn over rocky substrates in Champlain tributaries. Bald eagle feed in the lake but need nearby suitable nesting trees or structures to raise their young. Spiny softshells occupy the lake much of the year for basking, feeding, and over-wintering, but require adjacent beaches of sand or gravel/cobble for egg-laying. Bats feed on emerging aquatic insects over the lake, while utilizing upland roosting and nursery sites. Muskrat, river otter and mink find a rich aquatic food source within Lake Champlain and its associated wetlands, but must den above the waterline. Maintaining these connections to critical wetland, aquatic, and terrestrial habitat is key to ensuring the continuation of these SGCN in the lake.

Species of Greatest Conservation Need in Lake Champlain

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Lake Sturgeon (Acipenser fulvescens)
Silver Redhorse (Moxostoma anisurum)
Greater Redhorse (Moxostoma valenciennesi)
Sauger (Sander canadense)
Blackchin Shiner (Notropis heterodon)
Bridle Shiner (Notropis bifrenatus)
Crustaceans Group
Freshwater Mussels Group
Freshwater Snails Group
Spiny Softshell (Apalone spinifera)
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Cisco or Lake Herring (Coregonus artedi)
Lake Whitefish (Coregonus clupeaformis)
Mooneye (Hiodon tergisus)
Silver Lamprey (Ichthyomyzon unicuspis)
Shorthead Redhorse (Moxostoma macrolepidotum)
American Eel (Anguilla rostrata)
Atlantic Salmon (Salmo salar)
Lake Trout (naturally reproducing populations) (Salvelinus namaycush)
Muskrat (Ondatra zibethicus)
Northern River Otter (Lontra canadensis)

SGCN Note: Vascular plant SGCN not listed here: 38 (Appendix I). For more information about a specific Species of Greatest Conservation Need see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Alteration	Input of excessive sediments and nutrients from surface runoff and tributaries; caused by human land use nearby	High
Habitat Conversion	Loss of benthic habitat due to riprapping, bridge construction, boat access construction, etc.	High
Pollution	Vulnerability to Catastrophic Spills: Bordering roadways, bridge crossings, adjacent industry, and manure pits are examples of high risk points of entry for large-scale contaminant spills	High
Invasion by exotic species	Zebra mussels and water chestnut are currently impacting SGCN; other exotics may also be displacing native SGCN	High
Pollution	Water quality degradation due to contaminants from agricultural fields, stormwater runoff, other point and non-point sources	High
Inventory	Inventory needed for many SGCN, particularly those for which distributional and abundance information is greatly lacking	High
Monitor	Detect SGCN population trends to help guide conservation actions and to track the effectiveness of current management	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here.
See Chapter 9 for definitions of the acronyms used in the Partners and Funding Source columns

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor known SGCN populations	Number of known SGCN sites monitored	USFWS, ANR, TNC, Universities	SWG, VFWD, VT Watershed Grants
Conduct inventories to detect and gather information on new SGCN populations	Number of completed species or species-group inventories	USFWS, ANR, TNC, Universities	SWG, VFWD, VT Watershed Grants
Protect and restore habitats on which SGCN are dependent through pollution abatement, riparian buffers, floodplains, etc.	Number of acres of riparian and lakeshore natural vegetation protected and/or restored Number of acres of lake habitat restored/protected	LCLT, VLT, Watershed groups, USFWS, ANR, EPA	SWG, LCLT, VLT, NRCS, EPA, Clean Water Fund
Restore migration corridors for SGCN by removal of artificial barriers to spawning habitat or construction of effective fish passage facilities at dams	Number of artificial SGCN migration barriers removed or provided with passageways Number of adult SGCN fish passed migrating to upstream spawning habitat (e.g., lake sturgeon, greater redhorse)	USFWS, Hydro operators, FERC, ANR, Municipalities, VNRC, EPA	NRCS, USFWS, Clean Water Fund, EPA
Implement an invasive species monitoring program to prevent the introduction and spread of invasive exotic species. Manage, mitigate, and/or eliminate invasive species that are detected.	Number of acres controlled/year. Number of sites with control activities and/or invasive monitoring. Acres protected from invasives.	LCBP, ANR, Municipalities, USFWS, EPA, NRCS	USFWS, VT Watershed Grants, LCBP, EPA, Clean Water Fund
Provide technical outreach and financial assistance to private landowners, watershed groups, and other partners to maintain and enhance Lake Champlain for SGCN.	Number of actions implemented to maintain or enhance lake suitability for SGCN	EPA, VFWD, TNC, LCBP, VLCT, LCI, Watershed groups,	VT Watershed Grants, LCBP, EPA, Clean Water Fund

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Provide technical outreach to towns and regional planning commissions to maintain and enhance Lake Champlain for SGCN. Distribute *Conserving Vermont's Natural Heritage* (Austin et.al. 2004)	Number of towns considering SGCN in their planning. Number of actions implemented to maintain or enhance lake suitability for SGCN	EPA, AVCC, LCBP, RPC's Municipalities,	EPA, SWG
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of ecological functions	Number of riparian habitat acres acquired/enrolled	LCLT, VLT, ANR, TNC, NRCS, EPA	LCLT, VLT, TNC, SWG, NRCS, EPA, Clean Water Fund
Enhance coordination between government agencies and partners to ensure consistency in respective program implementation and increased sensitivity to SGCN requirements and problems to SGCN	Number of programs that incorporate SGCN conservation.	ANR, USFWS, COE, FEMA, FHWA, NRCS, LCI, Wildlife Services, VTrans	USFWS, EPA, Clean Water Fund
Update Vermont's baitfish rules as necessary and expand to include non-fish invasive bait species.	Baitfish rules are reviewed and amended as needed.	ANR	ANR

Coordination with other plans

See chapter 9 for definitions of the acronyms used in the lead column

Plan or planning entity	Goal/Scope of plan	Lead
Lake Sturgeon Recovery Plan	Lake Sturgeon restoration	VFWD
Vermont's Clean Water Initiative	Water quality improvement	VDEC
Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Reduction of phosphorous inputs to Lake Champlain	VDEC, AAFM
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (Version 1.2, April 2015). http://www.anr.state.vt.us/dec/waterq/lakes/docs/shoreland/lp_ShorelandHandbook.pdf#zoom=100	To allow reasonable development of shoreland along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
VTDEC Water Quality Division	Lake protection and restoration programs	VTDEC
NYDEC	Lake protection and restoration programs	NYDEC
Quebec Ministère de l'Environnement	Protection of Québec's ecosystems and biodiversity; prevention, reduction or elimination of water contamination	Quebec Ministère de l'Environnement
Vermont Osprey Recovery Plan	Recovery and management of osprey within VT	VFWD
Conserving Lake Champlain's Biological Diversity 6/102005	Strategic plan focused on conserving Lake Champlain's biological diversity	TNC
Various watershed planning efforts	Watershed protection and restoration; river and lake restoration and protection	VTDEC; local/regional watershed groups

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Lakes Summary (excluding Lake Champlain)

Characteristics and Location

Lakes or lacustrine areas include natural lakes and ponds throughout Vermont, which can be classified on the basis of their productivity and associated physio-chemical characteristics. Lake types discussed here include oligotrophic lakes, mesotrophic lakes, eutrophic lakes, high elevation acidic lakes, and dystrophic lakes. Lake Champlain, representing oligotrophic, mesotrophic and eutrophic habitat types, is not included in this summary due to its large size and unique species assemblages (see Lake Champlain Summary). The following descriptions of Vermont lake types are based in part on parameters provided by the Vermont Department of Environmental Conservation, Water Quality Division, Lakes and Ponds Section.

Types of Lake Communities:

Oligotrophic Lakes: These lakes are typically deep with clear, cold water; low in dissolved nutrients, such as phosphorus and nitrogen; and experience seasonal periods of temperature and oxygen stratification and de-stratification (mixing). Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, <10 μg/L; total nitrogen concentration, <0.35 mg/L; average summer chlorophyll-a concentration, ≤3.5 μg/L; and average summer Secchi disc depth, ≥5.5 m. Another general feature of oligotrophic lakes is the lack of an extensive littoral zone. Littoral plants are scarce and plankton density is low. Several SGCN uniquely associated with this lacustrine waters are landlocked Atlantic salmon, lake trout, and round whitefish. In Vermont, lakes of this type are predominantly located in the Northeast Highlands biophysical region.

Mesotrophic Lakes: Lakes of this type are intermediary between oligotrophic (nutrient poor) and eutrophic (nutrient rich) systems. Mesotrophic lakes are shallower than oligotrophic lakes, have a well-established littoral zone supporting aquatic vegetation, and are moderately rich in dissolved nutrients. Consequently, primary productivity and plankton densities are greater than in oligotrophic systems but less than in eutrophic waters. Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, 10 to 24 μg/L; total nitrogen concentration, 0.35 to <0.65 mg/L; average summer chlorophyll-a concentration, >3.5 to 7.0 μg/L; and average summer Secchi disc depth, 3.0 to 5.5 m. Several SGCN uniquely associated with meso-eutrophic lakes are bridle shiner, blackchin shiner, redfin pickerel, redbreast sunfish, Eastern Musk Turtle, and northern water snake. Lakes of this type are distributed throughout Vermont; however, those supporting one or more populations of SGCN tend to be represented in greater frequency in the Champlain Valley and Connecticut River biophysical regions.

Eutrophic Lakes: Lakes of this type are generally characterized as nutrient mature systems. They are richer in dissolved nutrients and generally shallower than oligotrophic and mesotrophic lakes with extensive littoral areas supporting prolific growths of aquatic vegetation. Primary productivity and plankton densities are greater than in mesotrophic lakes. Eutrophic lakes that thermally stratify are likely to experience oxygen depletion below the thermocline during summer and/or winter stratification periods. Oxygen depletion during winter can occur when ice cover prohibits atmospheric exchange of oxygen resulting in "winter-kill" conditions. Biochemical parameters generally characterizing this lake type are: (1) total phosphorus concentration in the summer photic zone, >24 μg/L; total nitrogen concentration, >0.65 mg/L; average summer chlorophyll-a concentration, ≥7.0 μg/L; and average summer Secchi disc depth, 0 to 3.0 m. SGCN associated with eutrophic lakes are like mesotrophic lakes with decreasing occurrence in lakes of more advanced eutrophication. Though advanced eutrophication may make unsuitable habitat for purely aquatic SGCN, the productivity of these waters may be important to terrestrial and semi-aquatic species (e.g., bald eagle, bats and northern water snake) due to the abundance of food organisms these waters are capable of producing. Lakes of this type are distributed throughout Vermont but are more likely to be at low elevations and in disturbed landscapes.

High Elevation Acidic Lakes: These are clear-water lakes generally located at elevations over 1500 feet with neutralizing capacity (ANC) less than 25 mg/L and more typically within the range of 0 to 5 mg/L. Lakes of this type are vulnerable to and in some cases are known to be adversely affected by acid deposition. These lakes are usually small and shallow, with rocky or gravelly bottoms, and little accumulated organic material. Dissolved nutrient concentrations and primary production are generally low. Relatively few SGCN are associated with high elevation acidic lakes. One possible associate is brook trout. In Vermont lakes of this type are generally distributed within the Northern and Southern Green Mountain biophysical regions.

Dystrophic Lakes: Lakes of this type are usually associated with bogs. These are characterized by brown stained water (color >50 Pt Co) and are high in nutrients and humic materials. Dystrophic lakes are often acidic and may be anoxic or nearly so in the deeper waters. Relatively few SGCN are associated with dystrophic lakes with the possible exception of brook trout. Although examples of dystrophic lakes may be found statewide, generally they are more abundant in the Northern Green Mountains, Southern Green Mountains and Northeast Highlands biophysical regions.

Lake Condition

Current Condition: The lake waters represented here have notably different physio-chemical characteristics, therefore problems and changes to their water quality and chemistry may affect each lake type and species assemblages in different ways. Most oligotrophic and mesotrophic lakes in Vermont have experienced abundant lakeshore development, both historically and currently, such as seasonal and permanent residences, marinas and docks, and public and private beaches. Cumulatively, Vermont's lakes and ponds have lost more than 45% of their intact healthy shoreline. In many instances these developments have altered natural lakeshore and littoral habitats through the addition of fill materials (e.g., sand, bottom barriers), removal of large woody debris, and removal of native aquatic vegetation for beach construction and maintenance, resulting in the direct loss of habitats for SGCN. Additionally, development has increased stormwater runoff to lakes and has elevated the input of pollutants, including sediments, nutrients, and toxic chemicals. Nutrient loading can accelerate the eutrophication process causing excessive growth of phytoplankton and other aquatic vegetation, reduced water clarity, and increased biological oxygen demand. Such water quality and habitat changes may be detrimental to certain SGCN associated with specific lakes. Many SGCN species are heavily dependent on healthy aquatic systems for food sources, such as abundant fish and/or invertebrate populations utilized by eagles, river otter, muskrat and bats.

Development of shorelands may alter habitat required by terrestrial SGCN that are associated with lacustrine areas, such as bald eagle and osprey. As an example, the reduction of mature trees by clearing within the riparian area may eliminate eagle and osprey nesting sites and reduce recruitment of woody debris into the littoral zone.

The invasion of lacustrine waters by habitat-altering exotic species and the subsequent control of these exotics may have degraded habitat for some aquatic SGCN. For example, the establishment of Eurasian milfoil in several mesotrophic lakes where blackchin shiners are known to occur has likely displaced native aquatic plant communities on which this fish species is dependent for spawning and refuge. While milfoil control activities, such as herbicide treatment, are conducted to restore lake conditions conducive to water-based recreational pursuits (boating, swimming, sport fishing), the result is loss of vegetative cover now provided by milfoil stands, increased predation on shiners by other resident fishes (e.g., bass, sunfish, pike), as well as the loss of spawning habitat. These pressures on blackchin shiner populations continue until littoral areas are adequately revegetated with native plant species, a process that may take many years if at all.

The deliberate and accidental introduction of plant and animal species to Vermont's lakes and ponds over the past 200 years has greatly changed natural communities and their ecological functions. Many fish species, including those native to the state as well as those brought from outside, have established in waters where they did not naturally occur. For example, largemouth bass, bluegill and northern pike, all native in Vermont to Lake Champlain only, now have transplanted populations in habitats nearly statewide. Rainbow and brown trout originated from the western United States and Europe, respectively, and now are established in many lakes within the state. The distribution of these species was expanded beyond their natural range for the primary purpose of increasing sport fishing opportunities; however, in the past little consideration was given to the negative effects these species have on native ecosystems. More recently, 1997, the exotic alewife was discovered in Lake St. Catherine where previously the species did not exist. This was the first recorded occurrence of alewife in the state. The impacts this species has on native fish communities are well documented, including: (1) out-competing other planktivores for food and causing shifts in zooplankton species composition and size structure; (2) preying on the eggs and larvae of native fishes; and (3) causing significant mortality syndrome in salmon and trout fry (Good 2001). The trans-state movement and introduction of exotic species into natural habitats has become an environmental problem of national scale. Past species introductions changed the current character of many Vermont lacustrine areas, and the problem is a persistent problem for maintaining lakes and ponds in a desired condition well into the future.

Currently dystrophic and high elevation acidic lakes are somewhat less limited by direct development pressures that other lake types are experiencing. On the other hand, these lakes are particularly vulnerable to habitat alteration through the effects of acid deposition.

Desired Condition (SGCN Needs): Lacustrine areas directly and indirectly support a host of species, including aquatic invertebrates (insects, crustaceans, mollusks), fishes, reptiles, amphibians, mammals, birds and plants.

Obligate SGCN associated with oligotrophic lakes (e.g., landlocked Atlantic salmon, lake trout, round whitefish) require deep, clear, well-oxygenated water for their survival. Potential increases in lake water temperatures due to climate change represent a problem for these oligotrophic lakes and the associated cold-water SGCN.

In contrast, species associated with mesotrophic and eutrophic lakes are more dependent on the high productivity of these lake systems to produce needed food sources and habitat complexity, such as well-established littoral communities for feeding, reproduction and refuge cover.

A number of SGCN, notably the reptiles and amphibians, have home ranges that encompass both lacustrine and terrestrial areas at particular times of the year. For example, spotted and musk turtles, which reside most of the year in lakes and ponds, leave these waters briefly for upland areas to lay eggs. Similarly, lake residing brook trout may seasonally ascend tributary streams to spawn. In contrast, Fowler's toads travel from their usual terrestrial haunts to aquatic habitats to deposit eggs along the shoreline. Forested riparian zones provide nesting and feeding perches for bald eagle and osprey. Mature trees that eventually die and are recruited into the littoral area contribute to forming refuge and basking habitats. Maintenance of water quality conditions characteristic of specific lake types is a requirement of SGCN associated and dependent on those habitats.

The desired condition for all lacustrine communities would include: 1) the existence of intact riparian conditions; 2) the existence of minimally disturbed littoral zones; 3) evolutionary (e.g. trophic) processes occurring at rates not accelerated by disturbance; 4) pollutant levels (e.g. sediment and toxics, including acid deposition) below concentrations that would adversely affect SGCN; 5) absence of exotic species that adversely affect SGCN; 6) unimpeded access by SGCN to habitats required for the maintenance of life cycle functions; and 7) unaltered hydrological and temperature regimes.

Implementing the 2005 Wildlife Action Plan

Shoreline and Development Surveys for Vermont's Lakes (2006-2008) led by VDEC's Lakes & Ponds Management and Protection Program compared the SGCN present in undeveloped and developed lakeshore areas, finding that with the exception of aquatic plants, there were significantly fewer SGCN species present at the developed sites than the undeveloped shorelines. The study then used reserve design methods to identify lakeshore areas that are most likely to support SGCN, producing a map that could be used to help prioritize lakeshore conservation efforts. Project findings also aided in efforts to enact the Shoreland Protection Act of 2014 which will help protect lakeshores from further degradation. The Shoreline Protection Act, however, does not provide for restoration of already degraded and developed shorelines.

In 2011, the VTDEC Lakes and Ponds Management and Protection Section identified 13 reference lakes across a gradient of lake sizes for a Sentinel Lakes Program Monitoring program to track the effects of climate change on Vermont's inland lakes. Annual monitoring at spring turnover helps tease out trends related to climate change from trends related to land use and acid precipitation. Selected lakes have the least amount of known stressors possible. Over time, and if funding permits, quantitative macrophyte surveys, continuous temperature chains, and dissolved oxygen sensors and continuous water level monitoring devices will be deployed. Temperature, frequency of lake mixing and water levels are expected to change as a result of climate change. Understanding the magnitude and frequency of these changes due to climate change will be important for the management of these and other lakes in the state and will contribute to our understanding of how Vermont's inland lakes are changing due to climate change.

In 2013, the Department completed the Vermont BioFinder project, a map and database identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. A notable outcome of the project was a classification of lakes and ponds based on alkalinity and trophic status and identification of best examples of each type. Follow-up efforts

The 115 lakes and ponds selected (table 1) are classified based on alkalinity and trophic status into 30 types, with Lake Champlain treated separately. Lakes and ponds were selected based on condition criteria, including naturalness of the outlet, water quality, milfoil abundance, degree of acid impairment, and lack of seasonal drawdown. Three additional lakes with special physical features were also added to the selection. Lily Pond, in Vernon, is included because of its similarity to ponds in the coastal plain. Lakes Champlain and Memphremagog are included because of their size and the extensive fisheries they support despite not meeting three other standards.

Bold: Lake/Pond name, *Italic*: location (town)

These are a subset of all lakes and ponds that occur in Vermont that represents most of lake types and examples of each type that are in the best condition for that type. The lakes and ponds are classified based on their trophic status, depth, and alkalinity, which are generally the main factors that shape biological communities in lakes (Wetzel 2001)

Table 1: Representative Lakes and Ponds

	Low Alkalinity		Moderate Alkalinity		High Alkalinity	
	Lake	***Pond***	***Lake***	***Pond***	***Lake***	***Pond***
Dystrophic	**Wheeler*** *Brunswick,* **Turtle*** *Holland,* **Branch*** *Sunderland*	**McConnell*** *Brighton,* **Dennis*** *Brunswick,* **Notch** & **S. American** *Ferdinand,* **Cow Mtn*** *Granby,* **West Mtn*** *Maidstone,* **Wolcott** *Wolcott*				
Ultra-Oligotrophic			**Crystal*** Barton, **Willoughby*** *Westmore*			
Oligotrophic	**Great Averill*** & **Little Averill*** *Averill,* Sunset* *Marlboro*	**Norford*** *Thetford*	**Echo*** *Plymouth*, **Woodward Res*** *Plymouth*, **Miller*** *Strafford*		**Caspian*** Greensboro	
Mesotrophic	**May** *Barton,* **Ricker** *Groton,* **Beaver*** & **Holland*** *Holland,* **Grout*** *Stratton*	**Athens** *Athens*, **Lakota** *Barnard*, **Nulhegan** *Brighton*, **Paul Stream** *Brunswick*, **Little Elmore** *Elmore*, **Pigeon** *Groton*, **Schofield*** *Hyde Park*, **Lewis*** *Lewis*, Lily & **Lowell** *Londonderry*, **McAllister** *Lowell*, **Kettle*** & **Turtlehead** *Marshfield*, **Ninevah** & **Tiny*** *Mt Holly*, **Kenny** *Newfane*, **Osmore** *Peacham*, **Gillett** *Richmond*, **Hancock** *Stamford*, **Stratton** *Stratton*, **Lily** *Vernon*, **Gates** & **Shippee** *Whitingham*	**Perch** *Benson*, **Long*** *Greensboro*, **Center** *Newark*, **Long*** & **Round*** *Sheffield*, **Hinkum*** *Sudbury*, **Bald Hill*** & **Mud*** *Westmore*, **Buck*** *Woodbury*	**Old Marsh** *Fair Haven*, **Daniels** *Glover*, **Horse** *Greensboro*, **Mudd** *Hubbardton*, **Milton*** *Milton*, **Fosters*** & **Mud** *Peacham*, **McLam*** *Ryegate*, **Bruce*** *Sheffield*, **Stannard*** *Stannard*, **Blake*** *Sutton*, **Abenaki** *Thetford*, **Flagg*** *Wheelock*	**Wardens*** *Barnet*, **Berlin** *Berlin*, **Emerald** *Dorset*, **Black*** *Hubbardton*, **Ewell** *Peacham*, **Rood*** *Williamstown*	**South** *Brookfield*, Coits *Cabot*, **Little Hosmer*** *Craftsbury*, **Keiser** *Danville*, **Mud*** *Leicester*, **Bean** *Lyndon*, **Johnson*** *Orwell*, **Jobs*** *Westmore*, **Chandler** *Wheelock*
Eutrophic	**Lefferts*** *Chittenden*, **Silver*** *Fairfax,* **Minards*** *Rockingham*	**Mile*** *Ferdinand*, **Little*** *Franklin,* **Spruce*** *Orwell*	**Colchester** *Colchester*, **Glen*** *Fair Haven*, **Harriman** *Newbury*, **Spring*** *Shrewsbury*, **High*** *Sudbury*	**Mollys*** *Cabot,* **Toad*** *Charleston,* **Mud*** *Morgan,* **Burr** *Pittsford*	**Great Hosmer*** *Albany*, **Memphremagog*** *Derby*, **Inman*** *Fair Haven*, **Zack Woods*** *Hyde Park*, **Long** *Milton*, **Round** *Milton*, **Huff** *Sudbury*, **Vail*** *Sutton*, **Valley** *Woodbury*	**Winona** *Bristol*, **Bliss** *Calais,* **Clarks*** *Glover,* **Little*** *Wells*
Lake Champlain*	Lake Champlain spans multiple trophic levels.					

**Highest Priority* = lake and ponds followed by an '*'. A total of 65 lakes and ponds.

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SGCN in Lacustrine Communities (excluding Lake Champlain)

High Priority
Bald Eagle (Haliaeetus leucocephalus)
Bridle Shiner (Notropis bifrenatus)
Blackchin Shiner (Notropis heterodon)
Fowler's Toad (Anaxyrus fowleri)
Common Mudpuppy (Necturus maculosus)
Crustaceans Group (3 species)
Freshwater Snails Group (15 species)
Odonates-Bog/Fen/Swamp/Marshy Pond Group (15 species)
Odonates-Lakes/Ponds Group (7 species)
Odonates-River/Stream Group (17 species
Silver-haired Bat (Lasionycteris noctivagans)
Eastern Red Bat (Lasiurus borealis)
Hoary Bat (Lasiurus cinereus)
Tri-colored bat (Perimyotis subflavus)

Medium Priority
Peregrine Falcon (Falco peregrinus)
Redfin Pickerel (Esox americanus)
Redbreast Sunfish (Lepomis auritus)
Round Whitefish (Prosopium cylindraceum)
American eel (Anguilla rostrata)
Atlantic salmon (Salmo salar) naturally reproducing populations in Lake Champlain & Memphremagog
Brook Trout-naturally reproducing populations (Salvelinus fontinalis
Lake Trout-naturally reproducing populations (Salvelinus namaycush)
Northern Water Snake (Nerodia sipedon)
Eastern Musk Turtle (Sternotherus odoratus)
Muskrat (Ondatra zibethicus)

SGCN Note: Vascular plant SGCN not listed here 38 species (Appendix I). For more information about a specific SGCN see that species' conservation report in Appendices A1-A5.

Problems & Information Needs

See Appendix C for definitions of problem and strategy categories used here

Problem/Info Need Category	Problem/Info Need Detail	Rank
Habitat Conversion	Loss of riparian, shoreline and littoral habitats from land and water development projects and activities.	High
Habitat Alteration	Alteration and degradation of riparian, shoreline and littoral habitats from development, invasive species, and aquatic vegetation control; water level regulation; loss and inadequate recruitment of large woody debris.	High
Sedimentation	Alteration and degradation of habitat (e.g., spawning areas); smothering of organisms.	High
Habitat Fragmentation	Interruption of migration and travel corridors to and from breeding/spawning/wintering habitats via alteration and conversion home range; construction of roads, dams and culverts.	High
Invasion by Exotic Species	Alteration and conversion of native littoral plant communities; inter-species competition for habitat and food; predation on native species; impacts resulting from invasive species control programs and activities.	High
Climate change	Alteration of water and temperature regimes.	High
Pollution	Nutrient and sediment overloading, acid deposition and other pollutants.	High
Pollution	Nutrient input to lakes accelerates the eutrophication process altering normal trophic succession.	High
Monitoring	Population and habitat monitoring: improved data on known SGCN populations is needed to track changes in species abundance and habitat quantity and quality as may be affected by natural processes and anthropogenic factors; habitats with potential for having existing SGCN populations or SGCN restoration potential should be investigated.	High

Priority Conservation Strategies

See Appendix C for definitions of problem and strategy categories used here

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Monitor, protect and restore riparian, shoreline and littoral habitats limited or impacted by development.	Number of SGCN sites (habitats) monitored; acres of undisturbed habitats protected; acres of disturbed habitats restored.	ANR, USFWS, NRCS, USFS, Lake and Watershed Associations	USFWS, EPA, Clean Water Fund, ANR
Monitor, protect and restore lake and pond water quality from excessive nutrient and sediment loading, other pollutants, and acid deposition.	Acres of SGCN habitat meeting water quality standards.	ANR, USFWS, NRCS, USFS, Lake and Watershed Associations	ANR. Clean Water Fund
Monitor, protect and restore migration and travel corridors limited or impacted by roads, dams, culverts, etc.	Number of identified artificial migration barriers removed or mitigated; number of migration corridors protected.	ANR, USFWS, NRCS, USFS, VTrans	USFWS, EPA
Monitor, protect and maintain known softshell turtle nesting sites; restore and protect additional nest sites.	Number of nest sites monitored, managed and protected; nest sites restored.	ANR, USDA, Wildlife Services, EPA	USFWS, EPA
Monitor lakes and ponds for invasive species; implement programs to prevent the introduction or spread of invasive species; implement control measures which take into account SGCN and their habitat requirements.	Numbers of SGCN habitats monitored for invasive species; number of SGCN habitats with plans in place designed to control invasive species and restore or enhance SGCN; incorporation of SGCN.	ANR, Lake and Watershed Associations	
Support policies and programs designed to reduce climate change.	Number of climate change policies and programs established or supported.	ANR, EPA, Other NE States	
Conduct inventories to detect and gather information on new SGCN populations and their habitats.	Number of potential SGCN habitats surveyed.	ANR, USFWS, USFS, EPA, USGS	USFWS
Provide technical outreach and financial assistance to private landowners, towns, watershed and lake associations, regional planning commissions, and other partners to increase their awareness of problems to SGCN.	Number of actions implemented to maintain or enhance lake function for SGCN.	ANR, USFWS, NRCS, TNC	USFWS
Acquire conservation easements for the protection of SGCN sites and maintenance or restoration of their ecological functions.	Number of SGCN habitats acquired or enrolled in land conservation easement programs.	ANR, TNC, USFS	USFWS
Enhance coordination between government agencies/partners to ensure consistency in respective program implementation and increase sensitivity to SGCN requirements and problems to SGCN.	Number of agencies and private conservation organization, which recognize and address problems to SGCN.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake and Watershed Associations	

Strategy	Performance Measure	Potential Partners	Potential Funding Sources
Implement Vermont Sentinel Lakes Program.	Trends in spring turnover water chemistry attributable to climate change. Changes in community structure of diatom, macrophyte and littoral macroinvertebrate communities due to climate change.	ANR, EPA, UVM EPSCoR Program, Maine DEP, NH DES	Northeastern States Research Cooperative, EPA 106 monitoring fund, EPA 319 funding
Pursue funding to enable lake shore restoration and enhanced protection.	Necessary funding provided.	ANR, USFWS, USFS, NRCS, VTrans, TNC, Lake and Watershed Associations	Vermont legislature
Update Vermont's baitfish rules as necessary and expand to include non-fish invasive bait species.	Baitfish rules are reviewed and amended as needed.	ANR	ANR

Coordination with other plans

Plan or planning entity	Goal/Scope of plan	Lead
Clean Water Initiative Program	Water quality improvement	VDEC
The Vermont Shoreland Protection Act: A Handbook for Shoreland Development (V 1.2, April 2015).	To allow reasonable development of shorelands along lakes and ponds while protecting aquatic habitat, water quality, and maintaining the natural stability of shorelines.	ANR
Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Vermont Lake Champlain Phosphorus TMDL Implementation Plan (Phase 1)	Lake Champlain TMDL Plan
Lake Champlain Basin Aquatic Nuisance Species Management Plan (2005).	Management and prevention of invasive exotic species in the basin	VTDEC, NYDEC
VTDEC Water Quality Division	Lake protection and restoration programs	VTDEC

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Appendix C

Threat & Action Definitions

Vermont’s Wildlife Action Plan 2015

Threat Categories for Wildlife Action Plan Revision

Element number three of the eight congressionally required elements of a Wildlife Action Plan requires that states: describe the problems that may adversely affect Species of Greatest Conservation Need or their habitats and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats. Problem and threats are defined as follows:

> **Problem:** Something that is a concern and could cause a negative impact at the species, population, habitat and/or landscape levels (e.g., habitat conversion, pollution, illegal pet trade). A problem can also be the lack of information or a data gap vital to the successful management of a species.
>
> **Threat (direct):** Processes or human activities "that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets" (adapted from Salafsky et al. 2008).
>
> **Threat (indirect):** The factors contributing to or enabling direct threats. Typically there is a chain of contributing factors behind any given direct threat. Synonyms include contributing factors, underlying factors, drivers, and root causes (adapted from Salafsky et al. 2008).

For the purposes of this report, problem and threat are used in a similar or related manner. For each Species of Greatest Conservation Need in the Action Plan we identified priority problems. Priority research needed to evaluate other potential problems was also identified. They are detailed in SGCN conservation summaries (Appendix A) and in habitat/ community summaries (Appendix B).

Each of the threats and problems identified in the Action Plan was assigned to one of 24 categories roughly grouped into habitat-related factors and non-habitat-related factors. These categories make it possible to search our database for similar factors impacting other species. It also makes it easier to roll-up for broad scale conservation planning. The categories were cross-walked (Appendix C) with those developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (Salafsky et al. 2008) to aid in the regional roll-up of Action Plan data as recommended by the Diversity Technical Committee of the Northeast Association of Fish & Wildlife Agencies (Crisfield 2013).

The categories are not mutually exclusive and threats can often logically be placed into more than one category depending on the particular stress it causes for a species or habitat. For example, a road can fragment the habitat of grassland nesting birds, cars traveling the road can injure or kill amphibians that were crossing the road to mate in an adjacent pool, and salt spread on the road to prevent icing can wash into a stream impacting its population of Brook Trout. In this example the threats stemming from the road would be recorded in the "Habitat Fragmentation," "Impacts of Roads & Transportation Systems," and "Pollution" categories.

Threats are often species and/or habitat specific. What may negatively impact one species may benefit another. For example, if a cold water stream with a healthy Brook Trout population was dammed it might no longer support Brook Trout. That impact to the dam would be described as the "conversion of habitat" category. However, the reservoir created by the dam might make it more suitable for a warm water fish species.

Clearly life is too complex to be placed into any one box. Therefore it is important to read the full description of a factor affecting a species or habitat in the appropriate species or habitat summary. Table C.1 lists the threat categories used in this Wildlife Action Plan.

Table C.1 Threat Categories for Wildlife Action Plan Revision

#	Threat/ Problem	Description	IUCN Category
	Habitat-Related Categories		
A	**Climate Change**	Long-term changes linked to global warming and other climate issues that can lead to major changes in habitat availability (e.g., high elevation habitats), vegetative composition and location (e.g., the movement up in elevation or north in latitude, invasion by exotic pests) as well as climate variability (e.g., change in snow depth, rainfall and/or natural disturbances).	11. Climate Change and Severe Weather
B	**Habitat Alteration/ Degradation**	A lessening of the quality of a habitat by human action stopping short of complete conversion (e.g., the reduction of mast production from a forest stand, the riprapping a streambank, and significant land use changes adjacent to a habitat such as replacing a forest stands on the edge of a wetland with a housing development. In the last case, the development would be a conversion of the forest stand and, if not designed properly, could also degrade the wetland). Habitat Conversion, Habitat Fragmentation, Hydrologic Alteration, Sedimentation, Pollution and Inadequate Distribution Of Successional Stages are closely related categories.	1, 7.3. Residential and Commercial Development; Other Ecosystem Modifications
C	**Habitat Conversion**	The complete transformation or loss of a habitat by human action (e.g., filling a wetland to create a grassy field, converting a forest into a parking lot, or damming a stream to create a reservoir). Habitat Alteration/Degradation, Habitat Fragmentation, Hydrologic Alteration, and Inadequate Distribution of Successional Stages are closely related categories.	1. Residential and Commercial Development
D	**Habitat Fragmentation**	The breaking up of habitats into smaller, non-contiguous patches as a result of habitat conversion (e.g., housing, commercial development, roads, utility lines). Fragmentation can: 1) render important habitats inaccessible (such as isolating a den site from a feeding site), 2) breakdown of the metapopulation structure of a species (for example grassland butterflies, spotted salamander, and tiger beetles); and, 3) degrade remaining habitat patches through edge effects that favor edge-tolerant species such as raccoons and crows, as well as invasive exotic species that can out-compete native and rare species. The result of habitat fragmentation is often increased predation, increased mortality, reduced mobility and changes in habitat micro-climates. Habitat Alteration/Degradation, Hydrologic Alteration and The Impacts off Roads and Trails are closely related categories.	1. Residential and Commercial Development
E	**Hydrologic Alteration**	Changes in the flow, periodicity or quality of a surface or subsurface water system (examples include a dam on a river preventing historic fluctuations in water level and mining activities causing a perennial seep to run dry). Dams can also increase water temperature. If warm water was identified as a problem then that problem would be placed in the pollution category. Hydrologic Alteration is a subset of Habitat Alteration but is a significant enough problem to warrant a separate category.	7.2 Dams and Water Management/Use

#	Threat/ Problem	Description	IUCN Category
F	**Impacts of Roads & Transportation Systems**	Transportation corridors that bring people, disturbance, and exotics to a habitat or directly impact a Species of Greatest Conservation Need (e.g., road kill, bird species whose mating calls are drowned out by the noise of road traffic, a road corridor that speeds the spread of an exotic invasive species. Habitat Fragmentation, habitat Alteration/Degradation and Impact of Roads are closely related categories. *In 2005 this category included trail impacts. For 2015 trail impact should be categories in Incompatible Recreation.*	4.
G	**Impacts of Energy Infrastructure & Development**	Threats from exploring for, developing, producing and distributing energy resources. Hydrofracturing and other natural gas extraction and distribution processes. Removal and distribution of minerals and rocks, limited to energy production. Generating and distributing power from the wind. Generating and distributing power from the sun.	
H	**Inadequate Disturbance Regime**	A disturbance regime is re-occurring process that disrupts a habitat, ecosystem, populations, and/or substrate causing significant change to a system (Picket and White). Many species have adapted to these disturbances and depend upon them to maintain habitats (e.g., the loss of beaver created wetlands, and a dam preventing the yearly flooding of floodplain forests that brings nutrients to the site and creates opening for early successional vegetation).	7.1. Fire and Fire Suppression (Other disturbance types need representation)
I	**Inadequate Distribution of Successional Stages**	The lack of either late, mid or early successional habitat in appropriate size and/or juxtaposition (examples include ruffed grouse and woodcock which prefers early successional forest stands, American marten which prefers late-successional stands and lynx which depends on a mix of stages).	7.3 Other Ecosystem Modifications
I	**Invasion by Exotic Species**	The introduction and spread of nuisance exotic and native species (plants and animals). These species may lead to the elimination of populations, threats to long-term stability or extirpation by out-competing a native species, displacing its food source or altering a key process or function of a habitat. Note that this category includes both exotic species and invasive native species such as cowbirds and sea lamprey. Exotic disease and parasites are addressed separately in the disease category.	8.1. Invasive Non-native/Alien Species/Diseases
J	**Parcelization**	Separating a large parcel into multiple smaller parcels. Parcelization is a significant driver of habitat fragmentation (and is often driven itself by tax policy). Parcelization can make it difficult to deliver management programs or present access issues which could impede actions benefiting SGCN even when fragmentation is not a problem (e.g., when a single 800-acre parcel is broken into many smaller lots some of the new landowners may choose to post their land while others may close logging roads).	1. Residential and Commercial Development

#	Threat/ Problem	Description	IUCN Category
K	**Sedimentation**	Excessive inputs (in frequency and/or abundance) of solid material (inorganic or organic solid fragments) that are carried and deposited by wind, water, or ice to a water body. These materials have a negative impact on Species of Greatest Conservation Need through their physical presence (example: soils washing into a stream from a construction site and smothering fish eggs and other aquatic species that live in the spaces between rocks and gravel in a streambed). Sedimentation was broken out from the habitat alteration/degradation category because of its significant impact on aquatic species. Note: a problem that exerted a negative chemical impact on wildlife (e.g., road salt), would be listed in the Pollution category.	9.3.2. Ag/Forestry Soil Erosion and Sedimentation (Other sedimentation sources need representation)
	Non-Habitat-Related Threat Categories		
L	**Competition**	Where two or more species compete for the same limited resource (e.g., space, food) decreased survival, growth rate and/or reproduction of competing individuals is possible (e.g., fisher, bobcat and coyote have overlapping habitat needs and prey preference).	8.2. Problematic Native Species
M	**Disease**	Any disease causing agent such as, fungi, bacteria and viruses (e.g., rabies, West Nile disease, whirling disease, chronic wasting disease, hemlock wooly adelgid, and sudden oak death). Diseases are often transmitted by parasites, a related problem.	8.1, 8.2, 8.3, 8.4-6. Invasive and Other Problematic Species, Genes and Diseases
N	**Genetics**	A reduction of survival or fecundity of a species due to inbreeding depression (the mating of close relatives) usually due to small and isolated populations, and outbreeding depression (the mating of different locally adapted populations). Examples include lake sturgeon and timber rattlesnake for whom inbreeding depression and genetic drift may be distinct possibilities due to small and isolated populations. Outbreeding depression can be a problem for native baitfish whose locally adapted genes may be swamped out by the accidental release of relatives taken from other waters in the state or elsewhere.	*Research needed*
O	**Harvest or Collection**	Legal or illegal taking of biological resources (e.g., hunting, trapping, collecting, fishing) for commercial, recreation, subsistence, research, or management purposes (e.g., the accidental taking of spruce grouse or American marten by a hunter or trapper, illegal collection of wood turtles for sale in the pet trade, and the harvesting of eels).	5.1, 5.2, 5.4. Hunting and Collecting Terrestrial Animals. Gathering Terrestrial Plants
P	**Incompatible Recreation**	Recreational activities (outside of established transport corridors) that directly impact SGCN or their habitats (e.g., include: poorly planned ORV or hiking trails that cause wildlife to abandon a den site, bird watchers getting too close to nesting loons causing loons to abandon their nest, and off-road vehicles operated outside of approved areas can run through vernal pools degrading the pool and crushing spawning amphibians and their eggs) Because of the scale of impact, the construction of a golf course or ski area would be listed in Habitat Conversion or Habitat Alteration categories respectively. Incompatible Recreation is also closely related to Impacts of Roads & Trails.	6.1. Recreational Activities
Q	**Loss of Food Base or Prey Base**	The disappearance of a food source important to a species' survival (e.g., lynx which feeds primarily on snowshoe hare and the whippoorwill whose primary diet of	*Research needed*

#	Threat/ Problem	Description	IUCN Category
		flying insects has been decreased).	
R	**Loss of Relationship with Other Species**	A species whose existence depends upon another for a process, function or product (examples include the larvae of many mussel species will attach to fish and depend on these fish for dispersal). Many insects, including butterflies and moths, have specific relationships with host plants that serve as its sole food. In some cases the host plant also conveys a chemical protection to the insect.) This category differs from the Loss of Prey Base category in that there are no alternatives (e.g., lynx and whippoorwill can take other prey, monarch butterflies won't persist without milkweed to feed on and to provide chemical protection from predators).	*Research needed*
S	**Parasitism**	A relationship between two species in which one benefits (the parasite) and the other (the host) is harmed, (Smith 1980) although not directly killed (e.g., ticks, sea lamprey parasitizing lake whitefish and lake trout). Parasites may transmit diseases to the host therefore disease is a closely related problem. Examples include ticks transmitting Lyme disease and mosquitoes transmitting West Nile virus.	*Research needed*
T	**Pollution**	Introduction of exotic materials (other than sediments) from point and non-point sources. Includes chemicals and toxins in the air, land, and water; excess nutrients from farm and municipal sewage plants; garbage and other solid waste; radioactive materials; road salt; excessive noise and infrasound noise; excessive heat; and light pollution that disturbs animals and disrupts migration patterns. Note: Sediments were broken out from this category because of its significant impact on some water bodies. Greenhouse gasses such as carbon dioxide and methane would be covered in the Climate Change category.	9. Pollution
U	**Predation or Herbivory**	Species or habitats negatively impacted by wildlife species that eat them (e.g., raccoons and skunks that eat wood turtle and spiny softshell turtle eggs and moose over-browsing vegetation and preventing the regeneration of a forest stand. This category differs from Competition in that competition is two or more species vying for the same specific resource, whereas predation is one species eating another.	*Research needed*
V	**Reproductive Traits**	Species whose specific reproductive strategies make it vulnerable, such as species producing very few offspring because they take a long time to reach sexual maturity and/or take a long time between reproductive events (e.g., lake sturgeon and wood turtle).	*Research needed*
W	**Trampling & Direct Impacts**	Non-recreational, and sometimes inadvertent, negative impacts to a species (examples include the crushing of wildlife by agricultural equipment operating in a farm field, vehicles operating off-road, the killing of rattlesnakes or bats out of antipathy for the species, increased nest abandonment by brown thrashers due to the proximity of people). Impacts to a habitat would be assigned to the Habitat Degradation/Alteration and perhaps Habitat Conversion. Incompatible Recreation and Impacts of Roads & Trails are closely related categories	5.1.3, 5.2.3, 5.4.3. Persecution/Control

Conservation Actions for Wildlife Action Plan Revision

Element number four of the eight congressionally required elements of a Wildlife Action Plan requires that states describe "conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions."

We identified actions to address the threats and problems impacting each of Species of Greatest Conservation Need (SGCN) and their habitats. Selected actions are based on the best science available today as well as a strategic assessment of needs and priorities of all wildlife species. In the coming years, as monitoring data on SGCN and conservation actions becomes available, as priorities change, or new threats or opportunities arise, actions may need to be revisited. Not every action in this report will be eligible for State Wildlife Grant funding. Furthermore, it may not be suitable, or feasible, for the Vermont Fish & Wildlife Department to implement some of the actions in this report, however, some conservation partners may find them fitting and practical.

Actions are described in short narratives in each SGCN conservation summary (Appendix A) and in each habitat, community and landscape summary (Appendix B). Actions are intentionally broad, directional, and nonspecific so as not to constrain our selection of procedures for implementing them. For example, an action such as "provide technical assistance to landowners to maintain or improve riparian habitat for Species of Greatest Conservation Need" allows for different approaches to providing that assistance and leaves the door open to a variety of providers to implement. Where action implementation is to be funded by the State Wildlife Grant program the approach should be consistent with the Department's mission and strategic plan, and precise procedures will be detailed in operational plans once the Action Plan is finalized.

Vermont's Action Plan was designed for the state, not just the Fish & Wildlife Department. While the VFWD may be responsible for implementing many of the actions in this report, it could be conservation partners that are the more logical and appropriate leaders for others, due to their skills and expertise, staffing, history, location, available resources and constituencies.

Each of the actions identified in this report were assigned to one of 27 categories in six major classes. The categories were developed by the Conservation Measures Partnership (Salafsky 2005) as a means of standardizing terminology (not practices) among conservation practitioners worldwide. Many states have used these same categories to organize the strategies and actions in their Action Plan. They have also been incorporated into Wildlife TRACS (Tracking and Reporting Actions for the Conservation of Species) the US Fish & Wildlife Services' system for tracking and reporting conservation activities. States, including Vermont, will use TRACS for all work funded through the USFWS once it is fully operational.

The action categories are used solely for the purpose of organizing and grouping strategies developed by Action Plan teams and committees. It was not our goal to create strategies for every category. A few categories were not applicable to the species or habitats in Vermont whereas others were deemed not as effective. Table C.2 lists the action categories used in this Wildlife Action Plan.

Table C.2 Conservation Actions for Wildlife Action Plan Revision

#	Strategy Type	Description
1	**Land/Water Protection**	
1.1	Creating Publicly-Owned Protected Areas	Setting up or expanding public parks, forests and other protected areas where wildlife conservation is a primary management objective (e.g., wildlife management areas, state forests, municipal lands)
1.2	Creating Privately-Owned Protected Areas	Setting up or expanding private reserves and other protected areas where wildlife conservation is a primary management objective (e.g., private lands managed by non-profit conservation or hunting groups)
1.3	Easements	Setting up protection of some specific aspect of a resource on public or private lands (e.g., development rights, wild & scenic river designation)
2	**Land/Water/Species Management**	
2.1	Protected Area Management	Generally managing protected areas where wildlife conservation is a primary management objective (e.g., site design, training park staff, managing water levels).
2.2	Compatible Resource Use	Promoting use of resource lands (where wildlife management is not a primary objective) to be compatible with conservation (e.g., promoting sustainable logging, grazing, fishing, hunting, trapping, farming, aquaculture, energy development, transportation infrastructure).
2.3	Invasive Species Control & Prevention	Dealing with invasive and/or alien plants, animals, and pathogens (e.g., developing boat wash stations, pulling noxious weeds from a habitat).
2.4	Habitat Restoration	Enhancing degraded or restoring missing habitats (e.g., clayplain forest restoration and riparian tree plantings). If a strategy specifically targets one or two species we consider it a species restoration strategy. If it specifically targets three or more species we consider it a habitat restoration strategy.
2.5	Natural Processes Restoration	Enhancing or restoring natural ecosystem functions (e.g., prescribed burns, dam removal and restoration of historic flow regimes, fish ladders).
2.6	Species Restoration	Enhancing or restoring specific plant and animal populations (e.g., translocating spruce grouse from Canada to Vermont, and erecting artificial nesting boxes/platforms for bluebirds and osprey.) If a strategy specifically targets one or two species we consider it a species restoration strategy. If it specifically targets three or more species we consider it a habitat restoration strategy.
2.7	Ex-Situ Conservation	Protecting wildlife out of its native habitats (e.g., captive breeding of bald eagles and creating regional refugia for New England cottontail rabbit).
3	**Law & Policy**	
3.1	Legislation	Making, changing, influencing, or providing input into formal legislation at all levels: international, national, state/provincial, local (e.g., lobbying to make the SWG program permanent, addressing greenhouse gas emissions).
3.2	Policy & Regulations	Making, changing, influencing, or providing input into policies and regulations affecting the implementation of laws at all levels: international, national, state/provincial, local (e.g., providing data to policy makers, development of wildlife harvest regulations).
3.3	Planning & Zoning	Developing, changing, influencing, or providing input into plans governing natural resource use and allocation (e.g., municipal zoning, public or private management plans for ecoregions, sites, habitats, or species, commenting on zoning plans, developing a town ordinance).

#	Strategy Type	Description
3.4	Standards	Setting, changing, influencing, or providing input into voluntary standards that govern practices (e.g., best management practices for forestry, habitat guidelines for state lands).
3.5	Compliance & Enforcement	Monitoring and enforcing compliance with laws, policies & regulations, plans, and standards (e.g., water quality standard monitoring, enforcement of ATV regulations).
4	**Research, Education & Awareness**	
4.1	Research	Conducting and disseminating research to improve knowledge about conservation issues (e.g., conducting inventories for SGCN, developing habitat maps, demonstration projects for sustainable forestry)
4.2	Technical Assistance, Training, Workshops	Enhancing knowledge, skills and information exchange for practitioners, landowners, stakeholders, and other relevant individuals in structured settings outside of degree programs (e.g., providing technical assistance to landowners, monitoring workshops, conferences, learning networks)
4.3	Lifelong Learning	Enhancing knowledge and skills of practitioners, stakeholders, and other relevant individuals through non-structured means (e.g., writing a how-to manual for landowners or towns and communities, stakeholder education on proper ORV use)
4.4	Awareness Raising, Communications	Raising conservation awareness and providing information through various media (e.g., websites, newsletters, presentations)
5	**Economic & Other Incentives**	
5.1	Linked Enterprises	Developing enterprises that directly depend on natural resources as a means of influencing behaviors, attitudes, and beliefs (e.g., ecotourism, sustainable forest product harvesting, fishing, hunting and trapping).
5.2	Substitution	Promoting products and services that substitute for environmentally damaging ones (e.g., floodplain restoration in place of dams and bank reinforcement, promoting recycling/use of recycled materials)
5.3	Financial Incentives & Market Forces	Using market mechanisms to influence behaviors, attitudes, and beliefs (e.g., forestry certification, positive incentives, negative incentives, forest banking, valuation of ecosystem services such as flood control)
5.4	Conservation Payments	Using direct or indirect payments to influence or reinforce behaviors, attitudes, and beliefs (e.g., landowner payment programs).
5.5	Non-Monetary Values	Using non-market forces to change behaviors, attitudes, and beliefs (e.g., landowner/land manager recognition awards).
6	**Capacity Building**	
6.1	Institutional Development	Creating or providing non-financial support, capacity building for non-profits, government agencies, and for-profits (e.g., creating new local land trusts)
6.2	Alliance Development	Forming and facilitating partnerships, alliances, and networks of organizations (e.g., Action Plan Conservation Partners, Vermont Monitoring Cooperative, Vermont Sportsmen's Federation).
6.3	Conservation Finance	Raising and providing funds for conservation work (e.g., State Wildlife Grants small grants program, private foundations, debt-for-nature swaps).

Appendix D

Vermont Species & Habitat Climate Vulnerability Assessment

Vermont's Wildlife Action Plan 2015

Introduction

During 2013 a group of Vermont Fish & Wildlife Department biologists and Chris Hilke, Climate Adaptation Program Manager for the Northeast Regional Office of National Wildlife Federation, collaborated to assess the vulnerability of fish, wildlife, plants and their habitats to climate changes. As part of this Vermont Species & Habitat Climate Vulnerability Assessment, the team investigated 18 key species, 20 upland habitats, 11 wetland habitats, and 13 freshwater habitats as shown the tables on the following pages. One Department biologist used a NatureServe tool to add in 13 more butterfly species. Species included Species of Greatest Conservation Need and important "surrogate" species that are widely considered representative of particular habitat types. Species assessments culminated in an overall vulnerability rating for climate-specific and non-climate stressors and an associated confidence score (see Rating Key at bottom of spreadsheet for details). Climate change vulnerability assessments were similarly conducted for Vermont's upland and wetland natural communities. For efficiency, the 95 natural community types were grouped into categories based on the environmental factors that drive their development and that could affect their susceptibility to climate change. Some natural community types were assessed individually and freshwater habitats were also assessed.

The most important lesson taken from this exercise is that species (and habitat) responses to climate change will not be uniform. For some, climate change may not be a significant threat, however if a species is already subjected to other stresses, climate change impacts may push that species over the edge. This is an important consideration to take into account. More information on climate change and wildlife conservation can be found in chapter 3: Climate Change & Conservation.

Vermont Species & Habitat Climate Vulnerability Assessment																								
	Vulnerability			Sensitivity Factors						Exposures & Key Climate											
										A	B	C	D	E	F	G	H	I	J	K	L
Species and Habitats	Climate Vulnerability Rating	Confidence Score	Vulnerability to non-climate stressors	Habitat specificity	Edge of range	Enviro or physiological tolerance	Interspecific or phenological dependence	Mobility	Exotic Pathogens or Invasive Species	Annual temperature - Increase	Seasonal temperature - Increase	# Hot days - More	# Cold days - Fewer	Variability - Increase	Annual precipitation - Increase	Seasonal precipitation - Variable	Heavy rainfall events - Increase	Soil moisture - Decrease	Snow - Decrease	Spring flows - Earlier	Summer low flow - Longers
Key Species (**Bold** text =SGCN)																					
Jefferson salamander	H	H	H	X	X	X		X							X	X			X	X	
Northern white cedar	M	M	H	X	X			X	X	X	X	X									
Fingernail clam	L	H	M	X				X							X	X		X	X	X	
Beaver	N	H	M																		X
Bobcat	L	M	M																		
Canada Lynx	H	H	M	X	X	X	X			X	X	X	X	X	X	X			X		
Brook Trout	H	H	H	X		X		X	X	X	X	X									X
Wood Turtle	M	H	H	X				X										X			
Pearlshell mussel	H	M	M	X			X	X		X	X										X
Fallfish	L	M	L			X															X
Smelt	M	H	M	X		X				X	X								X		
Lake trout	H	H	H	X	X	X				X	X								X		
Bald Eagle	L	M	L	X													X				
Bicknell's Thrush	H	H	H	X	X					X	X	X	X	X			X				
Common Loon	M	L	L	X	X	X															
Red Oak	N	M	N		X						X	X						X			
Sugar Maple	H	M	L		X	X		X		X	X	X	X								
West Virginia White	H	H	M					X	X	X	X	X						X			
Bog Copper	E	H																			
Edward's Hairstreak	E	H																			
Early Hairstreak	H	H																			
Hackberry Emperor	B	H																			
Tawny Emperor	B	H																			
Jutta Artic	M	H																			
Cobweb Skipper	N	L																			
Mulberry Wing	H	H																			
Broad-winged Skipper	N	H																			
Black Dash	H	H																			
Dion Skipper	H	H																			
Two-spotted Skipper	H	H																			
Dusted Skipper	N	H																			

Vermont Species & Habitat Climate Change Factors															**Non-Climate Stressors**						
	M	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**				**A**	**B**	**C**	**D**	**E**	**F**	**G**
Species and Habitats	**Ice dynamics - Changing**	**Fluctuating lake levels - Increase**	**Lake stratification**	**Flood events - Increase**	**# of short-term droughts - Increase**	**Storms - Increase**	**Fire**	**Growing season - Longer**	**Onset of spring - Earlier**	**Onset of fall - Later**	**Biological interactions**	**Other**	**List of exposures with the greatest Negative**	**List of exposures that might be beneficial**	**Acidity**	**Habitat Alteration- Altered Hydrology**	**Invasive Species**	**Channel Erosion-Sedimentation**	**Encroachment**	**Land Erosion**	**Nutrient Loading**
Key Species (**Bold** text =SGCN)																					
Jefferson salamander					X				X		X				X	X	X		X		
Northern white cedar				X			X	X			X				X	X	X				
Fingernail clam		X			X										X	X	X		X		
Beaver		X		X	X											X			X		
Bobcat																X					
Canada Lynx											X								X		
Brook Trout				X	X						X				X	X	X	X	X	X	
Wood Turtle				X	X											X	X				
Pearlshell mussel				X	X						X				X	X	X	X			
Fallfish				X	X											X	X				
Smelt	X		X		X											X	X	X			X
Lake trout	X	X	X		X						X						X	X			X
Bald Eagle						X													X		
Bicknell's Thrush					X	X	X		X						X	X			X		
Common Loon		X		X	X	X									X	X			X		
Red Oak					X	X	X				X					X	X		X		
Sugar Maple					X	X	X	X			X				X						
West Virginia White					X		X				X					X	X		X		
Bog Copper																					
Edward's Hairstreak																					
Early Hairstreak																					
Hackberry Emperor																					
Tawny Emperor																					
Jutta Artic																					
Cobweb Skipper																					
Mulberry Wing																					
Broad-winged Skipper																					
Black Dash																					
Dion Skipper																					
Two-spotted Skipper																					
Dusted Skipper																					

Vermont Species & Habitat Climate	H	I	J	K	
Species and Habitats	Thermal Stress	Toxic Substances-Pollution	Hanitat Fragmentation	Inventory Need	Notes
Key Species (**Bold** text =SGCN)					
Jefferson salamander					
Northern white cedar					Competition effects this species broadly
Fingernail clam	X	X			
Beaver			X		Keystone wetland builder - vulnerable via direct take
Bobcat					Coyote and fisher competition
Canada Lynx			X		trapping in Canada impacts Lynx in VT
Brook Trout	X	X	X		Rating is consistent w/ other states. Water temp is key, sedimentation also key issue
Wood Turtle			X		Other threats - Pet trade, agriculture and egg predation
Pearlshell mussel		X	X		
Fallfish			X		Risk by gravel scour when eggs present (May) 63F
Smelt					
Lake trout					Sea lamprey. Supplemental stocking
Bald Eagle		X			
Bicknell's Thrush					Red squirrel predation tied to cone production, limtited by patch size
Common Loon		X			direct impacts from fishing gear (hooks and lead)
Red Oak			X		A southern oak species so favored with CC, deer browse impacts seedling development
Sugar Maple					Likely climate loser over 100yr. Managed in sugar bushes which promotes over others
West Virginia White	X		X		
Bog Copper					Climate vulnerability and confidence score only performed for this butterfly species
Edward's Hairstreak					Climate vulnerability and confidence score only performed for this butterfly species
Early Hairstreak					Climate vulnerability and confidence score only performed for this butterfly species
Hackberry Emperor					Climate vulnerability and confidence score only performed for this butterfly species
Tawny Emperor					Climate vulnerability and confidence score only performed for this butterfly species
Jutta Artic					Climate vulnerability and confidence score only performed for this butterfly species
Cobweb Skipper					Climate vulnerability and confidence score only performed for this butterfly species
Mulberry Wing					Climate vulnerability and confidence score only performed for this butterfly species
Broad-winged Skipper					Climate vulnerability and confidence score only performed for this butterfly species
Black Dash					Climate vulnerability and confidence score only performed for this butterfly species
Dion Skipper					Climate vulnerability and confidence score only performed for this butterfly species
Two-spotted Skipper					Climate vulnerability and confidence score only performed for this butterfly species
Dusted Skipper					Climate vulnerability and confidence score only performed for this butterfly species

Vermont Species & Habitat Climate Vulnerability Assessment

	Vulnerability			Sensitivity Factors						Exposures & Key Climate											
										A	B	C	D	E	F	G	H	I	J	K	L
Species and Habitats	Climate Vulnerability Rating	Confidence Score	Vulnerability to non-climate stressors	Habitat specificity	Edge of range	Enviro or physiological tolerance	Interspecific or phenological dependence	Mobility	Exotic Pathogens or Invasive Species	Annual temperature - Increase	Seasonal temperature - Increase	# Hot days - More	# Cold days - Fewer	Variability - Increase	Annual precipitation - Increase	Seasonal precipitation - Variable	Heavy rainfall events - Increase	Soil moisture - Decrease	Snow - Decrease	Spring flows - Earlier	Summer low flow - Longers
Wetland Habitats																					
Cattail Marsh	L	M	L								X				X	X					
Shallow Emergent Marsh	M	M	M								X				X	X		X			
Marsh and Sedge Meadow (Formation)	M	M	M								X				X	X					X
Alluvial Shrub Swamp	M	M	L								X					X		X			
Basin swamps & wetlands	H	M	M								X	X					X	X			X
Floodplains	H	M	M								X		X			X	X	X		X	
Ground water seepage & Flood swamp	L	M	L								X		X			X		X		X	X
Open peatlands (precip-dependent)	M	M	L							X	X	X		X		X		X	X		
Open peatlands (ground-fed)	L	M	M								X	X				X		X			
Floodplain Forests	H	M	M								X		X			X	X	X		X	
Wet Shores	H	M	M								X	X					X	X			X
Upland Habitats																					
Alpine Meadow	E	M	M							X	X	X	X		X	X		X	X		
Spruce-Fir-Northern Hardwood	M	M	M							X	X	X	X		X	X		X	X		
Northern Hardwood Forest	L	M	L								X	X	X	X		X		X			
Oak-Pine - Dry Mesic Forests & Woodlands with deeper soils	L	M	M								X	X				X	X				
Rocky Forests and Woodlands	L	M	L								X	X				X		X			
Oak-Pine Southern Rocky - Southern Dry Rocky Forests and Woodlands	M	L	L								X	X				X		X			
Outcrops and upland meadows	N	L	L								X	X				X		X			
Cliffs and Talus	L	M	L								X	X				X		X			
Upland shores	M	M	H								X	X						X		X	
Subalpine Krummholz	E	M								X	X	X		X	X			X	X		
Montane Spruce-fir	M	M								X	X	X		X	X			X	X		
Red Spruce-Heath Rocky Ridge	M	M								X	X	X		X	X			X	X		
Montane Yellow Birch-Red Spruce Forest	M	M								X	X	X		X	X			X	X		
Red Spruce-Northern Hardwood	L	M								X	X	X		X	X			X	X		
Lowland Spruce-Fir Forest	M	M								X	X	X		X	X			X	X		
Boreal Talus Woodland	M	M								X	X	X		X	X			X	X		
Cold-Air Talus Woodland	H	M								X	X	X		X	X			X	X		
Limestone Bluff Cedar-Pine Forest	L	M									X	X				X	X	X			
Transition Hardwood Talus Woodland	L	M									X	X				X	X				
Dry Oak Woodland	H	L									X	X				X	X				

Vermont Species & Habitat Climate	Change Factors														Non-Climate Stressors						
	M	N	O	P	Q	R	S	T	U	V	W				A	B	C	D	E	F	G
Species and Habitats	Ice dynamics - Changing	Fluctuating lake levels - Increase	Lake stratification	Flood events - Increase	# of short-term droughts - Increase	Storms - Increase	Fire	Growing season - Longer	Onset of spring - Earlier	Onset of fall - Later	Biological interactions	Other	List of exposures with the greatest Negative	List of exposures that might be beneficial	Acidity	Habitat Alteration- Altered Hydrology	Invasive Species	Channel Erosion-Sedimentation	Encroachment	Land Erosion	Nutrient Loading
Wetland Habitats																					
Cattail Marsh		X									X		N	T, U, V		X	X		X		
Shallow Emergent Marsh		X		X	X						X		I	T		X	X		X		
Marsh and Sedge Meadow (Formation)		X		X	X						X					X	X		X		
Alluvial Shrub Swamp					X						X	X	I, S, C	U, T		X			X		
Basin swamps & wetlands	X	X		X				X					M, P			X	X		X		
Floodplains	X	X		X		X		X	X	X	X	K					X	X	X		
Ground water seepage & Flood swamp					X	X		X			X	X		X		X	X				
Open peatlands (precip-dependent)					X	X	X				X		G, Q								
Open peatlands (ground-fed)		X			X						X		G, I, Q			X					
Floodplain Forests	X	X		X		X		X	X	X	X		K, P, N,				X	X	X		
Wet Shores	X	X		X				X	X	X	X		M, P, W			X	X	X	X		
Upland Habitats																					
Alpine Meadow					X	X		X	X		X		B, C, J			X	X				
Spruce-Fir-Northern Hardwood					X	X		X	X				D, I, J, T	F	X				X		
Northern Hardwood Forest					X	X			X		X		B, C, D, I, Q, W				X				
Oak-Pine - Dry Mesic Forests & Woodlands with deeper soils					X	X	X						Q, Z			X	X				
Rocky Forests and Woodlands					X	X	X						Q, Z		X		X				
Oak-Pine Southern Rocky - Southern Dry Rocky Forests and Woodlands					X	X	X						C, Q				X				
Outcrops and upland meadows					X							X	B, C, J			X			X		
Cliffs and Talus					X	X							C, I						X		
Upland shores	X			X	X						X		M, N, P			X	X				
Subalpine Krummholz					X						X	X	I, A	F							
Montane Spruce-fir					X				X			X	I, A	F							
Red Spruce-Heath Rocky Ridge					X	X	X		X			X	I, A, S	F							
Montane Yellow Birch-Red Spruce Forest					X	X			X	X		X	I, A	F							
Red Spruce-Northern Hardwood					X	X	X	X	X	X		X	I, A	F							
Lowland Spruce-Fir Forest				X	X	X	X		X			X	I, A	F							
Boreal Talus Woodland					X				X	X		X	I, A	F							
Cold-Air Talus Woodland					X	X		X	X	X	X	X	I, A	F							
Limestone Bluff Cedar-Pine Forest					X	X	X				X		Q, W				X				
Transition Hardwood Talus Woodland					X	X	X				X		Q, W				X				
Dry Oak Woodland					X	X	X						Q, C				X				

Vermont Species & Habitat Climate	H	I	J	K	
Species and Habitats	Thermal Stress	Toxic Substances-Pollution	Hanitat Fragmentation	Inventory Need	Notes
Wetland Habitats					
Cattail Marsh		X	X		invasives - Phragmites
Shallow Emergent Marsh		X	X		invasives
Marsh and Sedge Meadow (Formation)		X	X		invasives
Alluvial Shrub Swamp		X	X		
Basin swamps & wetlands		X	X		Variability of water level could impact dragonfly transformation.
Floodplains		X	X		Elm was once an important component to floodplains
Ground water seepage & Flood swamp			X		Most vulnerable species include Black ash (AB) & Hemlock (WA)
Open peatlands (precip-dependent)					Black spruce and Sphagnum - Impacts of drying
Open peatlands (ground-fed)					Sphagnum is most vulnerable species
Floodplain Forests		X	X		Boxelder is non-native and likely to expand
Wet Shores					
Upland Habitats					
Alpine Meadow					More krumholz?
Spruce-Fir-Northern Hardwood			X		Most vulnerable species include Spruce & Fir
Northern Hardwood Forest			X		Most vul is Hemlock. Oaks & hickory will benefit
Oak-Pine - Dry Mesic Forests & Woodlands with deeper soils			X		Hemlock (HWA) will decrease; oaks and hickories will increase
Rocky Forests and Woodlands			X		Possible increase in red pine; possible decrease in N. white cedar due to drought and temp increase
Oak-Pine Southern Rocky - Southern Dry Rocky Forests and Woodlands			X		increase in oaks, hickories, white pine, and pitch pine
Outcrops and upland meadows					All woody species are likely to decrease in abundance due to heat and drought stress.
Cliffs and Talus					
Upland shores					Encroachment of woody species if there is less ice-scour and flooding.
Subalpine Krummholz					Less spruce and fir - area compressed
Montane Spruce-fir					Less spruce and fir, more hardwood
Red Spruce-Heath Rocky Ridge					Less spruce and fir, more hardwood
Montane Yellow Birch-Red Spruce Forest					Less spruce and fir, more hardwood
Red Spruce-Northern Hardwood					Less spruce and fir, more hardwood
Lowland Spruce-Fir Forest					Less spruce and fir, more hardwood
Boreal Talus Woodland					Less spruce and fir, more hardwood
Cold-Air Talus Woodland					Less spruce and fir, more hardwood
Limestone Bluff Cedar-Pine Forest					
Transition Hardwood Talus Woodland					less cedar more red pine
Dry Oak Woodland					< hemlock, more pitch pine if more fires, more hickory if not

Vermont Species & Habitat Climate Vulnerability Assessment											Exposures & Key Climate											
	Vulnerability			Sensitivity Factors							A	B	C	D	E	F	G	H	I	J	K	L
Species and Habitats	Climate Vulnerability Rating	Confidence Score	Vulnerability to non-climate stressors	Habitat specificity	Edge of range	Enviro or physiological tolerance	Interspecific or phenological dependence	Mobility	Exotic Pathogens or Invasive Species	Annual temperature - Increase	Seasonal temperature - Increase	# Hot days - More	# Cold days - Fewer	Variability - Increase	Annual precipitation - Increase	Seasonal precipitation - Variable	Heavy rainfall events - Increase	Soil moisture - Decrease	Snow - Decrease	Spring flows - Earlier	Summer low flow - Longers
Freshwater Habitats																						
Medium-sized river (4-6 order)	M	M								X	X	X					X				X
Large river (7+ stream order)	L	M									X	X					X				X
High gradient, coldwater acidic, 1-2 order	H	H								X	X	X	X	X		X	X		X	X	X
High gradient, coldwater, not acidic, 1-2 order	H	H								X	X	X		X		X	X			X	X
Low gradient marsh	M	M								X	X	X	X			X	X				X
Lake Champlain valley	M	M								X	X	X		X			X			X	X
High Elevation Lake	M	L	L								X	X		X						X	
Dystrophic Lake	M	L	L								X	X		X							
Lake - Oligotrophic, Stratified	L	H	L							X	X	X	X								
Mesotrophic-Eutrophic Lake (stratified)	M	M	M							X	X	X	X			X			X		
Mesotrophic-Eutrophic Lake (unstratified)	H	M	M							X	X	X	X	X			X		X		
Unstratified lakes	M	H	H							X	X	X	X	X	X	X	X		X	X	X
Stratified Lakes	M	H	H							X	X	X	X	X	X	X	X		X	X	X

Vermont Species & Habitat Climate Change Factors															Non-Climate Stressors						
	M	N	O	P	Q	R	S	T	U	V	W				A	B	C	D	E	F	G
Species and Habitats	Ice dynamics - Changing	Fluctuating lake levels - Increase	Lake stratification	Flood events - Increase	# of short-term droughts - Increase	Storms - Increase	Fire	Growing season - Longer	Onset of spring - Earlier	Onset of fall - Later	Biological interactions	Other	List of exposures with the greatest Negative	List of exposures that might be beneficial	Acidity	Habitat Alteration-Altered Hydrology	Invasive Species	Channel Erosion-Sedimentation	Encroachment	Land Erosion	Nutrient Loading
Freshwater Habitats																					
Medium-sized river (4-6 order)				X	X								L, C, P	F							
Large river (7+ stream order)				X	X								L, C, P	F, T							
High gradient, coldwater acidic, 1-2 order				X	X								F, H								
High gradient, coldwater, not acidic, 1-2 order				X	X	X							C, H, L	F, H							
Low gradient marsh				X	X								C, L	F							
Lake Champlain valley				X	X								C, L	F							
High Elevation Lake		X			X									B, M	X	X					
Dystrophic Lake		X		X	X							X	P, Q	B, M	X	X					
Lake - Oligotrophic, Stratified	X	X	X	X	X							X	A, B, C, D						X	X	X
Mesotrophic-Eutrophic Lake (stratified)	X	X	X	X	X	X		X			X		A, B, C, D, N				X		X	X	X
Mesotrophic-Eutrophic Lake (unstratified)	X	X		X	X	X		X			X		B, C, N	X			X		X	X	X
Unstratified lakes	X	X	X	X	X	X		X	X	X	X						X	X	X		X
Stratified Lakes	X	X	X	X		X											X	X	X		

Vermont Species & Habitat Climate					
	H	I	J	K	
Species and Habitats	Thermal Stress	Toxic Substances-Pollution	Hanitat Fragmentation	Inventory Need	Notes
Freshwater Habitats					
Medium-sized river (4-6 order)					Compositional changes may include loss of pearlshell
Large river (7+ stream order)					Compositional changes include an increase in the number of warm water species
High gradient, coldwater acidic, 1-2 order					Potential loss of coldwater stenotherms
High gradient, coldwater, not acidic, 1-2 order					Potential loss of coldwater stenotherms
Low gradient marsh					Potential loss of coldwater stenotherms
Lake Champlain valley					
High Elevation Lake					Most vulnerable species include brook trout
Dystrophic Lake					Most vulnerable species include brook trout
Lake - Oligotrophic, Stratified		X			Most vulnerable species include Lake trout & Round Whitefish
Mesotrophic-Eutrophic Lake (stratified)		X			Lake trount, smelt & pike will be most vulnerable
Mesotrophic-Eutrophic Lake (unstratified)		X			
Unstratified lakes					
Stratified Lakes					

Vulnerability Rating Key

Code		Description
E	Extremely Vulnerable	Abundance and/or range extent in Vermont extremely likely to substantially decrease (>75% loss) or disappear by 2050
H	Highly Vulnerable	Abundance and/or range extent in Vermont likely to decrease significantly (25-75% loss) by 2050
M	Moderately Vulnerable	Abundance and/or range extent in Vermont likely to decrease (10-25% loss) by 2050
L	Slightly Vulnerable	Available evidence does not suggest that abundance and/or range extent in Vermont will change (decrease, 5 - 10% loss) by 2050
N	Not Vulnerable, No Effect	Abundance and/or range extent in Vermont likely to increase or decrease by less than 5% by 2050
B	Increase Possible or Likely	Available evidence suggests that abundance and/or range extent in Vermont is likely to increase (>15% increase) by 2050
U	Unknown/Uncertain	Available evidence not available or not conclusive at this time

Confidence Ratings

Code		Description
L	Low	Not very confident (0-30% certainty in vulnerability score)
M	Moderate	Somewhat confident (30-60% certainty in vulnerability score)
H	High	Very confident (>60% certainty in vulnerability score)

Non-Climate Stressors

Code	Description
A	Acidity/Pollution
B	Habitat Alteration/Altered Hydrology
C	Invasive Species
D	Channel Erosion/Sedimentation
E	Encroachments
F	Land Erosion
G	Nutrient loading
H	Thermal Stress
I	Toxic Substances/Pollution
J	Habitat Fragmentation
Enter as free text	Other

Exposures & Key Climate Change Factors				
	Code	**Parameter**	**Trend**	**Projections (range = low to high emissions scenario)**
Temperature	**A**	Annual temperature	increase	by 2050, projected increase 3.7 to 5.8°F; by 2100, 5.0 to 9.5°F
	B	Seasonal temperature	increase	by 2050, projected increase in winter (DJF) 4.3 to 6.1°F; summer (JJA) 3.8 to 6.4°F
	C	# Hot days	more	more frequent and more intense; by end of century, northern cities can expect 30-60+ days of temperatures >90°F
	D	# Cold days	fewer	reduction in days with cold (<0° F) temperatures
	E	Variability	increase	greater variability (more ups and downs)
Hydrology	**F**	Annual precipitation	increase	by end of century, projected total increase of 10% (about 4 inches per year)
	G	Seasonal precipitation	variable	more winter rain, less snow; by 2050, winter precipitation could increase by 11 to 16% on average; little change expected in summer, but projections are highly variable
	H	Heavy rainfall events	increase	more frequent and intense
	I	Soil moisture	decrease	reduction in soil moisture and increase in evaporation rates in the summer
	J	Snow	decrease	fewer days with snow cover (by end of century could lose 1/4 to 1/2+ of snow-covered days; increased snow density
	K	Spring flows	earlier	earlier snowmelt, earlier high spring flows; could occur 10 days to >2 weeks earlier
	L	Summer low flows	longer	extended summer low-flow periods; could increase by nearly a month under high emissions scenario
	M	Ice dynamics	changing	less ice cover, reduced ice thickness
	N	Fluctuating lake levels	increase	greater variability, greater amount of change in lake levels
	O	Lake stratification		some lakes may stratify earlier
Extreme events	**P**	Flood events	increase	more likely, particularly in winter and particularly under the high emissions scenario
	Q	# of short-term droughts	increase	by end of century, under high emissions scenario, short terms droughts could occur as much as once per year in some places
	R	Storms	increase	more frequent and intense (ice, wind, etc.)
	S	Fire		more likely
Phenology	**T**	Growing season	longer	by end of century, projected to be 4 to 6 weeks longer
	U	Onset of spring	earlier	by end of century, could be 1 to almost 3 weeks earlier
	V	Onset of fall	later	by end of century, could arrive 2 to 3 weeks later
	W	Biological interactions		could potentially be disrupted

Appendix E

Taking Action: Implementing Vermont's First Wildlife Action Plan 2005-2015

2015

Taking Action: Implementing Vermont's First Wildlife Action Plan 2005-2015

A Decade of Fish and Wildlife Conservation

When the State Wildlife Grants (SWG) program began in 2001, the program came with a mandate: For states to continue to receive funding after 2005, they must adopt a strategic plan for prioritizing the conservation of the state's fish and wildlife with a focus on Species of Greatest Conservation Need (SGCN)—wildlife with declining populations, those that are threatened or potentially threatened, or those about which we knew so little that we had no means to assess conservation status.

The 2005 Wildlife Action Plan identified 143 vertebrates, 191 invertebrates, and 577 plants as SGCN. To provide guidance for the protection of these species, the plan also identified problems faced by these SGCN. While diverse, the most common of these problems included:

- Information needs and data gaps
- Loss of habitat
- Impacts of roads and trails
- Pollution and sedimentation
- Invasive species
- Climate change

The plan went on to recommend strategies for aiding SGCN to survive and thrive in the face of the above problems.

Now it is 2015, and a decade has passed since the Wildlife Action Plan was adopted. Vermont has made great strides to implement its Action Plan, and this document attempts to capture some of the success Vermont has had in accomplishing the plan's goals.

State Wildlife Grant has been a major source of funding for the projects below, though certainly not the only source. If not otherwise noted, it can be assumed that these projects were completed using SWG funds.

Surveys, Monitoring, and Data Systems

If we don't know what we have, we don't know what to conserve. While our knowledge of species has improved substantially over time, the 2005 Wildlife Action Plan identified numerous information gaps that have prevented us from creating conservation plans or implementing management strategies for many groups of wildlife. We didn't know what threats some species face or have a good grasp of their population dynamics. Over the past decade, Vermont has worked to fill many of these holes through surveys of species abundance and distribution. In many cases, trained volunteers aided in data collection efforts, amplifying the quantity of data collected and providing opportunities for public awareness. Updated data management systems also helped us to compile information, much of which can now be accessed by planners, government entities, conservation organizations and, in some cases, interested citizens.

Invertebrates

Vermont Butterfly Atlas

The Vermont Butterfly Atlas (2002-2007) surveyed the entire state and analyzed historic records and collections to document the distribution of 103 butterfly species, including 12 species new to Vermont as well as giant silkworm moths. The project was collaboration between VFWD, the Vermont Center for Ecostudies, and the Vermont Institute of Natural Sciences with more than 200 citizen scientists participating. Assessing the conservation status of each species and establishing a baseline for understanding future changes was the principle goal of the Atlas. Fifteen species were listed as Species of Greatest Conservation Need representing three ecological groups—wetlands, grasslands, and hardwood forests. We also calculated the vulnerability to climate change for 14 butterfly SGCN currently found in Vermont. Three species were found to be extremely vulnerable to climate change, five were highly vulnerable, one moderately vulnerable, three presumed stable and two could likely increase in numbers in Vermont. We hope to see the Butterfly Atlas repeated in ~2027 as a comparison to this baseline. More information, including *The Vermont Butterfly Survey, 2002 - 2007: A Final Report,* can be found at *http://www.vermontbutterflysurvey.org/*.

Damselfly and Dragonfly Survey

From 2007-2009 the first statewide field surveys, focused on peatland and large river habitat, were conducted to detect the presence of dragonflies and damselflies (collectively known as odonates) including 27 Species of Greatest Conservation Need. The survey data when compiled with existing records resulted in a total count of 142 odonate species in the state—98 dragonflies and 44 damselflies. This effort provided vital species distribution and occurrence information which has broadened our understanding of rare habitat-specialist dragonfly and damselfly SGCN. Habitat data collected as part of the study provides a comparative baseline for future population trend monitoring. Among the investigation's results were: new encounters with *Gomphus abbreviatus* (very rare to rare) on two rivers and a moderate gain in the knowledge of *Ophiogomphus* spp. (four species), particularly on the White River; discovery of at least two previously unknown populations of *Neurocordulia yamaskinensis* (uncommon), a species that had been rarely encountered in Vermont; an expanded knowledge of *Somatochlora* spp. (seven species) distribution in and around peatlands, including *S. albicincta* (very rare), *S. cingulata* (very rare to rare) and *S. franklini* (very rare to rare), revealing that Silvio Conte National Wildlife Refuge and West Mountain Wildlife Management Area have some of the highest *Somatochlora* diversity in New England; and two new peatland sites for *Williamsonia fletcheri* (very rare to rare). Future efforts toward odonate SGCN conservation will continue to rely on the information resulting from this and future field studies.

Bumble Bee Survey

When public attention was brought to bumble bee declines in the last decade, the Vermont Center for Ecostudies worked with the Vermont Fish & Wildlife Department to document distribution and determine the status of bumble bee species in the state. With the help of citizen scientists, a two-year survey amassed over 10,000 current bumblebee records from more than 1,500 locations, which were then compared to historic data. Twelve of the 17 species previously reported from Vermont were collected during this period. Three species appear to be more widespread than in the past, as well as the carpenter bee, which seems to have extended its range northward. This project enabled the Vermont Fish & Wildlife Department to assess the Natural Heritage conservation status of all of Vermont's bumble bee species in 2014, resulting in three species ranked as rare, one as uncommon, eight as common, three as having only historical records, and two species lacking information adequate to assign a rank. The three rare species were added to Vermont's Threatened and Endangered Species list in 2015: The Rusty-patched Bumble Bee (*Bombus affinis*) and Ashton Cuckoo Bumble Bee (*B. ashtoni*) are now listed as endangered, and the Yellow-banded Bumble Bee (*B. terricola*) is threatened. Harmful parasites accidentally imported from Europe and neonicotinoids, a class of pesticides toxic to bees and other insect pollinators, are believed to account for the bumble bee declines

Freshwater Mussels

Freshwater mussels are now recognized as the most endangered group of aquatic species in North America. In Vermont, ten of the eighteen native species are listed under the state endangered species law, one is federally endangered, and several others are considered rare. Between 2003 and 2010, surveys sought to describe the abundance, distribution, and habits of Vermont's freshwater mussel populations. Findings included a drastic decline in Brook Floater and a dramatic increase in Eastern Elliptio species in the West River. We now know more about fish hosts for Creek Heelsplitter and Fluted-shell, and have a better understanding of the distribution of Dwarf Wedgemussel and Elktoe. VFWD is in the process of developing a multi-species freshwater mussel recovery plan based on survey findings.

Vermont Invertebrate Database

The paucity of basic information such as species presence, geographic distribution, habitat associations, and life history has limited our ability to direct conservation actions for most groups of invertebrates. Some years ago, the Invertebrate Scientific Advisory Group to the Vermont Agency of Natural Resources' Endangered Species Committee recognized that a substantial amount of information already exists in past invertebrate collecting and research in Vermont, although it is scattered among various collections, government offices, research facilities, published works, gray literature, and other sources. The group recommended a centralized repository of invertebrate species data. What followed was the Vermont Invertebrate Database, an effort that beginning in 2006 compiled over 75,000 records representing over 400 species of invertebrate gathered from museum and private collections and literature. These data have been incorporated into the Vermont Atlas of Life, a database maintained by the Vermont Center for Ecostudies to provide a baseline of information for a broad spectrum of invertebrate taxa for future invertebrate conservation and research planning efforts.

Fish

Fish Surveys

Twenty-three percent of Vermont's native fish species are currently designated as rare, and many of these have experienced population declines due to habitat disturbance, overharvesting, pollutants, and the introduction of invasive species. Between 2004 and 2011, five Vermont water bodies were sampled to document abundance and distribution of some of these rare species (Lake Champlain, Holland Pond, Black River, Poultney River, and Missisquoi River). Surveys targeted Lake Sturgeon; Muskellunge; Shorthead, Greater, and Silver Redhorse; Eastern Sand and Channel Darter; Blackchin, Blacknose, and Bridle Shiner; Round Whitefish; and Stonecat. When Stonecat was discovered in a new location in 2004, fisheries biologists wondered if there may be additional, undiscovered populations, and rigorous additional effort was placed on locating new sites, to no avail. Sturgeon spawning was detected in three of the four rivers that had been known spawning sites in the past (Sturgeon spawning was detected in the Winooski, Lamoille, and Missisquoi Rivers), but not in the fourth, Otter Creek. The Sturgeon project also included genetic sampling of the Lake Champlain population, indicating that our local sturgeon is genetically distinct from other North American populations. Significant effort was placed on Muskellunge surveys not only to assess the current population but also to determine the potential to restore the species. Muskellunge were documented in Otter Creek (population established from a stocking program in the 1980's). None were captured in the Missisquoi River. The Missisquoi River between Swanton and Highgate dams is believed to have been the last known refuge population of "native" strain musky in the state but appears to have become extirpated following a chemical spill to the river during the 1970s.

Fish Historical Record Scanning

From the late 1800s to the 1960s, records of fish management activities and observations were documented in diverse paper formats and stored in several physical locations across the state. In recent years, much time and attention has been given to rare or endangered species, species in decline, fish and wildlife species distribution, fish and wildlife community changes and fish and wildlife species genetic composition, and yet the important historic data that could inform management strategies on these topics were difficult to access. For this project, over 2,000 documents were digitally scanned with text recognition software, and over 50 years of stocking records have been compiled into a digital database and made available through the Department's internal website. The digital format, text recognition capabilities and searchable databases have enhanced our ability to access these records to better understand historic species distribution and abundance, past management activities, and cultural impacts that may have influenced current fish and wildlife populations. This information is critical to making meaningful decisions for future conservation activities.

Amphibians and Reptiles

Town Surveys for Reptiles and Amphibians

First published in 1995, the Vermont Reptile and Amphibian Atlas relies heavily on volunteer citizen scientists to submit records of reptiles and amphibians throughout the state. The Atlas has greatly added to Vermont's knowledge of herp distribution and abundance, but one challenge with this type of volunteer-driven project is that some towns remain poorly surveyed. In these locations, knowledge of amphibian and reptile presence is very limited. In 2006, the Vermont Fish & Wildlife Department applied for a State Wildlife Grant to help fill some gaps by surveying three under-represented Vermont towns. In each town, 10-15 previously undocumented species were recorded.

The North American Racer, Eastern Ribbonsnake, and Common Five-lined Skink—all rare species in Vermont—were also surveyed statewide, resulting in many new and confirmed reports from both new and previously-reported locations.

Rare Amphibian Surveys

When the Boreal Chorus Frog was listed as a state endangered species in 1987, the cause of the population decline was—and still is—unknown. By 2007, it was unclear whether the frog remained on the landscape. While surveys followed over the next three years, the species was not detected, leaving us to suspect that the frog may either be extirpated from the state or no longer has any viable populations here. Fowler's Toads were also subject to repeated, targeted surveys in 2008, and these also failed to produce any occurrences. This toad species was last documented in 2007, and it has now been added to the state's endangered species list. Mudpuppy was also considered for threatened status in Vermont in 2011, but the decision was made against listing the species. This decision was based upon 2008-2010 surveys in which Vermont Fish & Wildlife Department refined a methodology to more effectively survey this difficult-to-detect species and thus learned more about mudpuppy population distribution. As part of this project, genetic sequencing across the state also revealed that Lake Champlain Mudpuppies show significant differentiation from those in the Connecticut River basin, which may have been introduced from outside the state.

Rare Snake Surveys

Timber Rattlesnakes, Eastern Ratsnakes and North American Racers are all restricted to just a few locations in Vermont. The rattlesnake is listed as state endangered and the ratsnake and racer are threatened. Traffic, mowing, and intentional kill all pose threats, as does human visitation to denning areas. In 2010, SWG funded a rattlesnake telemetry study to gain insight on home range and movements, parcel utilization, genetic analyses and some population demographic information, which provided a basis for developing the state's 2015 Rattlesnake Recovery Plan. Essential to the project were staff of The Nature Conservancy, local citizen volunteers, the Herp Scientific Advisory Group, and Vermont Reptile and Amphibian Atlas staff and contributors. During the project, Snake Fungal Disease was confirmed in both of Vermont's two rattlesnake populations. In 2012, a radio telemetry study was also completed for Eastern Ratsnakes to expand the knowledge base and known Vermont range for this species. North American Racers have been surveyed numerous times since 2006, with the latest two documented sightings surfacing in 2014. A Racer Habitat Improvement Project conducted from 2007-2014 in one Wildlife Management Area (WMA) has created new racer travel cover, several experimental hibernacula, foraging cover and egg-laying substrate.

Turtle Conservation, Planning, and Management

It is uncertain what the future holds for any of Vermont's seven turtle species. The Spotted Turtle is state endangered, the Spiny Softshell is state threatened, Wood and Musk Turtles have been identified as SGCN, and even the remaining are vulnerable to boat traffic, human disturbance, egg predation, road mortality, collection, and habitat conversion. With the help of SWG, USDA Wildlife Services, many volunteers, the Friends of Northern Lake Champlain, ECHO Lake Aquarium and Science Center, Missisquoi National Wildlife Refuge, the Vermont Forests, Parks, and Recreation Department, Audubon Vermont, and Green Mountain Audubon, VFWD established a Spiny Softshell Turtle monitoring and management program to develop and implement conservation and recovery methods for softshell turtles in Vermont. Several large, communal nesting beaches are intensively managed for the Spiny Softshell, with Map, Snapping, Painted, and Musk turtles also benefiting. Initial monitoring not only enhanced knowledge of distribution but also made it clear how to manage communal nesting areas to save eggs and hatchlings from predation, parasitic flies, and drowning. Additional turtle studies included a genetic analysis indicating that there is no female-mediated gene flow between the two Spiny Softshell subpopulations in the state and radio-tagging of Spotted Turtles to learn more about movements and habitat use. Invasive plants have been controlled at a Spotted Turtle Wetland.

Vernal Pool Mapping

Vernal pools are vital breeding habitat for a range of species, including several amphibians. A series of State Wildlife Grants helped in funding first a project that mapped potential vernal pools across the state using infrared photographs, and then to verify the mapped sites through field investigation. Work on this project is ongoing and relies on a large volunteer base as well as a partnership with Vermont Center for Ecostudies and Arrowwood Environmental. In all, some 2500 amphibian breeding sites were cataloged statewide. More information can be found at *http://vtecostudies.org/projects/forests/vernal-pool-conservation/vermont-vernal-pool-mapping-project/*.

Mammals

Rare Carnivores

For the most part, rare carnivore studies are limited to the collection and analysis of reported citizens' sighting information related to American Marten and Canada Lynx. Between 2005 and 2015, this involved reported sightings of 44 marten (27 confirmed) and 45 lynx (9 confirmed). For American Marten and Canada Lynx—species with known populations in the state—additional survey efforts to delineate presence include winter track surveys, remote cameras, and genetic analysis. A regional lynx survey—funded by USFWS's Endangered Species Program—was also conducted in cooperation with Silvio O. Conte National Wildlife Refuge and New Hampshire Fish & Game to test a remote camera-based protocol, and so far, 16 lynx have been recorded. A similar remote camera protocol was used to detect marten, with 8 successful detections. Genetic samples of rare carnivores have also confirmed one wolf, 17 marten, and four lynx. Because lynx sightings have been increasing, VFWD is also implementing a Canada Lynx Response and Handling Protocol to guide staff in their response to cases of injured, sick, or otherwise incapacitated lynx. Most of this rare carnivore work is funded through the Wildlife Restoration Program. We also received 317 citizen reports of mountain lions (none confirmed) and 6 wolves (none confirmed).

Bat Conservation and Management

There are nine species of bat in Vermont, and all have been identified as important conservation targets. In 2003, VFWD established a Bat Conservation and Management Program to learn more about distribution, abundance, and effective conservation strategies for all nine species. When White Nose Syndrome appeared in the Northeast, monitoring efforts intensified, including spring, summer, and fall mist net surveys coupled with winter cave surveys of large hibernacula. These revealed population declines in excess of 90% between 2008 and 2010 at many sites, with a lower rate of decline by 2013. An outreach effort known as "Got Bats?" was also implemented to collect citizen reports of Big Brown and Little Brown Bats in structures such as barns, attics, and bat houses, mapping over 500 maternity colonies across the state. This revealed that Little Brown Bat maternity colonies, once widespread and abundant, are now found primarily in the Champlain Valley. Radio telemetry tracking of Indiana Bats further aided in the development of a publication, *Forest Management Guidelines for Indiana Bats*, that details a series of conservation strategies developed over the course of the project. The funding for this work has been shifting from SWG to Wildlife Restoration Program funds.

Small Mammals of Vermont Atlas

When the 2005 WAP identified a need to improve our understanding of the status and needs of many of Vermont's small mammals, the Small Mammals Atlas was developed in response. In addition to compiling historic documents and museum collections, Small Mammals Atlas project staff conducted field surveys documenting 2,844 small mammal captures from 47 sites. This allowed for the construction of distribution maps for all 23 small mammal species in Vermont.

Birds

Breeding Bird Atlas

First published in 1985 using survey information from 1977-1981, a new Breeding Bird Atlas *(http://www.vermontbirds.org/)* was completed using surveys from 2003-2007, allowing for comparisons in bird distribution over time. This time, 200 bird species were documented—with accompanying range maps—including 17 species that were added since the first atlas and 14 species from the 1985 version that could not be confirmed as breeding in the state in 2007. Over 300 bird-savvy volunteers contributed expertise and nearly 30,000 hours for this Atlas. Vermont Center for Ecostudies handled project coordination with help from Audubon Vermont and its chapters, the University of Vermont, the National Wildlife Federation, and the VFWD. Additional funding from the World Climate Research Program helped make this possible. A website maintained by Patuxent Wildlife Research Center makes Vermont's breeding bird data accessible, at *http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=vt2003*.

Threats to Vermont's Mountain Birds

Bicknell's Thrush, Blackpoll Warbler, Swainson's Thrush, and several other bird species require the dense shrub thicket found only on Vermont's highest peaks as nesting habitat. This habitat type is not common, which limits the number of nests the birds can build and is often also correlated with low nesting success. Between 2007 and 2011, the Vermont Fish & Wildlife Department supported scientists at the Vermont Center for Ecostudies with the revision of the Mountain Bird Watch monitoring protocol to improve the estimating power of species abundance, distribution, and habitat preferences. This baseline information will allow the monitoring of population and habitat changes associated with climate change, habitat conversion/alteration, and pollution. A report of this study, commonly called "Birdwatch 2.0" can be found at *http://vtecostudies.org/wp-content/uploads/2014/09/VCE-MBW-USFWS-report-2013.pdf*.

Plants and Natural Communities

Rare, Threatened, and Endangered Plant Monitoring

Each year, New England Wild Flower Society and Vermont Fish & Wildlife Department train volunteers to monitor populations of regionally rare plants. In addition to locating and monitoring populations, there is currently a focus on seed collection of New England's rarest plants and identification of high priority sites for management. Vermont Fish & Wildlife Department conducts additional, regular monitoring of the endangered Northeast Bulrush and Jesup's Milk-vetch. Just this year, four new plant species were listed as endangered in Vermont: The Dwarf Birch, Tulip Tree, Whorled Milkweed, and Green Mountain Quillwort. Funding for the federally listed plant species comes, in part, from USFWS's Endangered Species Program; other funding is from Vermont's general fund.

Natural Community Inventories

Natural community inventories are a primary tool for identifying conservation targets, refining the natural community classification, and identifying important wildlife associations with natural communities. In the past decade, Vermont Fish & Wildlife Department has sought to fill data gaps by conducting inventories of Dwarf Shrub Bogs, Poor Fens, Limestone Bluff-Cedar Pine Forests, all types of softwood swamps, and Montane Spruce-Fir Forests. The Department is currently completing a statewide inventory of oak-pine-northern hardwood forest types. Results from these projects include identification of state-significant examples of natural communities that are added to the Natural Heritage Database and providing recommendations to private landowners on how best to manage the natural communities they own. State-significant examples of natural communities are considered high priority for conservation on both public and private land. Natural community inventory work remains a priority of the Department and will continue in years to come.

Invasive Species

Housed by the Vermont office of The Nature Conservancy, the iMap Invasives database tracks invasive species infestations, management activities to control them, and documentation of post-management population changes. Ongoing trainings by the Vermont Fish & Wildlife Department and The Nature Conservancy aid volunteers in correctly identifying invasive species and properly using the database. The Vermont Agency of Transportation has also partnered on the project to locate and document invasive plants along interstate highways. This work is supported via a contract with Florida State University, and the site can be found at *www.vtinvasives.org*. It follows up on previous work conducted in partnership with the New England Wildflower Society to train volunteers to conduct invasive plant surveys for the Invasive Plant Atlas of New England.

Herbarium Records

New England Wild Flower Society's 2003 Herbarium Recovery Project documented and annotated more than 18,600 specimens of regionally rare plants housed in 42 herbaria, and more than 90% of the data of interest to Vermont from this project has now been entered in Vermont's Natural Heritage Database. Additional specimen data from Vermont's own herbarium records has also been updated, and Vermont's Pringle Herbarium records are being scanned into the Consortium of Northeast Herbaria portal (*http://portal.neherbaria.org/portal/*) to make them more widely available. This project is paid for through Vermont's general fund.

Revision of Natural Community Ranking Specifications

Natural Community ranking specifications provide a means to consistently and objectively compare the relative importance of each occurrence of a natural community type across the state. New ranking specifications were developed for all 95 natural community types and a report on how to use these specifications is available for the public and consulting ecologists/biologists. The consistency in approach that is included in the natural community ranking specifications and the resulting Natural Heritage Database of state-significant natural communities has been the basis for including natural communities in recent revisions to two rules and land use provisions in Vermont: the Vermont Wetland Rules now includes significant wetland natural communities as a protected function, and Vermont's Use Value Appraisal program now allows for significant natural communities to be enrolled as Ecologically Significant Treatment Areas. Plant rarity ranks were also revised based on new records.

General Natural Heritage

Natural Heritage Inventory

Vermont's Natural Heritage Inventory documents the diversity of native plants, animals and natural communities in the state. The inventory is maintained using the "Biotics" software, which provides a common data management platform for members of the NatureServe network to achieve and maintain a unified taxonomy and consistent application of our shared data standards and methodology. The database tracks natural heritage elements including taxonomy, nomenclature, rarity ranks, habitat descriptions, threats, trends, and additional information for 1260 animal species, 1425 plant species, and 92 natural community types. In addition, there are over 10,000 populations documented, complete with GIS mapping. General information is available to the public for planning purposes through Vermont Center for Geographic Information (*http://www.vcgi.org/*) and the Agency of Natural Resources' online Atlas (*http://anrmaps.vermont.gov/websites/anra5/*). More detailed attribute data is made available to partners through data use agreements. NatureServe is a major partner and provides software support for Biotics and serves as a centralized repository for North American biodiversity information.

Structured Decision-making

The Vermont Fish & Wildlife Department, in partnership with the University of Vermont, developed a system for managing, archiving, sharing and analyzing wildlife data and information. This new system, known as Resources of Vermont, or ROVER, is a comprehensive database for a wealth of wildlife data in Vermont that compliments the comprehensive Natural Heritage Database that addresses rare, threatened, and endangered species and significant natural communities. While it will continue to grow and evolve it currently supports data for many species of birds and mammals. It will be used in the future to guide conservation decisions by providing more effective access to data and greater abilities to analyze and interpret information.

Wildlife Management Area Inventories

Whenever possible, Vermont uses Long Range Management Plans to guide activities in state-owned Wildlife Management Areas. Since 2004, the Vermont Fish and Wildlife Department routinely inventories bats, breeding birds, reptiles, and amphibians in state Wildlife Management Areas, to aid in the creation of well-informed management plans.

Research

The 2005 Wildlife Action Plan identified gaps not only in our knowledge of species abundance and distribution but also in potential threats species face, interactions with surrounding natural or human-altered landscapes, and the identification of conservation needs. The following are research projects seeking to answer questions that will inform the management of wildlife or their habitats.

Fishes

Lake Whitefish

In Vermont, Lake Whitefish occurs only in Lake Champlain where, prior to its closure in 1913, there was a substantial commercial seining whitefish fishery. Recent research conducted by the University of Vermont concluded the population is stable and unexploited but populations that once existed at two locations in the lake once supporting commercial harvest appear to be extirpated due to past exploitation and/or degraded spawning habitat. The university is currently conducting research of the effects of man-made barriers (e.g. causeways) in limiting whitefish movements among bays within the lake and whether these are causing the formation of spatially separate and genetically differentiated sub-populations within the lake. This work was partially funded by a State Wildlife Grant awarded by Vermont Fish & Wildlife Department. Other possible threats to Lake Whitefish in Lake Champlain are competition with exotic species (e.g. Alewife) and Sea Lamprey parasitism.

Stream Temperature

Because of land clearing, dams, and other shifts in land use that remove shade from stream banks, some of Vermont's historic trout streams are now too warm to support healthy trout populations. With funding from the State Wildlife Grant program, the Vermont Fish and Wildlife Department conducted a series of case studies to model watershed temperature conditions and predict quality brook trout habitat. One study examined potential management scenarios on river temperatures, finding that increasing shade on just the upper 50% of the watershed has a high impact on the resulting downstream water temperatures. In a second study, metrics were developed that allow researchers to assess coldwater habitat suitability when only temperature data are available. This study produced recommendations which can guide decision making for the conservation of native salmonid populations.

Stream Morphology

Physical processes form habitat in a stream channel, such as movement of sediment or woody debris, formation of scour and depositional features, and dynamic riverbank changes. Combined with chemical constituents and biological interactions, physical habitat determines biological productivity and diversity and drives the aquatic ecosystem. By taking a detailed look at the habitat resulting from the physical processes taking place in a stream, it may be possible to understand how fluvial processes impact aquatic communities. The Vermont Agency of Natural Resources Reach Habitat Assessment has been created as an integral part of the existing Vermont Stream Geomorphic Assessment Protocols, although it is also available for stand-alone usage. It builds on previous habitat assessments by fundamentally being based on stream processes and their link to resultant channel, bank, and cover features. Indicators of key physical ecological attributes were identified for inclusion in the assessment that are necessary for aquatic organisms to carry out life cycle functions.

Fish Health & Predator-Prey Dynamics

For fisheries biologists to effectively manage wild fish, they must first understand a wide variety of ecosystem functions, including diseases, predator-prey relationships, and more. For example, whirling disease is a parasite that can be detrimental to trout and salmon populations. From 2006-2008, Brook Trout, Brown Trout, Rainbow Trout and Atlantic Salmon were tested for the disease, which was confirmed to be present in several Vermont streams. In a different study, fisheries personnel developed standard operating procedures for hydro acoustic surveys that quantify populations of forage fish in Lake Champlain. These surveys are used to monitor the prey base for larger, predatory fish so that fisheries can maintain the balance of fish species in the lake.

Landlocked Salmon Stocking

Landlocked Atlantic salmon were once abundant in Lake Champlain, but habitat degradation and over-fishing destroyed the native population by 1850. Since 1973, the Vermont Fish and Wildlife Department, along with New York and the U.S. Fish and Wildlife Service, have since committed to restoring the salmon population and fishery. This effort relies on a successful stocking program—and there are several stocking methods that can be employed. The goal of this study was to evaluate one strategy to stock fry in tributaries to Lake Champlain. A rotary screw trap was employed to sample downstream migrating salmon smolts produced from fry stocking in the Huntington River, a tributary to the Winooski River and Lake Champlain. Results showed that significant numbers of smolts were produced, suggesting that fry stocking does indeed seem to be a promising restoration strategy.

Atlantic Salmon Genetics

Historically, anadromous Atlantic Salmon was native to the Connecticut River watershed but became extirpated by the early 1800s following construction of the first dam on the river in 1798 near present-day Turners Falls, Massachusetts. During the latter half of the 19th Century unsuccessful attempts to restore salmon to the river were undertaken. The most current restoration effort was initiated in 1965 and continued until 2012, when the U.S. Fish & Wildlife Service and other basin state fisheries agencies (New Hampshire, Massachusetts and Connecticut) withdrew from the program. Annual stocking of hatchery produced salmon fry continued through 2013 but since then no juvenile salmon have been released into Vermont waters, and smolt outmigration is expected to end after the spring of 2016. Even though salmon restoration has ended for the foreseeable future, its anticipated that adult salmon will return to the Connecticut River in small numbers and, therefore, will be provided upstream passage by dams at Holyoke and Turners Falls, Massachusetts and Vernon, Vermont as part of the power utilities commitment to providing fish passage for other anadromous fishes (e.g. American Shad). Given these recent events, anadromous Atlantic Salmon will likely remain an extirpated species in Vermont. In 2011, prior to termination of the salmon program, a State Wildlife Grant funded project was undertaken to test for genetic variation in smolt production and adult returns to determine smolt and adult return production from each stocked Connecticut River tributary. Genetic testing of samples has been completed, even though with termination of the restoration program this information probably will not be used to adaptively manage stocking efforts.

Lake Trout Genetics

Although Lake Trout are indigenous to most of Vermont's larger and deeper lakes, the status of the native populations was in question due to more than a century of stocking at all these lakes using lake trout sources from outside Vermont. A decade ago the lake trout populations in several Northeast Kingdom (NEK) lakes were supported entirely or predominantly by natural reproduction despite annual stocking. This study sought to determine the degree to which a century of lake trout stocking had genetically influenced these populations. Results irrefutably show that stocking has influenced all the contemporary populations, with the demonstrable degree of influence varying from one lake to another. However, the suite of genetics tests included in the study also reveals evidence that elements of the indigenous genomes persist. Unfortunately, in the absence of comprehensive historical documentation of lake trout stocking in Vermont accompanied by genetic material from the various source populations, it is impossible to describe the *family trees* of contemporary wild lake trout at the several NEK lakes. Lake trout stocking was discontinued in 2006 at most of the lakes, and the naturally reproducing populations continue to be monitored periodically.

Mammals

Indiana Bat

In 1973 the Indiana Bat was one of the first bats recognized as endangered under the federal Endangered Species Act. Populations then continued to drop through much of the species' range, although Vermont's summer populations have remained robust. Biologists recently began to suspect the decline's primary culprit to be the loss of summer habitat—particularly the roost trees where females form maternity colonies, give birth, and raise their young—but the recipe for attractive Indiana Bat habitat remained mysterious prior to this study. University of Vermont researchers worked with Vermont Fish & Wildlife Department staff to evaluate minimum habitat and maternity site requirements for the Champlain Valley and developed a tool to predict maternal nest sites and prioritize sites for conservation.

Bobcat Movement and Habitat Use

Animals with large home ranges can be tricky to study and manage, because their territories include a network of many different habitat types. The Bobcat is no exception, and prior to this study there were gaps in our knowledge of Bobcat habitat needs. To get a better sense of home range requirements, University of Vermont researchers and Vermont Fish & Wildlife Department staff captured Bobcats across a landscape that spanned urban, agricultural, and forested settings and outfitted them with GPS collars that recorded each individual's location over a 3-4-month period. This study provided critical information about how Bobcats travel through a landscape by staying under shrub cover as much as possible, allowed an estimation of minimum home range resource requirements for breeding females, and provided information to use in habitat suitability mapping and home range requirements for Bobcat conservation and landscape-scale management.

Habitat Blocks and Critical Crossings

Black Bear, Fisher, Marten, Lynx, and River Otter are among the species that rely both on large blocks of contiguous forest and secure means of crossing roads and human-impacted landscapes between these forest blocks. Although total forest cover in Vermont increased over the past century, it has again begun to decline, and it is breaking up into an increasing number of smaller blocks as a result of residential development and road construction. Because we still have a limited ability to prioritize conservation of these blocks and forest connecters, the Habitat Block project identified and mapped 4,055 habitat blocks, then evaluated them for biological and physical diversity and potential threat. Considerable work has been done to map and rank likely wildlife road crossing areas. Structural connectivity models showing potential road crossings have been developed and refined in partnership with the Agency of Transportation, and the Staying Connected Initiative is working with partners on several fronts toward a better understanding of functional connectivity. The Critical Paths project involved field-checking road crossings for signs of wildlife use, potential threat, and conservation priority, as well as several photo-monitoring projects that are capturing pictures of wildlife use of transportation infrastructure. Forest block and road crossing data has been made available to the public via the Vermont Agency of Natural Resources' online Atlas (*http://anrmaps.vermont.gov/websites/anra/*).

Birds

Bicknell's Thrush in Northeastern Vermont

Large-scale wind energy developments have recently been installed or proposed for several Vermont's peaks, and their arrival brought to the surface questions about the interplay between wind farms and the wildlife that inhabits Vermont's highest elevations. Because the peaks that developers believe are best suited for wind energy are largely covered by montane spruce-fir forest, this project studied possible effects from these developments on the rare Bicknell's Thrush that relies on this habitat. The wind project did not go forward, so the study was unable to ascertain the effects of building the towers. In their final report, biologists from Vermont Center for Ecostudies say that while Bicknell

Thrush ecology is too complex to make a specific prediction of development impacts, both short- and long-term effects are possible, and they may differ as initial impacts give way to succession. The report includes maps showing the location and size of current and potential Bicknell's habitat in the Northeast Highlands of Vermont, to be used to assess future wind development and conservation priorities. In addition to funding from State Wildlife Grants, the Nature Conservancy, Vermont Institute of Natural Science and Vermont Center for Ecostudies each provided aid.

Black Throated Blue Warbler Abundance and Nesting Productivity

Habitat quality—a phrase used extensively in conservation and land use planning—is often gauged by wildlife population counts. However, as habitats become modified for human uses and low-quality habitats become more dominant, wildlife may be using environmental cues that no longer relate to better reproductive success, causing them to make poor habitat choices. Indeed, results of this study indicate that for Black Throated Blue Warblers, preferred habitats did not correlate to the highest fitness levels in terms of daily nest survival or annual fecundity. It seems that predation and cowbird parasitism kept "popular" habitats from being as successful as some of the less-preferred habitats.

Landscape Conservation

Shoreline and Development Surveys for Vermont's Lakes

Lakeshores in Vermont provide vital habitat for a variety of SGCN, and until recently there was no regulation to protect them. This project compared the SGCN present in undeveloped and developed lakeshore areas, finding that except for aquatic plants, there were significantly fewer SGCN species present at the developed sites than the undeveloped shorelines. The study then used reserve design methodology to identify lakeshore areas that are most likely to support SGCN, producing a map that could be used to help prioritize lakeshore conservation efforts. The findings of this project also aided in efforts to get the Vermont legislature, governor, and the public to support lakeshore regulation, and in July of 2014, the Shoreland Protection Act was established.

Species Recovery

Over the past decade, 20 species (9 plants and 11 animals) were added to the state's Endangered Species list and are now receiving the additional protections that come with the listing. Because the goal of the endangered species program is recovery, some of these species have been targeted for additional action. A successful recovery restores a once endangered or threated species to a point where protection is no longer needed, because the species can sustain itself as a natural part of its ecosystem. Creating a recovery plan is generally the first step, which might include protection or restoration of habitat, species or habitat management activities, or even translocation of individuals from an outside population. The following are recovery projects that Vermont has undertaken in the past decade. All have been guided by the 2005 Wildlife Action Plan.

Invertebrate Recovery

The Cobblestone Tiger Beetle, the Hairy-necked Tiger Beetle, and several species of freshwater mussel are state-threatened in Vermont. After several years of surveying known populations of these invertebrates, Vermont Fish & Wildlife is in the process of completing recovery plans for the two tiger beetles and a multi-species recovery plan for freshwater mussel species, several of which are in rapid decline due to the invasion of the invasive Zebra Mussel.

Bat Recovery

Vermont Fish and Wildlife Department staff were in the process of creating a statewide bat conservation and recovery plan when two occurrences arose. First, proposals to expand wind energy facilities in Vermont brought up questions about the potential threat of wind development to bats, which needed to be better studied. In the winter of 2008, White Nose Syndrome (WNS) then appeared in Vermont, which has been detrimental to the bat population. Substantial efforts since then have gone toward research on the causes, threats, and spread of the disease. Now that the effects of both wind facilities and WNS are better studied and understood, a revised bat conservation and recovery plan can be developed, most likely within the next few years.

Bird Recovery

The past decade can claim several success stories among bird recovery efforts. Common Loon, Peregrine Falcon, and Osprey were all delisted from state-endangered status in 2005, and their recovery goals have been met. Common Tern is very close to its recovery goals and is being considered for downlisting, while the known nesting population of Bald Eagles in Vermont has grown from zero in 2007 to 18 nesting pairs with 17 fledglings in 2014. These species all continue to be monitored, with the help of Audubon Vermont, Vermont Center for Ecostudies and citizen volunteers. Other ongoing bird surveys include Black-backed Woodpecker, Whip-poor-will, Golden-winged Warbler, Grasshopper Sparrow, and a suite of wetland bird species. In addition, we are evaluating the results of Spruce Grouse Translocation efforts. Once down to just a single population of 150-300 birds, two State Wildlife Grants allowed a total of 134 birds to be captured in Maine and Quebec and then released in a small portion of the bird's former range in Victory, Vermont, twenty of which were fitted with radio transmitters to track movements. If the translocation efforts are successful, the establishment of this second sub-population will be a significant step toward downlisting the species.

Other Recovery Projects

Vermont's Rattlesnake Recovery Plan was adopted in 2015 after substantial research on the status of Vermont's two populations. The Vermont Eastern Spiny Softshell Turtle Recovery Plan was also approved and adopted in July of 2009. A draft restoration plan for Lake Sturgeon in Vermont was released in August 2015. Federal recovery plans were developed for the Jessup's Milk-vetch and Northeastern Bulrush which are found in Vermont. The New England Wildflower Society has developed conservation plans for many high priority plant species in the region with some technical support from VFWD for species found in Vermont.

Policy, Planning, and Land Acquisition

In some cases, the 2005 Wildlife Action Plan identified that Species of Greatest Conservation Need would benefit most from statewide policies, long-range planning, or the protection of additional habitat important at a statewide regional scale.

Vermont Conservation Design

Fish, wildlife and other elements of biological diversity rely on both landscape-level features such as forest blocks, connectivity, and riparian areas, and finer-scale elements of natural communities, specific habitats, and species. In 2015, Vermont Fish & Wildlife Department, Vermont Land Trust, Vermont Forests, Parks, & Recreation, The Nature Conservancy, Northwood Stewardship Center and others produced "Vermont Conservation Design: Maintaining and Enhancing an Ecologically

Functional Landscape." This report identifies coarse-filter conservation targets for landscape scale features including forest blocks, riparian areas, surface waters, wildlife and landscape connectivity, and physical landscape diversity that are necessary to ensure the conservation of many finer scale conservation elements in the face of climate change and habitat loss. This is a significant addition to conservation planning in Vermont. Phase 2 of this project will focus on natural communities, habitats, SGCN, and rare species.

Getting the Lead Out

Lead is known to be toxic to many wildlife. The Common Loon is particularly sensitive to it, and lead toxicosis contributes to the mortality of the loon and at least 23 other species in North America. Research in the northeastern United States and Canada has documented that poisoning from lead sinkers and jigs is the leading cause of observed loon deaths and can account for 10 to 50 percent of dead adult loons found. In 2006, Vermont Fish & Wildlife Department assisted in a successful campaign to ban the sale and use of lead sinkers for fishing.

Helping Landowners Protect Ecologically Sensitive Lands

Approximately two million acres of Vermont's forestland is enrolled in the Use Value Appraisal program, which requires active management of enrolled land. In 2009, changes to the Use Value Appraisal program allowed forest areas to be enrolled as "Ecologically Sensitive Treatment Areas," meaning that instead of being managed exclusively for timber, they can be managed for their values as significant natural communities. At the same time, the Use Value Appraisal program was also revised to allow for enrollment and management for significant wildlife habitat. To qualify, Vermont Fish & Wildlife staff review and approve proposals based on the Department's standards of significance for natural communities and wildlife habitat.

Land Acquisition

From 2005-2013, the Vermont Fish & Wildlife Department acquired 41 separate parcels in fee totaling 4,141acres, either to be added to existing Wildlife Management Areas or to create new ones. The Department also acquired 2,322 acres under conservation easement during the same period. Conservation activities have focused on a few key criteria: 1) the purchase of key inholdings and lands adjacent to existing Wildlife Management Areas; 2) ecologically-significant lands such as habitat for rare, threatened or endangered species and critical wildlife habitat; and 3) public access for wildlife-dependent recreation.

Technical Assistance and Public Awareness

With over 80% of Vermont's land in private ownership and most of land use and development decisions made at the local or regional level, the conservation of Vermont's wildlife relies heavily on private landowners, municipal governments, regional planning groups, and coordination among state agencies and conservation organizations. To fulfill the goals of the Wildlife Action Plan, Vermont has therefore allocated substantial resources toward working with all scales of stakeholders in Vermont.

Community Wildlife Program

In Vermont, land use and development decisions are made at the local or regional level, through municipal or regional plans and zoning bylaws. Distributing information to municipalities and regional decision-makers is therefore a critical piece of the state's natural resources planning process. After publishing *Conserving Vermont's Natural Heritage: A Guide to Community-Based Planning for the*

Conservation of Vermont's Fish, Wildlife, and Biological Diversity in 2004, Vermont Fish & Wildlife Department created the Community Wildlife Program to provide additional support and technical assistance to interested towns, regional planning commissions, and others in incorporating the latest information and strategizing for the conservation of fish and wildlife. Since 2003, the program has provided technical assistance to all 14 of Vermont's Regional Planning Commissions and more than 150 towns, created a web guide to technical assistance opportunities available in the state, expanded Vermont Fish & Wildlife Department's work with partner organizations in several landscape-level conservation projects, and has been instrumental in providing resources and guidance for grassroots regional planning projects. From 2008-2010, this work was further supported by a partnership with the Vermont Natural Resources Council, who conducted a review of every Vermont town plan and bylaw that pertains to fish and wildlife species and habitat protections. This updates a similar assessment from 2000, enabling a review of progress over the past decade. While trends are noticeably in the direction of increased attention to wildlife conservation—with 87% of all municipalities recommending the protection of wildlife habitat in town plans—the report found a sharp disconnect between municipal plan recommendations and the implementation of those recommendations through bylaws. This report has aided Community Wildlife Program staff and other state-level planners in appropriately targeting technical assistance to municipalities. For more information on the Community Wildlife Program, see *http://www.vtfishandwildlife.com/get_involved/partner_in_conservation/community_wildlife_program*.

Helping Private Landowners Help Wildlife

Because conservation in Vermont relies heavily on private landowners, VFWD has partnered with Vermont Coverts several times in the past decade to conduct landowner outreach. In addition to 23 workshops focused on protecting SGCN, a landowner orientation video and four publications were developed and distributed to 500 forest landowners. The partnership also reached out to new landowners by creating and distributing 100 "Welcome Wagon Kits"—buckets containing materials about land stewardship and wildlife conservation in Vermont. Two additional publications have targeted landowners; first, VFWD worked with the Center for Northern Woodlands Education to publish and distribute ~20,000 copies of *The Place You Call Home: A Guide to Caring for Your Land,* a magazine compiling formerly-published articles relating to land stewardship with an emphasis on technical forest management skills. Secondly, *Wildlife Habitat Management for Lands in Vermont* provides tips on recognizing wildlife habitat and then managing it to benefit wildlife in tandem with other management goals such as timber or hiking trails. This publication was the result of a partnership with the Vermont Department of Forests, Parks and Recreation and the USDA Natural Resources Conservation Service. Using non-SWG funding, VFWD works with the same partners to aid landowners through additional means, such as by helping landowners to incorporate wildlife habitat management and conservation considerations into forest management plans submitted to the Vermont Use Value Appraisal Program.

Public Opinion Survey

While surveys show that most Vermonters support the conservation of wildlife, an average of 6500 acres of wildlife habitat are lost in the state every year through the development of land. Prior to this study, it was unclear what messages and/or actions most effectively motivated the public to support specific conservation programs, and so data were collected to document public attitudes towards a variety of conservation strategies. In addition to creating a baseline against which we can monitor changes in public attitudes, these data aided in the development of a state communications plan and conservation message, including the "Respect. Protect. Enjoy" logo and tagline now used by the Vermont Fish & Wildlife Department.

Species of Greatest Conservation Need

The Vermont Fish & Wildlife Department provides technical support and guidance to protect Species of Greatest Conservation Need (SGCN) to those who work directly with these species and their habitats. Beginning in 2012, a State Wildlife Grant aided VFWD staff in providing technical assistance to other Vermont Agency of Natural Resources departments, private land managers and NGOs, interagency programs, and scientist researchers. Additional technical support is provided to the Vermont Endangered Species Committee and several Scientific Advisory Groups. A second State Wildlife Grant provided support at the municipal level, striving to connect citizens with the SGCN occurring in town forests and other municipally owned lands. This project worked through town partnerships to provide educational materials and technical assistance with municipal planning efforts in eight target communities.

Orange County Headwaters Project

In the summer of 2007 two University of Vermont graduate students undertook an inventory of wetlands and vernal pools in the towns of Washington and Corinth. A State Wildlife Grant, along with Connecticut River Mitigation and Enhancement Funds and Orange County Headwaters Project operating funds, provided additional support for identifying high priority areas for conservation and conducting outreach to community members. This included directing citizens to available conservation resources and researching recommendations for protecting vernal pools and wetlands while continuing active management for forest products. The program's efforts resulted in the permanent protection of 24 parcels through conservation easements as well as enrollment of four landowners in Audubon Vermont's Forest Bird Initiative program—a program that conducts habitat inventories and provides specific recommendations for the enhancement of forest bird habitat—and an equal number in NRCS's Wildlife Habitat Incentives Program.

Baitfish Workshop

The harvest, transport and use of baitfish has long been identified as a high-risk vector for the spread of aquatic invasive species and fish pathogens. Wild harvested baitfish are frequently moved to and used in other waterbodies or watersheds, and anglers tend to release unused live bait when done fishing. This workshop used the Hazard Analysis and Critical Control Point (HACCP) concept to teach risk identification and analysis to over 40 participants from Vermont's baitfish industry and state government. Presentations focused on managing the risk of inadvertently spreading invasives during day-to-day activities in their fields.

The Fishes of Vermont

Vermont supports the greatest freshwater fish diversity in New England, and the publication *The Fishes of Vermont,* a field guide to the fish species of Vermont, explains why. Researched and written by Rich Langdon (Vermont Department of Environmental Conservation) and Vermont Fish & Wildlife Department's Mark Ferguson and Ken Cox, the book describes glaciers and other forces that determined fish distribution while presenting a Vermont-specific identification key that maps and describes the life histories of all 92-fish species in the state. Fishermen, natural history buffs, conservationists and natural resource managers will all find this book useful. Its publication was funded by the Wildlife Conservation and Restoration Program—a precursor to State Wildlife Grants.

Bats on Private Land

Suitable summer roosting habitat is extremely limited for the federally endangered Indiana Bat, and much of what exists in Vermont is on private land. Vermont Fish & Wildlife staff provided technical assistance to private landowners interested in managing for Indiana Bats, which included assessing parcels for potential roost trees and desirable habitat characteristics and, when appropriate, connecting interested landowners with habitat incentives programs such as the Natural Resources Conservation Services' WHIP and EQIP.

Natural Communities and the Plant Stewardship Project

In Vermont, many significant natural communities and rare, threatened, and endangered species are located on private land. To support landowners and land managers the Vermont Fish & Wildlife Department has conducted outreach to identify these sites, map them, and then assess population levels, threats, and management needs. These visits and associated landowner communications were made possible thanks to funding from the Landowner Incentives Program over much of the past decade. Unfortunately, that federal program has been discontinued, and with it much of VFWD's financial capacity to carry on the program.

Management

For some species to thrive in Vermont, the 2005 Wildlife Action Plan identified a need for changes in species or habitat management. In some cases, habitats have been restored or expanded. In others, projects were implemented to mitigate conflicts between wildlife needs and human activities. Included below are some of the specific management efforts undertaken for the benefit of Species of Greatest Conservation Need.

Aquatic Organism Passage

Fish and other aquatic organisms need to move freely within stream networks to meet daily and seasonal life cycle needs. During the development of transportation systems in Vermont, numerous barriers to the movement of these populations have been created from the construction of culverts at road/stream crossings. An assessment of aquatic organism passage (AOP) at over 3000 culverts throughout the state found less than 6% were rated fully passable. Through this project we developed technical guidelines for designing AOP at road/stream crossings; conducted technical trainings on these techniques for state, federal and municipal transportation managers, engineers, regulators and biologists; refined culvert assessment protocols and screening tools to better utilize assessment data; produced outreach materials (Stream Crossing Handbook) and worked with partners to identify, design and implement AOP enhancements at existing stream crossings. These efforts have also served to inform regulatory improvements for design and performance standards for culvert replacement and repair projects. In addition to State Wildlife Grants, this work was funded through Sportfish Restoration Programs.

Prevention of Fish Disease

Preventing the introduction of diseases to fish culture stations and to natural fish populations can be a daunting challenge. To accomplish disease prevention goals, VFWD employs a comprehensive fish health program that follows strict biosecurity practices. Specifically, these biosecurity practices seek to reduce the risk of fish pathogen introduction into fish populations and minimize the risk of pathogen spread. Examples of the tools implemented include but are not limited to: strict fish importation permit program, regulations prohibiting the live transfer of fish from one body of water to another, the use of water filtration and disinfection equipment for fish culture station water source(s), regular use of disinfectants at fish culture stations and pathological examinations of both naturally produced fish and fish produced at fish culture stations.

Amphibian Crossings

On warm, rainy nights in spring, many roads in Vermont experience an inundation of frogs and salamanders attempting to reach the vernal pools, wetlands, and ponds where they breed. When these amphibian travel routes cross roads heavily traveled by human vehicles, mortality can be extremely high. In 2011 and 2012, funding was secured from State Wildlife Grants, Vermont Agency of Transportation's Transportation Enhancement Grant, private donors, and several smaller grants to build two wildlife crossing structures at one well-used amphibian crossing site in the Town of Monkton. General monitoring of this crossing dates to 1997 and monitoring specific to planned crossing structures began in 2011—prior to the structure's construction—to allow for future comparisons of road mortality. The crossing is expected to be built during the summer of 2015. Local partners and key supporters include the Town of Monkton Select Board, Monkton Conservation Commission, Lewis Creek Association, many volunteers, and many individuals who have financially supported the project.

Beaver Baffles

Wetlands created by Beaver are ecologically important and provide critical habitats for many Species of Greatest Conservation Need. However, Beaver wetlands also jeopardize—or are perceived to jeopardize—roads, dwellings, timber, homes, and water supplies. Beaver baffles are water control structures installed to alleviate flooding caused by beaver and satisfy the concerns of the landowner or town while maintaining as much wetland habitat as possible. From 2006-2010, 206 structures were installed and 1,785 wetland acres conserved because of this program, funded through State Wildlife Grants, the U.S. Fish & Wildlife Service Partners in Wildlife Program, the Duck Stamp Fund, and Vermont Agency of Transportation.

Grassland Birds at Airports

As a group, grassland birds have been on the decline, in large part because much of the area of grassland habitat has reverted from farmland to forest and woody shrub habitat. In an ongoing project, Vermont Fish & Wildlife Department works with Vermont Agency of Transportation to develop airport plans that include the consideration of grassland birds in their mowing schedule.

Golden-winged Warbler

To find a nesting Golden-winged Warbler, you would want to look in old fields with sparse trees or shrubs with a grassy understory close to mature forest. In Vermont, this type of habitat is becoming increasingly rare as forests mature, and you may have a difficult time finding one. Through funding from the NRCS's Wildlife Habitat Incentives Program (WHIP) and Conservation Innovation Grant (CIG), Vermont Audubon surveyed a transmission line corridor to prioritize suitable Golden-Winged Warbler habitat. Vermont Fish & Wildlife Department then worked with Audubon and private landowners on six high-priority sites to enhance habitat for the Golden-winged Warbler and other shrubland birds. In 2014—just six months after management activities—monitoring visits found hybrid Blue-winged/Golden-winged Warblers. While no true Golden-winged Warblers have yet been found at the treatment areas, monitoring will continue for the next 3-5 years.

Double-crested Cormorant Control

Wildlife management increasingly involves mitigating unwanted wildlife impacts, and Double-crested Cormorants have recently been the target of such efforts to restore island habitats and protect rare bird species. New to our area, cormorants remove leaves and sticks to use as nesting material, and their acidic guano accumulates near nesting sites, eventually killing trees and shrubs—vegetation that provides important nesting habitat for other species. In 1999, VFWD began applying corn oil to cormorant eggs and, in 2004, culling adult birds to limit reproduction. These methods eliminated the nesting cormorant population on the state-owned islands by 2008. The objective of this project was to use an adaptive management approach to restore the former islands' habitats, and it was found that the strategy of egg-oiling and culling, in combination with habitat restoration plantings of grasses, shrubs and trees as the cormorant and gull numbers declined, was indeed the most efficient strategy. The USDA/APHIS/Wildlife Services was an integral partner in controlling cormorants on the islands, and funding was provided by VFWD license funds. Habitat restoration was further funded by the Wildlife Restoration Program.

Partnerships with Natural Resources Conservation Service

The former Wildlife Habitat Incentives Program (WHIP) and the Environmental Quality Incentives Program (EQIP) are administered and funded by the National Resources Conservation Service (NRCS) with technical aid from Vermont Fish & Wildlife Department. These programs help private landowners with the resources and expertise needed to manage their land for the benefit of fish, wildlife and overall environmental quality—be it by releasing mast or apple trees for wildlife, creating early successional habitat for nesting song birds, or controlling invasive species, these programs have helped Vermonters manage their land for wildlife. When the Wildlife Action Plan was adopted in 2005, the Vermont NRCS office quickly adopted it as a guide for its work on these programs. Over the last 10 years of this agreement, Department staff have worked with landowners on approximately 986 WHIP projects and over 220 EQIP projects throughout Vermont. This agreement is ongoing and the continued partnership is improving habitat throughout Vermont.

Regional Partnerships

Because wildlife do not recognize political boundaries, we have found a need to go beyond our own and collaborate with our neighbors. Below are a few examples of Vermont's participation in regional conservation efforts.

Regional Conservation Needs Grant Program

Since 2007, the Vermont and the other twelve Northeast states and the District of Columbia have worked together as Northeast Association of Fish & Wildlife Agencies (NEAFWA) to implement landscape-scale wildlife conservation actions identified in their collective Wildlife Action Plans through the Regional Conservation Needs Grant Program. Partner states contribute 4% of their annual State Wildlife Grants Program allocations to this fund. Through the RCN program states develop, coordinate, and implement conservation actions that are regional or sub-regional in scope; build upon the multiple regional initiatives that already exist and compliment ongoing work in individual states. Each year, NEAFWA states contribute roughly a half million dollars of State Wildlife Grant funds, leveraging another half million dollars or more from the Wildlife Management Institute and grantees. This is a substantial investment in regional scale conservation. Details about the RCS program can be found at http://www.rcngrants.org.

The Staying Connected Initiative

Encompassing a region of five Northeast States and three Canadian provinces, the Staying Connected Initiative is a collaborative of NGOs and local, state, and provincial agencies working to protect connectivity, with a focus on wide-ranging mammals such as moose, black bear, fisher, bobcat, lynx, and marten. The Initiative brings a landscape scale vision but tailors actions to the needs of local communities, with approaches including conservation science, land protection, technical assistance to communities, land use planning, transportation mitigation, and policy development. Since the Initiative began in 2009, region-wide accomplishments include the protection of over 300,000 acres of land, technical assistance on land use planning and policies for over 40 municipalities and several regional planning agencies, numerous GIS models for conservation planning, the identification of priority road segments, the development of best practices for mitigating road impacts to wildlife, the creation and distribution of numerous tools and reports to aid with the implementation of connectivity actions, and assistance or outreach to local groups through workshops, field trips, citizen science opportunities, and other community engagement measures. While funding for the Staying Connective Initiative includes substantial contributions from all its partners, the Competitive State Wildlife Grants program, the Wildlife Conservation Society's Wildlife Action Opportunities Fund, and the Jessie B. Cox Charitable Fund, funding from Vermont's State Wildlife Grants program specifically targeted one wildlife linkage area between the Worcester Range and the state's Northeastern Highlands. Associated technical assistance included the hiring of a local coordinator to act as a liaison between partner organizations and the community, and the publication of an outreach guide entitled "An Enduring Place" (http://216.92.98.160/assets/enduringplacefinal.pdf). This guide is a celebration of place, weaving together the cultural and natural landscape in the region and calling out the regional importance of habitat connectivity. More information can be found at http://stayingconnectedinitiative.org/.

For the Future

The above list of projects and accomplishments represents only a fraction of the work undertaken in Vermont that has aided in the implementation of the Wildlife Action Plan. While this list captures the efforts of Vermont Fish & Wildlife Department and a few prominent partners—with a primary focus on projects funded through State Wildlife Grants—the true efforts have been diverse, accomplished not only by multiple state agencies but by Vermont's extensive network of conservation organizations, municipalities, regional groups, interest groups, and individuals. In the future, we would like to find a way to capture these collective efforts, to better represent Vermont's progress toward conserving wildlife on our landscape.

VERMONT CONSERVATION DESIGN

MAINTAINING AND ENHANCING AN ECOLOGICALLY FUNCTIONAL LANDSCAPE

Summary Report for
Landscapes, Natural Communities, Habitats, and Species

February 2018

Eric Sorenson and Robert Zaino

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For More Information

For data layers, technical reports, and additional information, please visit the Vermont Fish and Wildlife Department website: www.vtfishandwildlife.com, or contact the report authors.

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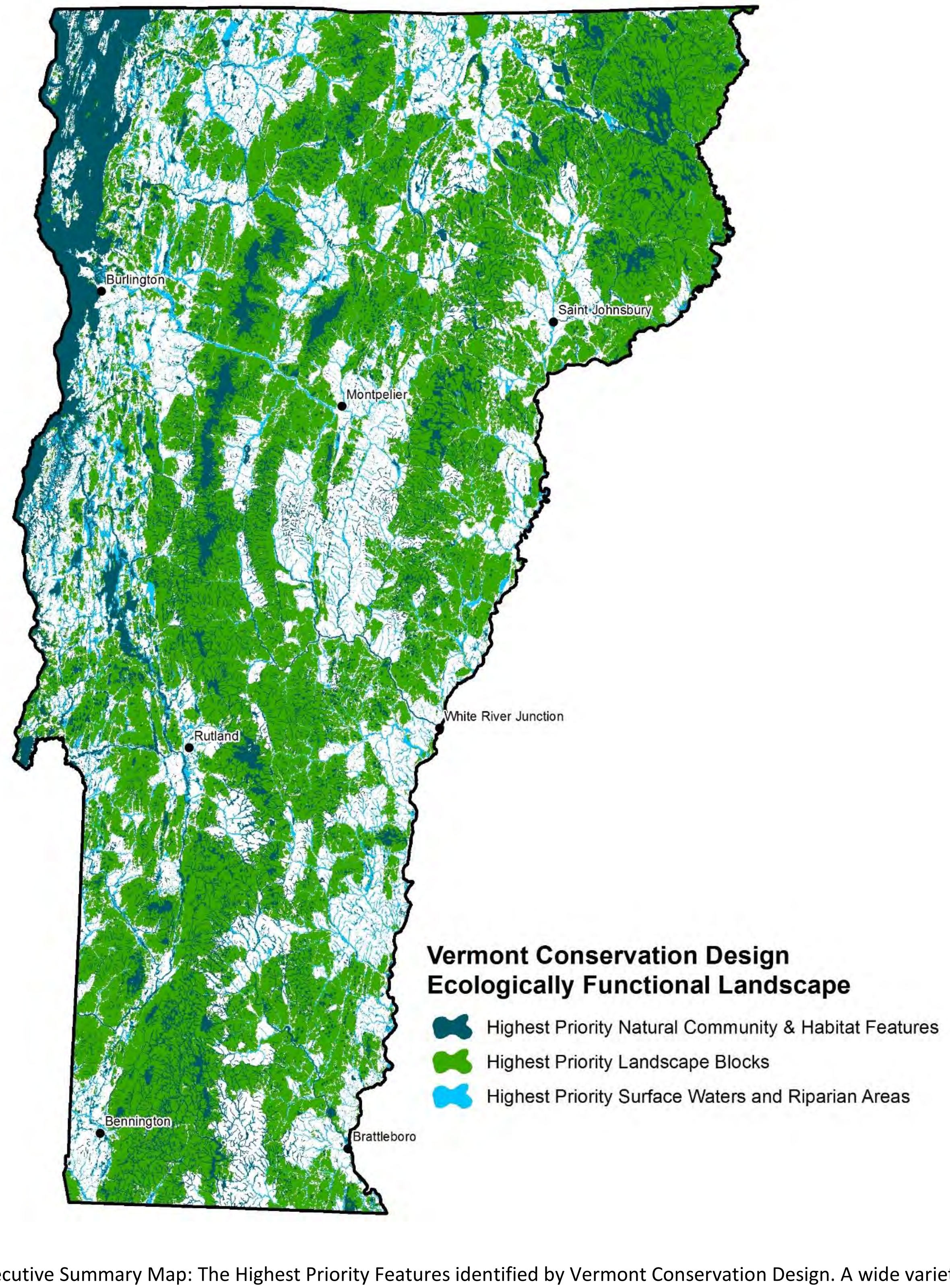
Executive Summary

- Public surveys show strong support for conservation in Vermont. Vermonters value wildlife, nature, the state's rural character, and our working forests and farms. We depend on the natural landscape to support these and other values.
- Habitat loss and fragmentation, non-native species, and a rapidly changing climate all pose grave threats to species and ecosystems. The future of Vermont's forests, waters, and wildlife is uncertain.
- Vermont Conservation Design is a practical and efficient plan to address that uncertainty and sustain the state's valued natural areas, forests, waters, wildlife, and plants for future generations.
- Using our best scientific data, we identify easily understood and recognizable features that, when appropriately conserved or managed, collectively offer high confidence for the long-term continuation of an ecologically functional landscape.
- The foundation of Vermont Conservation Design is an intact, connected network of unfragmented Forest Blocks, Surface Waters, and Riparian Areas. These landscape features provide many functions, such as habitat for interior forest wildlife and clean air and water. They also allow species to move around the landscape. Landscape features occupy a relatively large area but offer wide latitude in management and conservation strategies.
- Natural community and habitat features are smaller, special places such as hemlock forests, rich fens, young forests, old forests, aquatic communities, grasslands, or caves. These all support particular species or ecological functions and are key components of this design. They occupy a relatively small area but often benefit from more specific management or conservation strategies.
- Together, these identified features represent a rigorous, science-based conservation design for Vermont. We have high confidence that they can keep Vermont's common plants and animals abundant and help prevent the disappearance of vulnerable species.
- Vermont Conservation Design maintains nature and the benefits it provides. The ecologically functional landscape it envisions sustains environmental services, like clean air and water, carbon sequestration, and flood protection. It provides resilience to climate change, allowing plants and animals to shift distributions. It supports numerous social and economic values, including outdoor recreation, the forest products economy, and the natural beauty that draws people to Vermont.
- Vermont Conservation Design is a vision to sustain the state's ecologically functional landscape based on our best science. Many tools can be used to achieve this vision. Thoughtful stewardship of private lands, with public support and incentives, will be essential to success. Other tools include conservation easements, regulations such as local planning and zoning, and ownership by a public agency or conservation organization. This document and these maps do not presume which of these tools are best suited to specific places or features.



Executive Summary Map: The Highest Priority Features identified by Vermont Conservation Design. A wide variety of management and conservation strategies can be used to maintain the ecological functions of each feature.

Introduction

Forests and fields, waters and wetlands, and their wildlife and plants, are central to Vermont's identity. Vermonters strongly value wildlife, nature, and the state's rural, sparsely developed landscape, including lands that support outdoor recreation, and working forests and farms. We depend on the natural landscape to support these values along with environmental services such as clean water, crop pollination, and flood resiliency. Time and again, public surveys show strong support for conservation in Vermont (Roman and Ericson 2015).

Thanks to nature's resilience, and thoughtful conservation and stewardship, much of the state is in good ecological condition. However, habitat loss and fragmentation, the spread of non-native species, and a rapidly changing climate all pose grave threats to species and ecosystems. The future of Vermont's forests, waters, and wildlife is uncertain.

Vermont Conservation Design is a practical and efficient plan to address that uncertainty, and sustain the state's valued natural areas, forests, waters, wildlife, and plants for future generations.

Vermont Conservation Design is a practical plan because it sets science-based quantitative and distributional goals for maintaining and restoring an ecologically functional landscape. For the first time, this plan provides a scientific benchmark for long-term conservation success in the state. Vermont Conservation Design is also practical because the aim is sustaining ecological functions and environmental services, using the full range of conservation and management tools. These functions and services provide enormous benefits to nature and to people, and they cannot be replaced once they are lost. Vermont Conservation Design is grounded in Vermont's tradition of responsible land stewardship.

Vermont Conservation Design is efficient because it specifically identifies or targets a minimum number of features to achieve conservation success. Vermont has tens of thousands of native species; it is simply not possible to study and conserve each one individually. Using a "coarse-filter" approach, Vermont Conservation Design targets those features of the landscape that support the most species and ecological processes. In this way, we can confidently work towards long-term support of ecological function without needing to understand the life-history of every species. We recognize that some species will always require special conservation attention and Vermont Conservation Design helps us to focus on the species with the greatest needs.

In this report we identify four landscape features and six natural community and habitat features whose conservation and management is highest priority for maintaining ecological function. Landscape features—forest blocks and riparian areas—occupy large areas and are the foundation for intact and connected natural systems. Natural communities and habitats are the finer-scale pieces, such as hemlock forests, alder swamps, and grasslands that provide critical ecological functions and support our plants and animals. Together, these landscape and natural community-scale features form Vermont's ecologically functional landscape.

The results of this project represent a rigorous, science-based conservation design for Vermont. We have high confidence that if all these targeted features (forest blocks, surface waters and riparian areas, natural communities and habitats) can be conserved or managed appropriately, they will sustain nature and its benefits.

We present Vermont Conservation Design as a vision for Vermont's future—a vision that maintains nature and all its complexities as defining characteristics of this small and diverse state. The densely populated areas of southern New England provide a clear story of how natural systems, wildlife habitat, ecological functions, and rural economies can be compromised or lost. Vermont Conservation Design provides a framework for us to carefully consider our choices for the future.

The Ecologically Functional Landscape

Vermont Conservation Design is based on the concept of an *ecologically functional landscape*. Maintaining and enhancing ecological function across the landscape is fundamental to conserving biological diversity. Ecological function—the ability of plants and animals to thrive, reproduce, migrate, and move in response to land-use changes and climate changes, and the ability of ecosystems to function under natural processes—is served by high-quality terrestrial and aquatic habitat, natural connections across the landscape, a wide variety of habitat features from low elevation to high, clean water, and healthy rivers, streams, lakes, ponds, and wetlands.

An ecologically functional landscape contains all the native species in Vermont, and the full range of native habitats and natural communities known to occur in the state. It also contributes to regional conservation, by maintaining species and habitat conditions that may be in regional decline (such as grassland birds and their habitat), or that may be well-represented in Vermont but regionally rare (such as habitats resulting from calcium-rich bedrock). It must be well-connected at multiple scales, allowing species movement and gene flow across the landscape. An ecologically functional landscape is also resilient, allowing species to shift distributions and natural communities to rearrange themselves in response to a changing climate and other stressors.

Coarse-filter Conservation Approach

We used the coarse-filter approach to conservation (Noss 1987; Hunter et al. 1988). It would be overwhelming to identify and manage for the individual needs of the estimated 24,000-43,000 species of plants, animals, invertebrates, and fungi in Vermont. The coarse-filter conservation approach treats larger-scale components of the landscape as proxies for the species they contain (Panzer and Schwartz 1998; Molina et al. 2011; Shuey et al. 2012). If examples of all coarse-filter features are conserved at the scale at which they naturally occur, most of the species they contain—from the largest trees and mammals to the smallest insects—will also be conserved. By maintaining or enhancing these proxies, or coarse-filters, we can have high confidence that we can efficiently conserve the majority of Vermont's native species.

The coarse-filter conservation approach can provide for the habitat needs of many—very likely the majority—of Vermont's species, allowing for efficiency in conservation planning and design. This project focused on identifying coarse filters. We have high confidence that this conservation design identifies areas essential for the long-term functioning of Vermont's landscape and the species it contains. However, coarse-filter conservation alone cannot adequately address the needs of all Vermont's species. Very rare species, whose distributions on the landscape are infrequent and unpredictable, or species facing pests or diseases largely unrelated to habitat (e.g. moose and many bat species), cannot be conserved with coarse filters. Some species are simply vulnerable as a result of being in our human-dominated landscape and will always need conservation attention. A complementary "fine-filter" conservation approach is necessary, and Vermont Conservation Design has made it possible for the first time for us to identify many of those species in need.

Methods and Results

Vermont Conservation Design identifies landscape-level and natural community and habitat-level coarse filters—we refer to these as ***landscape features*** and ***natural community and habitat features***. These features were selected using a repeatable process, our best scientific data, and professional judgement. The specific rationale and methods for these steps are described in the Vermont Conservation Design Technical Reports. Broadly, we listed potential features that could serve as coarse filters, and the finer-scale elements (species, communities, and ecological processes) that could be effectively conserved by each. This allowed us to select coarse filters that are the most efficient while still being readily understood and recognizable. We then compiled a final set of features that provides high confidence for the long-term conservation of ecological function in the state.

Based on these steps, we selected five landscape features and six natural community and habitat features as being the most effective and parsimonious for maintaining an ecologically functional landscape. These ten features are:

Landscape Features

- Interior Forest Blocks
- Connectivity Blocks
- Surface Waters and Riparian Areas
- Physical Landscapes

Natural Community and Habitat Features

- Natural Communities
- Young and Old Forests
- Aquatic Habitats
- Wetlands
- Grasslands and Shrublands
- Underground Habitats

In addition, we also identified Wildlife Road Crossings as a key element of the conservation design. Wildlife road crossings are road segments with suitable habitat on both sides of the road. Although not actually a coarse filter, wildlife road crossings are essential to the functions of the five chosen landscape features and therefore are a critical component of maintaining and enhancing Vermont's ecologically functional landscape.

Once we had selected these features, we tested the overall design against a diverse list of more than 200 species. This list included common species, as well as rare and declining species of plants and animals that are Species of Greatest Conservation Need (SGCN) in the Vermont Wildlife Action Plan. The results of this analysis provide additional confidence in the overall functioning of the design.

When the ecological functions of each of these features are maintained and enhanced, and when each is conserved at the appropriate scale and distribution across the landscape, the majority of Vermont's species and ecological processes are very likely to be conserved even as the climate changes.

While each feature in Vermont Conservation Design is important on its own, they cannot function in isolation. Maintaining or enhancing an ecologically functional landscape in Vermont depends on both the specific functions of each feature, and the ability of the pieces to function together. Interactions between features are what support Vermont's environment and are essential for long-term conservation of Vermont's biological diversity and natural heritage.

Each of these features is described below, and whenever possible, a map shows the areas identified as "highest priority" for each. In some cases, it is not possible to map features due to lack of spatial information.

The following descriptions and maps identify a large percentage of Vermont's lands and waters for conservation priority. We are highly confident that these features and their ecological functions must be maintained if Vermont is to have an ecologically functional landscape into the future.

Conserving Ecological Function

The goal for each identified feature in the design is to maintain, restore, or enhance its ecological functions. As each feature has unique functions, the strategies and tools to achieve this will be diverse. For example, the goal for Interior Forest Blocks is to maintain the unfragmented, interior forest of these areas that provides critical habitat for many species of plants and animals. There is considerable leeway on what can happen within a forest block and still maintain interior forest function. For example, most forest management activities are compatible with maintaining the long-term interior forest functions for these blocks, providing these activities are thoughtfully planned.

Conservation and management of natural communities and habitats is very specific to the individual feature. A very rare, small patch natural community such as a Pitch Pine-Oak-Heath Rocky Summit might call for a minimalist approach – perhaps little more than invasive species control. In contrast, grassland habitat for nesting birds requires active management—the timing of field mowing is critical. Successfully implementing these targets will likely require the full range of conservation and management options available.

Many tools can be used to achieve the overall goal of retaining ecological function. With approximately 80% of Vermont's land privately-owned, management and stewardship of private lands will be an essential path to success. Other potential tools include landowner incentives, conservation easements, regulations such as local planning and zoning, and ownership by a state or federal agency or a private conservation organization. This document and these maps do not provide suggestions as to which of these tools are best suited to specific places. The Vermont Conservation Design Technical Reports include recommendations for further prioritization filters that users can apply to help make these decisions.

Each section below provides guidelines on what is needed to maintain ecological functions for that feature.

Landscape Features

At the most basic level, an ecologically functional landscape must have intact and connected natural systems. The large, unfragmented forest blocks and the network of aquatic systems and their riparian areas identified in this section are the foundation for ecological function in the state. Minimizing fragmentation of these features, and maintaining or restoring connectivity across the landscape, is critical to the conservation of all of Vermont's species and their habitats, and the ability of species to shift their distributions over time in response to ecological changes.

We identify the Highest Priority for each of the landscape features in this summary report. Additional Priority Areas are identified in Part 1 Vermont Conservation Design Technical Report. These Priority Areas form a second tier of importance for each feature. In addition, areas of Vermont that are not identified on any of the maps for landscape features may contain important forest blocks, habitats, natural communities, or other features. Although they are not identified as Highest Priority Landscapes, they too can be managed or conserved to contribute to an ecologically functional landscape.

Interior Forest Blocks

Forest blocks are areas of contiguous forest and other natural communities and habitats, such as wetlands, ponds, and cliffs, that are unfragmented by roads, development, or agriculture (Sorenson and Osborne 2014). Forests blocks are the first foundational unit of the Vermont Conservation Design.

Ecological Functions

Interior Forest Blocks provide many ecological and biological functions critical for protecting native species and the integrity of natural systems (Austin et al. 2004). These include: supporting natural ecological processes such as predator-prey interactions and natural disturbance regimes; helping to maintain air and water quality and flood resilience; supporting the biological needs of many plant and animal species, particularly those that are wide-ranging or sensitive to human encroachment; supporting viable populations of wide-ranging animals by allowing access to important feeding habitat, reproduction, and genetic exchange; and serving as habitat for source populations of dispersing animals for recolonization of nearby habitats that may have lost their original populations of those species.

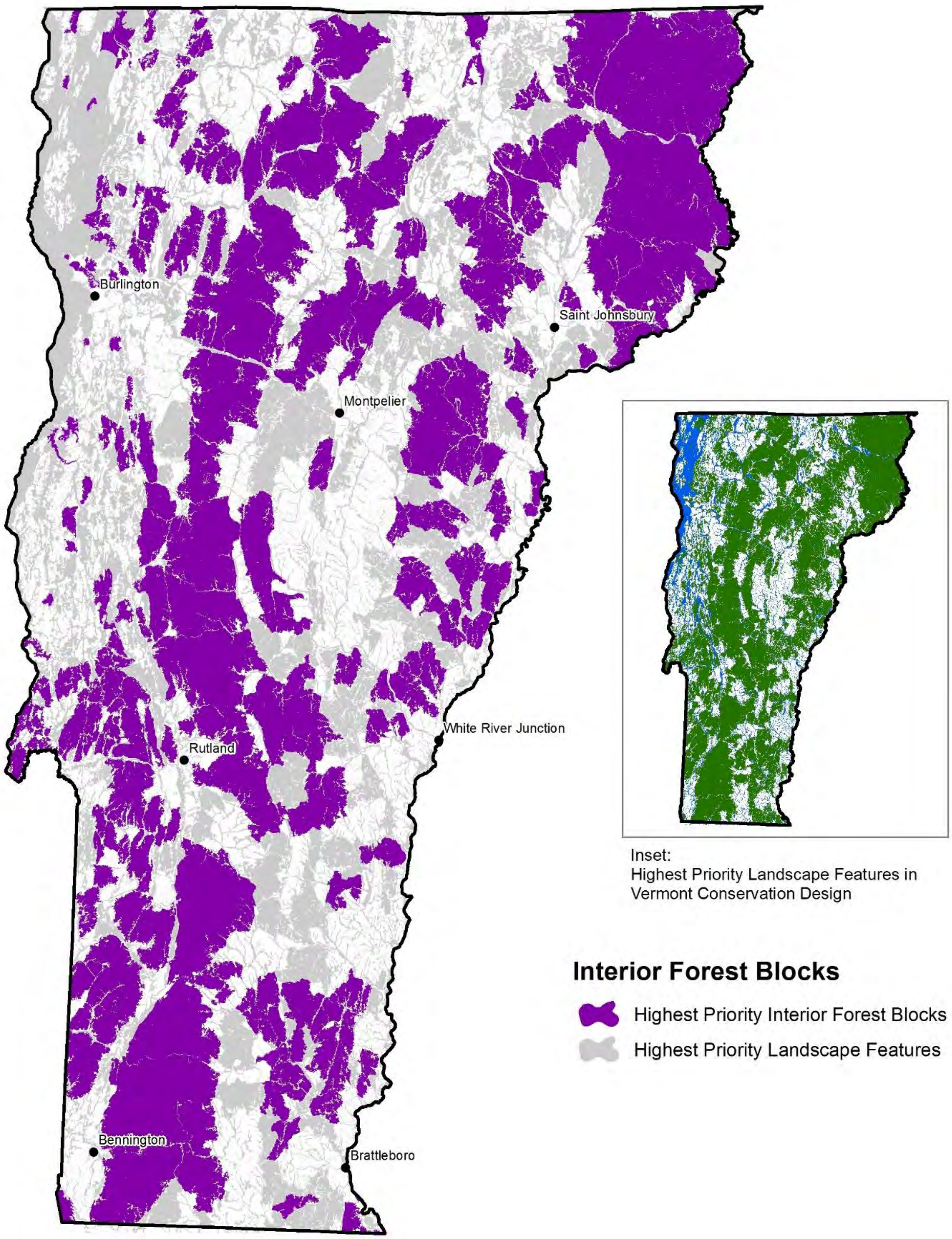
In addition, large, topographically diverse forest blocks will allow many species of plants and animals to shift to suitable habitat within a forest block in response to climate change within the next century without having to cross developed areas to other forest blocks (Beier 2012).

Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies a set of forest blocks across the state that are highest priority for maintaining interior forest. These are the largest and/or highest ranked forest blocks from all biophysical regions that provide the foundation for interior forest habitat and associated ecological functions. The primary goal for these areas is to maintain the interior forest condition by avoiding permanent fragmentation from development. Limited development on the margins of large forest blocks may not have a significant adverse effect, provided it does not reduce connectivity between blocks or encroach into the forest block interior. Forest management that maintains forest structure and results in a distribution of all ages classes is compatible with maintaining the ecological functions of these forest blocks.

For more information on interior forest blocks, see the following section in the Part 1 Vermont Conservation Design Technical Report:

- Interior Forest Blocks



Map 1. Highest Priority Interior Forest Blocks.

Connectivity Blocks

Landscape connectivity refers to the degree to which blocks of suitable habitat are connected to each other (Noss and Cooperrider 1994). Connectivity Blocks are the network of forest blocks that together provide terrestrial connectivity at the regional scale (across Vermont and to adjacent states and Québec) and connectivity between all Vermont biophysical regions. There is a high level of connectivity within individual forest blocks. The proximity of one forest block to another, the presence of riparian areas, and the characteristics of the intervening roads, agricultural lands, or development determine the effectiveness of the network of Connectivity Blocks in a particular area.

Ecological Functions

A network of Connectivity Blocks allows wide-ranging animals to move across their range, allows animals to find suitable habitat for their daily and annual life needs, allows young animals to disperse, allows plant and animal species to colonize new and appropriate habitat as climate and land uses change, and contributes to ecological processes, especially genetic exchange between populations (Austin et al. 2004). Maintaining the landscape connectivity function requires both Connectivity Blocks and Riparian Corridors, especially in highly fragmented areas of Vermont. There is general agreement among conservation biologists that landscape connectivity and wildlife corridors can mitigate some of the adverse effects of habitat fragmentation on wildlife populations and biological diversity (Beier and Noss 1998; Noss and Cooperrider 1994; Haddad et al. 2003; Damschen et al. 2006). Specifically, climate change adaptation is enhanced if the long-distance movements of plants and animals is supported by a combination of short movements within large, topographically diverse forest blocks and short corridor movements between forest blocks (Beier 2012).

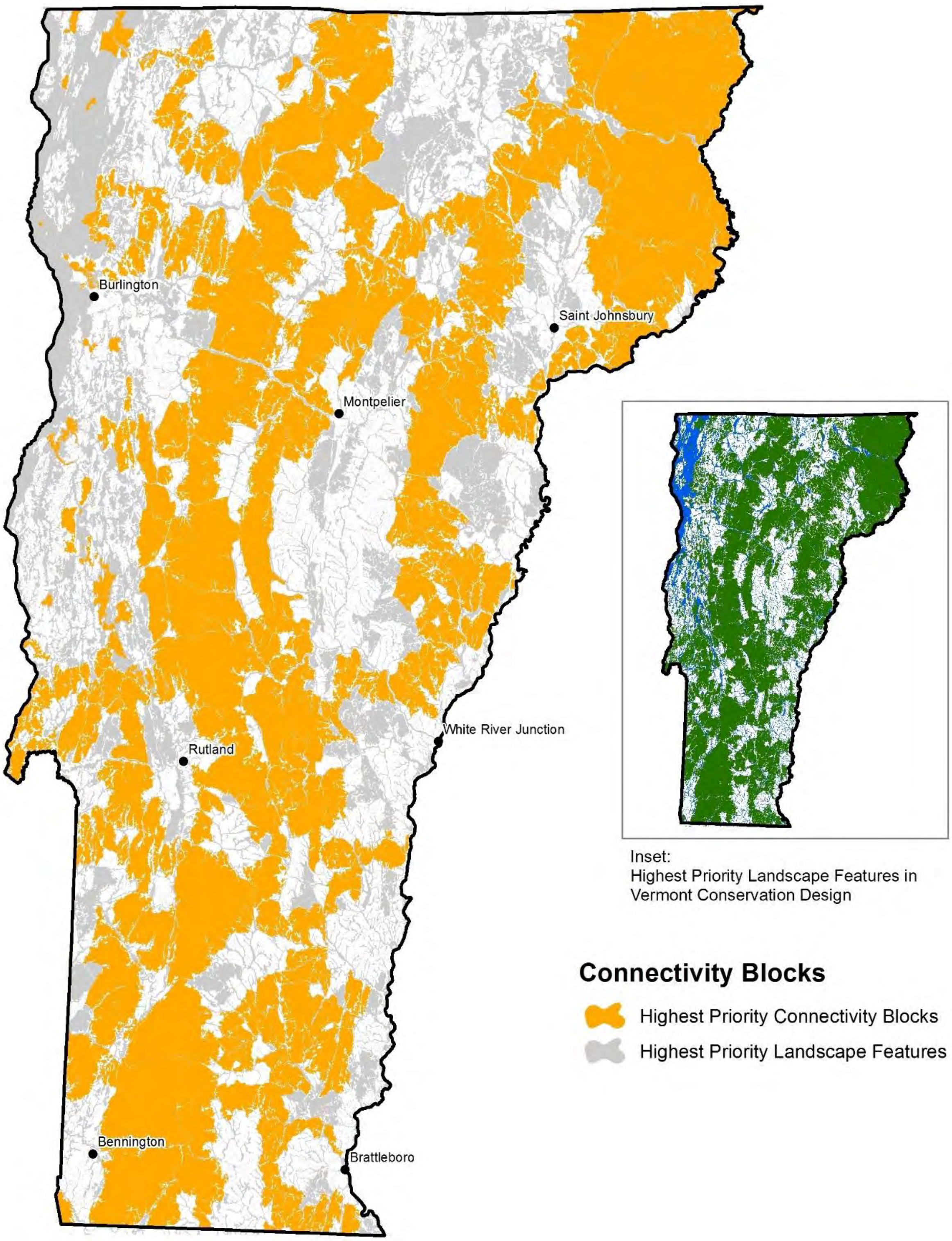
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies a highest priority network, or “backbone” of connectivity blocks. This “backbone” incorporates the spines of the major mountain ranges, connections outside Vermont to unfragmented habitat, and anchor blocks in fragmented biophysical regions based on abundant known occurrences of rare species and significant natural communities. Small forest blocks are included at pinch-points in the connectivity network as they are critical stepping stones.

Similar to Interior Forest Blocks, it is important to maintain the interior forest conditions in Connectivity Blocks by avoiding permanent interior forest fragmentation resulting from development. Connectivity within forest blocks will remain high if they remain unfragmented. For Connectivity Blocks it is also critically important to maintain or enhance the structural and functional connectivity that occurs on the margins of these blocks where they border other blocks. This can be accomplished by maintaining forest cover along the margins and by limiting development in these areas of block-to-block connectivity.

For more information on connectivity blocks, see the following section in the Part 1 Vermont Conservation Design Technical Report:

- Connectivity Blocks



Map 2. Highest Priority Connectivity Blocks.

Surface Waters and Riparian Areas

Vermont's network of lakes, ponds, rivers and streams, and their associated riparian zones, valley bottoms, and river corridors are the second foundational unit of Vermont Conservation Design.

Ecological Functions

Aquatic systems provide vital habitat for a rich assemblage of aquatic species, including fish, amphibians, reptiles, invertebrates (e.g., insects, mussels, snails, worms, freshwater sponges), and plants. Naturally vegetated riparian areas provide many functions, including stabilizing shorelines, storage of flood waters, filtration of sediments and nutrients, shading of adjacent surface waters to help moderate water temperatures, and direct contribution of organic matter to the surface water as food and habitat structure. Riparian areas are also very essential habitat for many species of wildlife, including mink, otter, beaver, kingfisher, spotted sandpiper, and wood turtle. The shorelines and riparian areas of rivers and lakes support floodplain forests, several other rare and uncommon natural communities, and many species of rare plants and animals.

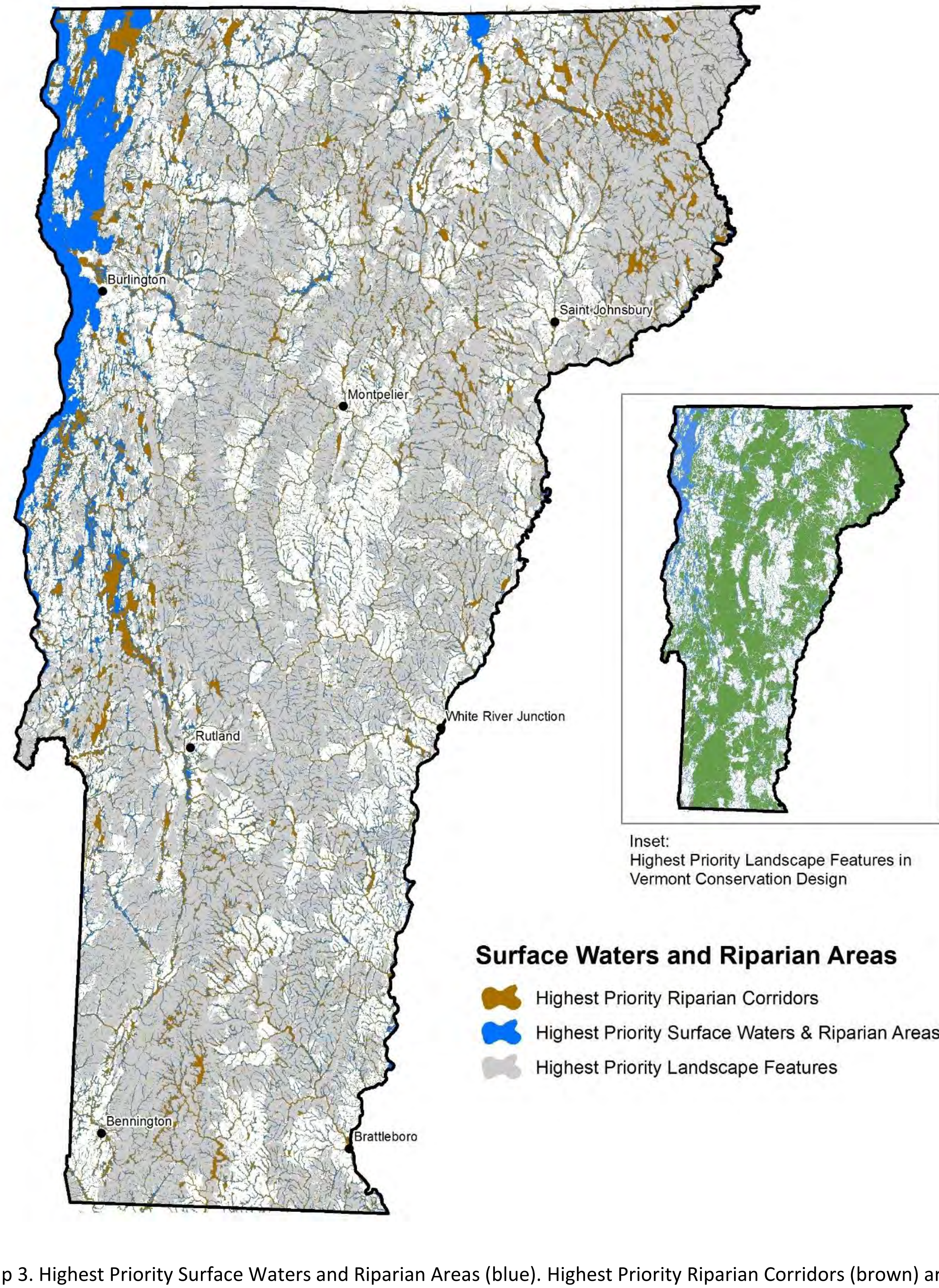
The linear network of riparian areas provides a crucial element of landscape connectivity. Many wildlife species use riparian corridors for travel to find suitable habitat to meet their life requisites, but certain species are almost entirely restricted to riparian areas, including mink, otter, beaver, and wood turtle. The combination of Riparian Areas for Connectivity, and Connectivity Blocks, provide the best available paths across the landscape, especially in highly fragmented regions like the Champlain Valley. Riparian connections also allow for long-term plant and animal movement in response to climate change (Beier 2012). Although many riparian areas and river corridors are highly altered by agriculture, roads, and urbanization, the risk of flooding serves as a natural deterrent for future development. Riparian areas also respond rapidly to restoration efforts (Beier 2012).

Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies the entire undeveloped network of surface waters and riparian areas as highest priority for maintaining an ecologically functional landscape. The ecological integrity of an aquatic system is critically tied to the condition of the riparian area adjacent to the stream or pond. Rivers and streams must have access to their floodplains and freedom to meander. Maintaining or restoring river channel equilibriums, the unimpeded movement of aquatic organisms, and natural riparian vegetation is essential to protecting water quality and providing high-quality habitat for terrestrial and aquatic species. The width of naturally vegetated riparian areas needed to provide terrestrial riparian connectivity varies from 100 feet or less on some small streams (50 feet each side) to 600 feet or more (300 feet on each side) for larger rivers or riparian areas that span long distances of otherwise unsuitable habitat.

For more information on surface waters and riparian areas, see the following sections in the Part 1 Vermont Conservation Design Technical Report:

- Surface Waters and Riparian Areas
- Riparian Areas for Connectivity (Riparian Corridors)



Map 3. Highest Priority Surface Waters and Riparian Areas (blue). Highest Priority Riparian Corridors (brown) are the naturally vegetated portions of the network that facilitate wildlife travel.

Physical Landscapes

Physical landscapes (often referred to as enduring features) are the parts of the landscape that resist change. They are the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. They remain largely unchanged when changes in land cover and wildlife occur, as plants and animals move, and even as the climate changes.

Ecological Functions

If nature is likened to a dramatic play, it's possible to think of the physical features as the stage and the individual species as the actors. The play is the natural communities, habitats and species that occur in a given place at a given time, but regardless of the action, the stage does not change. The importance of "conserving nature's stage" is that we can be much more confident in our ability to conserve biological diversity and maintain a functional landscape into the future, with the capacity to adapt and be resilient to climate change, if all elements of physical landscape diversity are represented in the conservation design (Anderson & Ferree 2010; Beier and Brost 2010; Beier et al. 2015).

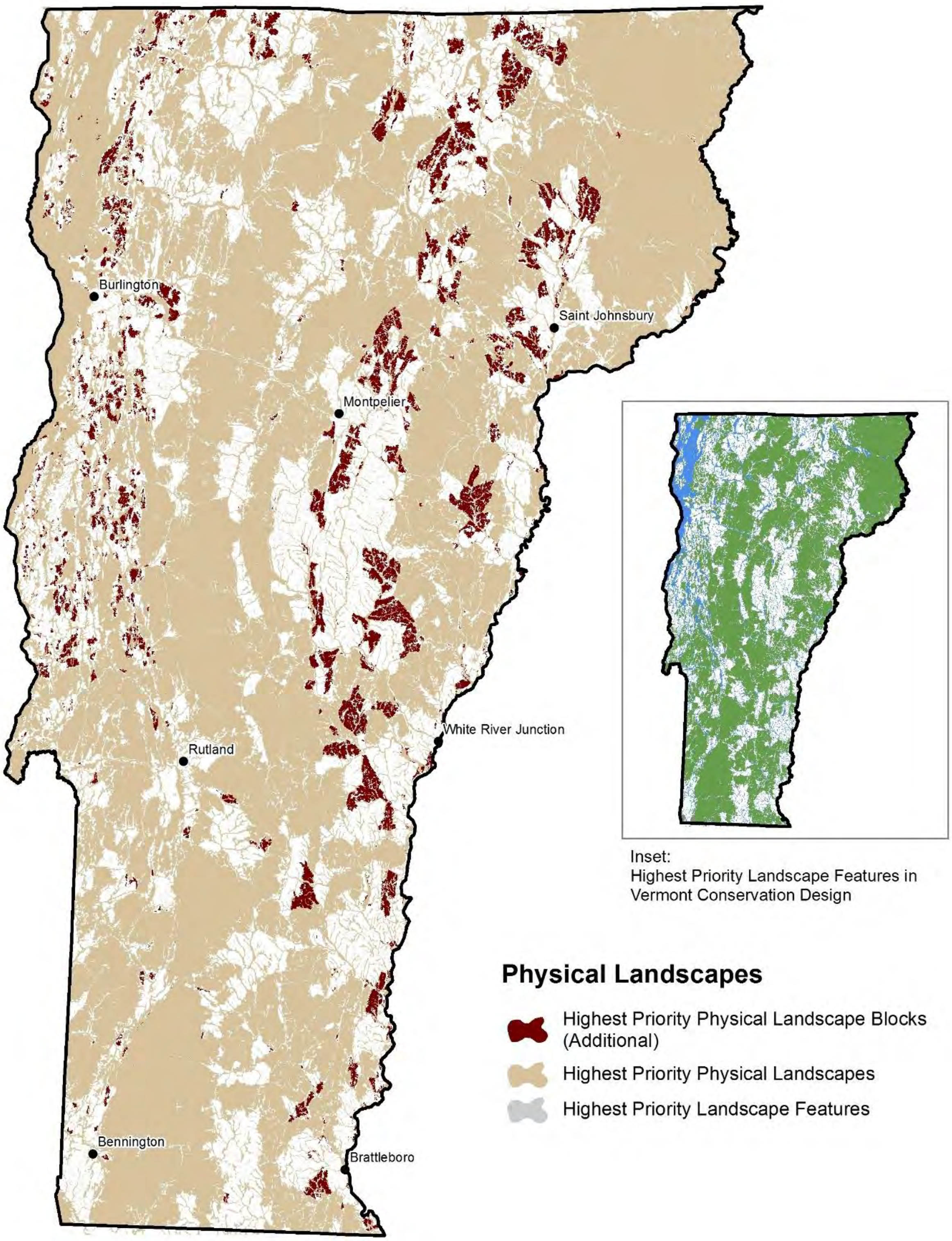
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies conservation of a representative selection of all physical landscapes as highest priority for maintaining ecological function. To do this, the entire landscape design includes all of Vermont's physical settings roughly proportional to their occurrence in the state. To do so, additional blocks—Physical Landscape Blocks—were added to the highest priority Surface Waters and Riparian Area network and the highest priority Interior Forest Blocks and Connectivity Blocks in order to reach an overall design that includes the full range of physical diversity found in Vermont. We highlight these Physical Landscape Blocks in Map 4, but stress that the conservation of the entire design is necessary to provide the coarse-filter and climate resilience functions provided by the full range of physical landscapes.

Similar to the Interior Forest Blocks, maintaining and restoring natural vegetation and limiting development within these areas will protect the functions of these physical landscapes. Forest management that maintains forest structure and results in a distribution of all age classes is very compatible with maintaining the physical landscape diversity functions.

For more information on physical landscapes, see the following section in the Part 1 Vermont Conservation Design Technical Report:

- Physical Landscape Diversity Areas



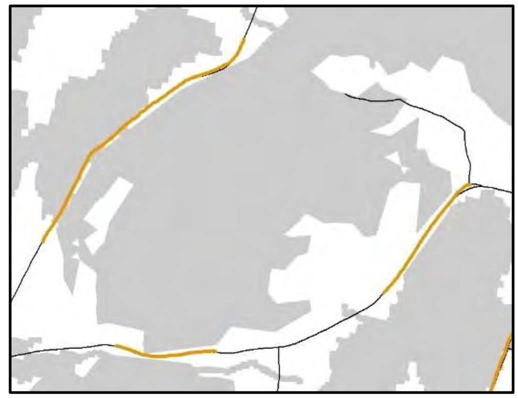
Map 4. Highest Priority Physical Landscapes. Blocks shown in dark red were added to the design specifically to increase representation of rare and important physical settings. Note that Highest Priority Physical Landscapes overlap all of the Highest Priority Landscape Features.

Wildlife Road Crossings

Landscape-scale connectivity and the ecological functions it provides depend on the ability of species to travel between forest blocks or along riparian corridors. Roads represent a barrier to wildlife movement and dispersal of many other species, including some plants.

Ecological Functions

Sections of roads that have suitable habitat on both sides are more likely to allow wildlife movement and dispersal of other species and, therefore, these sections of roads are critical components of maintaining or enhancing an interconnected, ecologically functional landscape. Wildlife road crossings that provide connectivity over or under roads are critically important between adjacent forest blocks and along linear riparian area networks. In addition, allowing for the passage of aquatic organisms through bridges or culverts is critical for the functioning of the network of rivers and streams.



Map 5. Highest Priority Wildlife Road Crossings connect forest blocks and riparian areas.

Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies a set of wildlife road crossings that are highest priority for maintaining connections between highest priority forest blocks, and that are highest priority for maintaining permeable riparian corridors.

Structural connectivity across identified wildlife road crossings is provided by the presence of forest cover, wetlands, or other natural habitats. Maintaining or restoring natural vegetation on both sides of identified road crossing segments will maximize the effectiveness of the road crossing for connectivity. Forest management that maintains forest cover adjacent to the road is compatible with this function. Roadside development that further restricts animal movement is detrimental to connectivity. Road and highway structures that allow or promote fish and wildlife movement, such as bridges and oversized culverts, and limiting the use of fences and roadside barriers that impede movement, are all effective in promoting wildlife passage.

For more information on wildlife road crossings in Vermont Conservation Design, see the following sections in the Part 1 Vermont Conservation Design Technical Report:

- Wildlife Road Crossings
- Connectivity Blocks
- Riparian Areas for Connectivity (Riparian Corridors)

Natural Community and Habitat Features

While landscape features such as forest blocks and riparian areas are foundational for ecological function, they are greatly enhanced when combined with finer scale features. In this section, we identify the highest priority natural communities and habitats that—when conserved in conjunction with the landscape features—are necessary to maintain and enhance an ecologically functional landscape in Vermont. These finer-scale features together occupy a much smaller land area than the landscape features. However, they are closely associated with more specific environmental settings or ecological conditions that are not fully reflected by the landscape features. Many plant and animal species depend on the combination of the landscape features and these specific natural communities and habitats.

We can fully describe the natural communities and habitats that are needed for an ecologically functional landscape, but we cannot necessarily map them all. Some, such as young forests or shrublands are temporary on the landscape, and shift locations over time. Others, such as natural communities and wetlands have incomplete inventory across the state, and mapping reflects the best current knowledge. The descriptions provided here should help planners and land managers determine if an unmapped, unassessed feature meets the criteria of being highest priority.

Natural Communities

Natural communities are interacting assemblages of organisms and their environment, and they are classified into types, such as Northern Hardwood Forest, Hemlock Forest, Red Maple-Black Gum Swamp, and Cattail Marsh, that repeat across the landscape wherever similar conditions are found.

Ecological Functions

Natural communities are one of the most important "coarse filters" for conserving biological diversity (Hunter 1991, Thompson and Sorenson 2000). This is because there are relatively few natural community types—97 in Vermont—compared to the tens of thousands of plant and animal species. Collectively, these 97 types in Vermont encompass the full range of habitat conditions that native flora and fauna evolved with and are adapted to. Therefore, conserving high-quality examples of all the natural community types is an efficient way to conserve most species.

Natural communities are relatively stable in a human timeframe, but their species assemblages have changed over thousands of years and will continue to shift in response to a changing climate. Sites with high-quality natural communities today represent places that are expected to continue to support important natural communities, and associated species, into the future.

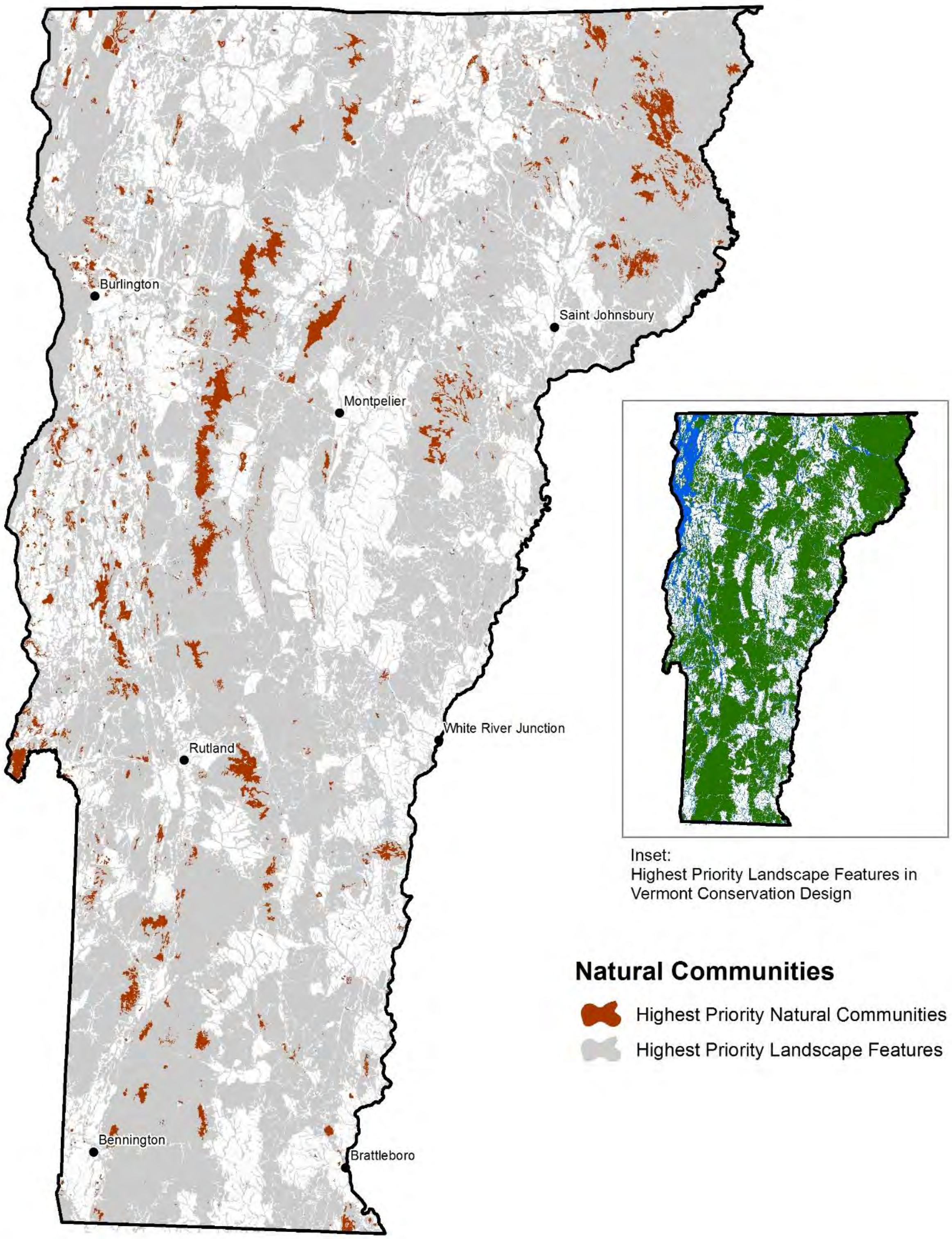
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies conserving state-significant examples of each of the natural community types as a highest priority for maintaining ecological function. Specifically, this means conserving all significant examples of rare natural community types, and 50% of the significant examples of more common types, distributed across biophysical regions, and within an intact and connected natural landscape whenever possible. Some community types can be effectively conserved by other coarse filters. Matrix community types, such as Northern Hardwood Forest, are effectively captured by forest blocks and old forests. Seeps and vernal pools are captured by forest blocks and wetlands, respectively.

These natural communities should be maintained in, or restored to, a state of high ecological integrity. This translates into several measurable characteristics. Each natural community should be dominated by the native species characteristic of that community type. The species composition and physical conditions (soils, hydrology, etc.) should be largely unaltered by, or mostly recovered from, human disturbances. Natural disturbance processes should predominate. In general, high ecological integrity will correspond to an A or B- ranked element occurrence, and A-ranked condition, using Vermont Fish and Wildlife Department's Natural Community Ranking Specifications.

For more information on natural communities, see the following section in the Part 2 Vermont Conservation Design Technical Report:

- Natural Communities



Map 6. Highest Priority Natural Communities. Mapping represents the best current knowledge; additional highest priority natural communities exist that are not yet mapped.

Young and Old Forests

Young forests are regenerating forests dominated by dense seedlings and saplings less than 15-20 years old. Old forests are biologically mature forests, generally with trees exceeding 150 years in age.

Ecological Functions

The vast majority of Vermont's native plants and animals are adapted to the forest conditions that preceded European settlement. Because approximately 80% of Vermont's forest was cleared in the 19th century, today the forest composition and structure is very different than the conditions in which these species evolved. Old forests with large trees, abundant dead and downed wood, and natural canopy gaps, are essentially absent on the landscape. The complex structure of these forests creates diverse habitats, many of which are not present in younger forests. These complex structures also make these forests remarkably resilient. Old forests will be important "life-boats" that allow species and ecological processes to adapt to a changing climate.

At the same time, in most regions of Vermont young forest is less abundant today than it was before European settlement when natural disturbance created gaps and openings in the widespread forest. Young forests support a suite of wildlife species, many of which are in regional decline. Young forests also support many common species. Prior to European settlement almost all young forest was created by natural disturbance. Currently, forest management creates the majority of young forest in the state.

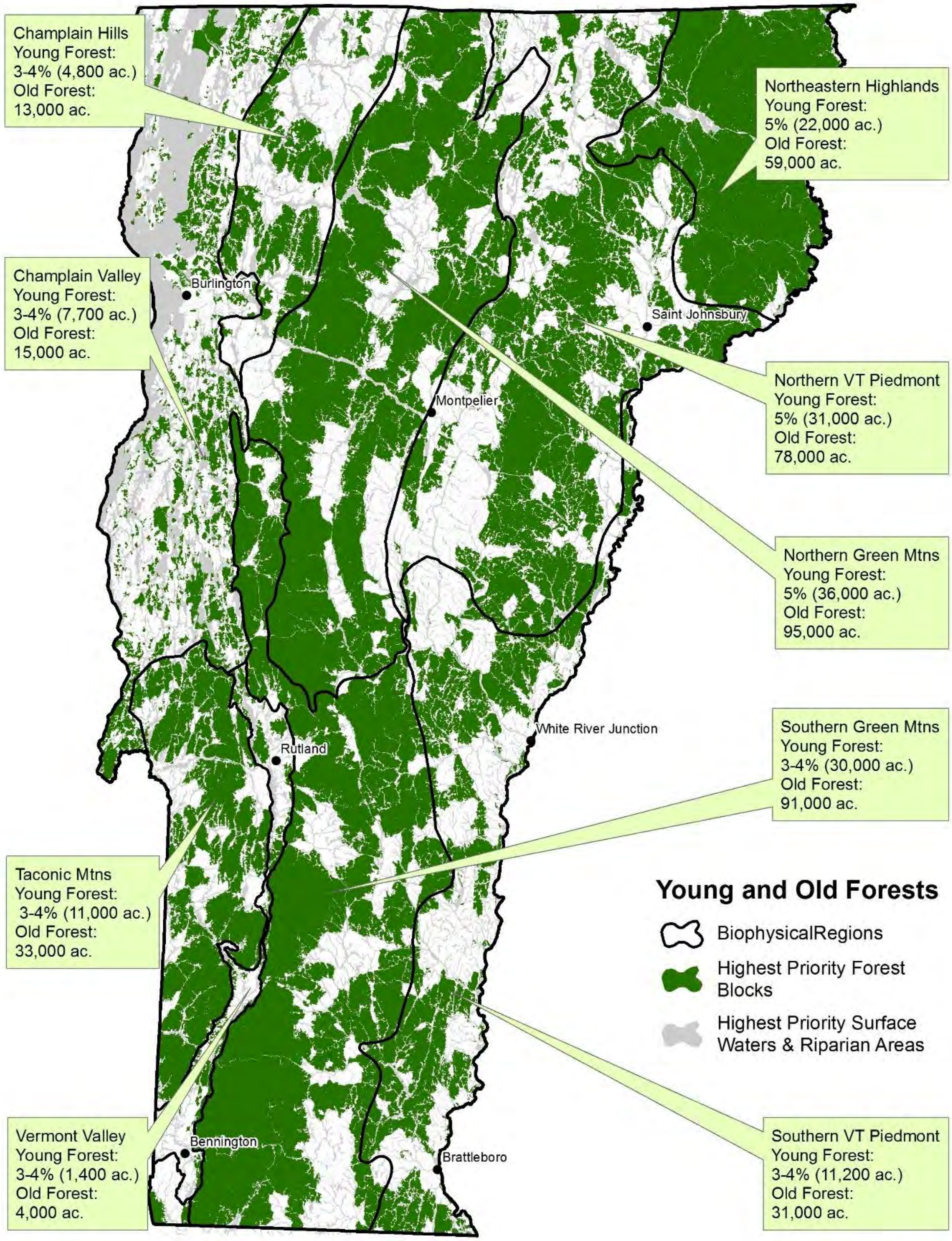
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies increasing the amount of both young and old forest in the state as highest priority for maintaining an ecologically functional landscape. A return to the pre-European abundance of young forest (approximately 3-5% of the forest) is needed to reverse a declining trend and reach a level that at one time supported all of Vermont's native species that require young forest. While it is not practical or possible to return to a landscape dominated by old forest, allowing about 9% of Vermont's forest (specifically, 15% of the matrix forest within the highest priority forest blocks) to become old forest will bring this missing component back to Vermont's landscape and offer confidence that species that benefit from or depend on this condition can persist.

Young forest patches should be large enough to meet the needs of obligate species (generally 5 acres or larger), without compromising the ecological functions of other highest priority features. Old forests should operate under natural disturbance regimes and need to be maintained in patches large enough to accommodate natural disturbance regimes without compromising old forest characteristics. In most forests, passive restoration will result in old forest. In some cases, active forest management may promote forest composition and structure suitable for subsequent passive restoration.

For more information on young and old forests, see the following sections in the Part 2 Vermont Conservation Design Technical Report:

- Young Forest
- Old Forest



Map 7: Highest Priority Young and Old Forest acreages within the highest priority forests blocks in each biophysical region.

Aquatic Habitats

Aquatic habitats are those found in rivers, streams, lakes, and ponds. These places are a vital subset of the Surface Waters and Riparian Areas network, but they still depend on the successful functioning of the entire aquatic network.

Ecological Functions

Aquatic habitats are essential for many species, including fish, amphibians, reptiles, invertebrates, and plants. Particular lakes and ponds, and segments of rivers and streams, make exceptional contributions to Vermont's biological diversity because of their unique physical characteristics arising from geology or topography, because they are good examples of aquatic habitats, or because they have concentrations of rare species and/or important species assemblages.

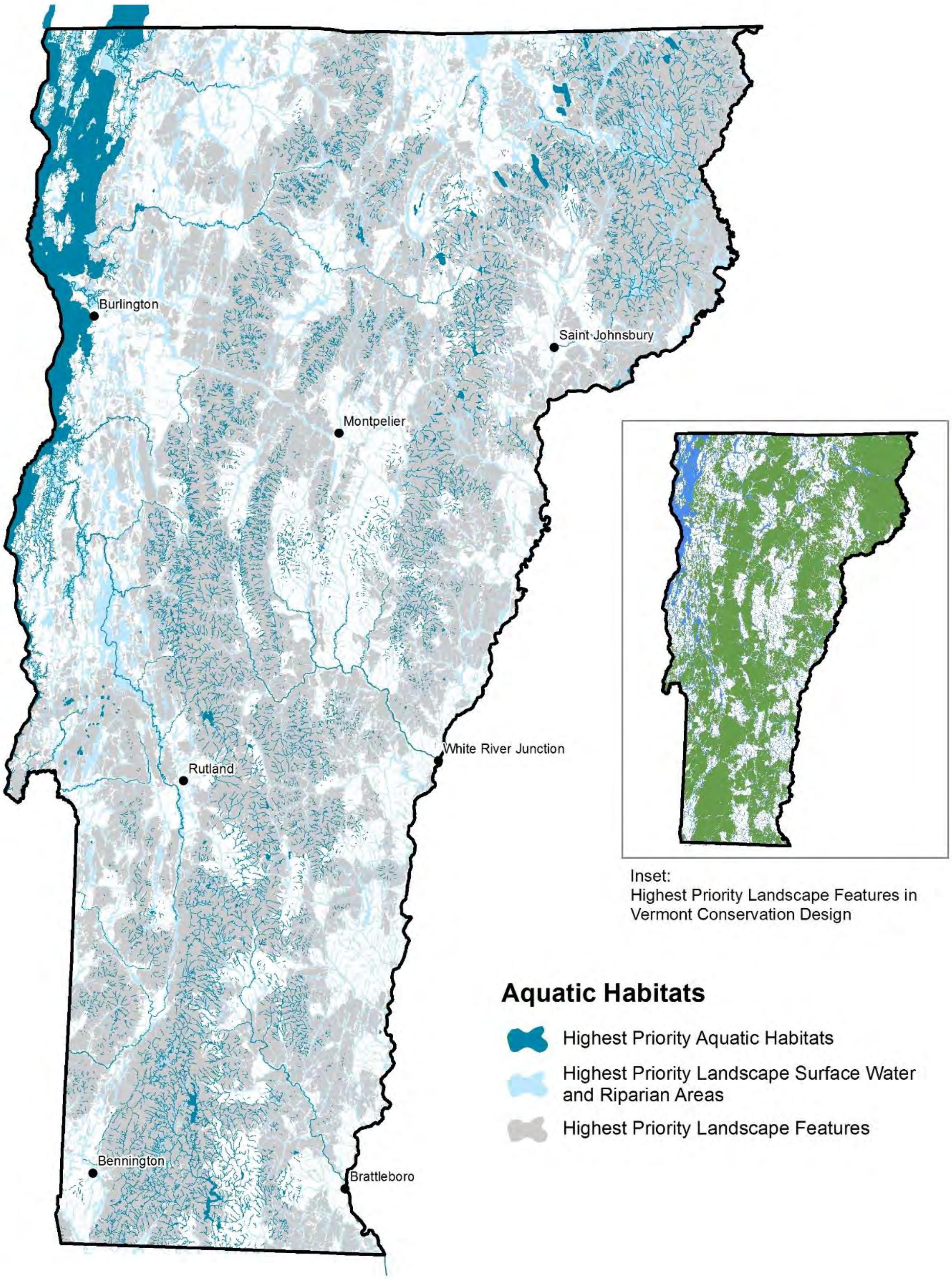
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies a set of aquatic habitats that are highest priority for maintaining ecological function. These are lakes and ponds, and segments of rivers and streams with known concentrations of rare species, exceptional species diversity, or which are examples of high-quality habitat. Collectively these features are representative of physical aquatic conditions. The river and stream segments include the full range of stream sizes, gradients, and temperature conditions in Vermont as identified by Anderson et al. (2013). Lakes and ponds include full representation of trophic status, depth, and alkalinity, which are generally the main factors that shape biological communities in lakes (Wetzel 2001). These highest priority aquatic habitats must be part of a fully functioning network of surface waters and riparian areas. Although areas with exceptional biological contributions can be identified, they cannot function independently.

An aquatic system's ecological integrity depends on the condition of the watershed in which it occurs, but it is critically tied to the condition of the adjacent riparian area. River channel equilibriums need to be maintained or restored. Artificial barriers to aquatic organism movement (culverts, dams, etc.) should be removed or mitigated. Natural vegetation should be maintained or restored along shorelines, and should have adequate width to maintain water quality, stabilize shorelines, and provide shade and the recruitment of downed wood and other natural organic matter. Runoff and erosion should be minimized along developed shorelines. Underwater habitat and vegetation should be maintained or restored to provide suitable conditions for foraging, shelter, and reproduction of aquatic organisms. The spread of aquatic invasive species and pathogens should be prevented and controlled where possible.

For more information on aquatic habitats, see the following sections in the Part 2 Vermont Conservation Design Technical Report:

- Important Aquatic Habitats and Species Assemblages – Rivers and Streams
- Important Aquatic Habitats and Species Assemblages – Lakes and Ponds
- Representative Lakes and Ponds



Map 8. Highest Priority Aquatic Habitats (dark blue). These features are a subset of the landscape-scale Surface Waters and Riparian Areas (light blue). Aquatic habitats depend on the ecological functioning of the entire aquatic network.

Wetlands

Wetlands are vegetated ecosystems characterized by abundant water. Vermont's wetlands range from small vernal pools and seeps to vast swamps and marshes covering thousands of acres.

Ecological Functions

Wetlands store water and attenuate downstream flooding. They maintain water quality by trapping sediments and removing nutrients and pollutants. Shoreline wetlands protect against erosion during floods and storms. Many wetlands are associated with groundwater discharge and form the headwaters of many cold-water streams. Wetlands provide important wildlife habitat and spawning and nursery habitat for fish species. Wetlands in Vermont provide habitat for a disproportionately high percentage of rare species. As climate change brings more frequent and larger storm events, and results in warmer surface waters, wetland functions will become even more important.

Vernal pools are a special type of wetland that provides critical breeding habitat for wood frogs and several salamander species, including spotted salamanders. These species migrate to vernal pools for spring breeding from the adjacent upland forests where they spend the majority of their life cycles. Eggs are laid in the pools and amphibian larvae develop and mature there. The mature amphibians then move to the adjacent forest for the fall and winter.

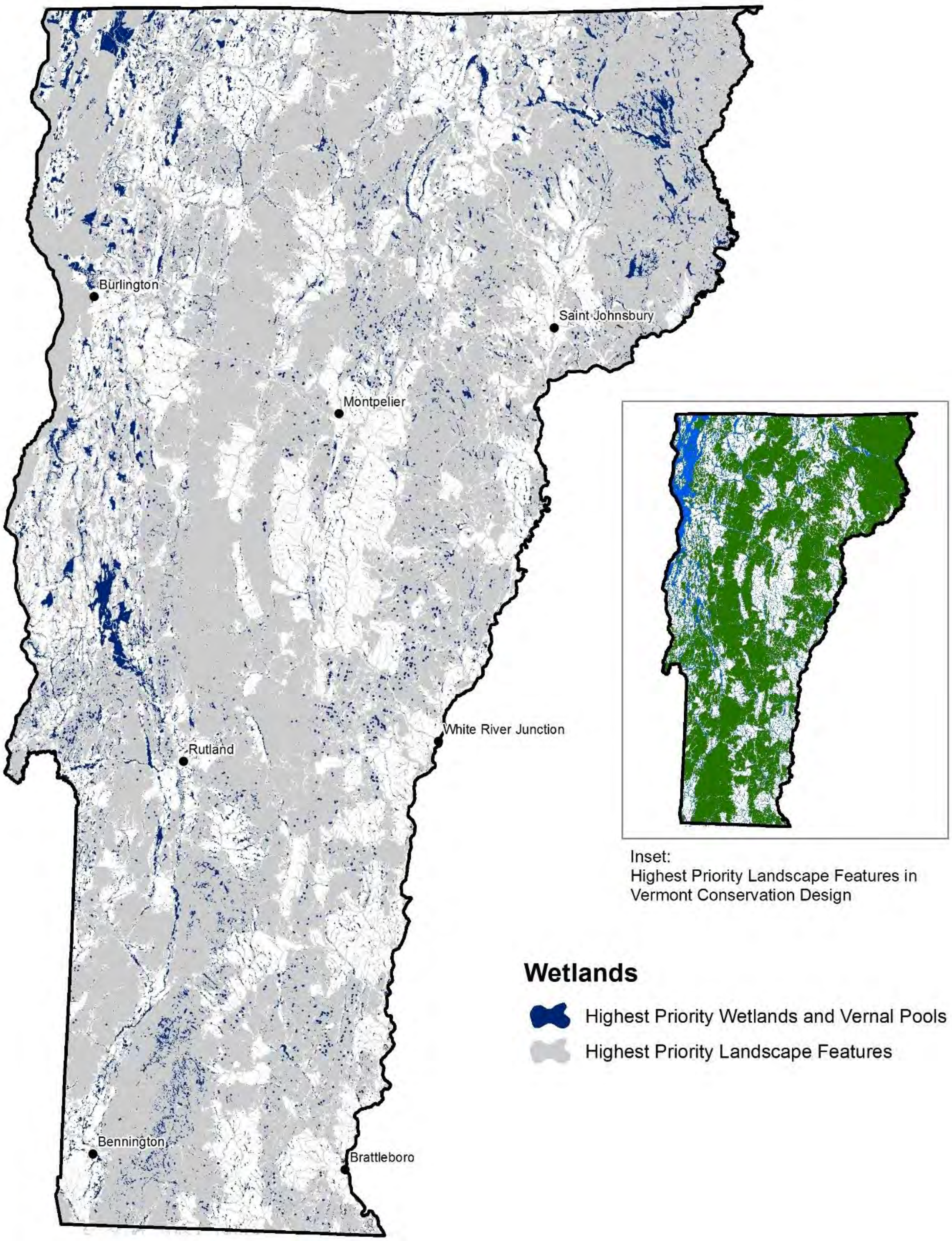
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation identifies a set of wetlands and vernal pools that are highest priority for maintaining ecological function. These are primarily wetlands and vernal pools associated with the landscape-scale forest blocks and riparian areas. It also includes wetlands in degraded watersheds where wetland functions are especially critical for water quality, water storage, and erosion control.

Wetland functions can be conserved by maintaining or restoring natural ecological conditions, including unaltered soils and hydrology, native vegetation appropriate to the site, and suitable conditions for native fish and wildlife species. Conservation should account for appropriate upland buffer zones, the ecological processes that support wetlands (especially hydrology), and a network of connected lands, waters, and riparian areas to allow ecological exchange between wetlands. More than 35% of the original wetlands in Vermont have been lost to agriculture, development, and other land uses, so wetland restoration is needed to achieve full ecological function across the landscape. For vernal pools, special attention is needed to maintain or enhance conditions in and around the pool for pool-breeding obligate species. In addition to the guidelines above, maintain or restore a mostly closed forest canopy with native species, abundant coarse woody debris, and a lack of artificial barriers to salamander movement in the 650 feet of forest adjacent to the vernal pool.

For more information on wetlands, see the following sections in the Part 2 Vermont Conservation Design Technical Report:

- Wetlands
- Vernal Pools



Map 9. Highest Priority Wetlands and Vernal Pools. Mapping represents the best current knowledge; additional highest priority wetlands and vernal pools exist that are not shown on the map.

Grasslands and Shrublands

Grasslands are dominated by non-invasive (but often non-native) grasses in agricultural settings. Shrublands are old fields and other upland areas characterized by at least 50% cover of native shrub species. (Wet shrublands, such as Alder Swamps, are included under natural communities and wetlands.) Grasslands and upland shrublands are managed habitats created by humans.

Ecological Functions

Grasslands and Shrublands support many wildlife species—particularly birds—that have become more abundant in Vermont since the start of widespread agriculture. In grasslands, these include bobolink, eastern meadowlark, and savannah sparrow. Shrubland species include American woodcock, brown thrasher, eastern towhee, blue-winged warbler, and eastern cottontail.

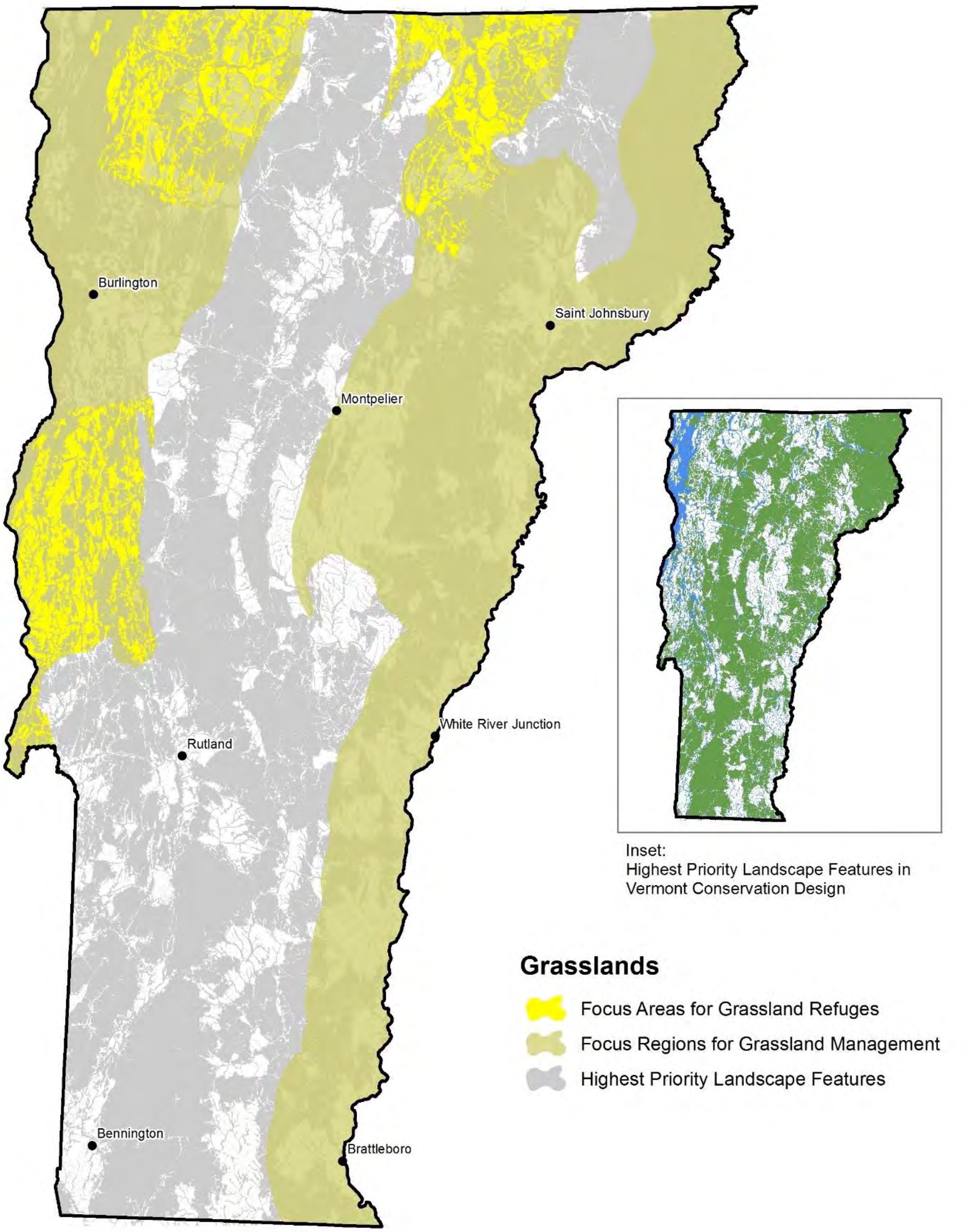
Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies the need to maintain these habitats and their associated species as highest priority for an ecologically functional landscape. Specifically, a total of 7,500 acres, divided between the northern Champlain Valley/Champlain Hills, southern Champlain Valley, and the Lake Memphremagog area, should be managed as "refuges" for grassland birds. In addition, bird-friendly practices should be promoted on active agricultural fields in the Champlain Valley, Champlain Hills, Northern Vermont Piedmont, and along the Connecticut River. Shrublands should be managed as a percentage of the undeveloped land in each biophysical region, with a target of 2-3% in the Champlain Valley and 0.5-1% in all other regions.

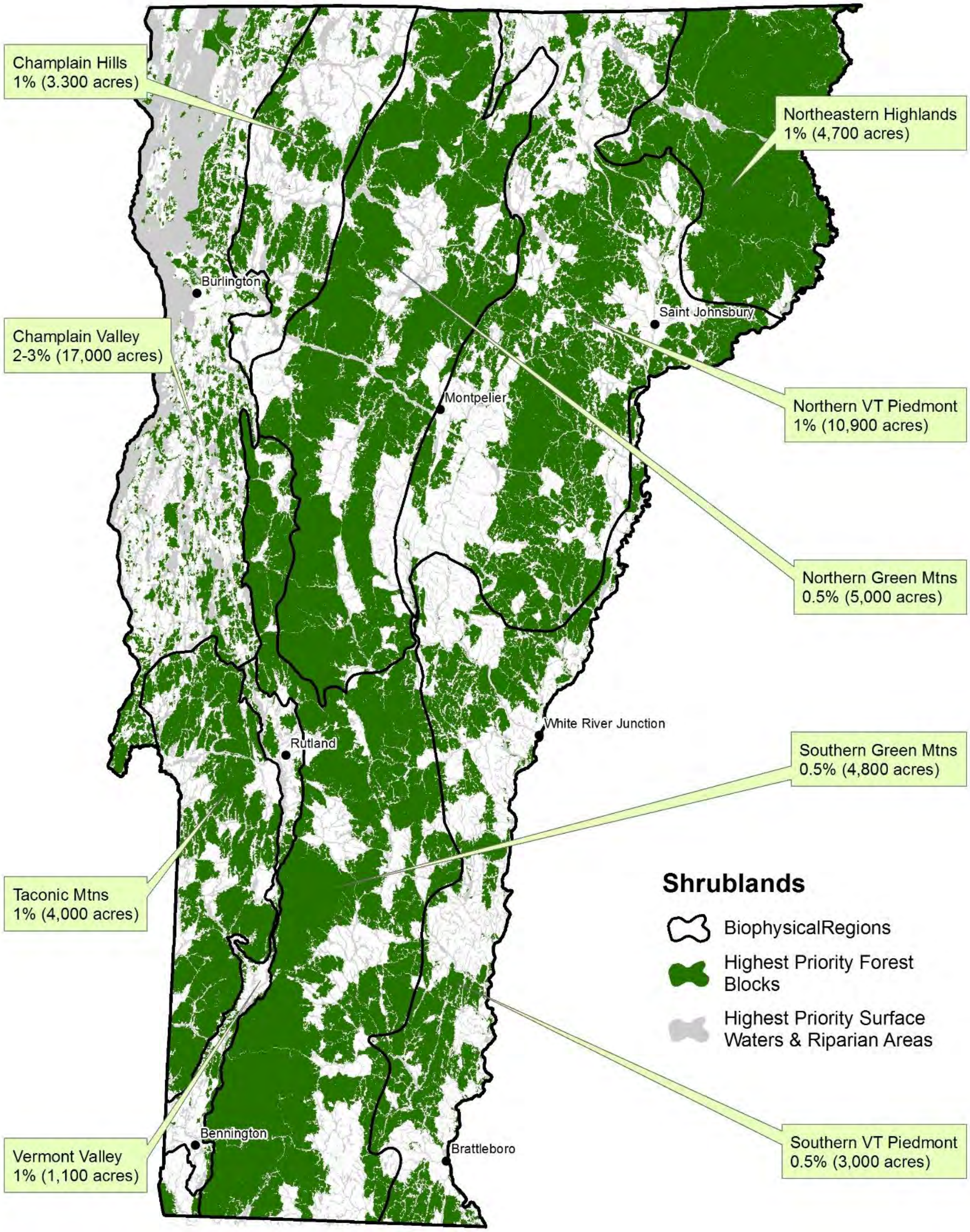
Grassland management must maintain quality grassland, while not destroying nests during the breeding season (May to early August). Mowing or other management should take place after August 1. Grassland patches should be larger than 25 acres. Patches that are blocky or circular have more interior area and support more birds. Mowing should incorporate best management practices for birds and reptiles. To avoid conflicts with other ecological functions, grasslands should be located outside of highest priority landscape features. Shrubland management (mowing, grazing, burning, etc.) should occur outside the growing season (preferably April-early May or October-November) to minimize mortality to foraging and nesting birds, reptiles, and insects. Disturbance should be regular enough to prevent trees from gaining dominance. To allow successful breeding of many shrubland birds, patches should be at least 5 acres and should be blocky or circular in shape to maximize interior area. Shrublands should be composed primarily of non-invasive vegetation.

For more information on grasslands and shrublands, see the following sections in the Part 2 Vermont Conservation Design Technical Report:

- Grasslands – Refuges
- Grasslands – Managed Agricultural Lands
- Upland Shrub-Forb



Map 10. Focus areas within which the Highest Priority 7,500 acres of grassland refuge could be established. Specific grasslands cannot be mapped due to a lack of spatial information. To avoid conflicts with other ecological functions, grasslands should be managed outside of the highest priority landscape features.



Map 11: Highest Priority Shrubland acreages by biophysical region. Shrubland can be created and maintained both within and outside of the highest priority landscape features, as long as it avoids conflicting with other ecological functions.

Underground Habitats

Caves are a unique habitat with a consistent environment of temperature, relative humidity, and air flow. Abandoned mines can provide many of the same habitat qualities of natural caves.

Ecological Functions

There are six species of bats known to hibernate in Vermont caves and mines. Recent surveys indicate that caves may hold as few as 10 individual bats to over 70,000. Bats use these sites for hibernation, but also spend a disproportionate amount of the year in the area surrounding the cave (e.g., fall swarming). Interest and understanding in the invertebrate communities associated with caves is just beginning, and even less is known about native fungi and other life forms. The condition and biology of the subterranean aquatic habitats is poorly understood. At the national and global scale, it is well-documented that caves provide habitat for specialized invertebrates (Peck 1998). Caves are expected to function as a coarse filter for these species which are poorly understood. Although abandoned mines are not of natural origin, they augment the natural habitats available and are an additional coarse filter for bat species.

Highest Priority Features and Guidelines for Maintaining Ecological Function

Vermont Conservation Design identifies a set of 22 caves and 19 abandoned mines that are highest priority for maintaining ecological function. Ideally, this set of caves would represent the full range of bedrock type and cave formations found in the state, but currently there is insufficient information to fully assess this. Additional study may ultimately refine these targets.

Changes in structure and hydrology could greatly affect the habitat provided by subterranean areas. Subterranean areas should remain intact, with limited human alteration or influence from above-ground pollutants. Maintain natural processes in caves, including temperature regime, airflow, humidity, and hydrology; natural vegetation conditions above the cave footprint and a 50-meter buffer to moderate air and temperature conditions; and natural groundwater sources. For abandoned mines, maintain the conditions that support hibernating bats or other known obligate species. Recreational exploration of caves and mines can pose a threat to physical conditions and species. Within a 0.25-mile zone around the cave or mine entrance, maintain natural forest vegetation with a diversity of age classes, and abundant live or dead known or potential roost trees with cavities, cracks, crevices, and/or peeling bark.

For more information on underground habitats, see the following sections in the Part 2 Vermont Conservation Design Technical Report:

- Caves
- Abandoned Mines

Caves and abandoned mines are not listed or mapped in this report in order to protect sensitive species and sites.

Species Conservation

Combined, the landscape, natural community, and habitat features identified in Vermont Conservation Design form the ecologically functional landscape. We are confident that these features, if appropriately conserved and managed to maintain their functions, will support the habitat needs of most of Vermont's native species. However, it is equally important to identify those species that will not be effectively conserved by this design. These species may need specific conservation and management actions to maintain viable populations in Vermont.

We tested the overall conservation design against a diverse list of more than 200 species. This list included common species, as well as rare and declining species of plants and animals that are Species of Greatest Conservation Need (SGCN) in the Vermont Wildlife Action Plan. We determined which of these species are expected to be conserved in Vermont by the identified features, and which are expected to require fine-filter conservation attention. Through this analysis, we found that all of the common species assessed can be effectively conserved by Vermont Conservation Design, and approximately 50% of the SGCN. This analysis of the design's capacity to conserve many common species and SGCN demonstrates the efficacy of the selected features and supports our confidence that the targets presented here will effectively conserve many other species—including cryptic and poorly understood species. This analysis of Vermont Conservation Design and the species it effectively conserves is a significant result of the project and will help guide our efficient conservation work—it is included in the Part 2 Vermont Conservation Design Technical Report.

We plan to expand this analysis in collaboration with experts on specific taxonomic groups to include more common species, more SGCN, and all rare plants and animals. To be most effective, this analysis will need to be an iterative process, with periodic reassessment of species as environmental conditions and risk factors change. The results of these analyses will provide a strong framework for focusing Vermont's species-level conservation and management work.

There will always be certain species that need attention. For example, spiny softshell turtles are extremely rare in Vermont and threatened by nest predation. Other species, such as some wildlife game species, have legal and social, as well as biological, considerations.

Species have come and gone from Vermont over the past millennia. We expect this shifting to intensify with current climate change. Northern species will likely shift out of Vermont, and southern species will likely become more abundant. These changes are part of nature's resiliency, and the ecologically functional landscape facilitates them. As these changes take place, however, we may face difficult choices. Should we attempt to keep in Vermont a species at the southern edge of its range, such as spruce grouse, knowing that its suitable climate is retreating northward? Should we embrace the movement of southern species, like tulip tree, into the state? Vermont Conservation Design cannot fully answer these questions, but it provides a framework to maximize our options into the future.

Putting it All Together: The Ecologically Functional Landscape

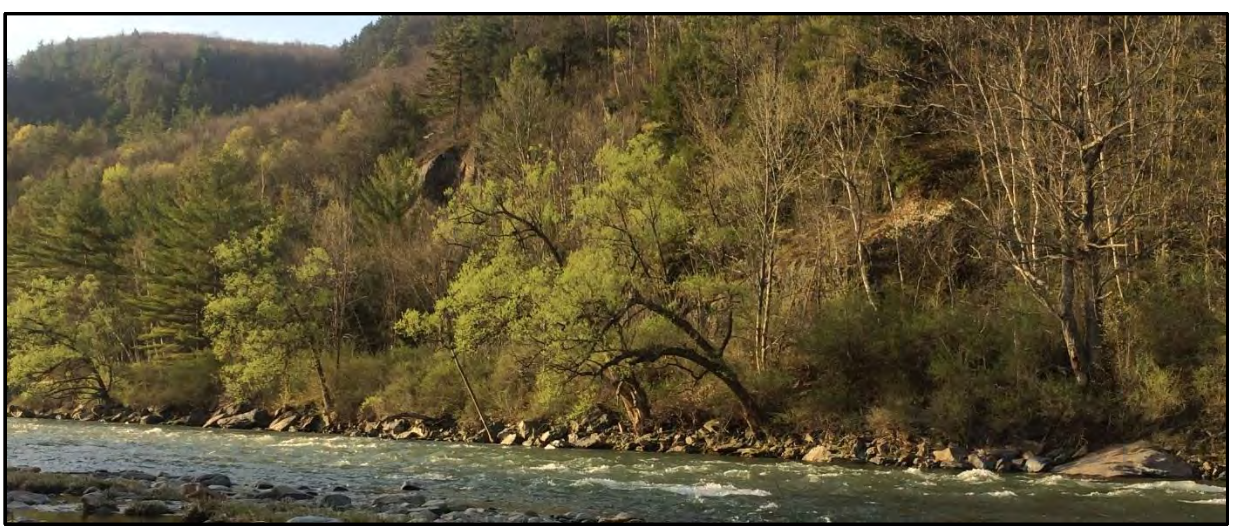
Maintaining or enhancing an ecologically functional landscape in Vermont depends on conservation of all the features described in this report: Interior Forest Blocks; Connectivity Blocks; Surface Waters and Riparian Areas; Physical Landscapes; Natural Communities; Young and Old Forests; Aquatic Habitats; Wetlands; Grassland and Shrublands; and Undergrounds Habitats. It is the specific functions of each of these features, and the complementarity of these features functioning together at multiple scales, that are critical for long term conservation of much of Vermont's biological diversity and natural heritage.

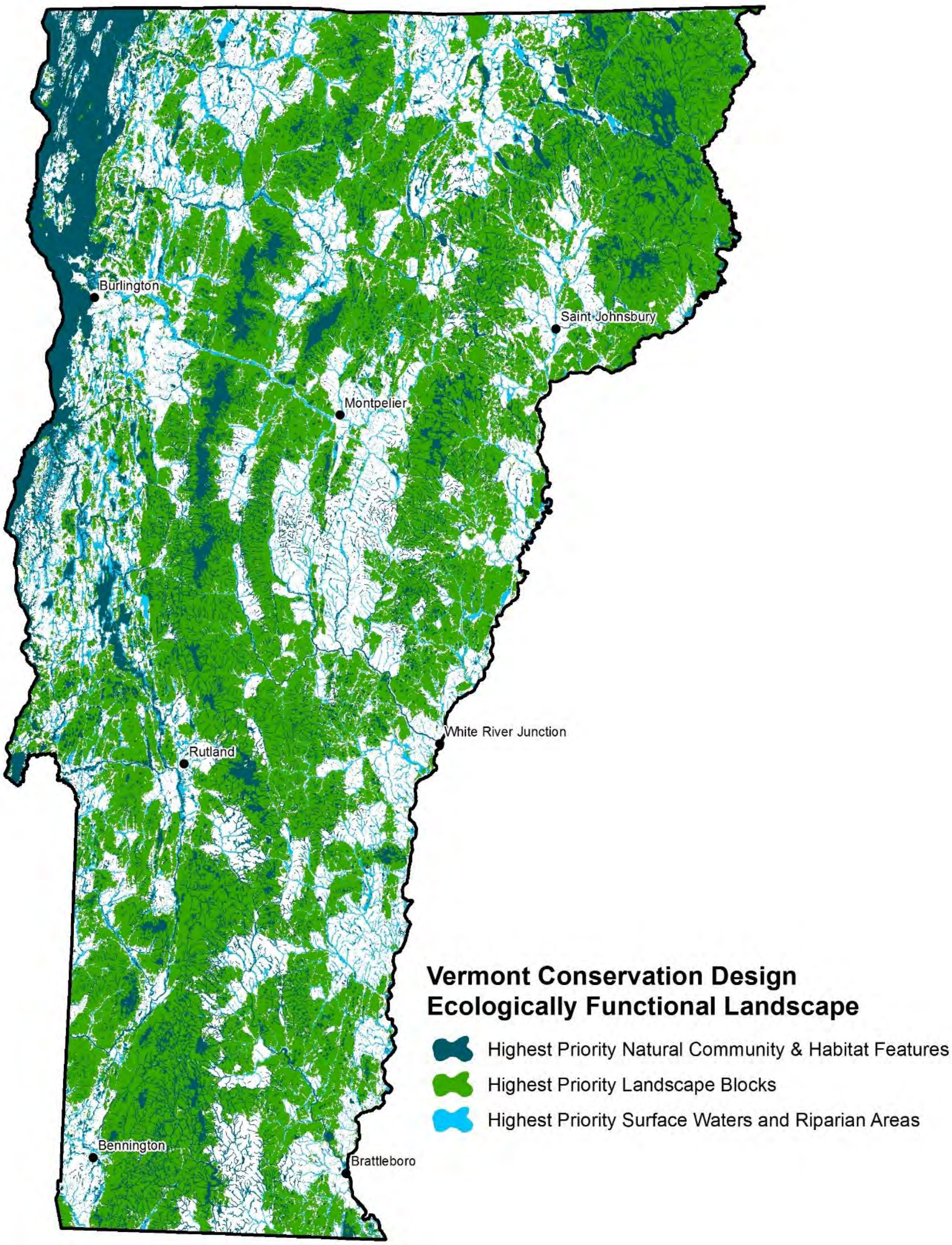
The following map shows the ecologically functional landscape conservation design, with all the highest priority landscape features and all the mapped natural community and habitat features included.

Vermont Conservation Design can maintain our valued natural landscape and the benefits it provides. The landscape it envisions sustains environmental services, like clean air and water, crop pollination, carbon sequestration, and flood protection. It provides resilience to climate change, allowing species and natural communities to rearrange themselves so that all these benefits continue into the future. It supports numerous social and economic values, including our outdoor traditions and outdoor recreation opportunities, the forest products economy, and the landscape that draws people to Vermont. It supports nature—for its intrinsic values, and our enjoyment and use.

It is our hope that this information will inform land management, local planning and development, and land conservation decisions throughout Vermont. We hope that private landowners, municipalities, state agencies, and conservation organizations will use this information as we all work together for a vibrant and healthy Vermont.

Vermont Conservation Design is a science-based vision for the future of Vermont's natural areas, forests, waters, and wildlife. It can guide us to the long-term conservation of the state's iconic landscape. Expansive forests, clean water, and abundant fish and wildlife can be our legacy.





Map 12: The Ecologically Functional Landscape of Vermont Conservation Design. Note that all three of the highest priority feature types shown on this map can overlap.

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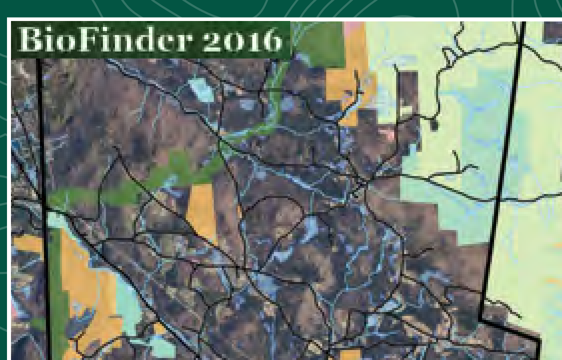
Mapping Vermont's Natural Heritage

A Mapping and Conservation Guide for Municipal and Regional Planners in Vermont



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A Mapping and Conservation Guide for Municipal and Regional Planners in Vermont

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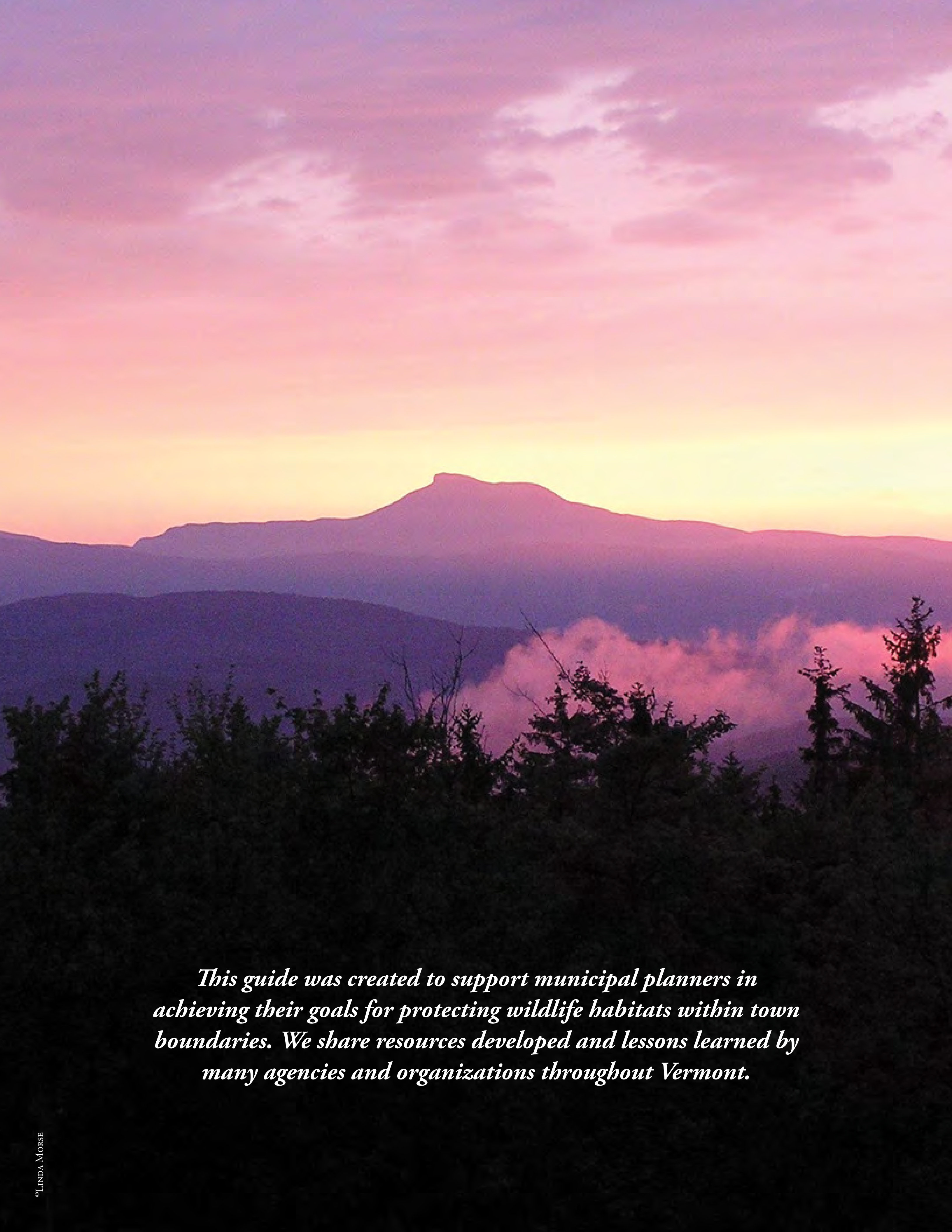

This guide was created to support municipal planners in achieving their goals for protecting wildlife habitats within town boundaries. We share resources developed and lessons learned by many agencies and organizations throughout Vermont.

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Background and Purpose

©John Hall

Vermont is known for its beautiful forests and agricultural lands, mountain streams and scenic landscapes. This is the Green Mountain State, where residents claim a love of rural places and where visitors come to ski, hunt, hike, and enjoy the scenery. Our landscape drives our economy and is largely what makes our state so special.

Surveys support these claims. Across the nation, only Alaska outranked Vermont for participation in wildlife-related recreation (i.e., fishing, hunting, or wildlife watching) in a 2011 survey (US Dept. of Interior). In the same survey, Vermont ranked first for wildlife watching activities, with 53 percent of residents participating, more than half our population, and it was estimated that more than $704 million was spent in Vermont on fish- and wildlife-based recreation. In 2015, a public attitude survey found that 83 percent of respondents agree that land use and development should be restricted to protect fish and wildlife and that 81 percent would like to see wildlife habitat protected even if it reduces the land use options of some landowners and developers (Duda et al). In Vermont, we like our wildlife and we want to see their continued presence on the landscape.

With more than 80 percent of the state's land in private ownership and the majority of land use and development decisions made at the local or regional level, the protection of Vermont's species, habitats, and ecological processes is firmly in the hands of landowners, municipal governments, and regional planning groups. At the same time, municipal planners must balance these wildlife needs with countless other goals, and prioritization of such diverse needs can be tricky.

This guide was created to support municipal planners in achieving their goals for protecting wildlife habitats within town boundaries. In it, we share resources developed and lessons learned by many agencies and organizations throughout Vermont, combining background information about our natural landscape, natural resources maps tailored to individual towns, and a step-by-step strategy for prioritizing ecological needs alongside diverse other goals. For those wishing to dig deeper, we have provided links to additional resources you may find helpful. Our goal is to provide planners with the knowledge and tools necessary to make wildlife-related planning decisions in their own towns or regions. If a community can identify and conserve the most important wildlife resources on its own landscape, it will also achieve goals set forth in Vermont's state-level Wildlife Action Plan and thereby aid with the conservation of wildlife on a state and even regional scale.

The Merriam-Webster Online Dictionary defines conservation as "the careful preservation and protection of something, especially planned management of a natural resource to prevent exploitation, destruction, or neglect." In this guide, we keep our use of the word broad, including any strategy that can aid in the protection or thoughtful use of the natural landscape to maintain or enhance its healthy condition.

Using This Guide

The CD and online files that accompany this guide include a set of seven maps centered on each town in Vermont. These maps are formatted to be printed at 44 x 36 inches, but they can also be adapted for printing on a home printer or viewed on your screen. The maps can also be recreated on an online program called *BioFinder*, described later in the introduction to this guide.

Part I provides information about each layer found on the maps. For each dataset, we describe the layer, its importance, how it was mapped, and considerations for conserving the resource.

Part II offers a step by step approach for determining which locations in a community are most important to conserve and then finding conservation strategies appropriate for the community.

An **Appendix** and **Glossary** can be found at the end of the guide.

Suggested Process:

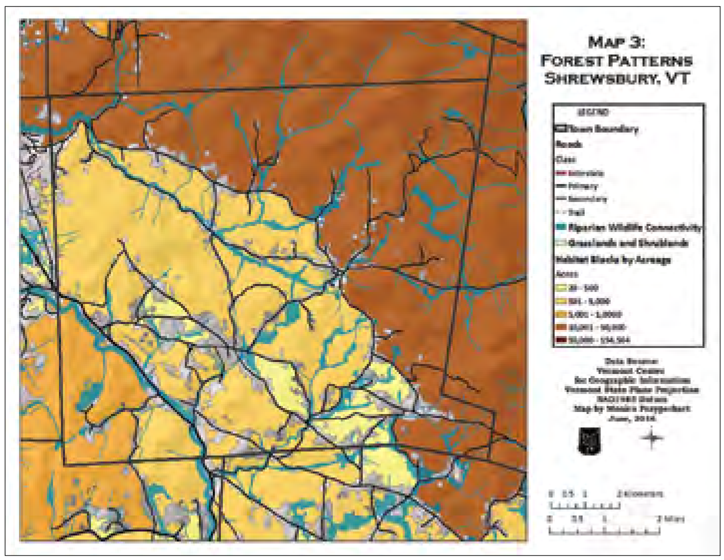
1. Start with Part I. Look at the seven maps of your community and understand the ecological components presented in each.
2. Read Part II and prioritize important locations in your community. As described in Part II, first identify broad patterns; then add finer details.
3. Go back to Part I and dig deeper into the natural heritage features found in your priority areas. Find strategies that will conserve first the broad patterns, and then any elements not captured by these patterns.

Natural Heritage

Natural Heritage includes all the natural resources Vermont residents and visitors value. Vermont's diverse resources, which include forests, clean waters, vibrant fisheries, healthy wildlife populations, rare species, significant natural communities, and a working landscape provide people with the opportunity to—among other things—hike, hunt, fish, trap, birdwatch, and work the land. Natural heritage also includes the concept of biodiversity, which is the variety of life in all its forms and all the interactions between living things and their environments.

Why Maps?

In 2008, the Vermont Supreme Court struck down a South Burlington zoning ordinance aimed at protecting a variety of natural resource values (In re Appeal of JAM Golf, LLC, 2008 VT 110). The court determined that the ordinance was too vague to effectively determine what "protection" of the natural resources listed should entail, thereby making it unenforceable. Because the South Burlington ordinance was written in language similar to that used by towns throughout the state, this ruling is a call to action for all towns wishing to protect their local natural resources. If towns want their plans and bylaws to be legally defensible, they must include clear, specific, and consistent standards that define exactly what types of development are allowed and prohibited in any given area (Garvey 2009).



A map is the first step in creating such clear, specific, and consistent standards. Before you can effectively plan, you first need to determine exactly what resources you have. The better your information, the more easily you can prioritize, and the more clarity you can provide. A map is essentially an inventory of one or several components of the landscape, and this guide highlights a series of seven maps created to feature the ecological, biological, and physical resources of each town in Vermont. When combined, these maps become even more powerful, showing how each individual dataset relates to every other.

Of course, every map also has limitations. Maps are static images, and yet they represent a changing landscape. They are also intended for use at a particular scale and can become inaccurate when used at other scales. Imagine, for example, a map of all the lakes present in the state of Vermont. At the state level, each lake appears accurately placed. However, if you were to zoom in on that map, magnifying everything within the boundaries of your hometown, you may find that the boundaries of the lake are off by 25 feet. When examining that map at the state scale, those 25 feet are unsubstantial. To a landowner whose home is depicted as partially underwater when zoomed to the parcel level, those 25 feet matter!

In this guide, we therefore explain the appropriate scales, data sources, and intended purpose of each map. We encourage you to read these descriptions thoroughly before including the maps or the data they contain in implementation efforts. When used appropriately, this information can open new ways of seeing your community and the many natural resources located there.

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But Wait! What About Private Property?

As mapping data increases in availability, some fear that the resulting maps could be used to infringe on landowners' property rights—or even that maps themselves can be an invasion of privacy. Certainly not unique to mapping, the question of how to balance protections of privacy with the collection and distribution of useful information pervades today's world. Many technological advances have forced us to consider where to draw the line between what is public and what is private. In terms of maps, there is no doubt that mapping content is substantially more detailed and descriptive today than it was in the past. This increase in detail allows us to learn more about the function of our landscape, and it increases the risk of invading personal privacy. The two go hand in hand.

For cartographers, this discussion is not new. The very nature of creating a map is to take what is present on the ground and draw it in a form that is easier to visualize, easier to understand, and easier to share. Maps are made in an effort to increase understanding of what is present, and to share this understanding with others. Maps by their very nature are central to this debate about balancing enhanced public knowledge and protection of privacy.

We have created this mapping guide because at this point in time, the information displayed on these maps is known. It already appears on public maps. While the data were collected for a variety of reasons, the people most affected by the information—and who can certainly also use it—are landowners and communities. At a local level, it is your land that appears on these maps. If anyone has a right to access these data, you do, too—along with information about the intended use of the data.

To some, the distribution of maps depicting natural heritage features is particularly concerning due to a perceived conflict between human interests and the needs of wildlife. To this end, it is true that just as what is "good" for one landowner may not be desirable for the next, some ecological priorities may conflict with a landowner's wishes for his/her land. In writing this guide, our goal is not to dictate any particular course of action; it is simply to describe the way the ecological landscape functions, map the components geographically, and guide you through possible techniques for making informed decisions about ecological priorities.

At that point, it is up to landowners and communities to decide what to do with the information. While this guide outlines a process for taking map information and creating a conservation strategy, the nature of that strategy needs to be decided at the local level. Some communities may use these maps purely for educational purposes. Others may use them when creating municipal plans and bylaws. Whatever the strategy, these decisions need to reflect local realities—ecological and societal. When implementing any strategy, some communities may find that the ecological components and priorities described in this guide are in conflict with community or landowner goals, and these communities may need to think very carefully about how to handle this conflict. Other communities may find that few conflicts exist. But without information about how the landscape functions ecologically, it is impossible to tell even whether there are conflicts. We provide this guide to allow you to make informed decisions about how to proceed, and encourage you to keep in mind the privacy of those whose land appears on these maps.

Getting the Most out of the Maps

Maps and inventory may be the basis of natural resources planning, but there are clearly several steps between identifying features on a map and having a plan. In this guide, you will find many references to *Conserving Vermont's Natural Heritage*, published in 2004 and updated in 2013 by the Vermont Fish & Wildlife Department and Agency of Natural Resources, and *Community Strategies for Vermont's Forests and Wildlife*, a 2013 document by Vermont Natural Resources Council. Together, these books provide a background of the natural heritage features found on the maps in this guide as well as explanations of a wide range of tools a community might use to protect these resources. We encourage you to read these books alongside this guide.

Additionally, Vermont's Agency of Natural Resources has developed several online mapping tools, such as BioFinder and the Natural Resources Atlas, to allow anyone with an internet connection to explore state mapping data. Using these resources, you can recreate any of the maps you see here, mix and match data, and zoom in and out to different scales on any map.

In addition to the above resources, we also recommend that your planning group captures the goals and values of your community and includes local citizens in the planning process even as you begin. Because it will ultimately be up to your community to adopt the plans and strategies you propose, it is important to be transparent about your intentions. The *Community Heart and Soul Field Guide* outlines one method for involving your community in the planning process, published in 2014 by the Orton Family Foundation and available online at www.orton.org/what-we-do/what-community-heart-soul. When combined with the scientifically based background information outlined in this guide and by natural resources professionals, this strategy can be a powerful way to connect with citizens in your community. Of course, all strategies are not for all towns, and this is just one of many possibilities!

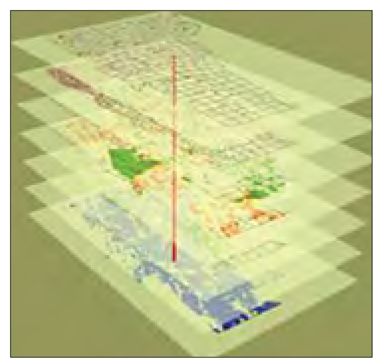
BioFinder: Vermont's Online Conservation Planning Mapping Tool

Found online at biofinder.vermont.gov

What is Biofinder?

BioFinder is an online mapping tool that allows Vermont citizens, such as planners, developers, educators, scientists, and so forth, to explore the lands and waters in Vermont that are most important for supporting ecosystems, natural communities, habitats, and species. BioFinder shows a variety of ecological components known to contribute significantly to biological diversity, then categorizes these components into conservation priorities. The goal is to allow citizens not only to locate ecologically important components on a local landscape but also to identify the *most important* locations for conservation or the most ecologically logical places for development.

Similar to many modern mapping programs, BioFinder uses a geographic information system, or GIS, that captures, stores, analyzes, and manages a diverse array of geographical information and allows it to be viewed simultaneously. In some ways, this process works just like taking physical maps, copying them onto transparent mylar, then laying one on top of another so that a location on one lines up with the same location on another. A user can look at multiple layers—meaning multiple sets of map data—at once and add or remove information as needed.



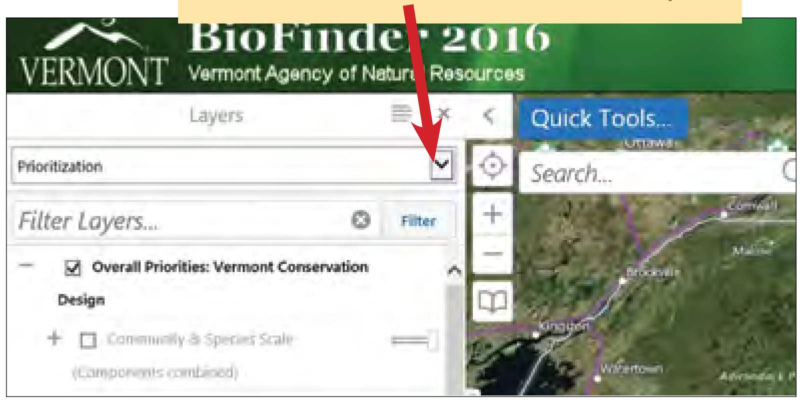
A GIS map layers datasets one on top of another, so that they align geographically.

In other ways, GIS is much more sophisticated than a set of transparent maps because the software not only layers the maps on top of one another but also provides tools to analyze them. For example, a user can see which conserved land has public access, view all lands within 100 feet of a wildlife road crossing, or identify places that are mapped both as a large habitat block and a deer wintering yard. BioFinder also allows users to make notes, print maps, and create reports of all the "priority" and "highest priority" ecological components found in a chosen geography.

BioFinder Themes

BioFinder categorizes all information into two themes. Each theme includes a separate list of map information that can be displayed or turned off as desired. The default theme, **Prioritization**, appears when you first open BioFinder, but an **Inventory** theme is also available. Change the theme by clicking in the box at the top of the information panel, under the word **Layers**.

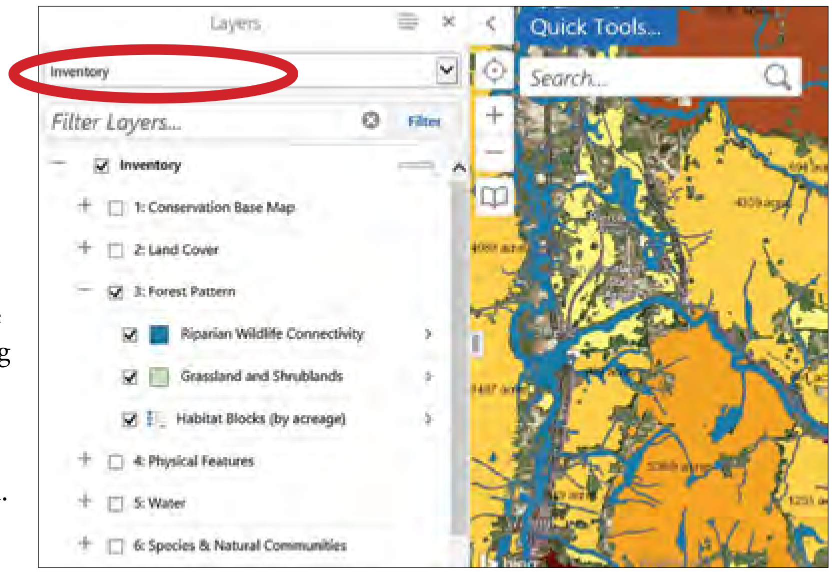
To change themes, click this box.
You can select **Prioritization** or **Inventory**.



Inventory

Answers the question "What's here?"

The Inventory theme on BioFinder mirrors this guide's presentation of *Part I. Inventory Maps*. This theme displays each individual dataset, organized in the same manner as the first 6 maps here. Just as in this guide, if you begin with Map 1 and view each map in the order presented, you will find yourself beginning with broad, landscape patterns and then zooming in to see increasing detail. Many of the map layers depict the same information shown in the Prioritization theme, but here information is shown in its raw form, before priorities have been assigned. This allows a user to explore the breadth of ecological components at play on a local or regional landscape.



Inventory Theme

Use the **Inventory** *theme to find specific information about which ecological components are present in an area of interest.*

Prioritization

Answers the question "Where are the locations of highest ecological importance?"

The **Prioritization** theme matches the discussion in this guide's *Part II. Prioritization and Implementation*, displaying maps of important components by ecological priority. This theme uses variations of the same data found in the Inventory section, but these data are categorized here to aid with conservation planning efforts. This theme identifies statewide ecological priorities based on their contribution to regional **ecological function**—the ability of plants and animals to interact as needed in order to thrive, reproduce, migrate, and move, even as the climate changes.

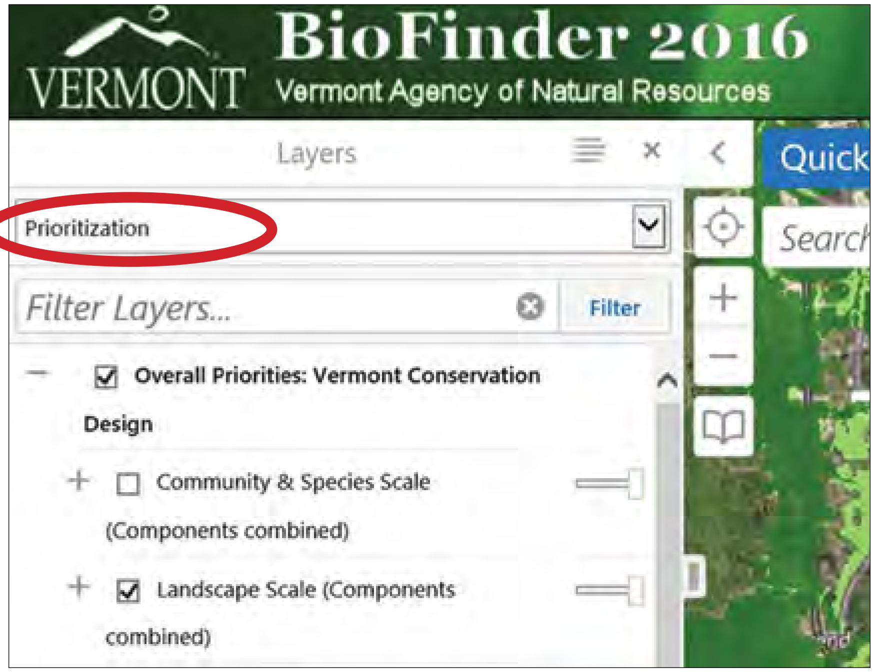
The theme considers two scales: Landscape scale and Community and Species scale. Landscape scale components include the forest networks, waterways,

Public Access to Digital Mapping Resources

In recent years, digital mapping resources have become increasingly sophisticated, enabling generation of abundant landscape-based information that was previously unknown. Even with these mapping developments, however, many resources remain relatively inaccessible to the public, requiring expensive software or technical training. The Vermont Agency of Natural Resources developed BioFinder and its sister application, the Natural Resources Atlas, to allow easy public access to map information.

and physical landforms that create a backdrop for interactions among the majority of Vermont's species. The community and species scale includes those components important to individual species or groups of species of conservation concern within Vermont, such as habitat for rare species, vernal pools, or locations where wildlife are most likely to cross roads.

At each scale, state biologists have divided components between "highest priority" and "priority" groups. Areas tagged as highest priority are those critical for maintaining an ecologically functional landscape. While areas labeled priority are also important, they play a lesser role in maintaining regional ecological function—though they may remain important locally. The highest likelihood of maintaining an ecologically functional landscape will be achieved by conservation of both highest priority and priority components.



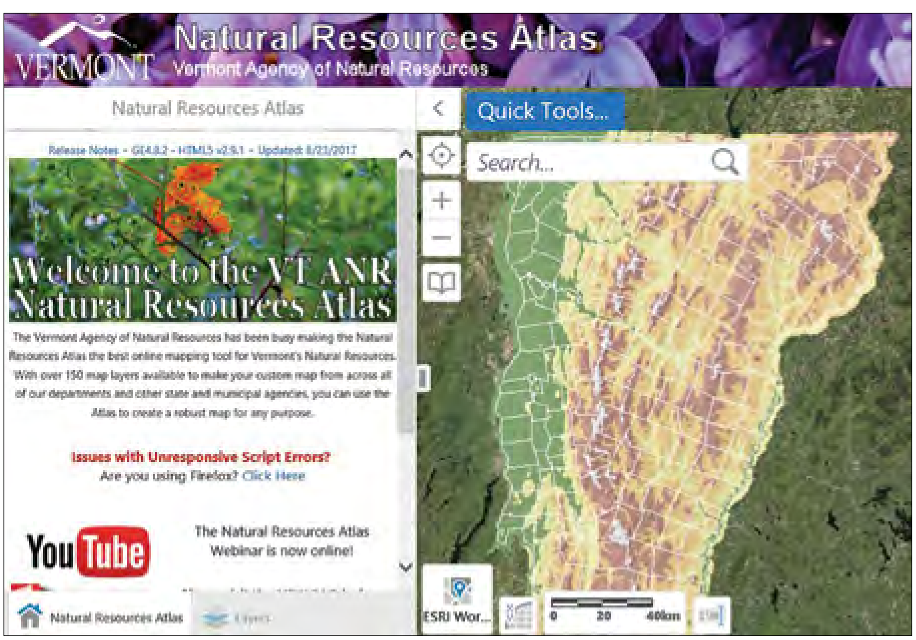
Prioritization Theme *Use the* Prioritization *theme to find locations containing generalized ecological priorities.*

The Natural Resources Atlas: A Sister to BioFinder

When conducting conservation planning, BioFinder is the tool of choice, but planners should also be aware of another mapping tool created by the Vermont Agency of Natural Resources: the Natural Resources Atlas. This application uses the same online platform, has the same functionality, and even contains much of the same data. The main difference is that BioFinder was created specifically to aid citizens in accessing natural heritage and conservation-related data, while the Natural Resources Atlas is intended for much broader use.

The Natural Resources Atlas acts as a clearinghouse for all data generated or used by each of the departments in the Vermont Agency of Natural Resources. It includes, for example, waste management, geologic, and groundwater protection data in addition to landscape and habitat features. While useful, many municipal planners and citizens find this overwhelming. When conducting conservation planning, you may find it simpler to start with BioFinder's pre-loaded subset of applicable data. If additional information is needed, any Atlas layer can be uploaded onto BioFinder. Because the tools contain the same functionality, users of one can generally transition to the other with ease.

Visit the Natural Resources Atlas at: anrmaps.vermont.gov/websites/anra5/.



Getting Started

***BioFinder** is found online at biofinder.vt.gov*

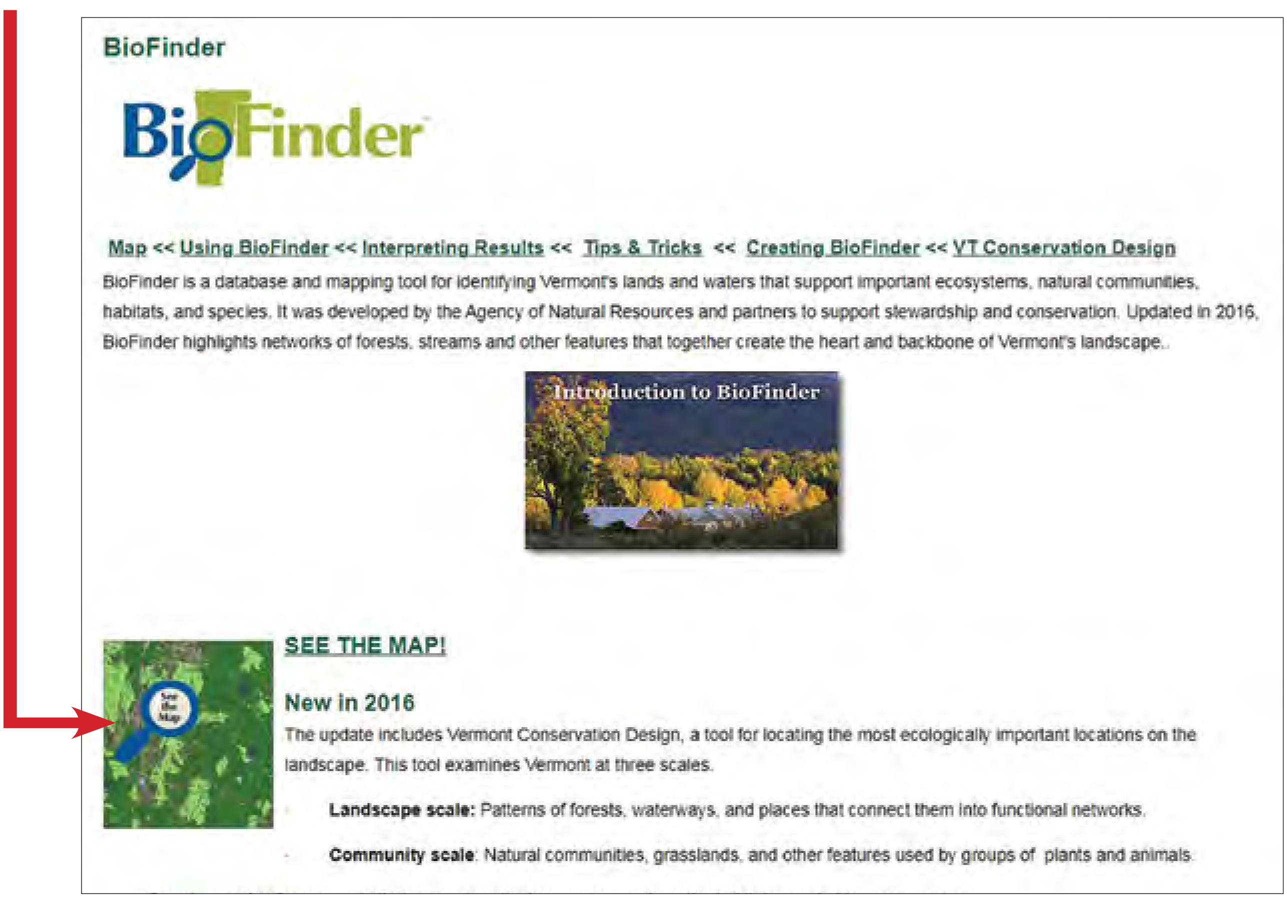
If you're new to online mapping tools, we suggest starting with a series of videos about BioFinder. This link takes you to a playlist of multiple videos, starting with an orientation, then continuing to tutorials about using specific mapping tools:
tinyurl.com/BiofinderHowToVideos.

In fact, there are quite a few instructional videos produced by the Vermont Agency of Natural Resources' GIS mapping team. All are available on a YouTube channel, which is where new videos will be posted as they become available:
www.youtube.com/user/vtanrgis.

The Help tools within the application may also prove helpful.

Using BioFinder, you can follow the steps below to view any of the maps described in this guide. Please note that colors may differ between those provided in this guide and online.

1. Open the BioFinder Homepage at biofinder.vt.gov. This page contains links for additional information, instructions, and tutorials.
2. Click the map icon with the words **See the Map**.



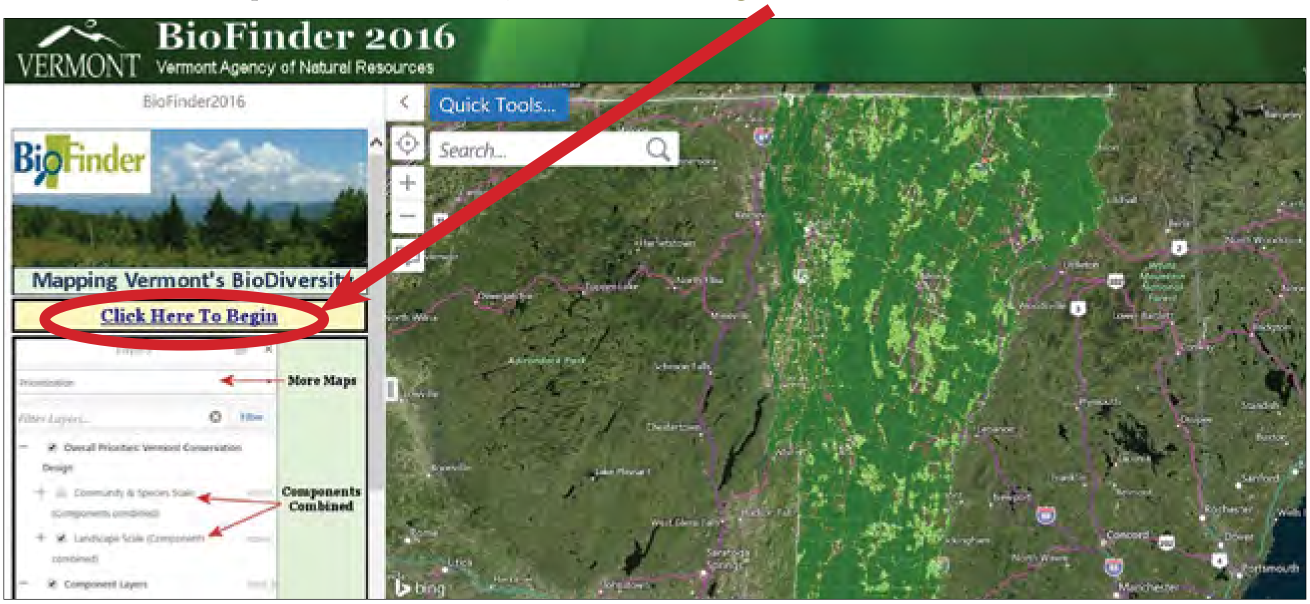
Reproducing the Maps in this Guide

While Vermont Fish & Wildlife Department has prepared static versions of Maps 1 through 7 in this guide specific to every town in Vermont (included on the CD that accompanies the guide), you may find it most useful to explore the maps online, which will allow you to zoom in or out to see locations of particular interest, mix and match datasets from different maps, or see how your town compares to surrounding locations.

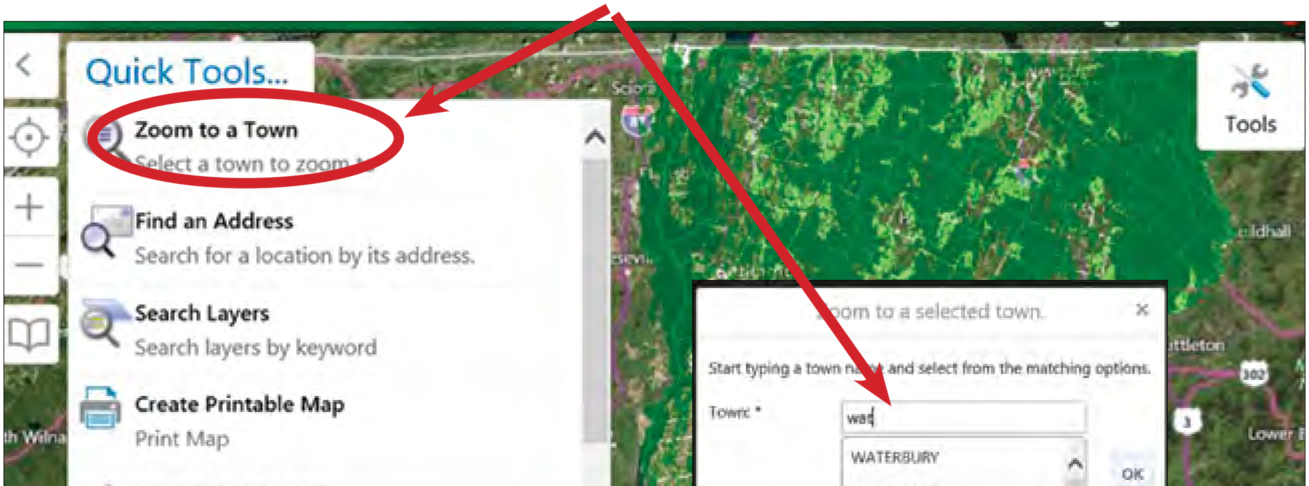
BioFinder Workshops

Want to explore BioFinder in an interactive training? Vermont Fish & Wildlife Department may be available to conduct such workshops. Please contact the department's Community Wildlife Program for more information on bringing a workshop to your region.

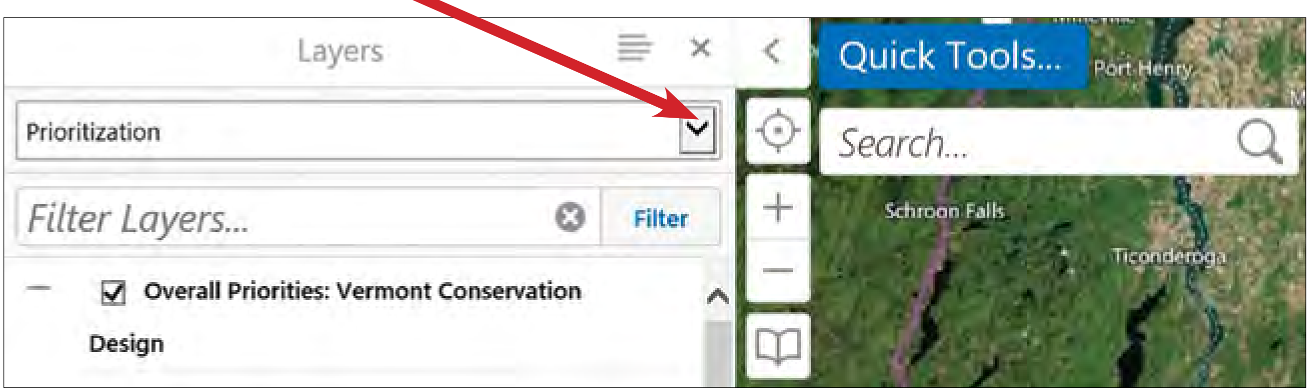
3. On the left-hand panel, click where it says **Click Here to Begin**.



4. Find your town by clicking **Quick Tools** in the top, center of the page. Using the **Zoom to Town** feature, type the first few letters of your town's name, and select your town from the list that appears.

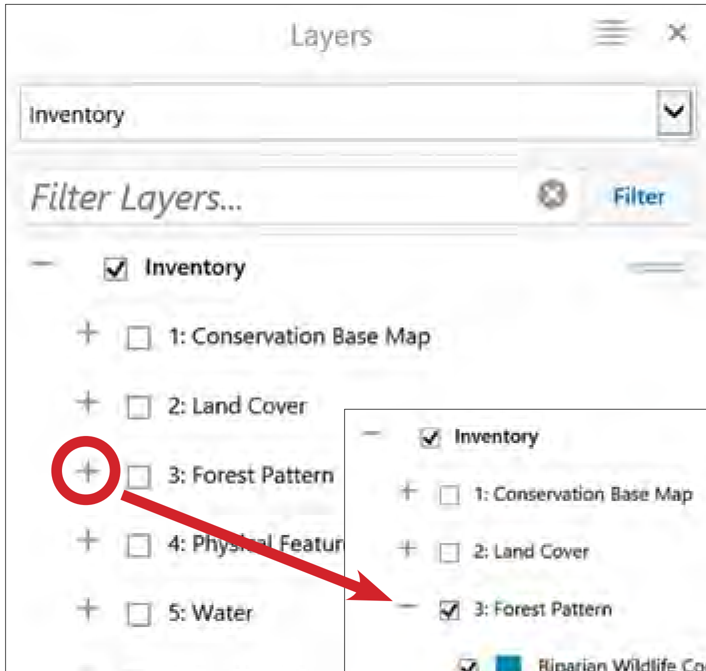


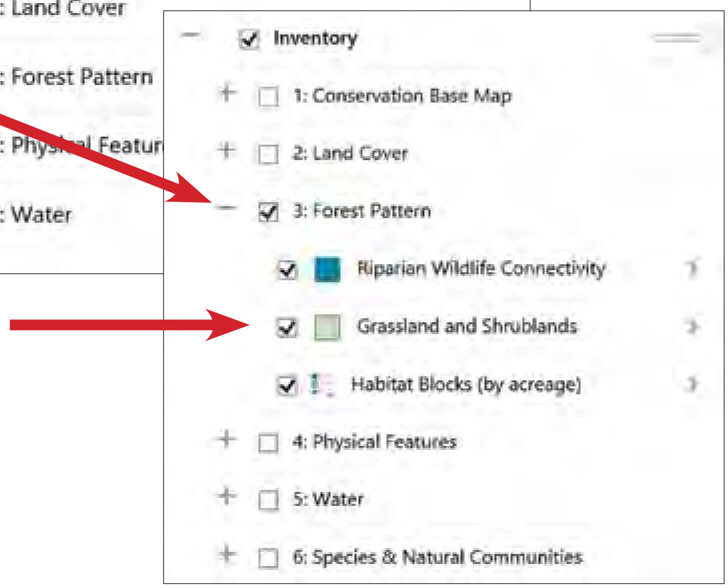
5. Find where a drop-down menu says **Prioritization**, under the word **Layers** at the top, left-hand side of the page. Select **Inventory**.



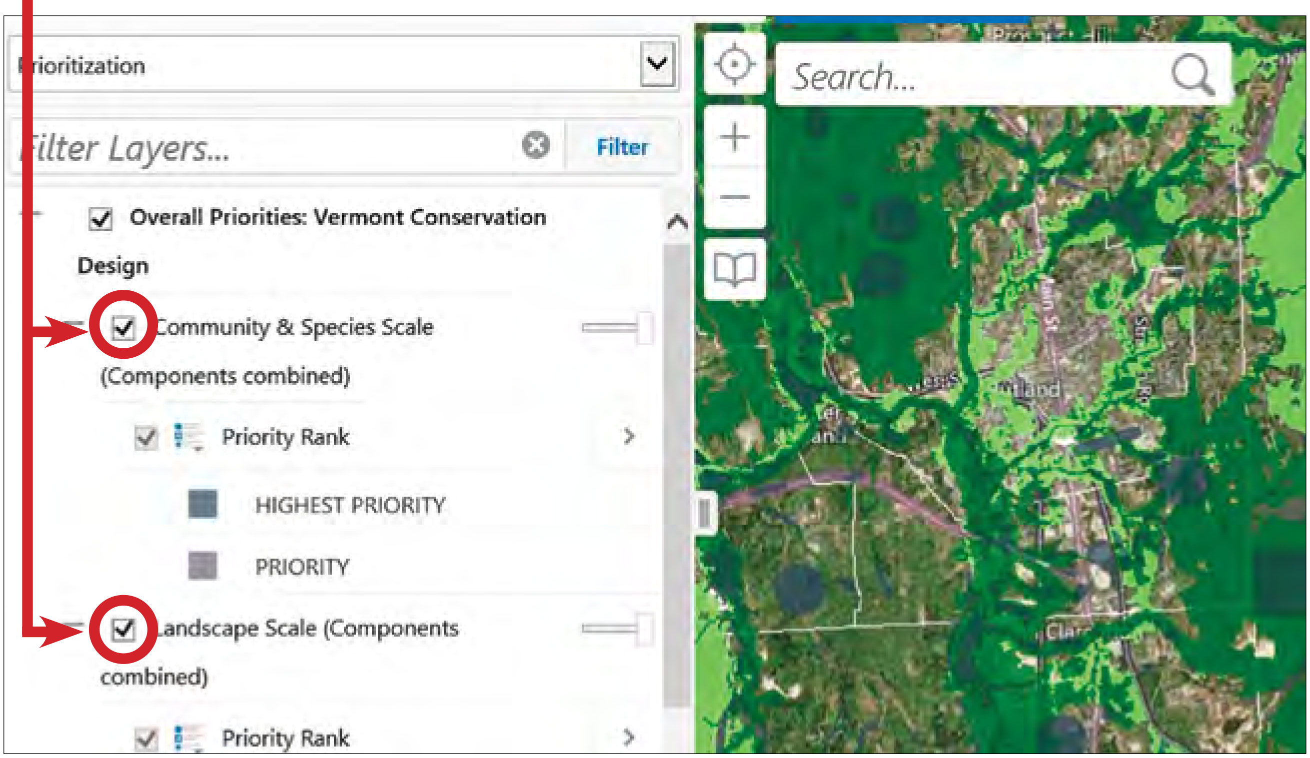
6. Maps 1 through 6 will appear underneath the word **Inventory.** These are the same as Maps 1 through 6 described in this guide.

7. Clicking the + sign will display a list of information that can be turned on or off for each map (the ○ in the image). You can control what information is displayed by clicking on the box next to each dataset (see the ⟶).

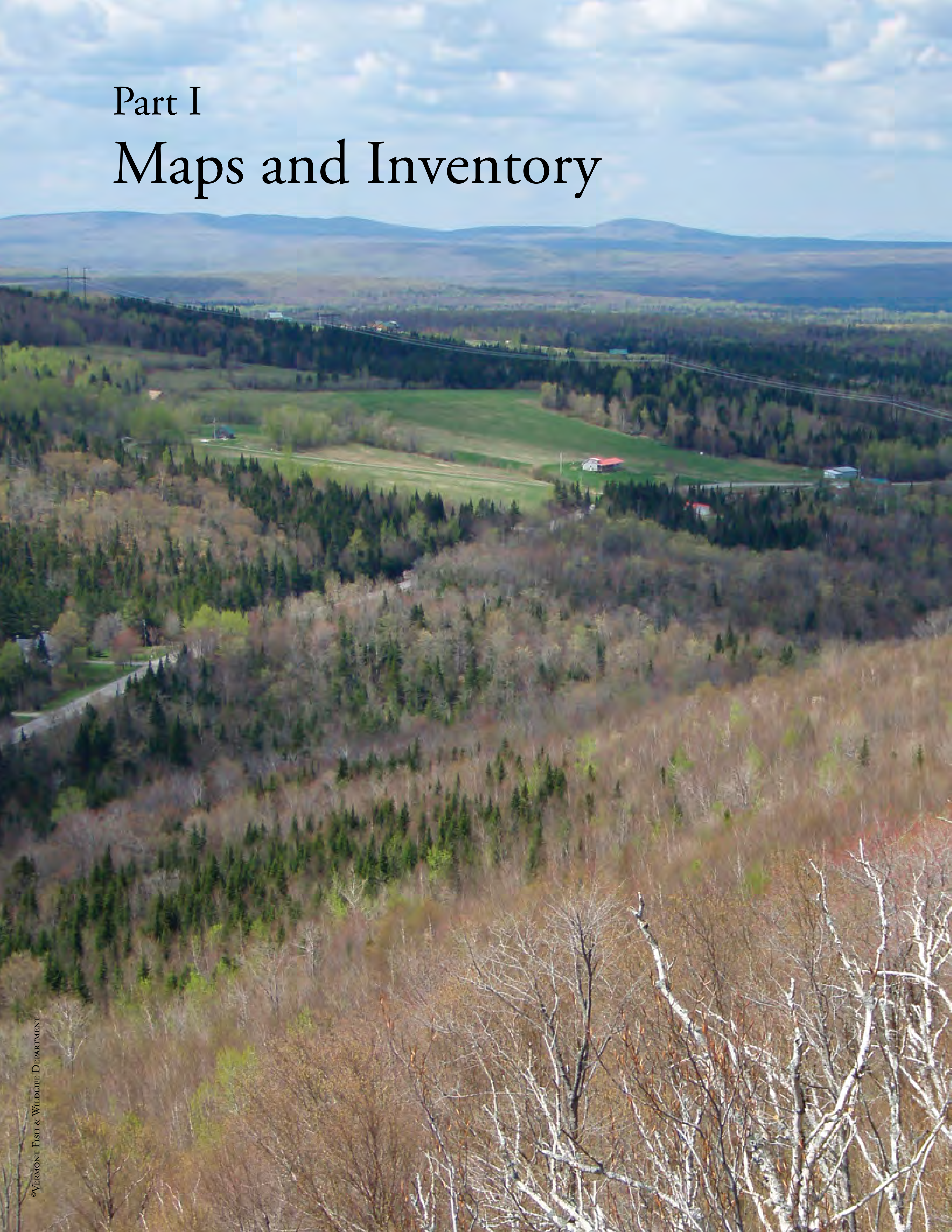




8. You can reproduce Map 7 using the default Prioritization theme. Change the theme back to **Prioritization**, then make sure both of the boxes beneath the **Overall Priorities:** [Vermont Conservation Design] category are checked. These are called **Community & Species Scale (Components combined)** and **Landscape Scale (Components combined)**. The image that appears should be very similar to Map 7 of this guide.



Part I
Maps and Inventory



©Vermont Fish & Wildlife Department

Maps and Inventory

There are many ways to look at any given place—even when focusing specifically on that place's natural heritage. In the following pages, seven maps provide seven different views, each with an eye toward a different aspect of the landscape.

While all maps are presented zoomed to the scale of a single town, the order of Maps 1 through 6 is designed to begin with an overview of the landscape—as though hovering in an airplane high above, looking down—and then slowly adding detail while descending. From each vantage point, they ask the question, *What's here?*

Once we have gained knowledge from all perspectives, Map 7 flies back up for a fresh look from afar, considering all scales and prioritizing some of the most ecologically important components onto a single map. The maps include:

Map 1: Conservation Base Map
Map 2: Land Cover
Map 3: Forest Patterns
Map 4: Physical Features
Map 5: Water
Map 6: Species and Community-Scale Resources
Map 7: State and Regional Priorities

As mentioned earlier, we suggest using this guide alongside the BioFinder website, allowing you to more carefully explore the data presented in these maps. The maps in Part I closely mirror BioFinder's Inventory theme. Please see the BioFinder section of the introduction for more information.

Altogether, the maps of Part I will provide the basis for the prioritization process outlined in Part II.

Navigation Tip

Start by finding the maps of your community on the CD that accompanies this guide. These should match each of the inventory maps described in the following pages. If you do not have a CD, the maps are available online as static pdf images, or you can create each map on the BioFinder website, following directions provided in each section of this guide. Keeping the map handy, go back and forth between map and interpretation until you fully understand what you are seeing in your community.

Terms We Use

Components: Each inventory layer in Part I of this guide represents a separate component—a piece of the natural world. These can be natural or cultural and may include physical landforms, land cover, water resources, vegetation types or assemblages, human land use, cultural boundaries, wildlife resources, and more.

Features: We refer to individual occurrences of components as features, such as a single block of forest, a ridgeline, or a specific mast stand.

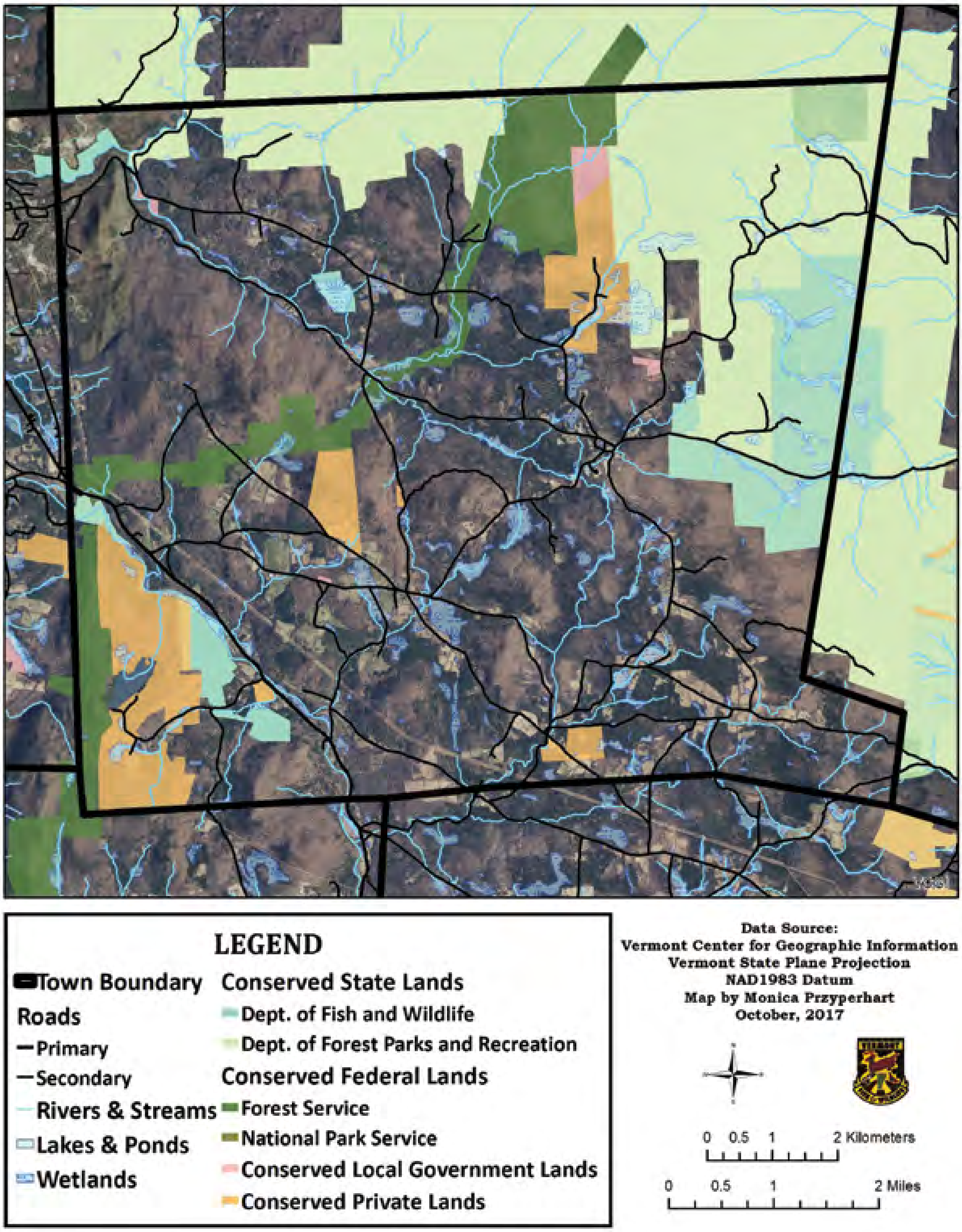
Example: The wetland in your town is an ecological feature. All wetlands in the state together make up the component we call Wetlands in this guide.

State vs. Local Priorities

It is important to recognize that this guide is produced for use across the state, using data available at the state level. After examining the maps contained herein, communities knowledgeable about the natural resources present on their landscapes may find some important ecological aspects missing from the maps. This is inevitable in statewide mapping efforts, because what creates a landscape's integrity differs from one community to the next. The information we collect and display here tells a story about the ecological patterns and contributions to biodiversity within Vermont as a whole that may or may not exactly match the most compelling local ecological story.

The next step in assembling natural heritage information is therefore to gather local, site-specific material through on-the-ground inventories and interviews with knowledgeable residents. These efforts will need to be tailored for each individual community, but we provide ideas for getting started with this kind of inventory at the end of Part I, in the Advanced Natural Resource Inventory section.

Map 1: Conservation Basemap



Map 1 Conservation Basemap

©Eric Sorenson

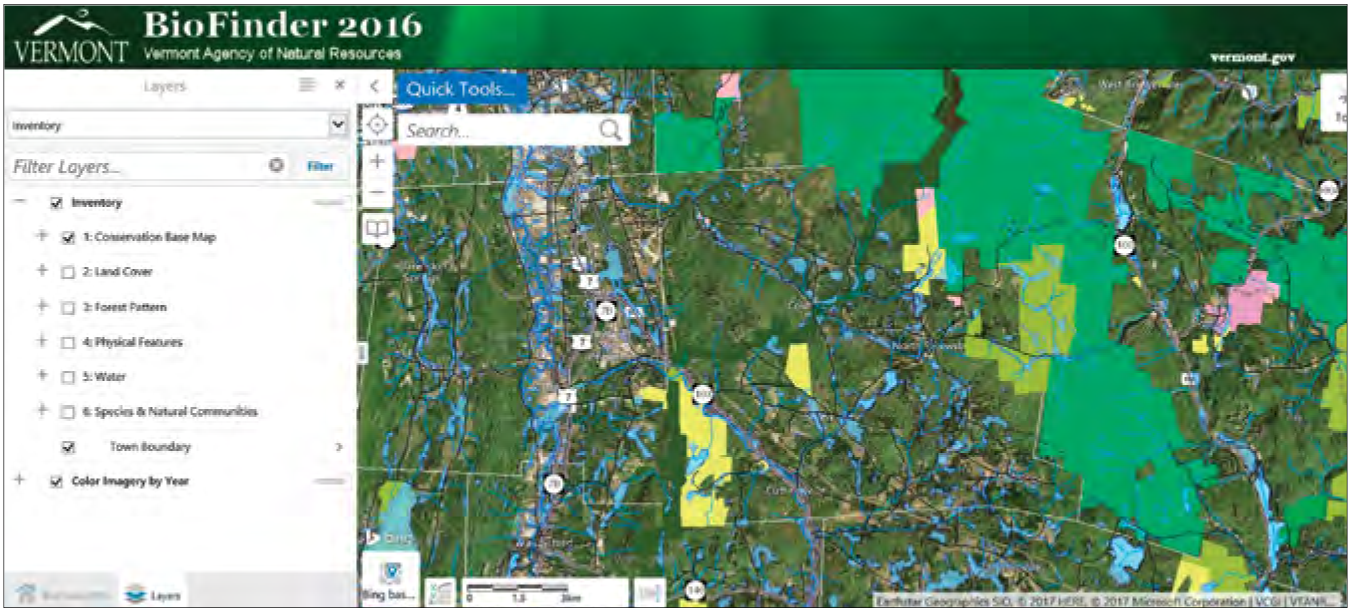
This map provides a visual overview of your community and identifies land that has been permanently conserved.

Inventory Layers (Described Below)	**Base Layers**	**Additional Online Data**
1. Conserved Lands	Aerial Photo Streams & Rivers Lakes & Ponds Wetlands Roads Town Boundaries	Use Value Appraisal Parcel Boundaries

Before identifying individual pieces of the landscape, let's start by getting acquainted with the landscape as a whole. This map is a snapshot of your community from afar, frozen at one point in time. It's not intended to be studied in any detail; instead, its goal is to allow us to take stock of what we have to work with and get our bearings.

The dataset highlighted on this map outlines the locations of conserved land on which development has been permanently restricted. For planners, this information provides an important starting point, because conserved lands are places for which some land use decisions have already been made. These are areas of more predictable future land use, which can help to guide planning in the surrounding areas.

Other layers on this map can be considered as base layers, and most will appear on other maps as well. The aerial photo background of this map is quite literally a snapshot, capturing anything that can be viewed from above, from a distance, unfiltered. Next, we see waterways, such as streams, rivers, lakes, ponds, and wetlands. While we examine water in more detail in Map 5, we use it here to get a first glimpse of where water flows across the landscape so as to frame other resources. This map also shows roads—the conduits for human activity—and town boundaries, which provide our theater walls, permeable though they are in the natural world.



To load Map 1 on BioFinder: Open the **Inventory** theme, then check the box next to **1: Conservation Base Map**. Click the **+** to see all layers associated with this map.

As you move forward in this guide, remember that this map's datasets can be displayed alongside other maps in BioFinder. For geographic reference points, you could leave town boundaries and roads "on." You may also find it interesting to see where natural features in other maps are located in relation to conserved lands. For example, are large habitat blocks (Map 3) or rare species (Map 6) located on conserved land in your region?

Conserved Lands

What are Conserved Lands?

Conserved land refers to property on which development has been permanently restricted, including buildings, paved roads, and most commercial infrastructure. The information displayed includes both land owned by a conservation entity and private land that has been protected through a conservation easement. These data were first published by the University of Vermont Spatial Analysis Lab and developed by a partnership between many federal and state agencies and departments, the University of Vermont, and several Vermont nonprofits.

To be more specific, the map includes all conservation lands owned by local, state, and federal government in Vermont. It also includes land owned by Vermont's nonprofit land trusts, such as The Nature Conservancy, the Vermont Land Trust, and others, and all land on which said entities have placed a conservation easement. This final category is generally land in private ownership for which a land trust or other entity holds the development rights. Conserved land therefore does not imply public funding or public access. The holdings of some small land trusts are not included in this dataset.

While the database is updated periodically, users should recognize that it may be a few years out of date at any given point in time.

Conserved Lands: Significance

The location of conserved lands in your community can frame other planning decisions, because these are known epicenters free from development. Even though surrounding land use may change, you can be confident that these lands will remain available as potential wildlife habitat.

Conserved lands' information may be even more useful when combined with other datasets. For example, you might look at conserved lands alongside rare species or significant natural communities (both described in Map 6 of this guide) to create a snapshot of which resources are already protected in a given area. A community may then be able to better prioritize the protection of additional natural heritage features.

In short, it can very interesting to see—at either a statewide or local scale—where the significant natural resources are located in comparison to the conserved lands. How many of your community's wetlands are on conserved land? Your largest habitat blocks? Statewide, many important natural resources are not protected, but you can see whether this is the case in your community.

Conserved Lands: Map Interpretation

While all lands in this dataset (also called the Protected Lands Database) are permanently protected from development of some type, there are several classes of conserved lands, and the map doesn't differentiate between them. Some conserved lands are managed strictly as natural areas, with activities such as timber harvesting prohibited. Others are managed specifically for the production of timber and other natural resources but prohibit development. Others are active, working farms where normal farming activities are expected (or even required), with development greatly restricted but not prohibited. In certain cases, conserved lands allow development for particular uses, such as public recreation, as is often true with state and town parks.

The information in the Protected Lands database can be used at any scale where precise boundaries are not important. Because many maps were digitized from paper versions that included sketch maps, deed descriptions, or old surveys that required a great deal of interpretation, no boundary line should be considered precise or used to determine protection status on a fine scale.

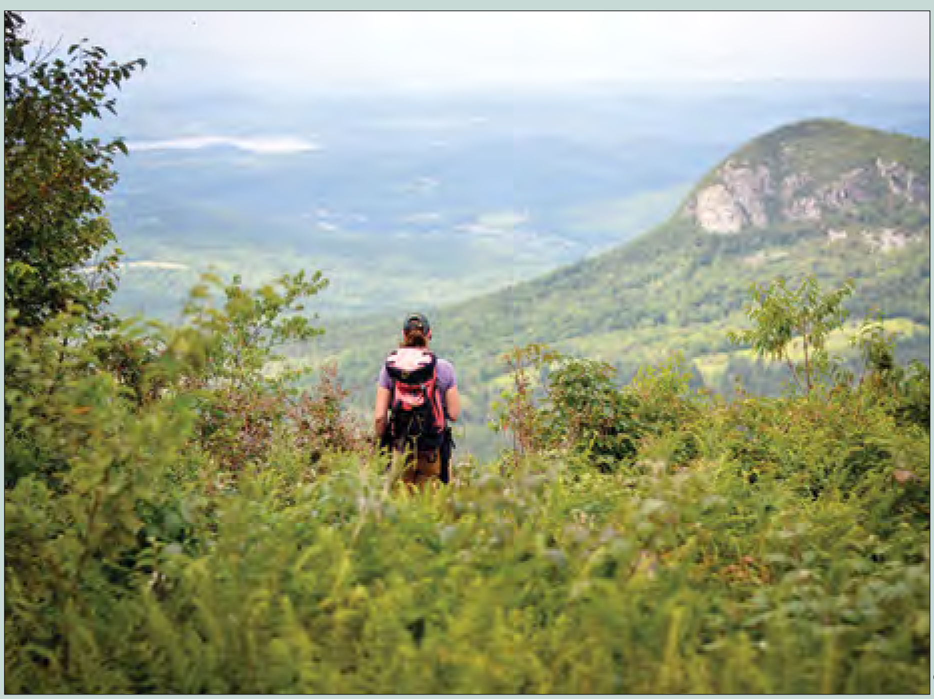
Because land may be conserved to protect any number of different qualities (e.g., agricultural soils, views, community resources, natural areas, historic landmarks, water quality, wildlife, and many other values) no inferences should be made about habitat quality or public access on conserved lands. This database includes large, public lands with advertised recreational trails, and it also includes small, privately-owned parcels with no public access. Similarly, this map conveys no information about management goals, though some public lands have management plans available.

Conserved Lands: Planning Considerations

Just as current areas of development are unlikely to grow into forest, conserved land is unlikely to become developed. Because wildlife populations are most likely to thrive if their habitats are interconnected and large, a community may want to consider the distribution of protected areas before planning areas of future development or conservation. From a natural resource protection perspective, it is often better to expand upon prior investments in land conservation

Community Strategies for Vermont's Forests and Wildlife: Case Studies

There are many reasons why a family, individual, or group may want to conserve land, and every conservation decision has a unique story. *Community Strategies for Vermont's Forests and Wildlife* documents a few of these stories, found on page 28 of the book.



©Tom Rogers

Growing a Town Forest

Many Vermont towns have found town forests to be community assets. In Bradford, the town began with a relatively small town forest, Wright's Mountain Conservation Area. As this area became increasingly used for recreation, education, wildlife conservation, forest management, and historic preservation, the town took opportunities to expand the conserved area, one parcel at a time. Some of this story can be found at www.uvlt.org/2011/02/bradford-extends-wrights-mountain-conservation-area/.

©Monica Przyperhart

than to create a new block of conserved habitat—although there are many exceptions. While habitat quality is not represented in this dataset, the size and interconnectedness of habitat is so important to wildlife abundance that simply having a parcel conserved elevates its general importance to resource planning.

Of course, permanently protected lands are not the only places that contribute to habitat conservation. Practicing good land management or enrolling land in an established conservation incentives program can be considered conservation—at least for the short term—and these are not included on this map. As you conduct planning in your community, you may want to look further into strategies that promote working forest management or maintain larger forest blocks. For example, you could connect landowners with the US Fish and Wildlife Service's Partners for Fish & Wildlife Program or the many incentives program managed by the Natural Resources Conservation Service. Please also see the information on the next page about Vermont's Use Value Appraisal Program ("Current Use").

Background: Aerial Photo

On Map 1 (and as the default on BioFinder) the background is an orthophoto, which is a patchwork of aerial photographs that have been matched with geographic coordinates to align with other map data. Orthophotos are useful in becoming oriented on a map, since we can pick out familiar features. When zoomed out, orthophotos can aid us in seeing patterns, such as places of dense or dispersed vegetation, road networks as they meander through the state, or density of development in one place compared to another. When zoomed in, we can sometimes see details such as the locations of guardrails along a road, the width or substrate of a river bank, or even differences in forest types(for example, conifer stands versus hardwoods) that are difficult data to collect through other means.

As a photograph, an orthophoto shows exactly what was present at a precise moment in time. This is raw data; it has not been interpreted in any way. It depicts the landscape, frozen in time, as it is. In fact, orthophotos are the basis for a variety for other map data; many layers described in this guide were created through the close examination of orthophotos.

Additional Online Data

When using BioFinder, the following datasets can also be selected to display on Map 1:

Use Value Appraisal (Current Use)

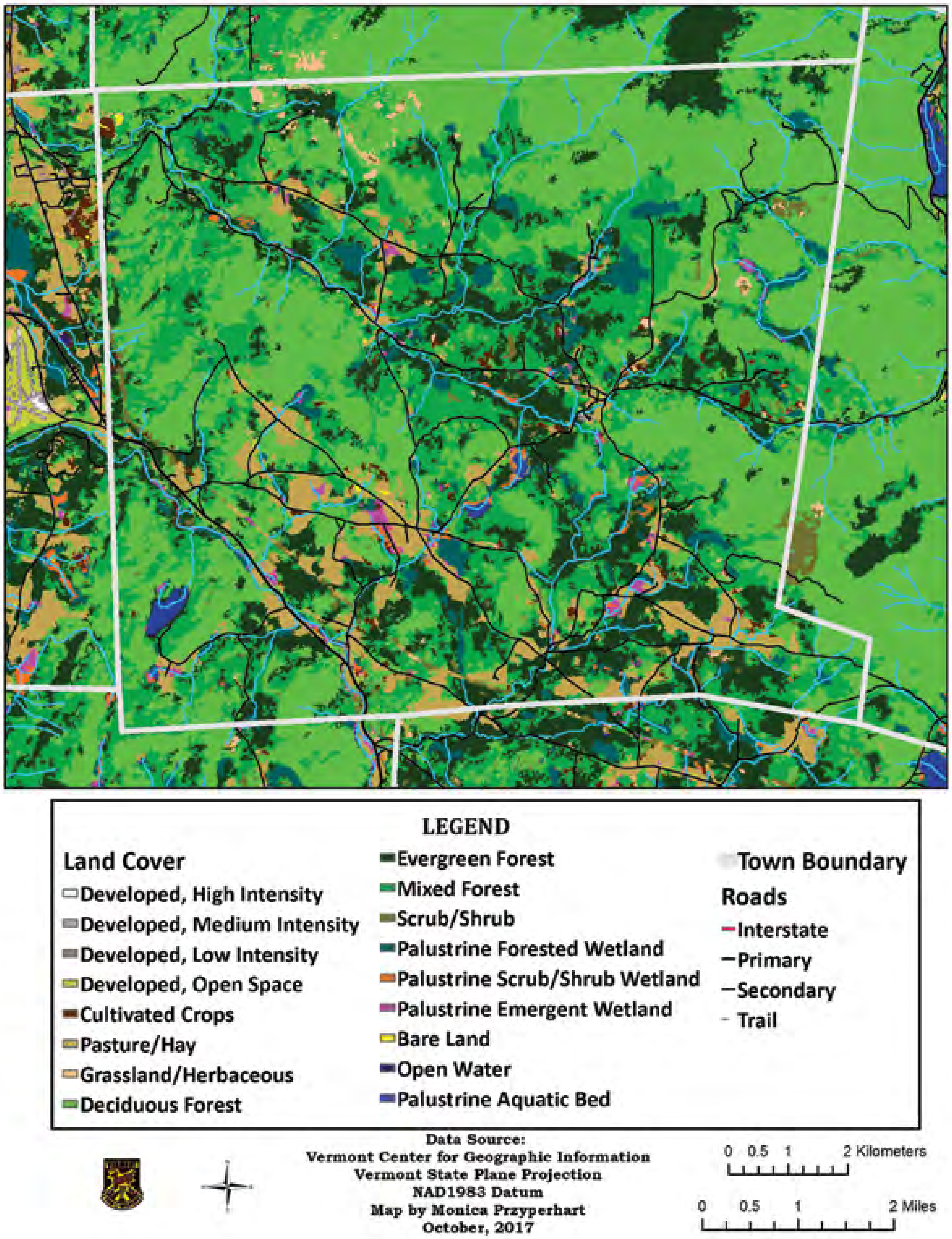
Through Vermont's Use Value Appraisal Program (also called Current Use), eligible private lands that are managed for timber can be appraised based on the property's value for wood production rather than for its development value. The result is generally a reduction in property taxes for those enrolled in the program, which in turn often reduces the pressure on a landowner to sell. Because lands can be removed from the program (subject to a tax), this form of land conservation isn't permanent. However, data show that between 2003 and 2009, undeveloped parcels of at least 50 acres enrolled in Current Use were twice as likely to remain undeveloped than those not enrolled (Brighton et al). Enrollment suggests a willingness on the part of a landowner to play an active role in land management and an investment in maintaining the property as forest.

A map layer of lands enrolled in Vermont's Use Value Appraisal program is included in the BioFinder version of Map 1. Learn more about the program through the Vermont Department of Forests, Parks, and Recreation website at fpr.vermont.gov/forest/your_woods/use_value_appraisal.

Parcel Boundaries

This layer displays the parcel boundaries in many Vermont towns. They are compiled from digitized tax maps. Most do not reflect the work of a surveyor and may contain inaccuracies, particularly when viewed at close range. All boundaries should be assumed to be approximations; for accurate parcel boundary information, please visit your local town office for recorded survey and/or deed information.

Map 2: Land Cover



Map 2 Land Cover

©Vermont Fish & Wildlife Department

This map is useful for seeing patterns of natural land cover and land use.

Inventory Layers (Described Below)	**Base Layers**
1. Land Cover	Roads Town Boundaries Streams & Rivers Lakes & Ponds

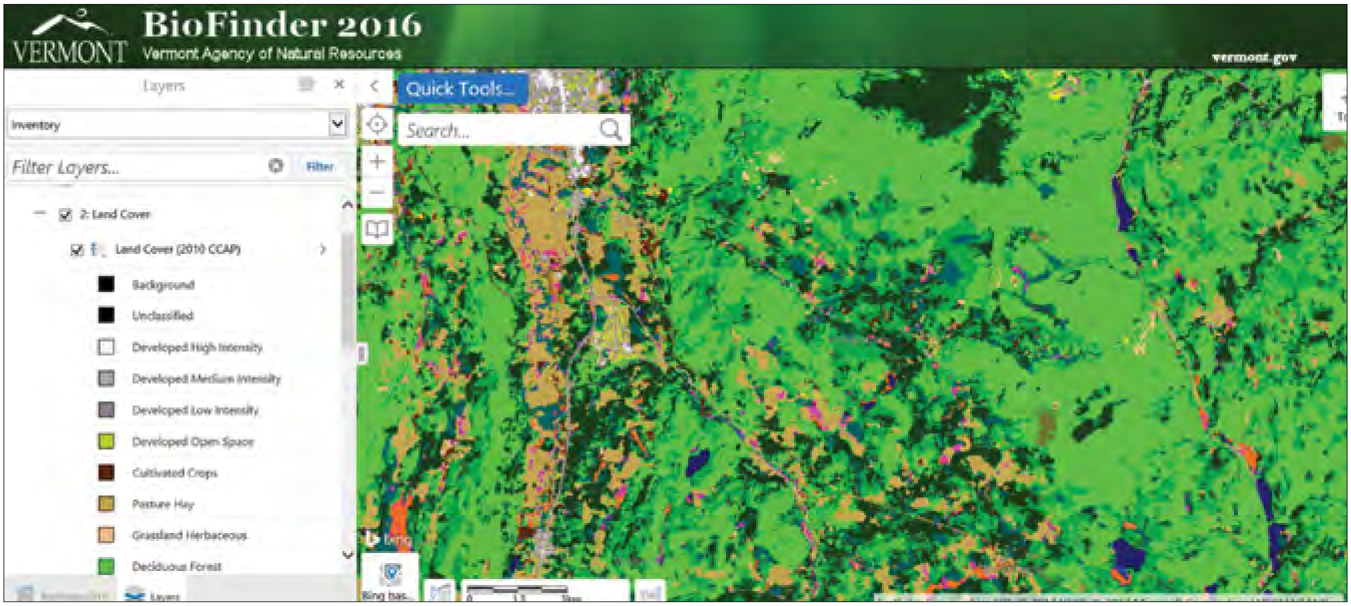
This map is useful at a broad scale for seeing patterns of natural land cover and land use. At a statewide scale, it is beneficial for picking out developed areas, agricultural areas, wetland complexes, and forested areas. More locally, these data can be used to locate forested blocks, predict where wildlife with wide home ranges may be able to travel through the landscape, and see where patterns of development may hinder wildlife movement. They can also be used to distinguish hardwood forests from softwood and mixed forests, which can be helpful in predicting locations of natural communities and wildlife species.

In a sense, this map is a simplified version of the base map presented in Map 1. We described that map as a snapshot of the action we see as we walk into a theater. This land cover map simplifies that snapshot, lumping raw data into categories so that we can more easily compare one place to another. Like Map 1, land cover information isn't intended to capture individual processes or species; it tells, very simply, what covers the ground at the present time.

Land Cover

What Is Land Cover?

Land cover records the landscape as surface components: forest, water, wetlands, urban, etc. For this guide, we have elected to use the National Oceanic and Atmospheric Association's (NOAA's) Coastal Change Analysis Program (C-CAP) as our data source, though other land cover datasets are available.[1] C-CAP produces a nationally standardized database of land cover and land change information for coastal regions and adjacent uplands—including Vermont. The image on the next page shows the data from the 2011 database.



To load Map 2 on BioFinder: Open the **Inventory** theme, then check the box next to **2: Land Cover.** To see the layers, click the **+** next to the layer title. For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide.

Land Cover: Significance

This map provides a first look at a landscape, identifying the abundance and distribution of general habitat types for animals and plants. It also provides an initial view of fragmentation—that is, how the landscape is connected or broken apart through both human and natural divisions. Because these C-CAP land cover maps are updated routinely for all of New England and New York using a standardized methodology, planners and managers can assess larger landscapes across state lines and use these maps for comparisons across geographic space and over time.

Land Cover: Map Interpretation

Across its range, this map depicts twenty-two standard categories of land cover, including detailed information on wetland types. Within Vermont, we see the following categories:

- High Intensity Developed (Urban, with a high density of impervious surface)
- Low Intensity Developed (Urban, with a low density of impervious surface)
- Cultivated land (Active agriculture, orchards, and vineyards)
- Grassland (Managed and unmanaged)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest (Forest not dominated by either deciduous or evergreen species)
- Scrub/Shrub (Less than 20 feet tall)
- Palustrine Forest (Freshwater wetland forest)
- Palustrine Scrub/Shrub (Freshwater wetland scrub/shrub)
- Palustrine Emergent (Freshwater wetland with emergent species such as marsh, lilies, etc.)
- Bare Land (Bare exposed rock, sand, and soil)
- Water (Open water)
- Palustrine Aquatic Bed (Floating vegetation and algal communities)

Because the land cover dataset was created by analyzing satellite and aerial imagery, the accuracy of some features recorded is higher than others. For example, open, similar cover types such as row crops and grasslands are not always correctly differentiated; however, different wetland types are shown with a high degree of accuracy.

Land Cover: Planning Considerations

NOAA developed C-CAP land cover data to aid with identification of regional landscape patterns and major habitat types, environmental impact assessment, urban planning, and zoning applications. For municipal planning purposes, the most useful application may be in visualizing existing landscape patterns. For example, large patches of green indicate large forests, and because we can differentiate between evergreen and deciduous forest, we can get a broad sense how habitats change across a given area. Another interesting pattern can be seen in the shape of a forest as it approaches a road. Often, forest cover gives way to more developed cover classes. Where it remains forest, the resulting shape may appear like an hourglass, as pictured in Figure 2.1. For wildlife, these areas may be important links between one forest patch and another and may represent significant road crossing areas. We can also focus on patterns of development, seeing where buildings are clustered in centers and where they spread out, creeping along road corridors into more rural areas. Because remote techniques were used to create this map, data should be field-checked before being used directly for planning or zoning.

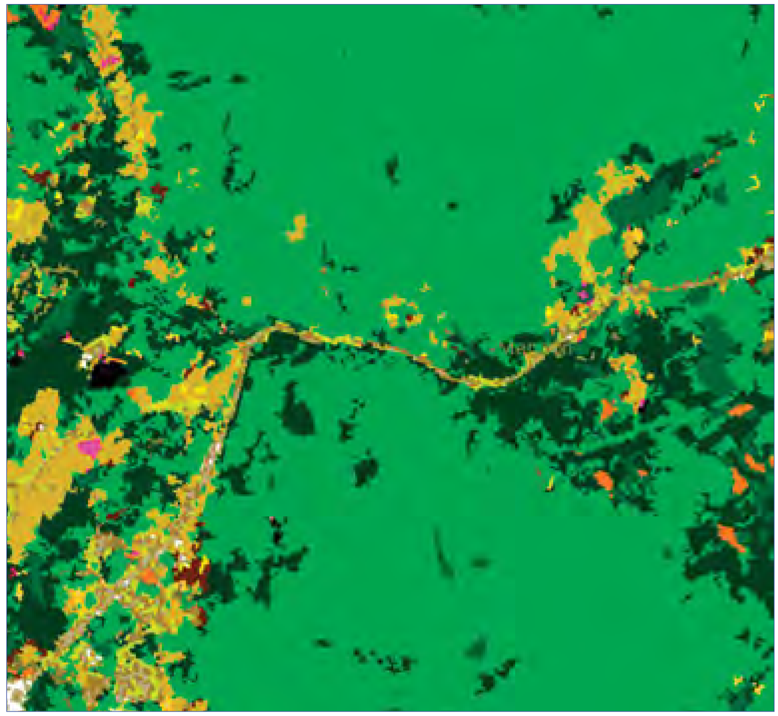


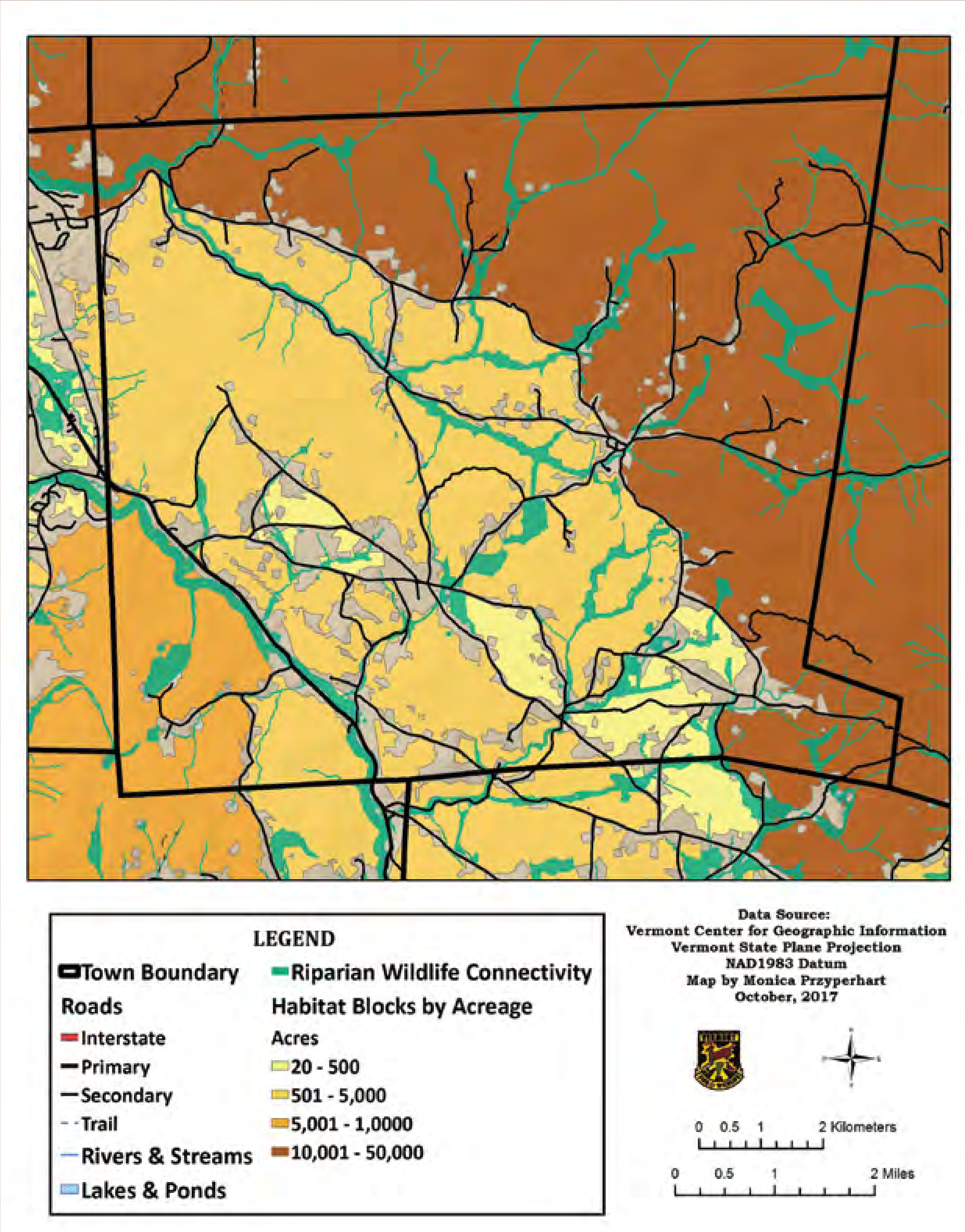
Figure 2.1 *The hourglass shape that emerges in forest cover as it crosses a road may indicate a location where wildlife are able to travel between the forests on either side.*

For More Information

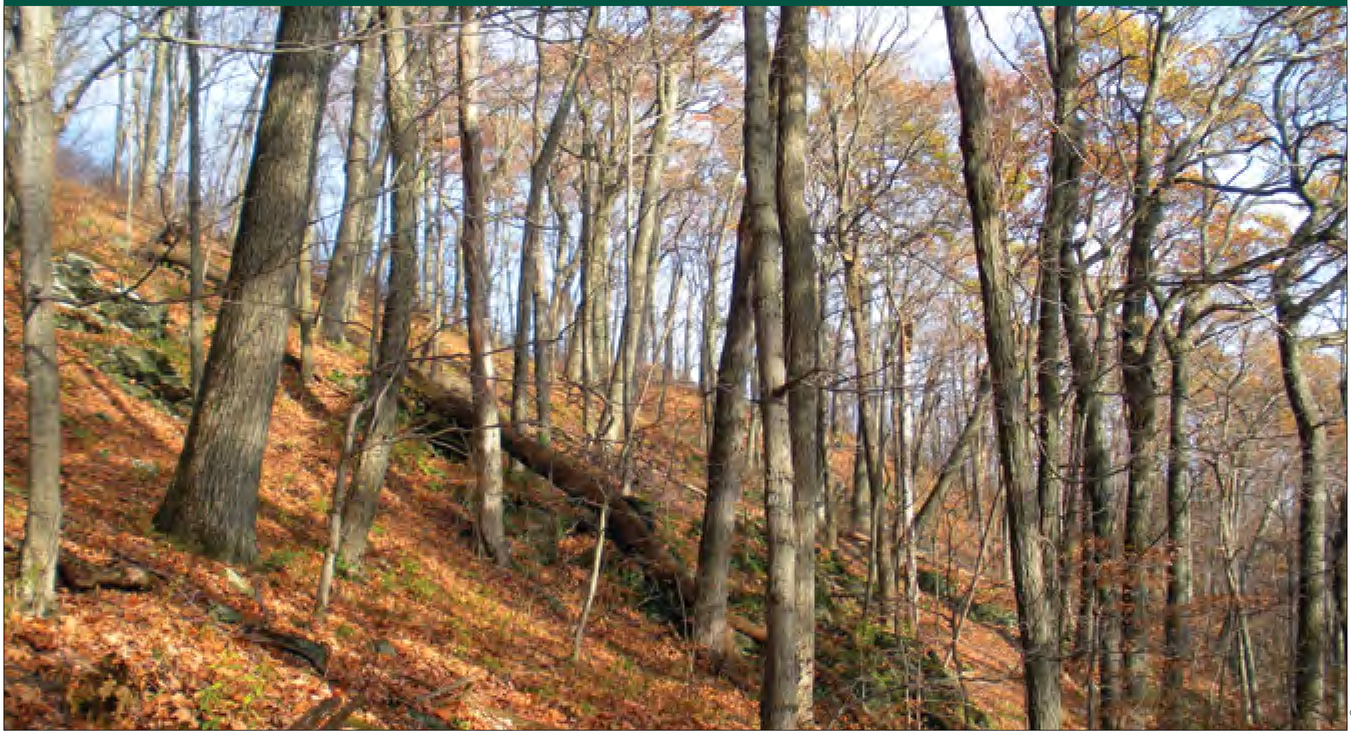
The NOAA Coastal Change Analysis Program, who created the dataset described above, has a website offering additional data, products, and tools that may be useful in natural resources planning. For example, one map layer shows changes in land cover from 1996 to 2001 and from 2001 to 2006.

©Monica Przyperhart

Map 3:
Forest Pattern



Map 3 Forest Pattern



©Vermont Fish & Wildlife Department

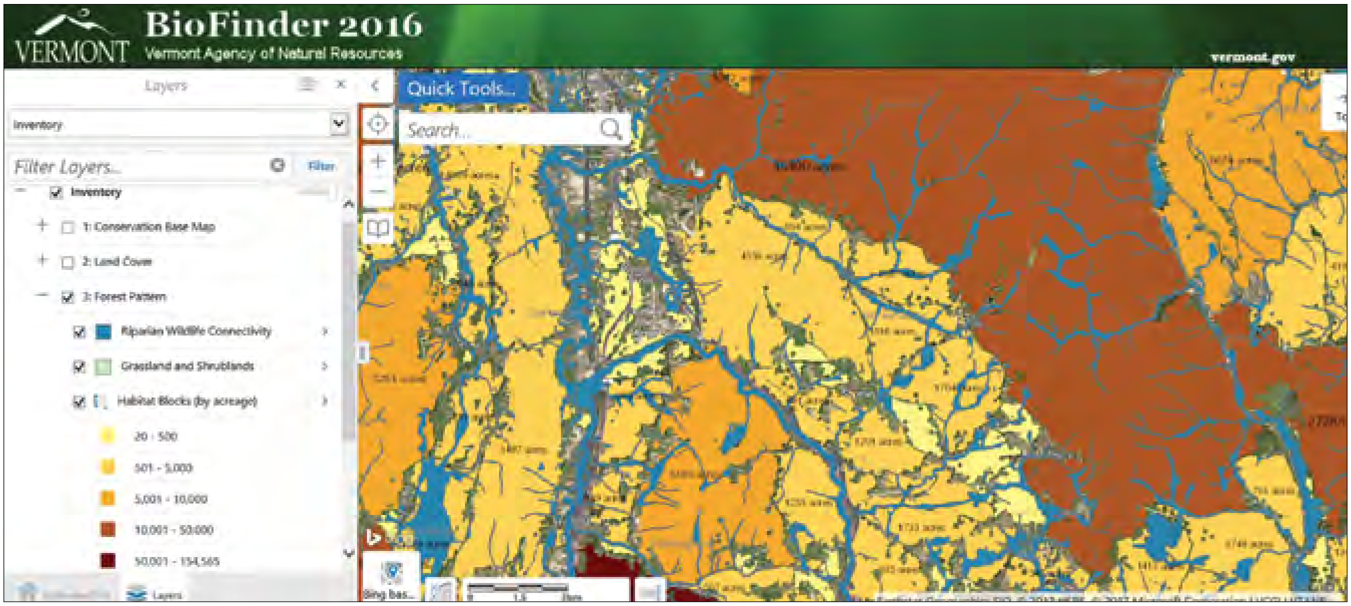
This map shows the pattern of forests and fields, separated by human activity, across your community.

Inventory Layers (Described Below)	**Base Layers**
1. Riparian Wildlife Connectivity	Roads
2. Grasslands and Shrublands	Streams & Rivers
3. Habitat Blocks (by Size)	Lakes & Ponds
	Town Boundaries

When considering wildlife on the local landscape, broad-scale vegetation patterns can be very revealing. The degree to which a landscape's vegetation is connected or separated has direct implications for where wildlife will be on a landscape and which wildlife are present. This concept of connectivity is particularly important in the face of climate change; maintaining connected pathways of natural vegetation across the landscape is a critical strategy for adapting to a changing climate, allowing animals and plants to disperse to locations that provide favorable conditions (Heller and Zavaleta 2009).

This map shows where the vegetated banks of streams, rivers, and lakes form continuous pathways in which wildlife can move. It shows where blocks of undeveloped land are located, organized by size. Finally, it shows grasslands and shrublands. These may be contained within larger habitat blocks, or they may appear isolated. Either way, there is an important assemblage of species that relies on these open fields or young stands for their survival.

In 2016, the Vermont legislature passed a bill (Act 171)[1] that requires regional and municipal planners to identify important forest blocks and habitat connectors, and then to limit fragmentation in these areas when conducting land use planning (Vermont General Assembly 2016). Map 3 allows a planner to take a preliminary look at where these forest blocks and connectors are likely to be located. In determining the ecological importance of habitat, size is primary factor, so habitat blocks are displayed here by size. Since wildlife frequently travel along the edges of waterways, Riparian Wildlife Connectivity can be used to visualize possible routes of wildlife movement.



To load Map 3 on BioFinder: Open the **Inventory** theme, then check the box next to **3: Forest Pattern.** To see all layers, check the box beside the layer title and then click **+** to expand the group. To see landmark locations, such as roads or town boundaries, check them on in **1: Conservation Basemap.**

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide, or Tips and Tools on the BioFinder website.

Inventory Layer #1: Riparian Wildlife Connectivity

What is Riparian Wildlife Connectivity?

When moving from one place to another, wildlife often use the vegetated lands adjacent to streams, rivers, lakes and ponds. Sometimes these areas are called corridors even though they are not always linear, as the term implies. The riparian area includes all land that is directly affected by surface water (Verry et al., 2000) and often extends some distance from the channel itself. This map highlights the vegetated areas next to rivers, streams, lakes, and ponds.

Riparian Wildlife Connectivity: Significance

In general, riparian ecosystems are high in biological diversity. While they are particularly important for species associated with rivers and lakes such as mink, otter, beaver, and wood turtle, they are used by a wide assortment of wildlife, with even more substantial benefits when continuous vegetated habitat remains alongside waterways for extensive distances. Then, they function as corridors for wide ranging mammals—those animals that must maintain large home ranges to obtain sufficient food, find shelter, or have access to mates—as they traverse the landscape.

Riparian corridors are also important to our human communities, providing highly valued ecological functions relating to water quality, flood attenuation, and shoreline stability.

Riparian Wildlife Connectivity: Map Interpretation

These data show streamside connectivity—on land—and not connected pathways within the water (referred to as aquatic organism passage). In other words, dams, waterfalls, or hanging culverts may prevent fish and other aquatic organisms from freely moving up and down streams even when those streams

Restoring Riparian Areas

In some cases, the riparian area may need to be restored before it can become functional for wildlife. The White River Partnership's Trees for Streams program is one example of a restoration project that works with landowners, students, and volunteers to establish functional riparian corridors: vtconservation.com/success-stories/white-river-partnership-trees-for-streams-program.

Riparian Habitat: A Starting Point

Not sure where to begin conserving your community's natural heritage? Consider starting with riparian habitat. Among conservation actions taken at the community level, maintaining riparian habitat has one of the greatest impacts for wildlife. It's also an area of great benefit for a community, since conserving the riparian area not only protects wildlife habitat but also maintains water quality, reduces erosion, provides flood resilience, and can support recreational opportunities.

are buffered by functional riparian areas. These aquatic barriers are not represented here.

When using these data, keep in mind that all segments of vegetated riparian habitat are treated equally; habitat is either present or lacking. Ecologically, however, some locations are certainly more functional for maintaining traveling wildlife populations than others, such as longer riparian sections or those that connect to high-quality habitat or large interior habitat blocks.

Riparian Wildlife Connectivity: Planning Considerations

Conserving a connected network of lands, waters, and riparian areas can be one of the most effective strategies for maintaining an area's wildlife habitat, particularly in response to changing environmental conditions. From an ecological standpoint, maintaining riparian wildlife connectivity may be the single most important goal a community can accomplish through planning. Restoration and conservation of riparian connectivity is especially important in areas of Vermont that are highly developed.

Because conservation of riparian wildlife connectivity should be considered alongside other goals for the riparian area, we list specific conservation strategies in Map 5, Surface Waters and Riparian Areas.

Inventory Layer #2: Grasslands and Shrublands

What are Grasslands and Shrublands?

Grasslands are open lands dominated by grasses, sedges, and other low vegetation, with few or no shrubs or trees. They include some wetlands, such as meadows wet enough to deter most larger vegetation, and managed lands such as hay fields.

As the name implies, shrublands are dominated by low, dense shrubs such as dogwood and willow. They are often associated with the margins of grasslands, including land managed for agriculture or other uses. Other shrublands are created by natural disturbances that remove larger vegetation, or beavers.

Vermont's grasslands are scattered throughout the state, with the highest concentration in the Champlain Valley. While some are natural, most that we see today are associated with current or past agricultural practices, with a few resulting from other human activities such as the meadows associated with airports, landfills, utility rights-of-way, fairgrounds, and industrial complexes. Most of Vermont's grasslands are in private ownership, although the state and federal governments own small areas of this habitat.

Shrubland habitats are more widely distributed throughout Vermont. They are associated with both upland and wetland conditions, and they occur on both public and private land. Some result from natural processes, and others represent the transition of agricultural lands and cleared areas into eventual forest.

Grasslands and Shrublands: Significance

Grasslands and shrublands provide essential habitat for many bird, mammal, reptile, and invertebrate species. Numerous birds require these habitats for their survival, with species such as upland sandpiper (endangered), grasshopper sparrow (threatened), sedge wren (endangered), vesper sparrow, savannah sparrow, bobolink, and eastern meadowlark found exclusively in grasslands. Birds specialized to life in shrubland habitat include American woodcock, brown thrasher, golden-winged warbler, eastern towhee, and field sparrow. While some of these species are considered common in Vermont, their populations are undergoing some of the steepest declines of any birds, both in the state and across the U.S.

Since the agricultural boom of the 1800s, Vermont's decline in grassland bird species is primarily a result of habitat loss as farm fields have grown into forests. Grasslands have also given way to residential, commercial, and industrial development. Other threats include changes in agricultural practices, extensive use of agricultural pesticides, and loss of wintering habitats outside of Vermont.

While the ranges of these grassland birds were historically concentrated outside of Vermont, conversion of natural grasslands elsewhere in the Northeast and especially the Midwest has led to the decline of grassland birds across their historic natural habitats. This has given Vermont, and the Northeast in general, a more important role in the conservation of grassland birds.

Grasslands and Shrublands: Map Interpretation

At a state level, this layer represents the best available grassland and shrubland data. That said, geographic representation of grasslands outside the Champlain Valley is lacking, and this dataset therefore omits many existing grasslands. Information on the location of shrublands are limited statewide; these are captured by extending grassland habitat data and including relevant categories from Vermont wetlands data.

Data for this layer were collected remotely, through the interpretation of satellite imagery. While this technique can be used to quite accurately record the locations of grasslands, shrublands are difficult to identify in this way. They are included in this dataset primarily because it is presumed that some grasslands identified in the original dataset will have grown into shrublands as time passes before the data is used.

In Vermont's landscape, these types of landscape are both transitional in nature. While some are entirely natural, such as wetland areas in which the soggy soil discourages the growth of larger plants and trees, the majority of grasslands and shrublands are locations of recent disturbance where trees have been cleared. Without continual management, these lands will become forestland. Without regular cutting, grasslands convert to shrublands, which eventually become forest. When using this dataset, it is therefore wise to keep in mind that grassland and shrubland habitats are difficult to model, and their ephemeral nature renders field data quickly out-of-date.

Because of this ephemeral nature, grasslands and shrublands are combined into a single map layer, to achieve a longer lifespan. Even as the species benefiting from the mapped land change from grassland species to shrubland species, the modeled area remains relevant as a broad conservation target. Given this, we estimate this data to be relevant for 10 years from each publication update, although land use changes during this 10-year period may alter wildlife habitat value significantly

Please keep in mind that these data could include row crops, which do not support grassland birds or quality habitat for most target species. These are included in this layer because many crops, such as corn and hay, are rotated year-to-year on many farms. One year the habitat may be good, and another, not.

Grasslands and Shrublands: Planning Considerations

Grasslands and shrublands, whether of natural origin or resulting from active land management, are critical to the survival of a suite of Vermont species, namely birds. Most of these species will continue to decline in Vermont if grassland habitat is not maintained.

Most strategies for maintaining grasslands and shrublands rely on individual landowners and managers. When planning, determine what the pattern of grasslands and shrublands looks like in your area. Then include important areas in your conservation planning, and consider working with landowners to ensure continued representation of these habitat types.

Keep in mind that shrubland is crucial to maintain at a regional level. It is wise to view this data at the scale of your town, then to zoom out and see how available this habitat type is in the regional context before taking action. While this habitat type is crucial for an assemblage of bird species in particular, it should be viewed as one relatively minor component of a diverse, connected landscape of other habitat types.

Grassland Bird Conservation

Because Vermont's grasslands are so closely associated with agriculture, conservation programs often work alongside farmers to make grassland bird conservation economically feasible. The Bobolink Project is one example of such a program: www.bobolinkproject.com

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In choosing conservation strategies, your town may want to consider the following strategies:

Conservation Goal	Conservation Strategies for Grasslands and Shrublands	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories as needed to improve maps.[2]	
	Learn more about grassland bird management.[3]	
Provide baseline protection	Adopt language in the town plan, including statements about the importance of grassland and shrubland habitat and policies on how they should be managed, protected, and restored.	
Ensure that management is compatible with wildlife	Practice management compatible with nesting birds on town-owned grasslands (the fields around schools or recreation fields, etc.).[4]	In site plan review, require that developments follow sound grassland bird management guidelines.
	Connect landowners to incentives programs for wildlife-friendly management practices, such as USDA,[5] USFWS Partners for Fish and Wildlife,[6] or the Bobolink Project.[7]	
	Provide citizen educational opportunities.	
	Establish a monitoring program for grassland birds.	
Maintain or protect habitat	Ensure that grasslands and shrublands are represented in local conservation efforts.	

Additional information on these strategies found in *Community Strategies for Vermont's Forests and Wildlife*.

Inventory Layer #3: Habitat Blocks (by acreage)

What are Habitat Blocks?

Habitat blocks are generally forested areas of at least 20 acres with no roads or low densities of Class IV roads. They contain little or no human development such as buildings, parking areas, lawns, gravel pits, active agricultural land, and so forth, but can be composed of any natural land cover type: various successional stages of forest, wetland, old meadow, among others. They are then categorized by size to make it easier to view them on the map and to provide a generalized comparison among the blocks in an area.

Habitat Blocks (by Acreage): Significance

Because forest fragmentation is one of the most significant threats to Vermont's natural heritage, maintaining large habitat blocks, and connections between these blocks, may be one of the best ways to ensure conservation. All else being equal, larger habitat blocks generally contain greater biological diversity (a much higher number of species) than smaller blocks. This is because these areas often contain a great diversity of habitat types, which support the requirements of many plants and animals. Some species live only in large patches of forest habitat, and others—such as bear, bobcat, and fisher—require such large home ranges to find the food, water, shelter, and access to mates that they require that they are unable to survive in a heavily fragmented landscape. Many human communities rely on large habitat blocks, too, to provide opportunities for recreation and forest management, which in turn support the local economy. Furthermore, large habitat blocks play a large role in maintaining the quality of our air and water.

Over time, the average size of habitat blocks has been shrinking in Vermont. As development pressure

Vocabulary Note

Habitat block, contiguous forest, core forest, forest block… You may find resources that use each of these terms. All refer to nuances of the same basic concept. While it is important to clearly understand and define any language used in a regulatory setting, these terms are nearly interchangeable in a general sense; they refer to habitat uninterrupted by roads or other human development.

To read more about the role of these areas, see page 39 in *Conserving Vermont's Natural Heritage*.

causes new roads to bisect natural areas, structures creep in from the edges. Species requiring large home ranges must increasingly use several smaller blocks rather than a single large block to get what they need to survive, although this is only possible in locations where enough cover exists between habitat blocks for animals to feel secure traveling from one to another. This often means crossing roads, which can be dangerous for both animals and humans. The Wildlife Road Crossings layer (Map 6) looks at such locations where wildlife are most likely to cross roads in order to link together habitat blocks. For many wildlife, the most suitable habitat is found within the largest blocks where crossing roads and other fragmenting features isn't necessary.

While size is the important characteristic in this map, there isn't a minimum size that is considered critical as important wildlife habitat. Blocks are best considered within the context of the landscape. A 100-acre habitat block located in Vermont's heavily fragmented Champlain Valley may play a much more ecologically important role than a 100-acre block in the Northeast Kingdom, where larger blocks are prevalent. The general rule of thumb is "the bigger, the better," and you can determine what big means in your region by viewing the habitat block layer at a regional scale using BioFinder. Habitat configuration is also important. An area that is highly irregular in shape, containing a high proportion of edge compared with interior forest, may be less functional for some species than habitat of the same acreage with a regular shape.

Vermont's development history adds an interesting twist when we think about habitat block size. Because our areas of human settlement and development have historically and currently been along streams and in valleys, the largest remaining areas of contiguous habitat tend to be in high-elevation areas and those in which soils are unsuitable for agriculture or building. However, it is often those same valley bottoms where we would naturally see the greatest biological diversity. As you identify the largest areas of contiguous habitat in your town, keep in mind that they may be biased towards the uplands or other undevelopable landscape, but it is also important to include lowlands when planning for conservation.

Habitat Blocks (by Acreage): Map Interpretation

Habitat blocks are derived from the land cover data depicted on Map 2. They include all areas of natural cover surrounded by roads, development, and agriculture, ranging in size from 20 acres to 154,000 acres. Here, they are displayed by size. In Map 6, we show the same data again, prioritized for biological importance. To learn more, you can find the original report from Vermont Fish & Wildlife Department and Vermont Land Trust online at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Conserve/Vermont_Habitat_Blocks_and_Habitat_Connectivity.pdf.

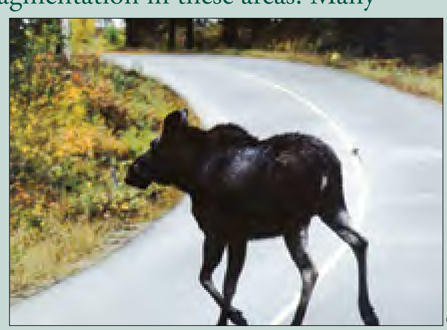
Habitat Blocks (by Acreage): Planning Considerations

As you examine the habitat available to wildlife in your community, you may find the following useful in evaluating and prioritizing different areas:

- ***Size:*** In general, larger habitat blocks are likely to have higher ecological value. They often also provide greater benefits to the civic community through opportunities to access forest resources, hunting, or recreational use.
- ***Condition:*** Areas that contain diverse natural habitat types normally have a greater variety of plant and animal species.
- ***Landscape Context:*** Locations in which several habitat blocks are close to one another and separated only by minimal fragmenting features like roads, development, or agricultural land may function better as wildlife habitat for many species.
- ***Connectivity:*** Connecting features can link blocks together to effectively function as

Act 171 and Forest Fragmentation

In 2016, the Vermont legislature passed a bill requiring regional and municipal planners to identify important forest blocks and habitat connectors and to plan development so as to limit forest fragmentation in these areas. Many communities may find Habitat Blocks to be a good starting point for this requirement. While size is not the only consideration, it will be helpful to know where the biggest blocks and fragmenting features are located as you begin the process. Learn more about this legislation at www.legislature.vermont.gov.



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larger blocks. While larger blocks generally remain better for wildlife than a series of linked smaller blocks, these features can allow a broader diversity of wildlife to inhabit human-populated areas.

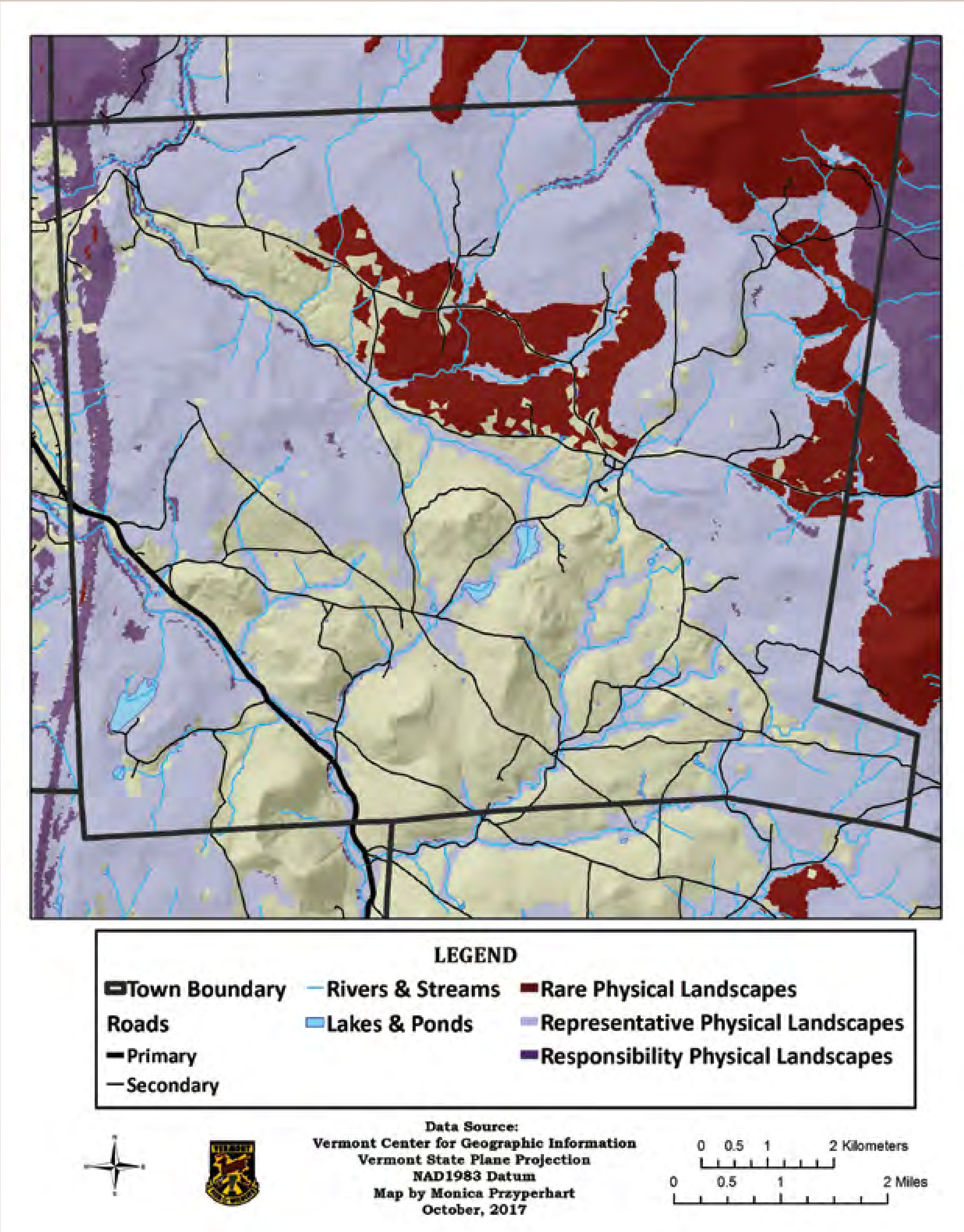
In Map 6, you can see how these blocks have been prioritized by state biologists, keeping in mind that your local priorities may be somewhat different than those chosen at the state level. In Part II of this guide, these prioritized habitat blocks will appear again, categorized into highest priority and priority interior forest blocks and connectivity blocks.

Once you have identified priority habitat blocks, the following may be appropriate methods for conserving them:

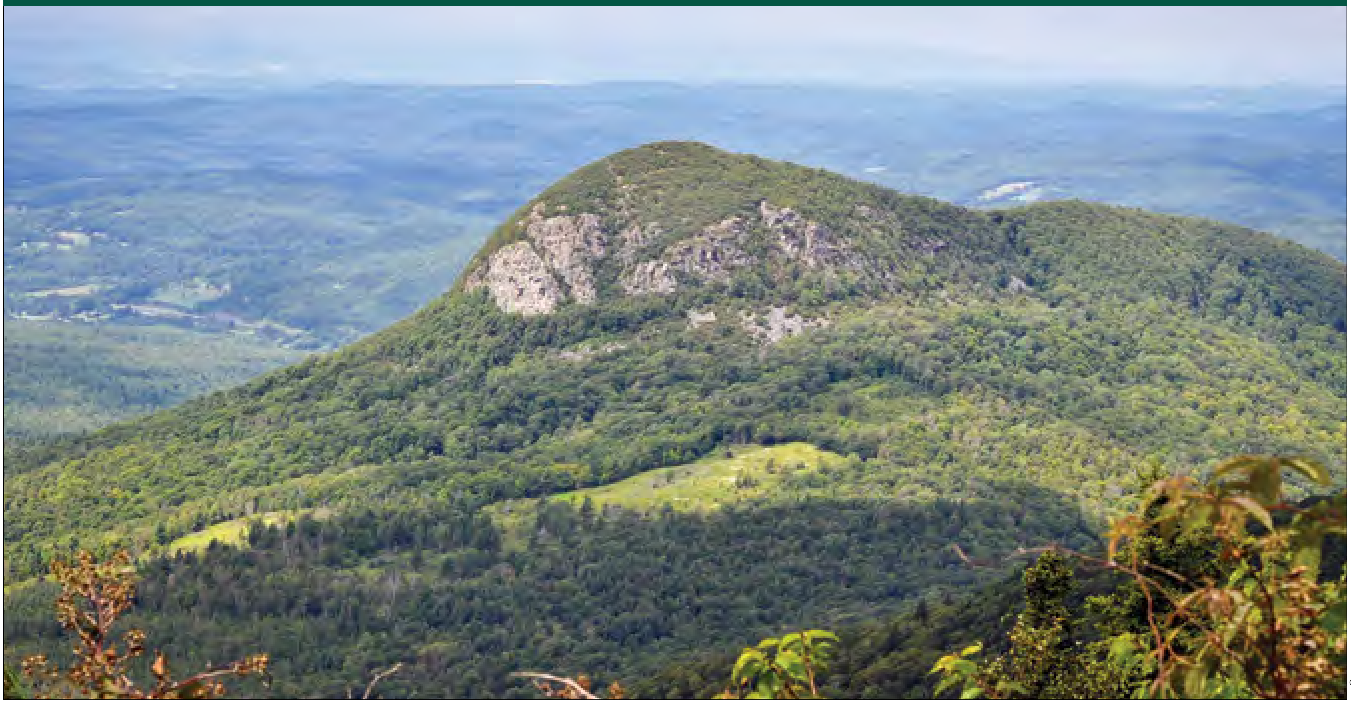
<table>
<tr><th rowspan="2">Conservation Goal</th><th colspan="2">Conservation Strategies for Priority Habitat Blocks (by Acreage)</th></tr>
<tr><th>Nonregulatory Strategies</th><th>Regulatory Strategies</th></tr>
<tr><td rowspan="3">Provide baseline protection</td><td>Adopt language in the town plan, including statements about the importance of large forest blocks and policies on how they should be managed, protected, and restored.</td><td>Check clarity of definitions in zoning bylaws and update if needed.</td></tr>
<tr><td>Provide citizen educational opportunities.</td><td>Review standards in zoning (subdivision, CU, or use standards), and update if needed.</td></tr>
<tr><td>Work with neighboring communities and/or the regional planning commission to plan for forest conservation at a regional scale.</td><td>Review purpose statements in zoning and update if needed.</td></tr>
<tr><td rowspan="3">Provide stewardship of forestland</td><td>Encourage residents to work with a forester to create forest management plans.[8]</td><td rowspan="3">Establish an impact fee program.[9]</td></tr>
<tr><td>Encourage enrollment in Current Use (or local tax stabilization program).[10]</td></tr>
<tr><td>Connect landowners with supporting organizations, such as Vermont Coverts,[11] Vermont Woodlands Association,[12] the Natural Resources Conservation Service,[13] or your local Natural Resources Conservation District.[14]</td></tr>
<tr><td rowspan="6">Avoid fragmentation</td><td>Encourage residents to enroll in Current Use (or local tax stabilization program).[15]</td><td>Allow a greater development density in defined growth areas (like village or commercial districts) than in rural land (through a Forest, Conservation, or Rural Residential Zoning District).</td></tr>
<tr><td>Encourage citizens to engage in estate planning.</td><td>Establish or expand a Wildlife Habitat or Wildlife Corridor Overlay District.</td></tr>
<tr><td>Encourage residents to conserve their forestlands in important areas.[16]</td><td>Establish building envelopes, clearing standards, or limits on driveway length in bylaws to limit the impact of development.</td></tr>
<tr><td rowspan="3">Create or expand a Town Forest.[17]</td><td>Establish or improve Subdivision Regulations.</td></tr>
<tr><td>Establish road and trail standards.[18]</td></tr>
<tr><td>Review rural residential-type districts to determine whether lot sizes and site design requirements allow for continued function of rural land (i.e., 2- to 5-acre lot sizes can cause fragmentation even if open space remains.)</td></tr>
<tr><td rowspan="2">Provide support for working forests</td><td>Encourage residents to enroll in certification programs that promote long-term support for land management.[19]</td><td>Institute local forest products purchasing policy (for municipal purchases).</td></tr>
<tr><td>Encourage support for businesses that use local forest products.</td><td>Ensure that regulations include standards that allow for continued access to working forests and associated infrastructure (e.g., log landing areas).[20]</td></tr>
</table>

Additional information on most strategies can be found in *Community Strategies for Vermont's Forests and Wildlife*.

Map 4:
Physical Features



Map 4 Physical Features



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This map gives a big-picture view of how physical features are geographically distributed.

Inventory Layers (Described Below)	**Base Layers**	**Additional Online Data**
1. Physical Landscape Diversity	Roads Streams & Rivers Lakes & Ponds Town Boundaries	Biophysical Regions

Physical landscapes, also referred to as enduring features, are the parts of the landscape that resist change. They are hills and valleys, underlying bedrock, and deposits left behind by glaciers or ancient lakes. They remain largely static when natural- or human-induced changes in land cover and wildlife occur, as plants and animals expand or contract their ranges, and even as the climate changes.

Because of the strong influence of the physical landscape on which plants, animals, and natural communities appear and thrive, understanding the physical landscape can help us predict habitat conditions and species presence. Physically diverse landscapes support diverse natural communities and species (Anderson & Ferree, 2010), and thus one way to ensure that biological diversity persists on our landscape is to conserve a variety of physical landscapes.

The background of this map is a representation of elevation in which steep slopes are shaded to produce a "shadow." The effect helps us to visualize the hills and valleys across a landscape. In BioFinder and on other mapping resources, this effect is called hillshade.

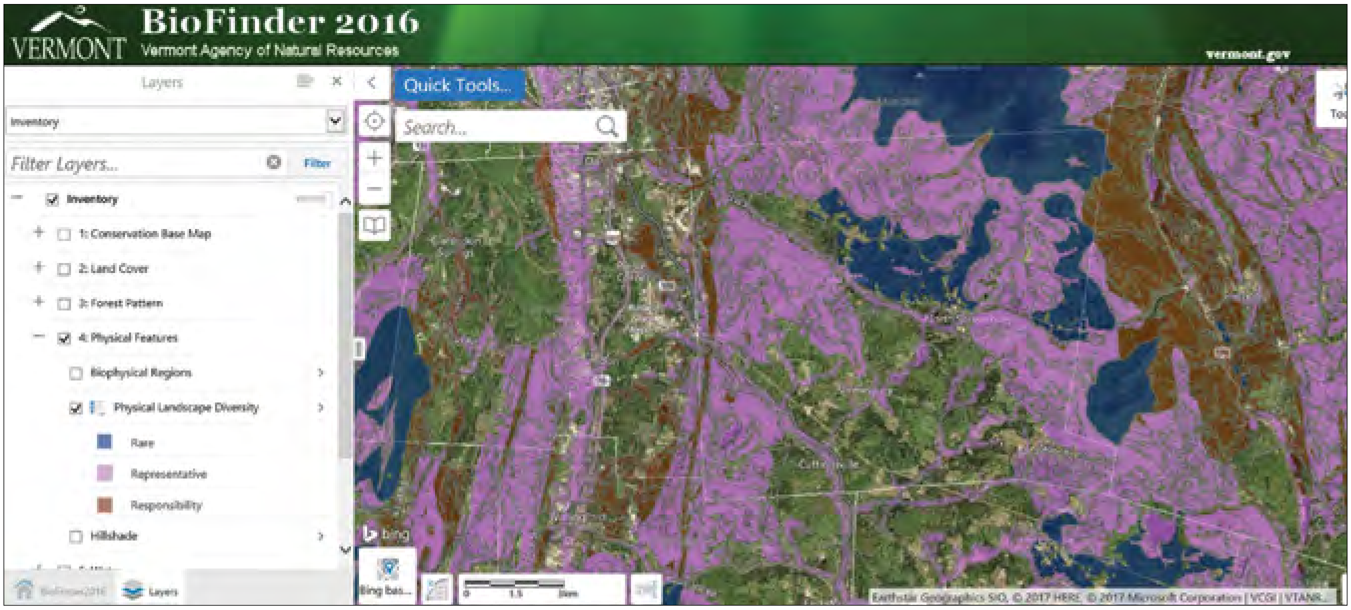
Physical Landscape

What is the Physical Landscape?

The physical landscape includes:

- Bedrock: the rock that underlies everything we see on the surface
- Surficial materials: the gravel, sand, silt, clay, or peat that sit on top of the bedrock
- Topography or Landforms: cliffs, coves, summits, flats, and so forth
- Elevation

Individually, each of the physical attributes above influences the ecological landscape in a particular way. As any gardener or landscaper knows, different plants grow on a shady, north-facing slope than on a



To load Map 4 on BioFinder: Open the **Inventory** theme, then check the box next to **4: Physical Features.** To see all available Map 4 layers, click on the + next to the layer name.

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide.

sunny hillside that looks south, or in shallow, rocky soils than in deep clay. When these physical attributes are mixed and matched, the resulting patterns can be quite complex. In order to describe the numerous combinations of physical features found across Vermont's landscape, we use Ecological Land Units, or ELUs, results of a computer analysis developed by The Nature Conservancy to standardize the way the physical landscape is described (Ferree & Anderson 2008).

The model combines the physical attributes listed above with additional factors such as soil types and climatic features to create a visual representation of variation in the physical landscape. For example, the ELUs of the Green Mountains illustrate subtle variations in steep terrain with acidic bedrock and rocky glacial deposits, while the Champlain Valley features combinations of flatter, calcium-rich clay plains.

The Physical Landscape

The physical landscape is like the stage of a theater. While it doesn't change in response to the drama of a play, it does influence the actions of the actors—the plants, animals, and other species that live there.

Because there are several hundred ELUs that appear on the Vermont landscape, maps displaying each ELU unit are impractical. Instead, only the ELUs considered most important for conservation are displayed, divided into *rare*, *responsibility*, and *representative* categories.

Rare Physical Landscapes

Rare physical landscapes are those types least commonly found in Vermont, each covering less than 4.5 percent of the state's land area. Because rare physical landscapes often correspond with the presence of rare species or natural communities, they can be used as a filter for maintaining the state's overall biodiversity. This is particularly important because there are many species about which we know very little (for example, insects, plants, or mosses) and identifying rare physical landscapes can help us to predict where diversity among these unstudied species may occur.

Rare associations include the following:

- Calcareous (Calcium-rich) Metamorphic High Hills/Low Mountains
- Connecticut River Valley (Historic Lake Hitchcock) Sediments
- Enriched Slopes
- Granitic Basins
- Granitic High Hills/Low Mountains

- Granitic Mid-Elevation Hills
- Marine-Lacustrine-Glaciofluvial Coarse Sediments
- Precambrian Plateau
- Upper Mountain Slopes/Mountaintops
- Valley Floor Glacial Lake/Marine Plains
- Vermont Escarpment
- Water-deposited glacial sediments along major riverways

Responsibility Physical Landscapes

Some combinations of physical features are common in Vermont, but rare in the surrounding region or even worldwide. These are called responsibility physical landscapes since we have a "responsibility" to maintain them in our conservation efforts. While individual occurrence of a responsibility physical landscape may not appear particularly special within the local context, including examples of these landscapes in conservation efforts ensures that the species relying on these landscapes can persist at a grander scale.

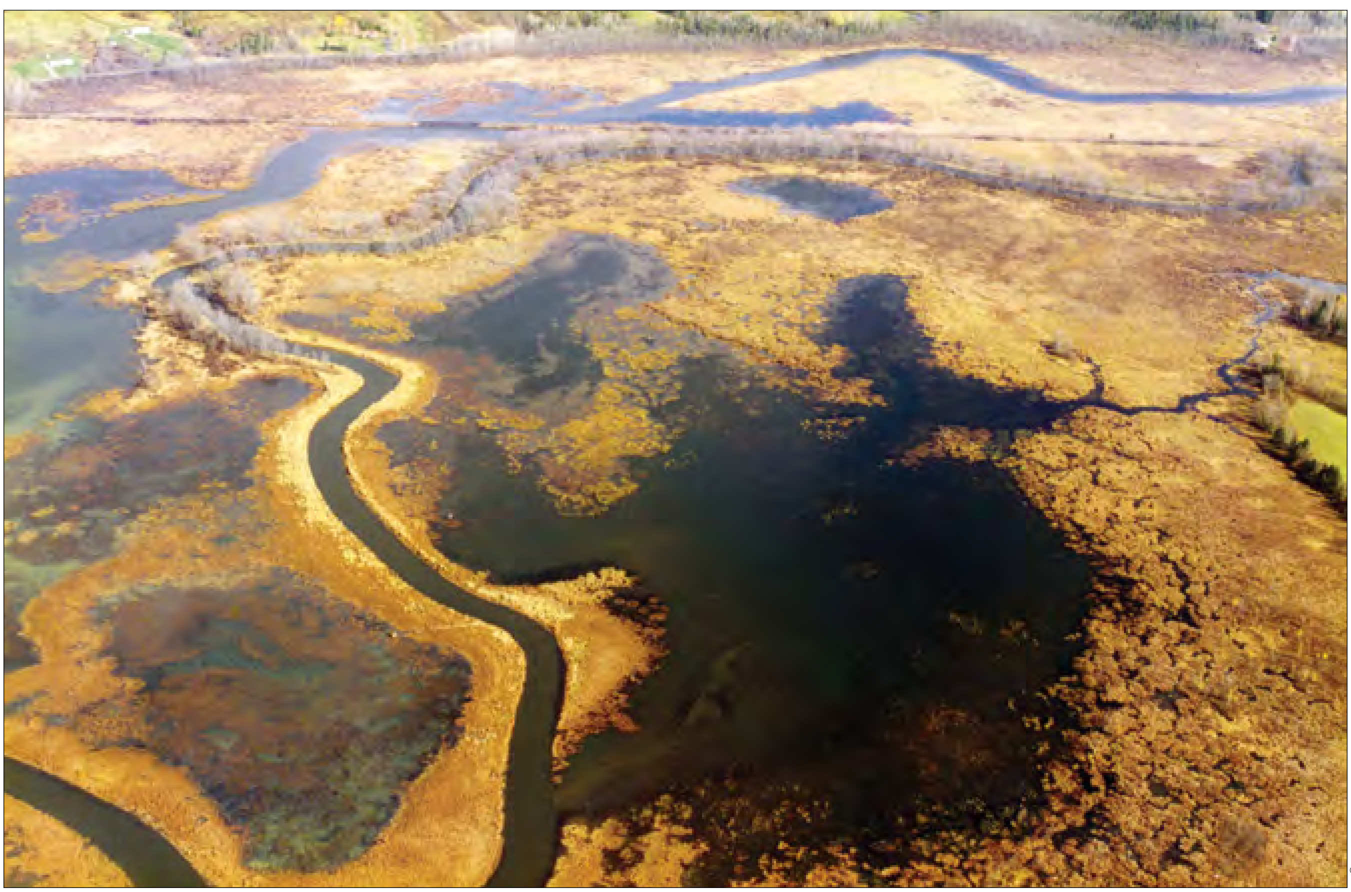
Responsibility physical landscapes include locations with underlying calcium-rich rock, underlying mafic (magnesium- and iron-rich) rock, and cove landforms. While these are fairly common within the state, Vermont has a high responsibility for the conservation of these landscapes regionally.

Representative Physical Landscapes

For each Ecological Land Unit not included on the rare or responsibility lists, high-quality examples were selected throughout the state based on condition and patch size. These are mapped as representative physical landscapes since they "represent" landscapes that include our most common species and natural communities. Common species and natural communities are every bit as important as the rare species conservation efforts often focus on, but without datasets like this, it can be difficult to include their importance on a map.

Physical Landscapes: Significance

In assessing biodiversity within Vermont, we can't inventory every species in every location across the state. Of Vermont's 24,000 to 43,000 species, only 426 are vertebrate animals, and 2,000 are vascular plants (e.g., trees, shrubs, flowering plants, grasses, and so on). We know very little about the remainder, comprising invertebrates, fungi, algae, lichens, mosses, and liverworts. This leaves us unable to accurately quantify



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biodiversity. In the absence of such an inventory, the inclusion of physical features in planning efforts is a way to capture biodiversity. Physical features portray the ecological potential of the landscape.

This idea of ecological potential is especially important given that the distribution of species on today's landscape has been impacted heavily by human land use history. Physical features allow us to see beyond current land cover and land use to instead see where biodiversity would flourish naturally.

Since physically diverse landscapes correspond to diversity in species, conserving wildlife habitat within rare, responsibility, and representative landscapes encourages a diversity of species to flourish. This is particularly true in the face of global climate change. As changes occur over time, plant and animal species adjust their ranges to more climatically suitable conditions. Areas of diversity in the physical landscape will allow for these adjustments to be made more easily, and these areas are likely to continue as the stage for biological diversity even as species composition changes.

Physical Landscapes: Map Interpretation

This Physical Landscape Diversity map can be very useful at a statewide or multi-state scale where a high degree of accuracy is unnecessary. When viewing physical landscapes within a single town, they should be interpreted with caution. This dataset is mapped as a grid, with each box of the grid representing a 30m x 30m area. At this scale, the boundaries between two ELU types cannot be considered highly geographically accurate. However, the physical landscapes map can be used as an initial bird's eye view to help in thinking about the local landscape in a new way when determining conservation strategies.

On the printed maps associated with this guide, physical landscapes are mapped only as rare, responsibility, or representative. On BioFinder, a user can identify each ecological land unit individually.

Physical Landscapes: Planning Considerations

In many locations, mapped physical features overlap with other important components, such as forests and waterways. In these cases, the importance of the physical landscape can strengthen the prioritization of these other features in conservation work.

However, some areas highlighted as important physical landscapes are quite different from those outlined on other maps in this guide. This is because other layers tend to reflect current landscape condition, where habitat exists now. Rare and responsibility

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physical landscapes are often places where diversity in habitat types could exist in the future, alongside the places where we currently find biodiversity. When planning with climate change in mind, we need to remember that the species we're now familiar with are likely to shift their ranges or be affected by a new host of stressors such as disease or drought. Meanwhile, new species will be establishing themselves in the region—not only trees and large animals that we can study easily, but also microorganisms in the soil, fungi, insects, etc. While we can't predict the exact composition of species that will be living in our communities, this map suggests some areas that together will provide the setting necessary to maintain a rich diversity of plant and animal species.

When planning, one way to look at the Physical Landscape Diversity map is therefore to see how current conservation lands are distributed across physical landscape types. If some significant physical features are underrepresented, consider prioritizing them in future conservation efforts.

At its core, this map provides a lens for erasing current land use patterns to allow you to think about the ecological potential of the land. If your community is interested in restoration or land conservation efforts, or in planning for a changing climate, you may find this map particularly enticing.

You might also try the following strategies for conserving important physical landscapes:

Conservation Goal	Conservation Strategies for Important Physical Landscapes	
	Nonregulatory Strategies	*Regulatory Strategies*
Include physical landscapes in conservation efforts	Compare maps of physical landscape diversity to conserved lands. Prioritize under-represented features in conservation efforts.	When feasible, locate building envelopes outside these areas.
	Encourage residents to conserve their land.	
	Encourage residents to enroll in Current Use (or local tax stabilization program).	
	Conduct planning efforts so as to avoid development in these areas.	
Protect habitat blocks or waterways that include important physical landscapes	See Map 3, Layer #3, and Map 5, Layer #2.	

For additional information, see *Conserving Vermont's Natural Heritage*.

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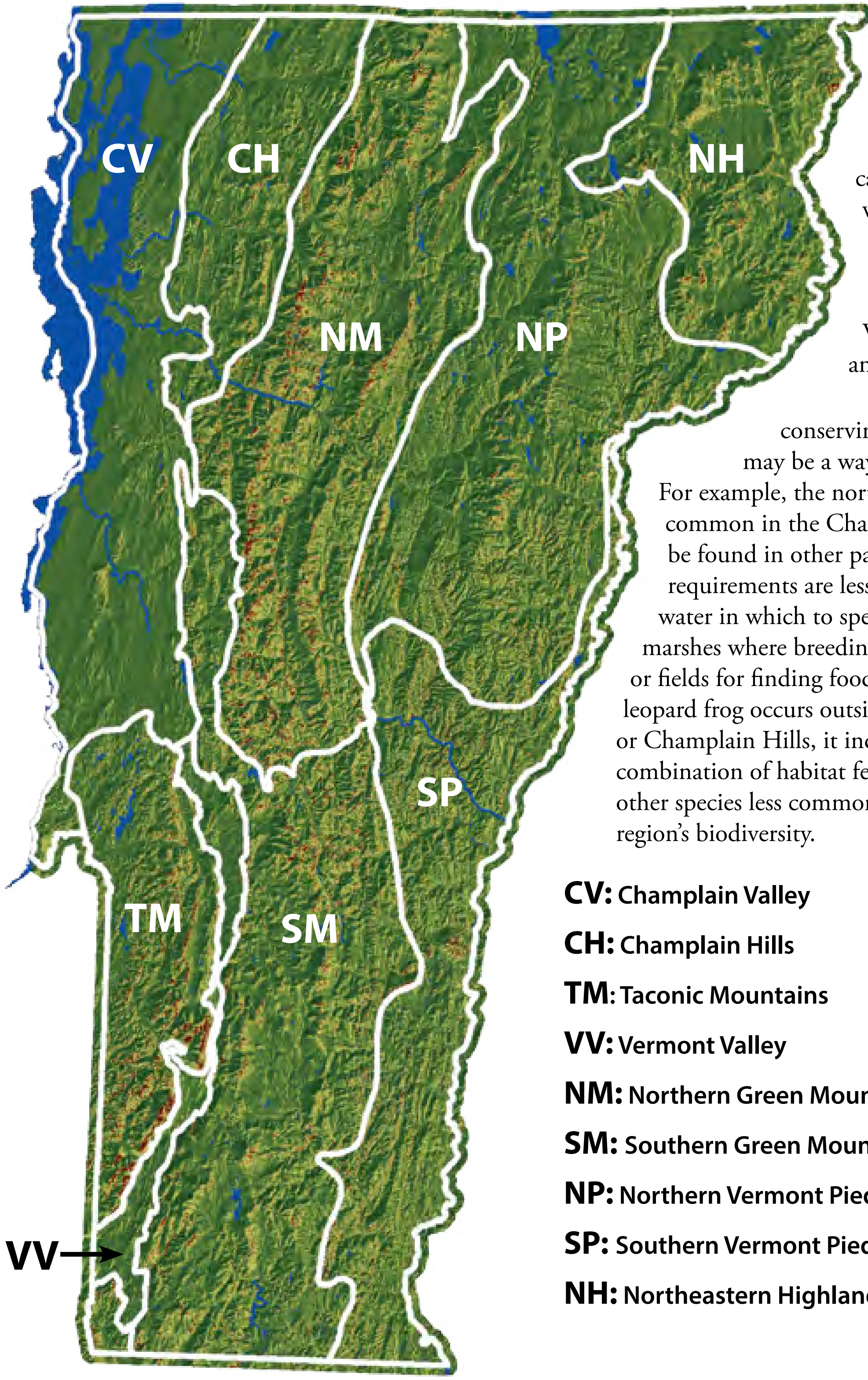
Additional Online Data

Biophysical Regions

In the Physical Landscape Diversity map described above, landscapes are broken into specific component pieces. However, we can also lump them into much more general categories, called biophysical regions, to divide the entire state into areas with like physical features.

Each of these regions share similarities in climate, bedrock, geologic history (glacial deposits, flooding, and so on), topography, land-use history, and hydrology (water flow patterns). When conducting planning efforts (especially at a statewide or regional scale), these biophysical regions can be used as a lens through which to assess conservation priorities, because what may be common in one biophysical region of Vermont may be rare in another.

In the area in which it is rare, conserving habitat for that species may be a way to preserve biodiversity. For example, the northern leopard frog is quite common in the Champlain Valley. While it can be found in other parts of the state, its habitat requirements are less widespread: permanent water in which to spend the winter, floodplains or marshes where breeding occurs, and wet meadows or fields for finding food. When the northern leopard frog occurs outside the Champlain Valley or Champlain Hills, it indicates the presence of a combination of habitat features that may support other species less common in the region, adding to the region's biodiversity.



CV: Champlain Valley

CH: Champlain Hills

TM: Taconic Mountains

VV: Vermont Valley

NM: Northern Green Mountains

SM: Southern Green Mountains

NP: Northern Vermont Piedmont

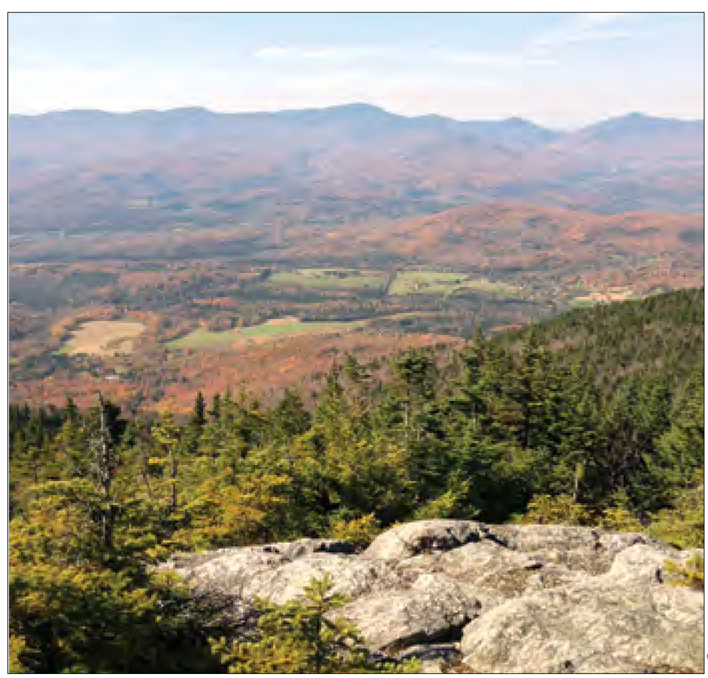
SP: Southern Vermont Piedmont

NH: Northeastern Highlands

Vermont's nine biophysical regions are:

- **Northeastern Highlands**
  Granite bedrock dominates this cool region, which is characterized by large wetlands, remote mountains, and lakes and ponds. Spruce and fir dominate both lowlands and high elevations, while northern hardwood forests cover the mid-elevations.
- **Northern Vermont Piedmont**
  Calcium-rich soils combine with a cool climate to support mixed forests and northern white cedar swamps, fens, and other interesting natural communities in this region. The uplands have fine agricultural soils, but a short growing season.
- **Southern Vermont Piedmont**
  Calcium-rich soils and rolling hills make this a good place for agriculture. The climate is average for Vermont, except in the extreme southeast where it is quite warm. Northern hardwoods and red oak dominate the vegetation.
- **Southern Green Mountains**
  A broad plateau is dotted with a few dominant peaks. Climate is cool and rainfall is relatively high. Northern hardwoods, spruce, and fir dominate, and there are a number of small lakes and ponds.
- **Northern Green Mountains**
  This area has a cool climate and high elevations. Northern hardwoods dominate the sideslopes, whereas high elevations have spruce and fir as well as alpine meadow communities.
- **Champlain Valley**
  This region of Vermont has a warm climate and abundant fertile farmland. The Champlain Valley contains both northern hardwood forest and various species of oaks and hickory. It has some of the state's most significant natural diversity and the state's most densely populated areas.
- **Champlain Hills**
  This region consists of the hills and footslopes located between the Champlain Valley and the Green Mountains. Soils are primarily derived from glacial till and are shallower and rockier than in the Champlain Valley. There is some agriculture, but not nearly to the extent of the valley below. Northern hardwood forests dominate the region, dotted with softwood and mixed stands, dry oak communities, and wetlands.
- **Taconic Mountains**
  The slate belt of Vermont, the Taconics are dramatic wooded hills dominated by sugar maple, beech, and yellow birch forests. Dry oak and hickory forests are found on the lower elevation knolls, while spruce and fir occur at the highest elevations.
- **Vermont Valley**
  The Marble Valley has marble and limestone with glacial deposits on the valley walls, abundant springs, and wetlands.

Some communities may find it useful to visit this map on BioFinder to see where the boundaries of these regions fall geographically. If your community contains sections of different biophysical regions, you may find it useful to frame your planning efforts within the context of each region, even if it divides your town. For example, the regional ecological needs of the Champlain Valley and the Northern Green Mountains are somewhat different. A town spanning the boundary between these two regions may want to consider strategies for the two areas separately, keeping in mind that boundaries are approximate. The map was intended to describe landscape characteristics at a state scale; there is no way to identify an exact boundary line between any two regions.



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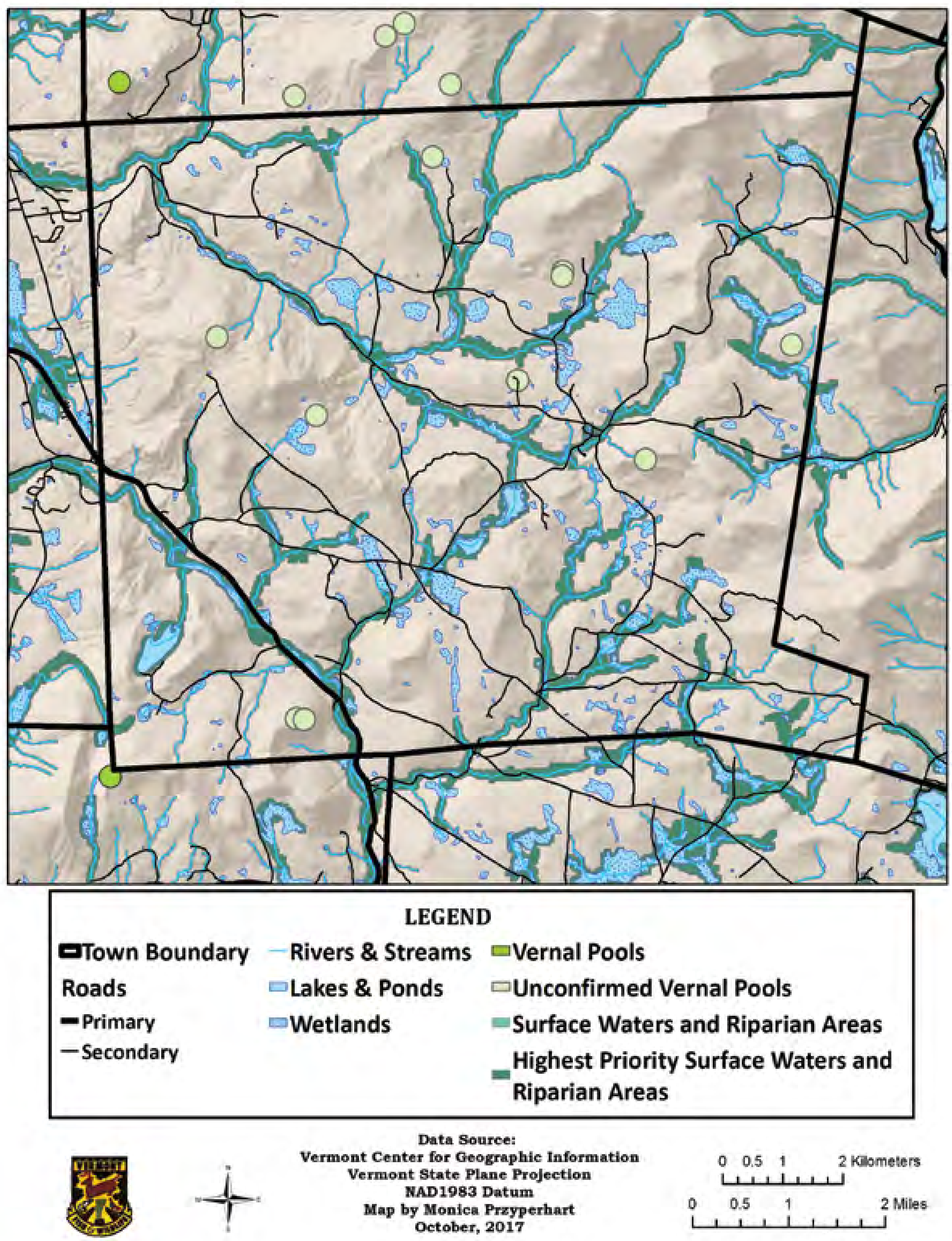
Map 5: Water


LEGEND
Town Boundary
Roads
Primary
Secondary
Rivers & Streams
Lakes & Ponds
Wetlands
Vernal Pools
Unconfirmed Vernal Pools
Surface Waters and Riparian Areas
Highest Priority Surface Waters and Riparian Areas
Data Source:
Vermont Center for Geographic Information
Vermont State Plane Projection
NAD1983 Datum
Map by Monica Przyperhart
October, 2017
0 0.5 1 2 Kilometers
0 0.5 1 2 Miles

Map 5 Water

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This map is intended to provide a broad overview of the water resources in your community.

Inventory Layers (Described Below)	**Base Layers**	**Additional Online Data**
1. Rivers, Streams, Lakes & Ponds 2. Surface Waters and Riparian Areas 3. Vernal Pools (Confirmed and Unconfirmed) 4. Wetlands	Town Boundaries Roads	Stream Crossings Bridge and Culvert Inventory

Water is an important resource for both wildlife and human communities. While not particularly scarce in the Northeast, water-based ecosystems can be both highly valued and highly vulnerable. In addition to the rivers, streams, lakes, and ponds included on other maps, this map includes wetlands, vernal pools, and a more extensive layer of riparian areas than included in other maps.

Additionally, you can use BioFinder to see the locations of bridges and culverts and stream crossing areas. This information has implications both ecologically and for determining safe and effective locations for human activities.

Inventory Layer #1: Rivers, Streams, Lakes, & Ponds

What do These Layers Show?

On the map, these data appear as two distinct layers: Rivers & Streams, and Lakes & Ponds. The same layers are included on other maps to provide geographic reference points. Together, this is the most complete set of rivers, streams, lakes, and ponds available in Vermont. While wetlands were not specifically delineated in this effort, those wetlands containing open water have also been captured.

To load Map 5 on BioFinder: Open the **Inventory** theme, then check the box next to **5: Water.** To see all available Map 5 layers, click on the **+** next to the layer name.

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide.

Rivers, Streams, Lakes, & Ponds: Significance

Rivers, streams, lakes, and ponds are by nature diverse ecosystems, with plant and animal communities changing according to water depth, turbulence, available oxygen, and a host of other features. Shorelines contribute additional variety to the communities found in aquatic ecosystems. Together, these communities form an extensive food web that includes everything from tiny microorganisms to bears and humans. This web also includes reptiles and amphibians, plants, waterfowl, songbirds, bats, mink, and otter.

Rivers, Streams, Lakes, & Ponds: Map Interpretation

These data are formally known as the Vermont Hydrography Dataset and are part of a larger, nationwide effort by the United States Geological Survey to map waterways across the country. Rivers and streams are represented by lines capturing the centerline of a stream, not the entire water body. This means that the data may be most meaningful in capturing a general sense of where water flows through the region, at the scale of an entire town or larger. We depict this information on Map 5 on top of **Riparian Areas** (Layer #2) because together, these show a much more complete picture of the geographic area influenced by each body of water.

Because waterways are dynamic by nature, their exact boundaries or extent can be expected to change, both seasonally and over time. For planning purposes, your community may therefore want to clearly define any planning or regulatory terms involving water through a measurement other than this static map that represents one moment in time (for example, the

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distance from the top of the streambank or slope). It should also be noted that while this layer is the most complete map available of Vermont's surface waters, data were derived through the interpretation of aerial photographs and topographic data and many have not been checked in the field.

Rivers, Streams, Lakes, & Ponds: Planning Considerations

In nearly all cases, the most important planning considerations for waterways include maintaining vegetation on the surrounding streambank, which is often called the riparian area. Conservation strategies for surface waters and riparian areas are therefore discussed together at the end of the Surface Waters and Riparian Areas description.

Rivers, Streams, Lakes, & Ponds: Additional Information

Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities is a good source of detailed information about different buffer widths and the species and functions they protect.[1]

Inventory Layer #2: Surface Waters and Riparian Areas

What are Surface Waters and Riparian Areas?

Surface water refers to all water that appears on the ground's surface (rivers, streams, lakes, ponds, and some wetlands) but excludes groundwater. This layer therefore includes all the water bodies described in Layer #1, with two main differences: First, Layer #1 maps only the centerline of each stream or river. Surface Waters and Riparian Areas expands upon that centerline to estimate a width for the water body. Secondly, Surface Waters and Riparian Areas maps the entire area impacted by these waterways, including not only the water itself but also the surrounding land. This surrounding area is referred to as the riparian area.

The word "riparian" literally means "pertaining to the bank of a river or lake." Riparian areas are complex and interrelated networks of streams, rivers, lakes, wetlands, and the floodplains surrounding all these waterways. Because the waterways themselves are discussed in Layer #1 above, this section focuses on the terrestrial portion of the riparian area.

In general, larger bodies of water have wider riparian areas. Mountainous headwater streams are usually contained within steep, narrow valleys, with narrow riparian areas that transition into upland forests. Large streams and rivers, however, wind through wider, flatter valleys, with riparian areas extending the width of these valleys. Even though small streams in steep valleys have narrow bands of riparian habitat, the forest surrounding these streams plays an important role in protecting the riparian habitat and stream, especially where steep slopes threaten landslides, rapid storm water runoff, and hillside gullying.

Surface Waters and Riparian Areas: Significance

Riparian ecosystems are unique in their high biological diversity. Characterized by periodic disturbances—flooding, the deposition of sediments, erosion, and the forces of water and ice movement—riparian habitats are highly complex and variable, and therefore extremely ecologically diverse (Verry et al., 2000). In fact, for a community faced with limited resources, prioritizing the conservation of riparian areas can be one of the best ways to help a wide diversity of wildlife species.

Surface Waters and Riparian Areas: Map Interpretation

As mentioned above, Layer #1 depicts the centerlines of rivers and streams in Vermont, along with outlines of lakes and ponds. The Riparian Area dataset was built around these centerlines through estimation of a width for each water body and then by adding a buffer to capture the floodplain. The overall width is therefore based on a combination of factors that includes relative stream size and physical landscape characteristics.

Once the floodplains were mapped, Vermont biologists divided this dataset into two categories. "Highest Priority" was given to those riparian areas in which there is currently no development. This includes

Riparian Wildlife Connectivity vs. Surface Waters and Riparian Areas

In Map 3, we introduced Riparian Wildlife Connectivity. Now we introduce Surface Waters and Riparian Areas. There is substantial overlap between the two datasets. The difference is that Surface Waters and Riparian Areas includes developed areas and agricultural lands when they occur within the floodplain and projected riparian zone; Riparian Wildlife Connectivity includes only areas with vegetated cover.

areas with natural vegetation and agricultural lands. While lands covered by crops, hay, or pasture do not perform all the functions of a forested riparian area, they will be much easier to manage for function or restore than developed lands. To see a map of only vegetated riparian areas, go to Riparian Wildlife Connectivity, in Map 3.

"Priority" status was given to riparian areas in which development currently exists. While all areas mapped are likely to be inundated by floodwaters periodically, these lands will be much more difficult to maintain or restore as functional riparian area for protecting water quality, providing flood resilience, or for wildlife habitat.

In using these data, keep in mind that this is a state-wide model; there is no way to depict at this scale the specific area that functions as important habitat or protects water quality. Local factors play a large role, such as steepness of slope, the quality of surrounding habitat, and so forth. To get a better sense of riparian function in your town or region, a local inventory may provide more specific information.

Surface Waters and Riparian Areas: Planning Considerations

Maintaining a vegetated riparian area may be the single most effective way to protect a community's natural heritage. The riparian area provides high quality habitat for a great diversity of both aquatic and terrestrial species. Downed wood, leaves, and similar organic material filter into the water to become important components of the food base and habitat structure. Mature trees in riparian areas shade aquatic habitats, helping to control water temperatures.

Terrestrial animals use riparian areas as travel corridors, while many plant and tree seeds float downstream to disperse. Streamside vegetation helps to control flooding, and it is crucial in filtering overland runoff—which protects water quality—and stabilizing stream banks, which prevents excessive streambank erosion and sediment buildup. What's more, maintaining the riparian area is one of the most cost-effective ways to provide resilience for a changing climate.

In your town, your specific conservation goals will dictate how wide an area to consider for protection around a stream or lake. These areas are often referred to as riparian buffers. In general, a naturally vegetated 100-foot-wide riparian buffer protected from development or intense human activity on each side of a stream will protect many of the functions associated with healthy riparian habitat, while a 330-foot buffer will protect nearly all the functions we value, including high-quality cover for many wildlife species.

Of course, we value riparian areas for their contributions to human values, too—including water quality, recreation, education, spiritual well-being, and sense of place. Riparian habitats also play a critical role in flood resilience, which has become particularly important since Vermont is experiencing increasingly frequent flood events.

In most areas, the above buffers would protect these human values alongside wildlife needs. They would also allow rivers to be dynamic. Naturally, rivers and streams change course over time, widening their banks through erosion in some areas and depositing sediment in others as they meander. While these maps are not intended to predict future changes in stream shape, they do include the areas in which most these changes are most likely to occur.

Buffer Regulations

Some towns in Vermont have established buffer regulations to protect the riparian area. Read Georgia's story here: vtconservation.com/success-stories/buffer-regulation

Protecting Riparian Areas and Responsible Recreational Use

Some communities have been able to protect riparian areas alongside human interests. For example, the Lamoille River Paddler's Trail promotes recreational use of the river by providing access points, portage trails, and primitive campsites while also promoting the conservation and stewardship of riparian areas. Learn more at www.lamoilleriverpaddlerstrail.org.

When looking for strategies effective at protecting water and riparian areas, you might consider:

<table>
<tr><th>Conservation Goal</th><th colspan="2">Conservation Strategies for Water and Riparian Areas</th></tr>
<tr><td></td><td>Nonregulatory Strategies</td><td>Regulatory Strategies</td></tr>
<tr><td rowspan="2">Learn more</td><td>Learn about river planning, management, and protection through the Vermont Department of Environmental Conservation.[2]</td><td rowspan="2">N/A</td></tr>
<tr><td>Learn about managing and protecting lakes and ponds through the Vermont Department of Environmental Conservation.[3]</td></tr>
<tr><td>Provide baseline protection</td><td>Adopt language in the town plan, including statements about the importance of riparian areas policies on how they should be managed, protected, and restored.</td><td>Check clarity of definitions in zoning bylaws and update if needed.[4]</td></tr>
<tr><td rowspan="6">Protect surface waters and riparian areas</td><td>Support the creation of River Corridor Easements[5] (conservation easements that allow rivers to change course naturally, without human interference).</td><td>Require forested riparian buffers in the general standards section of your bylaws, to apply in all districts, or in River Corridor bylaws, if you have them.[6]</td></tr>
<tr><td rowspan="5">Connect owners of riparian land to incentives programs for wildlife-friendly management practices, such as USDA or USFWS Partners for Fish and Wildlife.</td><td>Establish standards for minor activities (footpaths, etc.) acceptable within the riparian area.</td></tr>
<tr><td>Add standards in subdivision regulations or zoning (River Corridor, Flood Hazard, Lakeshore Overlay, or Forest District) that require clustering or setting back development away from riparian areas, river meanders, or floodplains.</td></tr>
<tr><td>Require minimum setbacks from waterways in zoning and subdivision regulations.</td></tr>
<tr><td>Adopt town road management standards to comply with Vermont's Clean Water Act.[7]</td></tr>
<tr><td rowspan="3">Enhance Riparian Quality</td><td>Assist landowners in restoring riparian habitats.[8]</td><td rowspan="3">Require restoration of riparian habitat in site plan or subdivision review by designating "no-mow" zones, allowing for regeneration of woody vegetation, or by planting native species.</td></tr>
<tr><td>Create an invasive species control program for riparian areas.[9]</td></tr>
<tr><td>Connect landowners to incentives programs, such as through USDA or USFWS Partners for Fish and Wildlife.</td></tr>
<tr><td rowspan="4">Maintain Water Quality</td><td>Assist landowners in reducing stormwater runoff.[10]</td><td rowspan="4">Recommend or require vegetated buffers to filter pollutants before they reach waterways.</td></tr>
<tr><td>Encourage residents to reduce use of chemical lawn care products.</td></tr>
<tr><td>Identify ways to reduce flood damage to major infrastructure.[11]</td></tr>
<tr><td>Support public awareness of the Acceptable Management Standards for Maintaining Water Quality of Logging Jobs in Vermont.[12]</td></tr>
</table>

Most of these conservation tools are explained in detail in *Community Strategies for Vermont's Forests and Wildlife (vnrc.org/programs/forests-wildlife/guide)*.

Inventory Layer #3: Wetlands

What are Wetlands?

In a sense, wetlands combine the traits of upland and aquatic habitats. While they function differently than either, they provide an interface in which species of both communities dwell and interact, alongside numerous species that occur only in wetlands. They include the vegetated, shallow-water margins of lakes and ponds, the seasonally flooded borders of rivers and streams, and an amazing diversity of topographic settings across the landscape.

Although many definitions have been developed for the term and concept of "wetland," we consider wetlands to have three basic characteristics. First, all are inundated by or saturated with water for at least two weeks during the growing season. Second, they contain wet (hydric) soils, which develop in saturated conditions and lack oxygen and other gases. Finally, they are dominated by plant species known to be adapted to these saturated soils.

Wetlands are known by many common names, with some common names associated with particular wetland conditions. For example, swamps are dominated by trees or shrubs. Marshes are dominated by herbaceous plants. Fens are peat-accumulating, open wetlands that receive mineral-rich groundwater. Bogs, also peat-accumulating wetlands, receive most of their water and nutrients from precipitation rather than from an inflow of water from a stream, river, groundwater, or even the surrounding landscape. Recently, vernal pools have also been included as wetlands (although we map them separately in this guide). Each of these wetland types supports a unique group of plants and animals, many of which require these wetland habitats to survive.

Community Strategies for Vermont's Forests and Wildlife: Case Study

While statewide wetland protections are offered through the Vermont Wetland Rules, some towns have chosen to further protect these important natural features. The town of Warren protected wetlands and other ecologically sensitive areas by requiring a Conservation Subdivision Design in the review of major subdivisions, for example. You can read more about the town's process on page 58 in *Community Strategies for Vermont's Forests and Wildlife (vnrc.org/programs/forests-wildlife/guide)*.

Wetlands: Significance

Wetlands are beneficial to a variety of native plant and animal species, as well as to the health, safety, and welfare of the general public. They provide fish and wildlife habitat, flood and erosion protection, nutrient and pollution filtration, groundwater recharge, aesthetic diversity, and sites for educational and recreational activities.

It is estimated that 50 percent of Vermont's historic wetland area has been lost or severely impaired due to draining, dredging, filling, or excavation activities associated with industrial, residential, and agricultural activities. Since 1995, the current rate of wetland loss in Vermont is estimated at 20 acres per year. While restored wetlands offset this number somewhat, these restored wetlands generally take many years before they provide the full functionality of a natural wetland.

Fish and wildlife that depend on wetlands for survival tend to be easily disturbed or negatively affected by human activities, and activities often associated with residential development can disturb habitat or cause displacement of a variety of wildlife.

Wetlands: Map Interpretation

This map layer uses the most comprehensive source of information on wetlands available: the Vermont Significant Wetlands Inventory (VSWI), which is a subset of the larger National Wetlands Inventory. This inventory was created to provide a broad-scale overview of where wetlands are located. Keep in mind, however, that these maps were prepared using aerial photography. Wetlands that are hard to see on aerial photos—such as those that are forested—may not show up, while other features were occasionally mistaken for wetlands and displayed on this map. Before using these data for specific planning purposes, you will want to verify this information, but it can be a good starting place.

Wetlands: Planning Considerations

Wetlands receive some protection through the Vermont Wetland Rules. These rules regulate land use, including restrictions on development, guidelines on acceptable management activities, and a list of allowed uses. They apply within the wetland itself and a surrounding buffer. On maps, you will find wetlands to be classified as Class I or Class II, with Class I wetlands receiving the highest level of protection, and with most mapped wetlands falling into the Class II category. You can learn more through Vermont's Department of Environmental Conservation.[13]

The first step in planning for wetlands locally generally involves an evaluation of how well the state-level rules achieve your community's goals for wetland conservation. To achieve local or regional goals, some communities take additional steps to protect certain functions. The most common additional steps address either the extent of the undeveloped strip of land (a "buffer") encircling the wetland or the land that extends between a wetland and a nearby natural area or body of water. While Vermont Wetland Rules generally apply within a 50-foot area around a Class II wetland, for example, a wetland that provides extensive habitat for breeding waterfowl or that is surrounded by steep slopes and is therefore at a high risk of erosion may benefit from a 100- to 300-foot buffer wherever possible. In other locations, maintaining a vegetated area that connects a wetland to nearby natural areas or waterways provides a pathway for traveling wildlife.

In addition to considering the specific benefits a wetland provides to fish and wildlife, your community may also want to consider the wetland's role in flood and erosion protection, nutrient and pollution filtration, groundwater recharge, aesthetic diversity, and potential use for educational and recreational activities.

Conserving Vermont's Natural Heritage Tip

There are a variety of ways to plan for the future of the wetlands in your community. *Conserving Vermont's Natural Heritage* suggests starting with creating goals such as the following for the conservation of wetlands:

1. Protect or provide for long-term stewardship of wetlands that support significant functions and values for natural communities, rare species habitat, or wildlife habitat, and prevent additional loss of wetlands within the town.
2. Restore and/or enhance the functions and values of wetlands already affected by human disturbance.

The book goes on to provide specific recommendations of tools—both regulatory and non-regulatory—that may be useful in fulfilling these goals. See more on page 62 of the book.

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To protect or restore wetlands in your region, consider the following strategies:

Conservation Goal	Conservation Strategies for Wetlands	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Improve knowledge of local wetlands and create a town wetlands map.	
Provide baseline protection	Adopt language in the town plan, including statements about the importance of wetlands and policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed.[14]
Protect wetlands and surrounding habitat	Encourage residents and/or businesses to conserve their wetlands through conservation easements.[15]	Petition for reclassification of significant wetlands to Class I, which receive the highest level of protection. If wetlands are not mapped, seek to add them as Class II wetlands on inventory maps.[16]
	Encourage residents to enroll their wetlands in Current Use, in an Ecologically Significant Treatment Area (ESTA).[17]	Require buffers through the general standards section of your bylaws, to apply in all districts.[18]
	Encourage landowners to work with a forester to choose forest management practices that protect wet soils and fragile species.	Require development design that clusters development away from wetlands and their buffers in subdivision and zoning regulations.[19]
	Support public awareness of Vermont's Wetlands Rules.[20]	Incorporate minimum setbacks from wetlands in zoning and subdivision regulations.
Restore wetlands	Restore wetlands on town-owned lands.[21]	Create town road management standards to maintain and restore natural vegetation and hydrology.[22]
	Connect landowners with incentives programs (USDA, USFWS, etc.) to aid in restoring wetland habitat.[23]	

Information about many of the tools above can be found in *Community Strategies for Vermont's Forests and Wildlife*.

Wetlands: For More Information

National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS): This is the agency responsible for mapping wetlands throughout the United States, including the data displayed. Information about the USFWS's classification system can be found on the National Wetlands Inventory website[24] or in the book *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979).

Wetlands Section, Vermont Department of Environmental Conservation:[25] This program regulates wetlands in Vermont, monitors the biological condition and status of Vermont's wetlands, and provides technical assistance on wetland identification, delineation, and protection through planning and other mechanisms. It is also a source of information on the functions, values, and locations of wetlands throughout the state.

Inventory Layer #4: Vernal Pools

What are Vernal Pools?

A vernal pool is a depression in the forest floor that fills with water each spring and often dries out later in the growing season. Although trees and shrubs rarely grow in vernal pools, typical vernal pools are well shaded by the surrounding forest.

In the Northeast, many vernal pools start filling with fall rains; retain water, ice, and snow through the winter; and collect more water with the arrival of spring rain and snowmelt. Some are further influenced by rising groundwater in the fall and spring.

The pools typically lack inlets and outlets, and while many vernal pools are dry by mid-summer, some may retain water throughout the year in wet years.

Vernal Pools: Significance

Vernal pools may take up a small amount of land area, but they are necessary habitat for amphibians and very important for a number of additional species. In Vermont, vernal pool-dependent species include mole salamanders (spotted salamander, blue-spotted salamander, and Jefferson salamander), Eastern four-toed salamander, and wood frog. All of these species may breed in other wetlands but rely heavily on vernal pools to maintain their populations.

For vernal pools to be effective breeding habitats for these amphibians, they must retain water for at least two months during the spring and summer breeding season most years so that amphibians can complete their aquatic larval stage. The periodic drying of a vernal pool is essential, too, as this eliminates populations of fish and diving beetles that prey on amphibian larvae.

Other animals use pools as well, such as fairy shrimp, fingernail clams, snails, eastern newts, green frogs, American toads, spring peepers, and a diversity of aquatic insects. Fairy shrimp are thought to survive only in these temporary pools. Because the amphibians and invertebrates found in vernal pools constitute a rich source of food, various species of birds, mammals, and reptiles may be attracted to the pools. Despite their small size and temporary nature, vernal pools are highly productive ecosystems.

Vernal Pools: Map Interpretation

The data depicted in this layer were collected through the Vermont Vernal Pool Mapping Project, a statewide effort to map the locations of vernal pools. These pools were initially mapped using aerial photographs; many have also been visited to confirm existence and to collect data.

You will notice that this information is divided into two similar layers: a "vernal pools" layer and a "vernal pools (potential)" layer. "Potential" vernal pools have been mapped purely using aerial photographs but have not been confirmed in the field; others have been visited and enough data has been collected to say for certain that these pools exist and are used by wildlife.

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Vernal Pool Mapping Project

By using a combination of professional expertise and volunteer vigor, the Vernal Pool Mapping Project continues to identify vernal pools throughout the state. Learn more at vtconservation.com/success-stories/vernal-pool-mapping-project.

The locations of confirmed pools are therefore accurate to a fine scale and can be used even down to a parcel level; "potential" vernal pools should be visited (with landowner permission) prior to taking any next steps.

Vernal Pools: Planning Considerations

Vernal pools and the organisms that depend on them are threatened by activities that change the way water flows into and around the pool, alter the substrate at the base of the pool, or significantly modify the surrounding forest. Construction of roads and other development in the upland forests around vernal pools can negatively affect salamander migration or result in mortality (Forman et al., 2003).

Some types of timber harvesting can also have significant effects on vernal pools, including alteration of the vernal pool depression, changes in the amount of sunlight, leaf fall, and woody debris (such as branches, decaying wood, and so on) in the pool, and disruption of amphibian migration routes by the creation of deep ruts. Even when the pool is dry, alteration of the depression substrate may affect its ability to hold water and may disrupt the eggs and other drought-resistant stages of invertebrate life that form the base of the vernal pool food chain.

In Vermont, vernal pools with breeding amphibian populations have recently been included as Class II wetlands and are therefore offered some protection under the Vermont Wetland Rules. However, many wetland maps used for regulatory purposes do not include vernal pools, limiting the rules' enforceability. Similarly, town plan and bylaw definitions of wetlands generally lack inclusion of vernal pools.

When planning for the conservation of vernal pools, one starting place may be to update maps of Class II wetlands to include vernal pools and to re-define a "wetland" in the town plan or bylaws. At that point, planning for vernal pools and wetlands could be accomplished simultaneously, if this would achieve your community's goals.

You might also consider the following strategies for conserving vernal pools:

Conservation Goal	Conservation Strategies for Vernal Pools	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories as needed to improve maps of vernal pools.	
Protect vernal pools and associated amphibian populations	Write management plans for town-owned land designed to protect vernal pools.[26]	Require buffers in the general standards section of your bylaws, to apply in all districts.[27]
	Encourage landowners to create forest management or stewardship plans to conserve vernal pools and surrounding habitat.	Create a Wildlife Habitat Overlay District that includes vernal pools and surrounding habitat.[28]
	Provide citizen educational opportunities.	Encourage subdivision and site plan designs in zoning or subdivision regulations that cluster development away from vernal pools.[29]
	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	Require minimum setbacks in zoning or subdivision regulations.
		Seek to add vernal pools as Class II wetlands on inventory maps (where they are often missing).
Protect or restore forested habitat between vernal pools	Include a map in your town plan to show possible dispersal corridors between pools.	
	Target high priority corridors in land conservation efforts.	

Information about many of the tools above can be found in *Community Strategies for Vermont's Forests and Wildlife*.

Additional Online Data

The following datasets are available on BioFinder, but they are not featured on the included inventory maps.

Stream Crossings

This dataset shows how well aquatic organisms, such as fish or bottom-dwelling macroinvertebrates, are able to pass through culverts and other road-associated structures.

Many aquatic species need to travel both up- and downstream during different life stages. For example, some trout species lay eggs in cooler, upstream locations but must find deeper pools, generally downstream, in which to spend the winter months. When culverts (or other natural landforms or human-made structures) form waterfalls too high for fish and other organisms to travel across, these species are cut off from upstream habitat.

This layer describes a fish's ability to pass through culverts, bridges, and other road-related structure with the following categories:

- Fully Passable
- Reduced Passage
- Impassable except for Adult Trout (Adult trout can leap higher distances than younger trout or other species.)
- Impassible
- Bridge/Arch (fully passable)

When conducting planning efforts, your municipality may want to consider efforts to enhance structures that impair passage. In doing so, remember that roads may fall under the jurisdiction of private parties, towns, or the state.

Bridge and Culvert Inventory

In many Vermont towns, you can view data on the locations of all bridges and culverts. This information is divided into:

- VTRANS State and Town Long Structures (with a span greater than 20 feet)
- VTRANS State Short Structures (with a span less than 20 feet)
- Town Bridge
- Town Culvert

This information can be useful when thinking about how water flows through an area or how some wildlife might move safely across roads (by traveling underneath).

Suggested Additional Data

The 100-Year Floodplain

In some parts of Vermont, maps of the 100-Year Floodplain are available. While not included on BioFinder, these maps can be helpful in understanding an area's flood potential. It can be found on the Natural Resources Atlas. There, it is entitled DFIRM and includes several individual components. Compiled by the Federal Emergency Management Agency, these data have strong implications for both human and ecological communities.

While streams and rivers overflow their banks on a yearly basis in many communities, the highwater mark from one year to the next varies greatly. If we compare the water level reached in one flood to that of the next flood, we can calculate a recurrence interval for each inundation level. Some land is inundated every year. Some land floods on an average of every five years. A 100-year flood reaches very high water levels and can dramatically alter the landscape of our communities.

Hundred-year floodplain information is used commonly for economic and emergency management purposes, namely insurance. Using this map, we can visualize the area most likely to be underwater in a dramatic flood event—including houses, roads, and other infrastructure.

While the data were compiled with human communities in mind, they have ecological implications, too. Historically, these are lands in which flood sediments, such as sand, gravel, and other materials, have been deposited, and these materials create the substrate. Periodic flooding also creates disturbances that prevent certain vegetation from growing and allowing other species to rely on these regular inundations of water, sediments, and nutrients. In general, the 100-year floodplain is a dynamic region that acts as an interface between water and land.

Compiled by the Federal Emergency Management Agency, these data are the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). In other words, this map layer is based on the database used by flood insurance companies to predict the likelihood of flooding for any particular location. The categories pictured are therefore classifications of flood risk: 1 percent annual chance of a flood event (the 100-year floodplain) and 0.2 percent annual chance of a flood event (the 500-year floodplain).

Flood hazard areas are determined through the analysis of records of river flow, storm tides, and rainfall, consultation with communities, topographic surveys, and analysis of water flow. The map also uses elevation models. This information is not available in all counties of Vermont.

Of course, the extent to which water will cover any given piece of land in a future flood is not predictable, because there are so many factors affecting the locations where water will flow. Data are based on past events and provide a historic record of inundation rather than predictions for the future.

This map has strong implications for both human communities and ecological conservation. As described above, this information was compiled with emergency management in mind, and its implications for human safety and financial costs are clear. However, these lands are also critical for a variety of wildlife, making the 100-year floodplain a place of common ground. While historic development within this region was common and substantial infrastructure currently exists inside the limits of the 100-year floodplain, there is a good chance that infrastructure built on the floodplain will not last without substantial effort and cost. On the other hand, wildlife thrive in an undeveloped floodplain. Rivers and streams provide corridors for movement between one block of quality habitat and the next. Some species rely on floodplain sediments or nutrients.

Climate Change & the 100-Year Floodplain

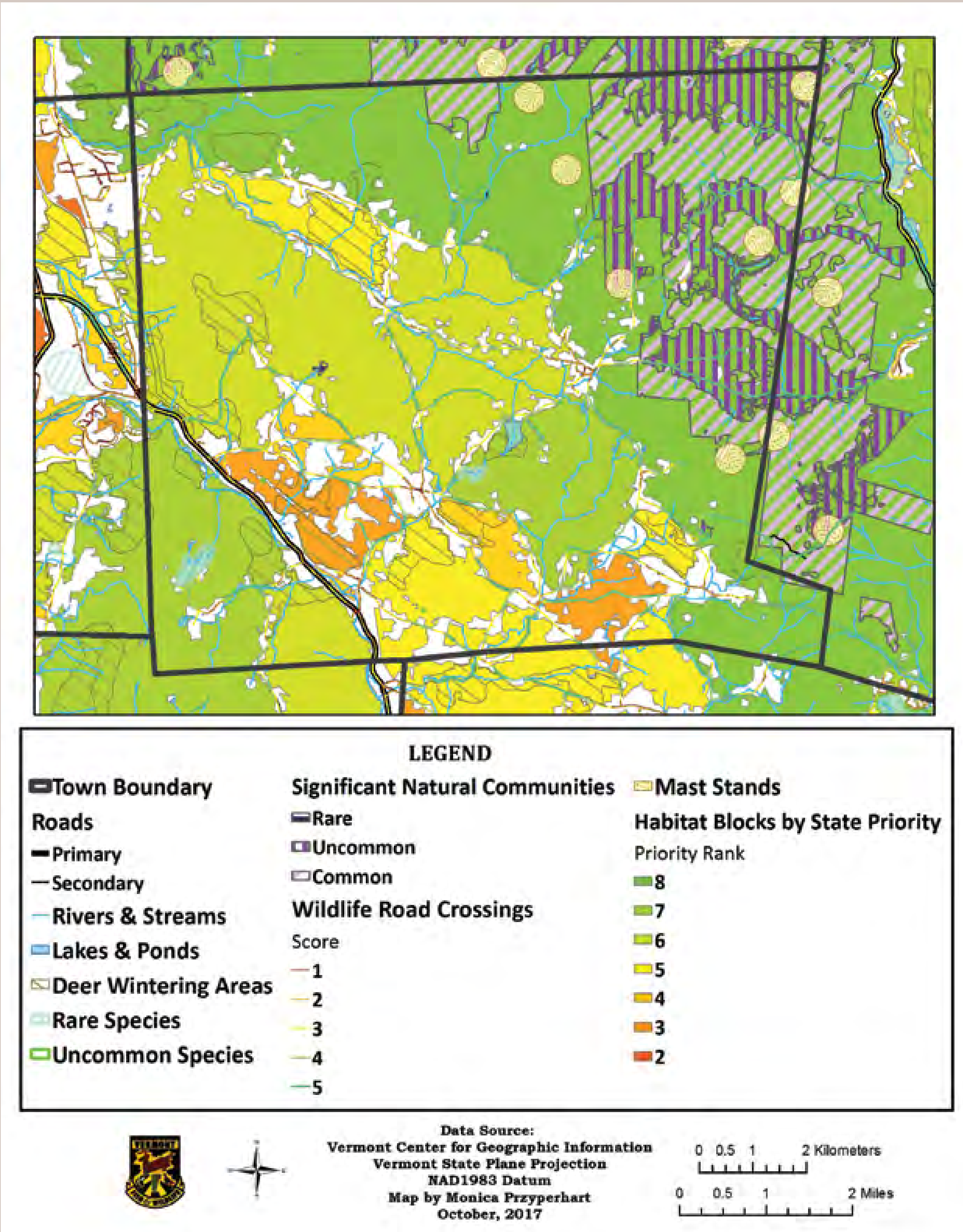
Flood recurrence intervals are based on historic averages. However, high-intensity flood events are predicted to occur with increasing frequency as our climate changes. For example, a 2015 study of the Winooski River in Waterbury found that when climate change predictions are factored in, the land currently mapped as the 500-year floodplain (with a 0.2 percent annual chance of inundation) will more likely be a 100-year floodplain (with a 1 percent annual chance of inundation) by 2065 (Schiff et al. 2015).

The 100-Year Floodplain=1% Annual Chance

The 100-hundred year floodplain is all the land inundated by a flood with a recurrence interval of 100 years. A flood of this magnitude has a 1 percent chance of occurring each year.

An insurance company might look at this statistic from a different angle: Over the life of a 30-year mortgage, property within the 100-year floodplain has a 26 percent likelihood of flooding.

Map 6:
Community and Species Scale Resources



Map 6 Community and Species Scale Wildlife Resources

©John Hall

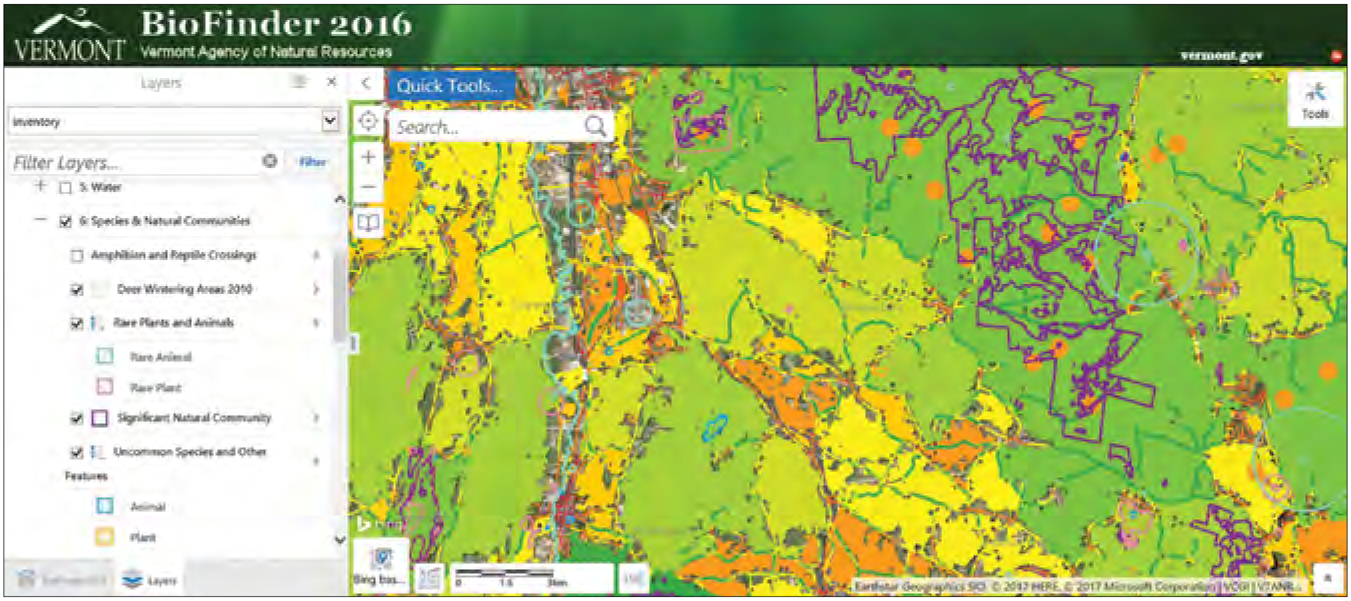
The data on this map is accurate to a finer scale than other maps.

Inventory Layers (Described Below)	**Base Layers**	**Additional Online Data**
1. Deer Wintering Areas 2. Rare and Uncommon Plants and Animals 3. Significant Natural Communities 4. Wildlife Road Crossings 5. Mast Stands 6. Habitat Blocks (by State Priority) Locally Specific Inventory Layers	Roads Streams & Rivers Lakes & Ponds Town Boundaries	Indiana Bat Habitat

In the context of this map, the Community Scale includes the components and process that occur between groups of plants and animals as they interact with one another and with their physical environment. For example, mast stands are described at this scale because they are associated with a particular set of physical features, plants, and wildlife that function together as a community.

The Species Scale refers to those habitats necessary for the survival of specific fish, wildlife, and plants. For example, wildlife crossings are locations where bear, bobcat, fisher, and other wide-ranging species are most likely to cross roads as they travel to meet daily or seasonal dietary needs, disperse to find mates, or fulfill other requirements. While they tend to be small in size, species-scale components are essential for maintaining biodiversity by supporting species with a known conservation need in the state or region.

As you look at this map, you can imagine zooming in from previous maps to examine the details of your local landscape, even analyzing layers at the level of an individual parcel. Of course, while data are accurate at a local scale, they aren't comprehensive. For example, a mark depicting a rare species is spatially accurate, but the absence of a rare species marker is not a definite sign that there are no rare species present. Because the entire state has never been inventoried for all rare species, there are inevitably omissions from the database. This is true for most of the data displayed on this map. Local inventory information could greatly enhance a community's knowledge of community- and species-scale resources.



To load Map 6 on BioFinder: Open the **Inventory** theme, then check the box next to **6. Species & Natural Communities.** To see all Map 6 layers, click the **+** next to the layer title. You can add navigational landmarks such as roads and town boundaries by checking them on in **Map 1, the Conservation Base Map**.

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide, or **Tips and Tools** on the BioFinder website.

Inventory Layer #1: Deer Wintering Areas

What are Deer Wintering Areas?

Deer wintering areas vary in size from a few acres to more than 100 acres and provide essential relief to deer from winter conditions. Covered by dense, mature or maturing softwood trees, they provide protection from deep snow, cold temperatures, and wind. These areas may be characterized by a favorable aspect (south-facing, or perhaps southeast or southwest-facing but rarely north), they generally occur at moderate elevations, and they are found in places with low levels of human activity in winter. Tree cover is most often from hemlock and white pine in the southern part of the state, and white cedar, spruce, and fir in the north. Deer inhabiting these areas expend less energy walking in the reduced snowpack and maintaining their body temperature in the sheltered environment, thus enhancing their survival.

From one year to the next, wintering areas do not change significantly, so these areas can be used by generations of deer over many decades if habitat conditions are maintained. Deer annually migrate—often several miles—from fall habitats to wintering areas, and a single large deer wintering area can occasionally attract deer from a radius of several towns.

Deer Winter Habitat

Additional information on deer winter habitat requirements and management recommendations can be found in the publication *Wildlife Habitat Management for Vermont Woodlands, a Landowner's Guide*, which is available from the Vermont Fish & Wildlife Department.

Deer Wintering Areas: Significance

The conservation of deer wintering areas is essential to maintaining and managing white-tailed deer in Vermont. Deer wintering areas make up a relatively small percentage of the land base of most towns; only eight percent of the forested landscape of Vermont has been mapped as deer winter habitat. However, residential, commercial, or industrial development within or adjacent to these areas decreases the amount of winter habitat available to deer and can eventually reduce the number of deer within the area. Without adequate winter habitat, deer populations would be subject to extreme fluctuations due to heightened levels of winter mortality during moderate and severe winters.

Deer Wintering Areas: Map Interpretation

Deer wintering areas were identified in 2010 using aerial observations, infrared aerial photos, and ground confirmation. Additional areas are added to the database as they are discovered. It is important to keep in mind that not all deer wintering areas have been mapped, and that changes in forest cover and land use affect an area's use as a deer yard. If you suspect an area serves as deer winter habitat that is not mapped, we recommend that you contact us.

©Vermont Fish & Wildlife Department

Deer Wintering Areas: Planning Considerations

In addition to benefits for deer, dense softwood stands provide critical winter shelter and food supplies for a variety of other wildlife species including porcupines, snowshoe hare, fox, fisher, coyotes, bobcats, crows, ravens, red and white-winged crossbills, and many others. Logging can be either detrimental or beneficial to the habitat depending on whether a dense softwood cover and food supply are maintained.

Because so many of the species that use deer wintering areas use them as one type of habitat in a matrix of others, this dataset may be most useful when used to reinforce the importance of larger blocks of forest habitat that contain deer wintering areas. In other words, a broad-scale conservation measure to limit forest fragmentation or support large blocks of undeveloped land that include deer wintering habitat may be the most effective way to conserve this habitat type. For specific planning considerations, please see Layer #3: Habitat Blocks in Map 3.

If you decide to add additional protections specifically for deer wintering areas, you might consider the following:

Conservation Goal	Conservation Strategies for Deer Wintering Areas	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps.	
Protect habitat blocks that include deer wintering areas	See Map 3, Layer #3.	
Protect deer wintering areas	Encourage residents to conserve their land through conservation easements.[1]	Establish development design standards that cluster development away from deer wintering areas.[2]
	Encourage residents to enroll their land in Current Use, using Ecologically Significant Treatment Areas (ESTAs) in appropriate locations[3] or working with a forester to plan for the long-term health of the resource.	Establish or improve a Wildlife Habitat Overlay District.[4]
	Adopt language in the town plan, including statements about the importance of deer wintering areas, and policies on how they should be managed, protected, and restored.	Require buffers around deer wintering areas.
	Provide citizen educational opportunities.	

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*. You can also learn more about deer wintering areas and associated conservation goals in *Conserving Vermont's Natural Heritage*.

Inventory Layer #2: Rare and Uncommon Plants and Animals

What are Rare and Uncommon Plants and Animals?

A careful look at the map key will reveal that this data is divided into two layers: "rare plants and animals" and "uncommon species and other features." Because both refer to individual known occurrences of species that are not commonly encountered in Vermont, we discuss them together.

A rare species is one that has only a few populations (generally fewer than 20, depending on the species) and faces threats to its continued existence in Vermont. Uncommon species also face a risk of extinction, but a more moderate one, with between 20 and 80 populations statewide. In general, rare species are subject to state or federal regulations; uncommon species are not, though there are exceptions.

Most of these species in Vermont are rare because they are on the edge of their range or they are separated from the main species population by a large distance. For example, the spiny softshell turtle is found in Vermont in parts of Lake Champlain, and the next nearest population is in the St. Lawrence River. The majority of the population is found west of New York. Several rare species occur in unique habitat types or rare natural communities. Animal species with large home ranges, such as osprey, are considered rare when their overall populations consist of small numbers of breeding pairs.

Included alongside uncommon species data are "other features." These are rare species or natural communities that have been identified but incompletely documented. This means that as with uncommon species, these features are unlikely to trigger state or federal regulatory review as recorded. However, this may change if these features are better studied.

Rare, Threatened, or Endangered? What's the Difference?

The maps described in this guide are based on how common or rare a species is in Vermont. This follows a system that ranks species on a scale of S1 through S5 in which S1 and S2 are considered rare, S3 is considered uncommon, and S4 and S5 are common. This parallels a global ranking system that records rarity of a species throughout its range on a scale of G1 through G5.

The words threatened and endangered refer to the species' legal status. Threatened and endangered species have been offered protection under the Vermont Endangered Species Law or federal Endangered Species Act. While this status is based on rarity, species are not offered protection without a legal designation.

Legal status is not included in BioFinder. However, it is shown on the ANR Atlas. The two maps use identical data; only the display format differs. To see a complete list of Vermont's rare species that includes state and federal legal status, visit the conserve/conservation-planning/animal-inventory and conserve/conservation-planning/plant-inventory pages on vtfishandwildlife.com.

Rare and Uncommon Plants and Animals: Significance

Rare native species in Vermont, such as Indiana bat, loon, spiny softshell turtle, goldenseal, and ginseng are an important part of Vermont's natural heritage. Rare species can play crucial roles in ecosystems, with other species relying on them for their survival. Many of these species are also admired and appreciated by people for their beauty, sounds, or mere presence on the landscape.

Each town harbors its own set of rare and uncommon species that contributes to the overall diversity of the state. Even though Vermont is a small state, it has varied terrain, aquatic systems, elevations, wetlands, geology, and natural communities. It is likely that the rare species mapped in your community are in habitats that are ecologically important at the state or even regional level, even if they don't seem particularly rare in a local context.

Rare and Uncommon Plants and Animals: Map Interpretation

The data shown on this layer were compiled through the Vermont Fish & Wildlife Department's Natural Heritage Inventory (NHI), which is the state's contribution to a greater, regional database of conservation information. Unlike many layers in this guide, all information depicted about rare and uncommon species represent field-confirmed, geographically accurate data points.

Map users should be aware that when a point is used to represent a rare species observation, the size of the population may not correspond to the size of the point. A mapped point may represent only a few square yards, but it could also indicate a large wetland, a river stretch over a mile long, or an extensive ridgetop that provides habitat for the rare species. Usually, more specific data is recorded in the NHI database, and you can learn more by contacting the Vermont Fish & Wildlife Department. In addition to learning more about the location or population size of a mapped rare species, the database sometimes includes notes recorded by those conducting field inventories, such as threats or management needs such as an invasive species that is affecting the rare species.

©Tom Rogers

While rare and uncommon species locations are provided on this map, you will notice that plant and animal species information is missing. Nationwide, this information is omitted from mapping efforts so as not to jeopardize the survival of sensitive species.

Some rare organisms are sought for collection, others are targeted as unwanted (such as the timber rattlesnake), and others draw attention from those attracted to the uniqueness of the species, which can sometimes disturb the species' natural habitat or behavior (as can happen with the peregrine falcon or bald eagle). In addition to the potential damage to the species, these behaviors can also be disruptive to land owners and managers.

As a result, each location mapped here is labeled generally as a plant or animal. Landowners, land managers, and town officials can contact the Vermont Fish & Wildlife Department for additional information, but the information is not provided to the public.

Rare and Uncommon Plants and Animals: Planning Considerations

In Vermont, state and federal laws protect threatened and endangered species. However, most rare and uncommon species have not been given this legal status, and they receive no protection. Review and consideration of rare and uncommon species in local and regional planning efforts can help to ensure that important habitat remains.

When planning, the first step may be to contact Vermont Fish & Wildlife Department for more information about the rare and uncommon species found in your community. It is wise to consider the habitat needs of these species, as well as the age and quality of the data, before determining a particular conservation strategy. In some cases, collection of additional field data may also enhance your decision-making ability.

Because the planet in general (and possibly Vermont specifically) is experiencing the loss of species at a rate never before experienced, those species most at risk serve as barometers of the state of the environment (George 1998). Protecting and restoring rare and uncommon species represents one of the most difficult present-day conservation challenges in Vermont. If we are to see the continued presence of these species in our state, we need to address their needs at all levels of planning, including local, regional, and statewide.

More Resources

Chapter 6, page 106 of *Conserving Vermont's Natural Heritage* details many strategies for keeping rare, threatened, and endangered species on our landscape.

To conserve rare and uncommon species, you may consider the following strategies:

Conservation Goal	Conservation Strategies for Rare and Uncommon Species	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps of rare and uncommon species.	
Provide baseline protection	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed.[5]
	Provide citizen educational opportunities.	
Protect significant species	Encourage landowners to conserve land that supports rare or uncommon species.[6]	Create a Conservation or Wildlife Habitat Overlay District that protects significant wildlife habitat and a surrounding buffer.[7]
	Encourage landowners to enroll in Current Use and enroll eligible areas as Ecologically Significant Treatment Areas (ESTAS).[8]	
Manage invasive species	Provide landowners with opportunities to learn about management options for invasive species.[9]	Adopt a mowing policy in which town roadsides with invasive species are mowed before they go to seed.
Restore degraded habitat	Connect landowners with incentives programs (USDA, USFWS, etc.) that aid in restoring significant natural communities or habitat.[10]	

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*. You can also learn more about rare and uncommon species and associated conservation goals in *Conserving Vermont's Natural Heritage*.

Inventory Layer #3: Significant Natural Communities

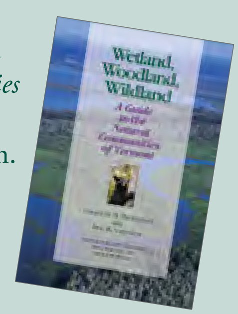
What are Natural Communities?

A natural community is a group of plants, animals, physical features, and natural processes that can be found together wherever similar environmental conditions exist. For example, the most common natural community type in Vermont is northern hardwood forest, dominated by a matrix of sugar maple, yellow birch, and American beech. Young forests of this type often contain mixes of quaking or big-tooth aspen and paper birch. In Vermont's higher elevations with cooler temperatures and shallower soils, montane spruce-fir forest is more common, with red spruce, balsam fir, and paper birch as the dominant species. Each community of trees grows on specific soil types and is associated with a predictable assemblage of understory plants. Each vegetative matrix in turn provides habitat for a somewhat different array of wildlife species. Together, the combination of species commonly occurring together is considered a separate natural community.

This layer is divided into three sub-categories: "rare," "uncommon," and "common." Rare natural communities have the fewest occurrences on Vermont's landscape, and they are generally associated with rare physical or environmental conditions. For example, a rare natural community may occur on a type of bedrock that has limited distribution in Vermont or be associated with climatic conditions that occur only in small parts of Vermont's geography, such as when Vermont is at the edge of a climatic range. Natural

Wetland, Woodland, Wildland

Vermont's natural communities are described in detail in a publication entitled *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont*, by Elizabeth H. Thompson and Eric R. Sorenson. The guide is available online at vtfishandwildlife.com or in printed form in bookstores.



©Charlie Hohn

actors, however, this map identifies a few occurrences in which they are strongly demonstrating their roles in the play.

Natural Communities: Significance

Natural communities represent the distribution of plant and animal species that have grown in response to current and past environmental conditions and natural processes. Although the species composition of natural communities may shift over time in response to a changing climate, it is believed that locations of present-day high-quality natural communities will continue to support important natural communities into the future because they represent differences in the physical landscape setting. Rare natural communities typically include rare species and occur in environmental settings that are rare. Common natural communities occur in more common environmental settings. Natural communities can therefore act as a filter for long-range conservation efforts by showing us locations worthy of protection.

In such conservation efforts, it is important to include not only rare and uncommon natural communities, but common ones, too. Increasingly, conservation strategies include "keeping common species common," because it is far easier to maintain a common species or community than to work only with those that have become rare and try to restore them. Common natural communities are important ecologically because they form the natural matrix of the Vermont landscape, provide habitat for innumerable species and support ecological processes such as natural disturbance, water filtration, and carbon sequestration.

Natural Communities: Map Interpretation

The locations of the rare and uncommon natural communities mapped here represent known examples in the state. They are based on detailed site surveys, so they are accurate even at a very local scale. However, a comprehensive natural community inventory has not been done at the state level. While rare and uncommon natural community types are better represented than common types, the database contains many omissions for all natural communities. Nearly all mapped examples of common natural communities are on

communities can also become rare as the result of habitat loss due to human activity. Uncommon natural communities result from similar conditions, but with a slightly heightened rate of occurrence in Vermont. Common natural communities include all natural community types that are not rare or uncommon.

For all categories, only those occurrences of natural communities that are considered state-significant appear in BioFinder or in the maps associated with this guide. Significance is determined based on the quality of an individual occurrence, coupled with the rarity of the community type. A rare natural community is considered significant for all but the poorest quality occurrences. Uncommon natural communities are considered significant when they are ranked as having either "good" or "excellent" quality. Only the highest-quality occurrences of common natural communities are considered significant, included as examples of the natural communities that create the matrix of Vermont's landscape.

Using the analogy of a theater production, natural communities are our best way of representing all actors (species) and plot elements (natural processes) without needing to identify each individually in an extremely complex drama. Rare and uncommon natural communities are the elements of the play that stand out as different from the standard plot line. Common natural communities represent the majority of actors and plot that make up the play. Instead of pointing to each of the many occurrences of these groups of state-owned land, with few examples mapped on private land despite the numerous high-quality natural communities occurring there.

Interacting with this map on BioFinder will provide you with an opportunity to learn more about an individual natural community. A click on a mapped feature will open an information box, and the box will tell you the type of community and other information. Included in this box is also a "State Rank" category, which refers to a scale ranging from S1 through S5. On this scale, S1 and S2 are considered rare, S3 is considered uncommon, and S4 and S5 are common.

Natural Communities: Planning Considerations

Because significant natural communities can encompass so many different types of habitat, this dataset may be most useful when used to reinforce the importance of the larger habitat blocks that contain them. In other words, a broad-scale conservation measure to limit forest fragmentation or support large blocks of undeveloped land is likely to also protect the natural communities in that block. For specific planning considerations, please see [Layer #3: Habitat Blocks] in Map 3.

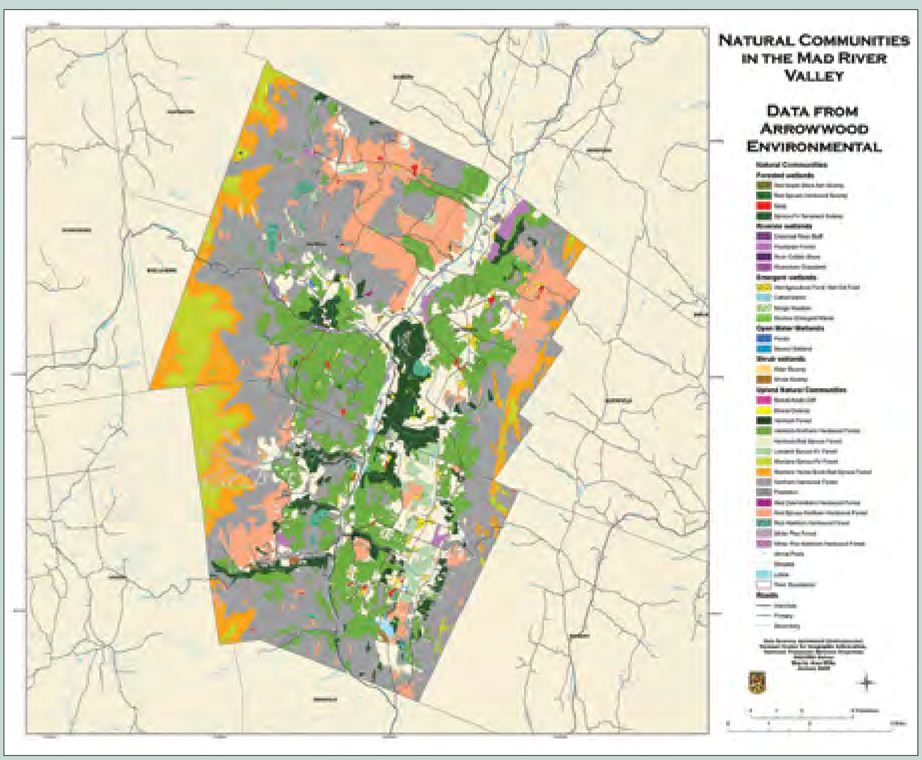
However, some significant natural communities may not be located within large blocks of habitat. In these cases, communities should consider conserving them on their own. Often, these natural communities are located closer to developed areas, and they are frequently located along rivers or other waterways. When this is the case, strategies to conserve riparian areas such as those suggested in [Map 5, Layer #2] may be appropriate.

Because natural community information is incomplete across the state, most communities wishing to conserve their natural heritage could benefit from a local inventory of natural communities. This would build on the data available through state resources to provide a better sense of the types and distributions of natural communities in the local area.

If a community's goal is to protect biodiversity, one effective approach is to then to conserve and/or restore high quality examples of all natural community types that occur within the area. To be most effective, these efforts should consider not only the natural communities themselves, but also the ecological processes that support them—hydrologic patterns throughout the landscape, for example, or movement of wide-ranging species as they travel between natural community types. Consideration should also be given to the extent to which invasive species are impacting biodiversity. In some locations, management of these invasive species may be an important step in conserving the resource.

Natural Community Inventories

Several Vermont communities have conducted natural community inventories to capture a snapshot of the diverse habitat elements present in the local landscape. The Mad River towns of Fayston, Warren, and Waitsfield together hired a consultant to conduct such an inventory. Read more: [vtconservation.com/success-stories/arrowwood-inventory-of-fayston-warren-and-waitsfield-natural-community-mapping].



You might find the following strategies appropriate for conserving natural communities:

Conservation Goal	Conservation Strategies for Natural Communities	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps of natural communities.	
Protect habitat blocks that include significant natural communities	See Map 3, Layer #3.	
Protect significant natural communities	Encourage landowners to conserve land that supports rare or uncommon natural communities.[11]	Create a Conservation or Wildlife Habitat Overlay District that protects significant natural communities and a surrounding buffer.[12]
	Encourage landowners to enroll in Current Use and enroll eligible areas as Ecologically Significant Treatment Areas (ESTAS).[13]	
	Create or expand a Town Forest.[14]	
	Provide citizen educational opportunities.	
Manage invasive species	Provide landowners with opportunities to learn about management options for invasive species.	Adopt a mowing policy in which town roadsides with invasive species are mowed before they go to seed.
Restore degraded habitat	Connect landowners with incentives programs (USDA, USFWS, etc.) that aid in restoring significant natural communities or habitat.	

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*. You can also learn more about natural communities and associated conservation goals in *Conserving Vermont's Natural Heritage*.

Inventory Layer #4: Wildlife Road Crossings

What are Wildlife Road Crossings?

Just as the term implies, wildlife road crossings are areas where wildlife are most likely to cross roads. They are one type of "connecting habitat"—land that links together larger blocks of habitat. When wildlife can successfully cross roads between habitat blocks, these blocks sometimes fill the role of an even larger habitat block, allowing for enhanced movement and migration of animals and plants. Of course, these crossing areas are most effective for wide-ranging mammal species such as black bear, bobcat, and fisher; even a road routinely crossed by these species can present an insurmountable barrier to other species.

While each species prefers a slightly different combination of habitats that increases the likelihood of crossing a road, there are some general trends. Many species are most likely to cross a road when:

- Terrain is relatively flat, with no steep slopes on either side of the road;
- Wetland exists on at least one side of the road;
- Evergreen cover grows on both sides of the road;
- No houses are nearby (within 50m, for example);
- Animals can access larger habitat blocks on each side of the road.

For some species, the presence of guardrails also significantly reduces the likelihood of crossing in a particular location, and when a bridge or large culvert is present, some species may be able to cross under a road rather than across the road surface.

Wildlife Road Crossings: Significance

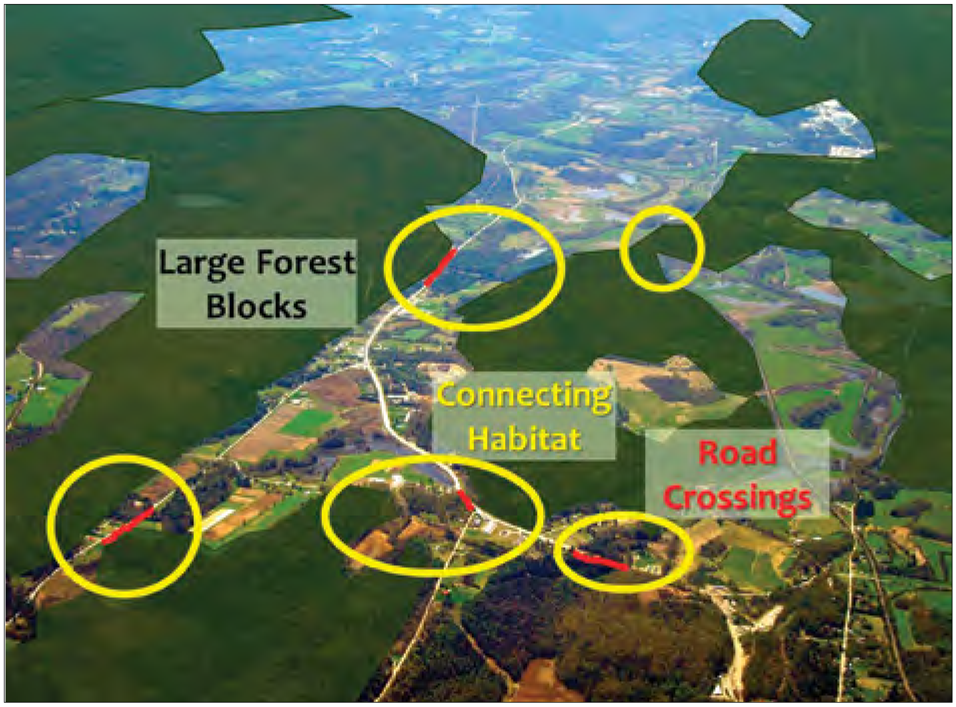
Roads present a significant barrier for many of Vermont's wildlife species. They fragment habitat, preventing animals from accessing food, appropriate

Connecting Habitat Types

To read more about the variety of connecting habitat types that link our landscape, see page 48 in *Conserving Vermont's Natural Heritage*.

shelter, and mates. Some species live only in interior forest, far from roads, and biodiversity decreases in roadside areas. Furthermore, reproductive success for plants and trees can be impacted, water flow patterns can be altered, and roads can be conduits for the introduction of invasive species to new areas.

While most roads diminish the habitat available to Vermont species, some roads present more substantial barriers than others. The wildlife crossing areas depicted can be used by many species, but they are particularly important for wide-ranging mammals, such as bobcats and black bears that maintain large home areas to meet their needs. In some cases, roads may be crossed daily as animals fulfill routine dietary needs. Others may be crossed only periodically. For example, the food resources important to black bears change seasonally, and crossings can allow access to different foods as they become available. Crossings can also prevent the isolation of populations, avoiding problems associated with inbreeding. In these cases, an individual animal may cross a road only once during its lifetime as it seeks to establish a new territory. Even in these cases, that single successful road crossing can be critical for maintaining wildlife populations in Vermont for the long term.



For wildlife to get from one large forest block to another, they need to pass through connecting habitat that may be composed of smaller patches of forest, shrubs, fields, or residential land. Within this connecting habitat, locations where wildlife can successfully cross roads are crucial.

Wildlife Road Crossings: Map Interpretation

These data were generated by the Vermont Fish & Wildlife Department to provide a preliminary look at where wildlife are most likely to cross Vermont roads. The department used a computer modeling process to locate areas with a high concentration of the landscape features most closely associated with wildlife crossing areas. These features were weighted according to importance, and then road segments were given a score of 1 to 5, with 1 being the locations with the fewest associated features (the worst crossing areas) and 5 being the locations with the most (the best crossing areas).

While the crossings depicted on this map are sometimes very small and can be viewed at a fine scale, please keep in mind that these are locations of probable wildlife road crossings—that is, places that contain landscape features associated with wildlife

Wildlife Road Crossings in BioFinder

There are two versions of this dataset available on the BioFinder website. The version described in the text can be found in the **Inventory** theme, on Map 6. As mentioned, roads are all ranked on a scale of 1 to 5, with 5 (in green) being the most probable crossing areas.

In the **Prioritization** theme, you can find an alternative version, broken into **Highest Priority Wildlife Crossings** and **Priority Wildlife Crossings.** While these layers use the same data source, they each display only a subset of the full dataset. Highest priority is given to those crossings ranked as 3, 4, or 5 in which a section of the crossing is located in either a riparian area or a Highest Priority Connectivity Block. Priority was given to crossings ranked 3, 4, or 5 found in other locations.

crossing areas. Additional field investigation is needed to confirm the frequency at which wildlife actually use these potential crossings.

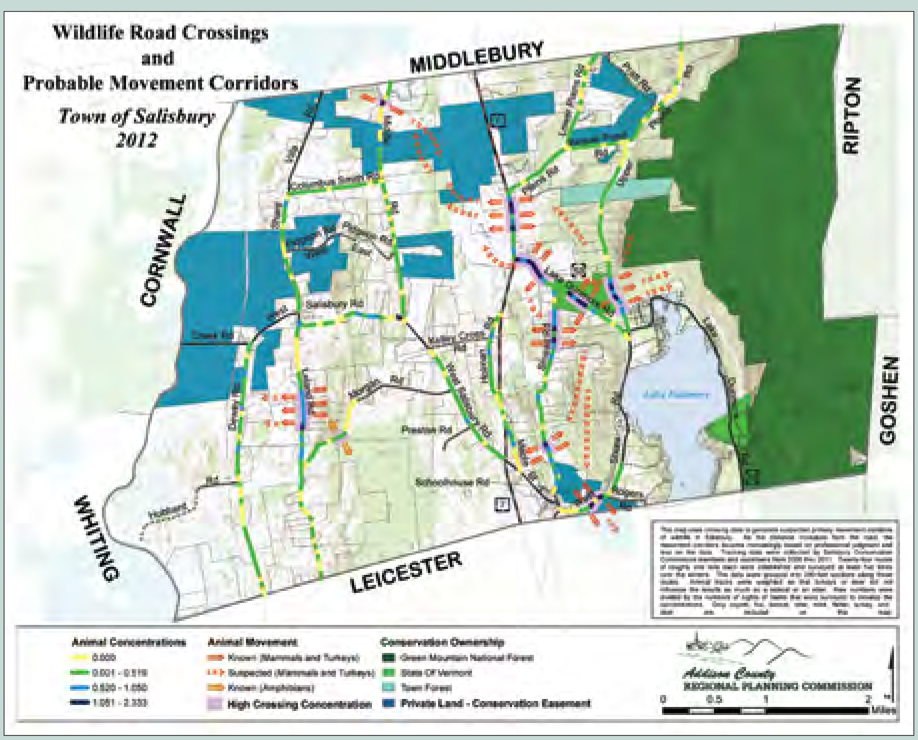
It should also be noted that the dataset's focus is on terrestrial species. There is certainly a lot of wildlife movement that isn't captured by this computer model, such as amphibian crossing areas or fish passage. This layer also doesn't show the connecting habitat between the road and the bigger blocks, only the road itself. Maintaining this buffer of roadside habitat is generally critical for continued use of the crossing by wildlife. Regardless, these data offer a first step in addressing a likely pattern of wildlife movement across a town or region.

Wildlife Road Crossings: Planning Considerations

As mentioned earlier, there are other forms of habitat connectivity. Road crossings address only one feature that fragments landscapes (i.e., roads) but there are other fragmenting features, ranging from human-built infrastructure to natural features such as steep slopes or wide lakes. Your community may want to identify other potential connecting habitats through the interpretation of aerial or orthophotos and/or by enlisting a natural resources professional. Once you have identified wildlife road crossings and other potential connecting features in your community, the next step may be to confirm which areas are most heavily used by wildlife by conducting field assessments of wildlife use in probable areas.

As you examine this layer, keep in mind that this map does not represent the safety of different road crossing areas. An unsuccessful wildlife crossing attempt can be disastrous for both the human and the animal involved in a collision. Some crossing areas are therefore better choices in terms of road crossing success—and human safety—such as roads with lower speed limits or straight roads that provide heightened visibility to drivers. Even more ideal are places where wide culverts or bridges provide enough space for animals to cross under roads rather than across them. As you consider strategies that allow for wildlife connectivity in your community, you may simultaneously be able to address these safety concerns.

Planning efforts that use wildlife road crossings data should also include habitat blocks, since these are the destination points for wildlife as they cross roads. Together, consideration of these two layers will benefit a wide range of native plant and animal species by enabling them to shift geographically or adapt to a changing climate. However, maintaining only crossing areas will not necessarily protect an area's ecological values and biological diversity in an otherwise developing area.



Wildlife Road Crossings in Town Plans

In 2006, the Town of Salisbury set out to determine which of the town's roads were most heavily used by wildlife to cross from one patch of habitat to another. Wildlife road tracking surveys were conducted by Conservation Commission members and local volunteers during the next several years, data were analyzed and mapped, and eventually, the town changed their town plan to reflect their newfound information.

To conserve wildlife road crossings, you might consider the following strategies:

Conservation Goal	Conservation Strategies for Wildlife Road Crossings	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps of roads used as wildlife crossings.	
Protect habitat around wildlife crossings	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed.[15]
	Encourage residents to conserve their land through conservation easements, particularly when crossings are part of larger parcels that have additional conservation values.[16]	Require vegetated buffers around wildlife crossings in the general standards section of your bylaws, to apply in all districts.[17]
	Connect landowners to incentives programs, such as through USDA or USFWS Partners for Fish and Wildlife.	
	Encourage residents to enroll in Current Use.	Adopt road management standards to allow vegetation to remain up to the road.
	Encourage residents to manage their land so as to leave vegetation right up to the road.	
	Provide citizen educational opportunities.	
Limit fragmentation	When conducting planning efforts, consider wildlife road crossings and connectivity blocks together.	Establish or improve a Conservation District.
		Establish or improve a Wildlife Corridor or Wildlife Habitat Overlay District that includes both areas of habitat and important wildlife road crossings.[18]
		Review or establish an access management plan and consider limiting curb cuts in important wildlife crossing areas through site plan review or other standards within the zoning.[19]
Reduce danger to humans and wildlife	Work with road officials to provide appropriate signage and install/remove structures (fences, guardrails, and so on) to guide animals to cross in safer areas (under bridges, on straighter road segments, and so on).	Establish traffic rules that ensure the safety of humans and wildlife along roadways in which wildlife are most likely to cross.
	As needed, upgrade culverts and road infrastructure to VTrans standards. VTrans requires that all crossings include full-width banks and natural, at-grade bottom substrates to facilitate aquatic and terrestrial organism passage.[20]	Adopt road management standards to avoid guardrails, the removal of roadside vegetation, or deep roadside ditching in crossings wherever possible.

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*.

Inventory Layer #5: Mast Stands

What are Mast Stands?

Mast is the fruit or seeds of shrubs and trees that are eaten by wildlife. It provides many species with an important calorie source, particularly in the fall months as wildlife are preparing for winter. Hard mast refers to nuts (especially those of beech and oak trees), whereas soft mast refers to berries and fruits of species such as black cherry, raspberry, blackberry, and apple. While most forested areas contain at least a few mast-producing trees and shrubs, forests producing significant concentrations of mast are much less common. In general, hard mast production areas of beech and oak that are used by wildlife represent a small fraction of the landscape. Only hard mast areas are represented on this map.

Mast Stands: Significance

Significant mast production areas are recognized as a very important wildlife food source, both because available food is concentrated into a small land area and because the food contains a high energy content, especially when beech nuts and acorns are present. Mast stands are used by at least 170 species of wildlife in Vermont, including deer, black bear, turkey, blue jays, and cedar waxwings. Red and gray squirrels rely on beechnuts and acorns for their survival and reproductive success, and since these are prey for fisher, coyote, fox, owls, hawks, and other predators, the influence of mast stands can be seen throughout the food chain.

Hard mast production areas of beech and oak are also important for the survival and reproduction of black bear in Vermont. Studies have documented that the availability of hard mast in the fall affects the minimum reproductive age of bears, productivity rates, and cub survival, and that female bears may skip reproduction after poor mast years (Elowe and Dodger 1989).

www.pxhere/en/photo/1154662

Beech nuts are used as a vital food source by numerous species.

Mast Stands: Map Interpretation

A mast stand is identified as being important for bear if scars left by climbing black bears can be found on at least 15 to 25 tree trunks or show other evidence of use by bears, such as a "bear nest" in the crown of a tree (where bears have bent numerous branches in order to strip them of their mast). Because evidence of use by bear is easier to see than signs left by other animals, this layer relies entirely on bear data. All data on this map represent stands of hard mast as mapped by Vermont Fish & Wildlife Department. It is important to note that while mast stands are represented as points on the map, the actual habitat covered by each mast stand could be either larger or smaller. Dots cover 65 acres of area, which is the average acreage of all mapped mast stands in the state.

It should be noted that this dataset is incomplete; there has not been a statewide survey of mast production areas. Throughout the state, just 277 mast production areas appear on the map, although the real number is far larger. Because data for this map were collected by individuals visiting field locations, we can say with assurance that there are, or at least have been historically, mast stands in the locations mapped. However, it cannot be assumed that there are no mast stands in areas lacking mapped points. If using mast stand information for local planning purposes, a local field inventory may reveal additional examples and provide additional accuracy.

Of the data present on this map, mast stands are more likely to have been reported in areas containing beech, because bear scarring is so prominent on this species and remains in the bark of the tree for so long. While other types of hard mast are certainly also important, this dataset favors beech. It should also be noted that the current condition and wildlife use of mapped mast production areas is not known, as they are not periodically monitored. Furthermore, Beech Bark Disease, an invasive fungus that has been reducing the health of beech in recent years, has been altering the productivity of some mast stands.

Mast Production Areas: Planning Considerations

Because the wildlife that use mast stands also rely on the surrounding forest areas, mast stand information is best used to elevate the importance of the habitat blocks that encompasses them. Any strategy used to limit fragmentation or otherwise protect or maintain these large forest blocks can then be used, such as those listed in Map 3, Layer #3.

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To conserve mast stands, you might consider the following strategies:

Conservation Goal	Conservation Strategies for Mast Stands	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps.	
Protect habitat blocks that include mast stands	See Map 3, Layer #3.	
Protect mast stands	Encourage residents to conserve their land through conservation easements.	Establish or improve a Wildlife Habitat Overlay District.*
	Connect landowners with educational resources, such as landowner habitat management guidelines or mast production area guidelines.	
	Connect landowners with incentives programs (particularly USDA) to aid with possible financial and technical assistance.	Establish development design standards that cluster development away from resources.*
	Encourage residents to enroll their land in Current Use, using Ecologically Significant Treatment Areas (ESTAs) in appropriate locations.	Require buffers around mast stands.*

**Improving inventory information is necessary before implementing any of the regulatory strategies above. State-level information does not provide enough spatial accuracy for these actions.*

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*. You can also learn more about mast stands and associated conservation goals in *Conserving Vermont's Natural Heritage*.

Inventory Layer #6: Habitat Blocks (by State Priority)

What are Habitat Blocks?

We first introduced habitat blocks in Map 3, and the same data are used again here. Habitat blocks are areas of at least 20 acres with no roads or low densities of Class III or IV roads. They contain little or no human development such as buildings, parking areas, lawns, gravel pits, active agricultural land, and so forth, but can be composed of any natural land cover type: various ages or stages of forest, wetland, and so on, or former, inactive agricultural land.

> **Habitat Blocks**
>
> In Map 3, we displayed Habitat Block information by block size. This map uses the same data, categorized here through a statewide ranking system.

Habitat Blocks (by State Priority): Significance

Prioritizing habitat blocks is one way to capture the functional role that each block plays within its region. This layer allows us to evaluate habitat blocks not only as groups of trees but for their contributions as core habitat for diverse species, connected landscapes for wildlife requiring movement or migration routes, or enhancement of other natural processes.

Habitat Blocks (by State Priority): Map Interpretation

In Map 3, habitat blocks were displayed by size. However, there isn't a minimum size block that is considered critical as important wildlife habitat. While size is certainly an important factor and can sometimes be the best factor for determining priority, other features can be important, too.

For example, a habitat block that is well-connected to other habitat blocks through wildlife road crossing areas, stream corridors, or other means is more likely to be used by wildlife than one isolated from other blocks. A habitat block containing a variety of habitat components—wetlands, ridgelines, a high density of lakes or streams, or a mix of forest types, for example—is also likely to contain higher biodiversity than a block that contains primarily uniform habitat. The same is true for a block with a lower density of Class IV roads compared with a block containing many of these low-traffic roads.

The prioritization depicted on Map 6 also considers the regional context. A 100-acre habitat block located in Vermont's heavily fragmented Champlain Valley may play a much more ecologically important role than a 100-acre block in the Northeast Kingdom, where larger blocks are prevalent. While Champlain Valley forest blocks are smaller, they also include greater species diversity due to a low elevation and variety of habitat types. The configuration of the habitat is also important. An area that is highly irregular in shape (containing a high amount of edge) may be less functional for some species than habitat of the same acreage with a regular shape.

> **Habitat Blocks Information Background**
>
> To learn more about how habitat blocks information was generated, you can find the original report from Vermont Fish & Wildlife Department and Vermont Land Trust online at vtfishandwildlife.com. The full report is entitled *Vermont Habitat Blocks and Habitat Connectivity: An analysis using Geographic Information Systems.*

> **Conserving Habitat Blocks**
>
> While there are many possible strategies for conserving habitat blocks, the Town of Enosburg addresses habitat block fragmentation through their zoning. Find their story at: vtconservation.com/success-stories/zoning-changes-in-the-town-of-enosburg-2013.

Habitat Blocks (by State Priority): Planning Considerations

When considering conservation measures for habitat blocks, refer to list found in the Habitat Blocks description in Map 3. In general, appropriate conservation measures avoid fragmenting these blocks and maintain connections between them. The added benefit of the information on this map is that it provides a sense of priority. A block labeled as a higher priority on this map indicates that biologists have recognized the block as playing a significant role in maintaining the regional ecosystem. In your conservation planning, consider focusing efforts on higher-priority blocks.

Additional (Locally Specific) Inventory Layers

In specific locations across the state, we have included additional datasets representing important wildlife habitat. While these datasets are each relevant only to particular regions of Vermont, the habitat is considered important regionally. Clayplain fragments and Indiana bat hibernacula are both important in the Champlain Valley, but absent from other regions of the state. While comprehensive amphibian and reptile road crossing information could be relevant in most Vermont towns, inventories have been conducted only in a few select areas, so this information, too, has been placed here.

Clayplain Fragments

Clayplain forest is a unique natural community that occurs on the clay soils of the Champlain Valley. It is dominated by oaks and hickories, and prior to European-American settlement, it was the dominant forest type in the Champlain Valley. Aided by a climate somewhat milder than in much of the state, these fertile but poorly drained soils once grew more species of native plant than any other New England forest type. In addition to the oaks and hickories that dominate the natural community are maple, ash, elm, beech, basswood, white pine, and hemlock. Shrubs and other plants proliferate, including several that are found only in this type of forest. Similar diversity is found not only in plants, but in all forms of wildlife: amphibians, birds, mammals, reptiles, and insects. Because the deep, rich, soils and flat topography provided ideal agricultural lands, most clayplain forests were cleared and are now quite rare. Remaining remnants are scattered, and most are no bigger than 20 or 30 acres.

Even these small fragments represent important landscape diversity, but they alone are unable to support the variety of wildlife once found in the Champlain Valley. Larger species and those that maintain large home ranges are now rarely seen in this habitat type, and they are unlikely to return unless clayplain fragments are connected together and/or incorporated into larger blocks of forest habitat.

Amphibian and Reptile Crossing Areas

In Map 5, we described vernal pools and their importance for amphibians. Streams, rivers, lakes, ponds, and wetlands provide habitat for a host of other amphibian and reptile species.

But for many reptiles and amphibians, conserving these aquatic habitats alone isn't enough, because the animals' habitat needs change at different times of the year. Vernal pools, for example, are used only in the breeding season and for the safe development of eggs and larvae. The adult frogs and salamanders turn to other forest habitats for year-round needs. They need two different habitat types and a safe travel route between them.

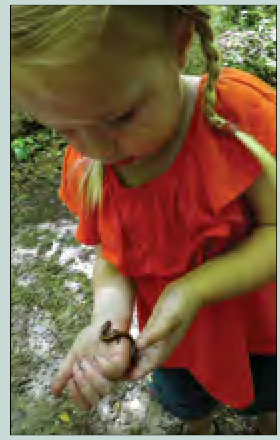
Consider the spotted salamander. Throughout most of its adult life, a spotted salamander lives a solitary life in woodlands, generally in hardwoods or mixed forests where it burrows into loose soil and under moist leaf litter. But each year, spotted salamanders emerge from their woodland homes and head en masse to their closest breeding spot—generally a vernal pool, but sometimes a pond or wetland. For this species, 95 percent of the movement occurred within 600 feet of the vernal pool (Faccio 2003)

Even where a vernal pool is surrounded by forest or other natural habitat, this journey can be hazardous for an amphibian due to predation, weather-related events, or other dangers. For vernal pools and other breeding grounds located near roads, the journey can be particularly risky, in many cases putting populations at risk of extirpation (Gibbs and Shriver 2005).

This dataset displays known and suspected locations where reptiles and amphibians cross roads in order to move between year-round and breeding habitats. There are certainly omissions from this dataset; there has been no statewide survey to map all the locations important for breeding reptiles and amphibians. Locations are mapped as potential road crossing areas when first reported, confirmed when field data have demonstrated that numerous individuals of at least one species cross roads each year to reach breeding habitat.

Community Education & Science

In several Vermont communities, amphibian crossing areas provide opportunities for community education and science to come together. Salisbury has documented one example here: vtconservation.com/success-stories/amphibian-road-crossing-at-morgan-road-salisbury-vermont.



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Indiana Bat Hibernacula and Summer Habitat (Online Only)

Listed as a federally endangered species, Indiana bats have been on the decline across the United States. Because these bats live in different habitat types in summer and winter, conservation of the species requires protection of both summer and winter habitat. Summer colonies can be found in trees, rock ledges, and occasionally buildings, but the preferred habitat is trees with loose bark, such as shagbark hickory or older trees with sloughing bark. These trees must also have accessible habitat nearby for finding food, generally including a relatively open stand below a main canopy. Forest edges, connected forest patches, lakes, streams, and wetlands are all important habitat as well.

Bat Habitat

For more information on important bat habitat, see page 92 of *Conserving Vermont's Natural Heritage*.

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In winter, the bats migrate to a place providing a constant temperature and protection from weather and predators, often in a cave or mine. Bats may migrate from great distances to hibernate at these sites, as they are rare on the landscape.

Like Vermont's other five hibernating bats, Indiana bats are susceptible to white-nose syndrome, a disease that was discovered in the northeastern U.S. in 2006 and has caused drastic population declines to a species with already-low populations.

These map layers, appearing online on BioFinder only, highlight the towns in which Indiana Bats are known to occur. The map treats summer and winter habitats separately; the towns in which bats hibernate in winter are often different than those with summer habitat for maternal colonies. Because the Indiana bat is an endangered species, the map shows only very general areas (i.e., towns) where the species occurs, rather than individual caves or trees used by the animal, to protect these areas from over-visitation or abuse. However, many of these specific spots are known, and interested town officials can contact Vermont Fish & Wildlife Department for additional information.

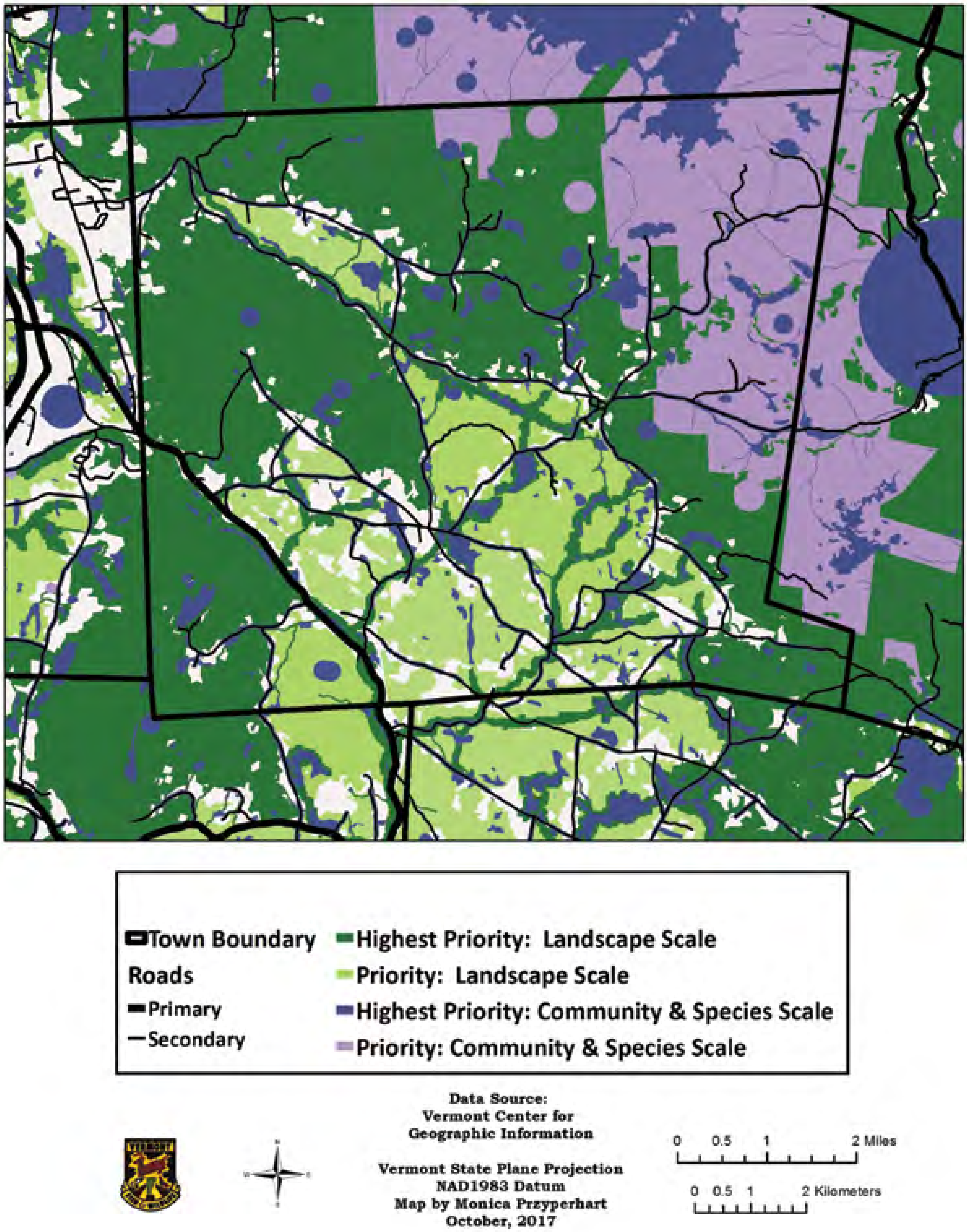
To conserve locally specific important wildlife habitat you might consider the following strategies:

Conservation Goal	Conservation Strategies for Locally Specific Important Wildlife Habitat	
	Nonregulatory Strategies	*Regulatory Strategies*
Seek additional information	Conduct field inventories and improve maps of locally important resources.	
Protect habitat blocks that include important resources	See Map 3, Layer #3.	
Protect wildlife resources	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	*Establish or improve a Wildlife Habitat Overlay District.[21]
	Encourage residents to conserve land with important resources through conservation easements.[22]	
	Encourage residents to enroll their land in Current Use, using Ecologically Significant Treatment Areas (ESTAs) in appropriate locations[23] or working with a forester to plan for the long-term health of the resource.	*Establish development design standards that cluster development away from resources.[24]
	Provide citizen educational opportunities.	*Require buffers around these resources.

**Improving inventory information is necessary before implementing any of the regulatory strategies above. State-level information does not provide enough spatial accuracy for these actions.*

Additional information about using these tools is available in *Community Strategies for Vermont's Forests and Wildlife*.

Map 7:
State and Regional Conservation Priorities



Map 7 State and Regional Priorities: Vermont Conservation Design

©Dennis Curran–VT Department of Tourism & Marketing

This map broadly outlines the most important regional natural heritage priorities in your community.

Map Layers (Described Below)	**Base Layers**
Landscape-scale Priorities	
Highest Priority	Roads
Priority	Surface Water
Species and Communities-scale Priorities	Town Boundaries
Highest Priority	
Priority	

In the first six maps, we have been zooming increasingly closer to ground level, eventually identifying very specific ecological features such as deer wintering areas and rare species. Now, we'll zoom back out to see the big picture, incorporating all scales into a single map. Unlike the other maps in this guide, this map does not represent inventory information; instead, it assigns priorities to natural heritage features as we move toward action steps for conservation. A compilation of many ecosystem components, this map identifies the network of Vermont lands and waters most important for supporting ecologically functional ecosystems, natural communities, habitats, and species.

In Part II, we will get into detail about how to use this map to support planning efforts and develop conservation strategies. For now, we insert this map as a bridge between the previous maps, which ask *What's there?* and Part II of this guide, which asks *How can we move from maps and data to conservation actions.*

Map 7 on BioFinder: Prioritization

This map explores the **Prioritization** theme on BioFinder, which will be described in detail in Part II. We recommend viewing this map online, where BioFinder's interactive tools allow for a fuller understanding of the map's priority ranking system.

To load Map 7 on BioFinder: Open the **Prioritization** theme, then check the boxes next to both **Overall Priorities: Vermont Conservation Design** layers: **Community & Species Scale (Components combined)** and **Landscape Scale (Components combined)**.

For additional guidance on using BioFinder, please see Getting Started in the introduction to this guide, or **Tips and Tools** on the BioFinder website.

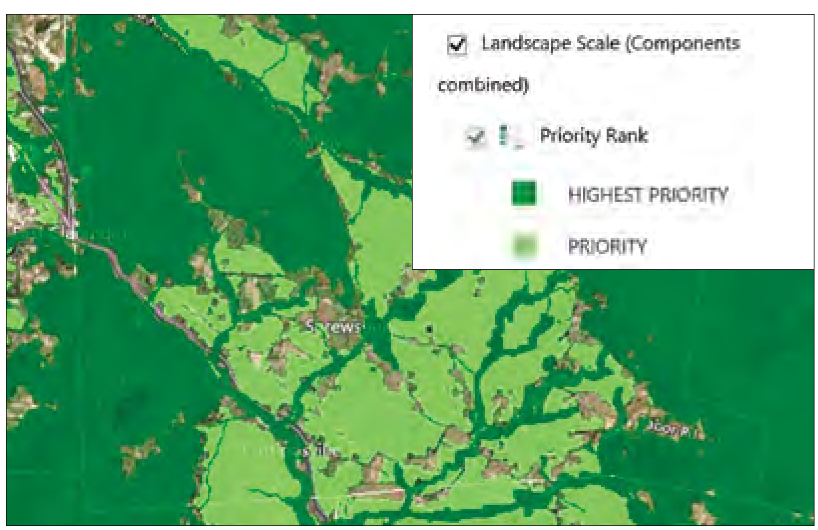
Vermont biologists call this map Vermont Conservation Design, because it looks holistically at ecological function. Instead of identifying and mapping components individually, Vermont Conservation Design identifies the connected network of components that create the basis for most ecological interactions. None of the data represented on this map are new; all have been introduced in previous maps. Here, datasets are combined and prioritized to provide a sense of how they work together to create an ecologically functional landscape. We introduce this concept briefly here; ecological function will be explained in detail in Part II.

The map presents priorities at two scales. "Landscape Scale" priorities form the background of the map and represent broad ecological patterns and processes important across Vermont. We then combine the components critical to maintaining individual species and groups of species into a "Community & Species Scale" dataset. These priorities are just as important for maintaining biodiversity as the broad, landscape patterns but are much more concrete, depicted as individual occurrences rather than broad patterns.

Landscape Priorities

What are Landscape Priorities?

The two-toned, green background of this map depicts network of ecological priorities at the landscape scale. In a dramatic play, you can think of this map as outlining the stage on which most ecological interactions occur, and as such they cover 68 percent of Vermont's land area. Because all green areas work together as a network, all contribute significantly to overall ecological function. The dark green areas are the most important.



This layer combines the following datasets, described in detail below:

- Interior Forest Blocks
- Connectivity Blocks
- Riparian Wildlife Connectivity
- Surface Water and Riparian Areas
- Physical Landscape Diversity

Some of these you will recognize from the data presented in previous inventory maps. Others use the same basic data already presented, now prioritized according to particular selection criteria. All datasets have been divided into two classes: "highest priority" and "priority."

Landscape Priorities: Significance

The datasets included in this map were specifically chosen because as a group, maintaining or enhancing these features is likely to conserve the majority of Vermont's species and natural communities, even as the climate changes. Put another way, these maps outline the areas of land that need to remain healthy and intact if we want to provide plants, animals, and natural resources the best chance of survival over time. On the other hand, a decline in the quality of these lands is likely to correspond to a decline in the state's ecological function.

Landscape Priorities: Map Interpretation

To create this map, Vermont Fish & Wildlife Department biologists assigned priority or highest priority status to interior forest blocks, connectivity blocks, riparian corridors, surface waters, and physical landscapes, taking into account the regional context in which each component was found. In other words, a smaller interior forest block in the Champlain Valley may qualify as highest priority, because large forest blocks are less common in the Champlain Valley than in the Green Mountains or Northeast Kingdom. In these areas, large blocks are more plentiful, and an interior forest block of the same size may not be considered highest priority. Each data layer was considered within the context of its own region. To learn more about how priorities were assigned for each component layer, visit the BioFinder website.

Because a fully functional landscape includes all of the components mapped, the map displayed amasses all priority areas on any of the layers. Lands mapped on any component map as highest priority are given highest priority status on the compilation. Land mapped as priority is likewise assigned priority status, unless covered by another component's highest priority ranking. While the printed map shows only the compilation, you can see which individual components are "priority" or "highest priority" on BioFinder.

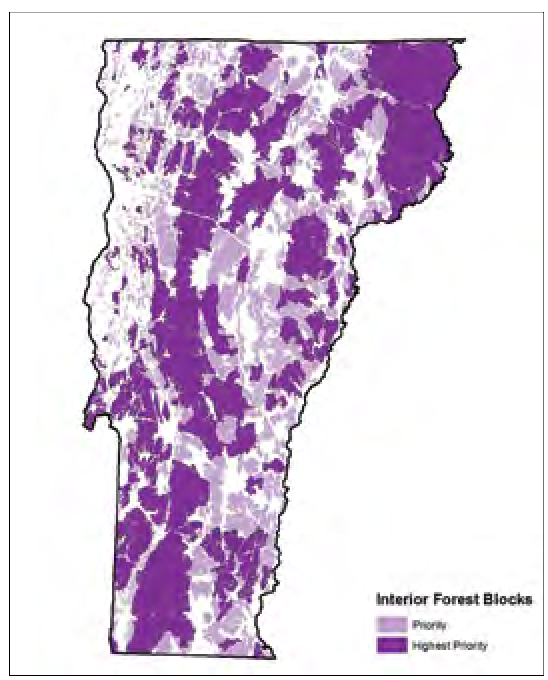
The datasets include:

Interior Forest Blocks

This is a subset of the Habitat Blocks layer that we described in Maps 3 and 6. This selection includes those blocks that are most important for maintaining interior forest, separated into highest priority and priority status.

Interior forests are those large enough to support the highest diversity of ecological processes, such as predator-prey interactions and natural disturbance regimes. They help to maintain air and water quality, and they promote flood resilience. They support numerous plant and animal species, including some that occur only in these large forest blocks, away from edges or development. Interior forest is also essential for wide-ranging mammals, which need sufficient habitat to support their daily and seasonal needs.

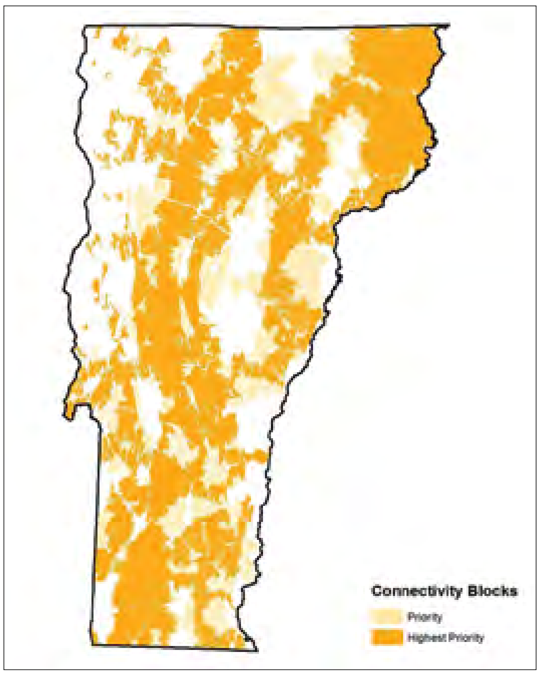
Highest priority was assigned to the largest or highest quality habitat blocks within each Vermont biophysical region. This means that smaller habitat blocks were included in the Champlain Valley where large forests are relatively scarce than in the Green Mountains or Northeast Kingdom. Highest priority represents the best remaining interior forest examples within a regional context. Priority includes all other blocks that were assessed to be large enough or of high enough quality to perform the functions of interior forest.



Connectivity Blocks

Landscape connectivity is the degree to which blocks of suitable habitat are connected to each other (Noss and Cooperrider 1994). While Interior Forest Blocks generally provide the majority of suitable habitat at the landscape scale, Connectivity Blocks include both these large blocks and the necessary smaller blocks that together create a linked network. The proximity of one forest block to another is the major criterion for determining connectivity, but the presence of riparian areas and the character of intervening roads, agricultural lands, or development are also important.

Together, this network enables wide-ranging animals to move across their range, allows animals to find suitable habitat for their daily and annual life needs, provides the habitat in which young animals can disperse, provides plant and animal species places to colonize new and appropriate habitat as climate and land uses change, and contributes to ecological processes, especially genetic exchange between populations.



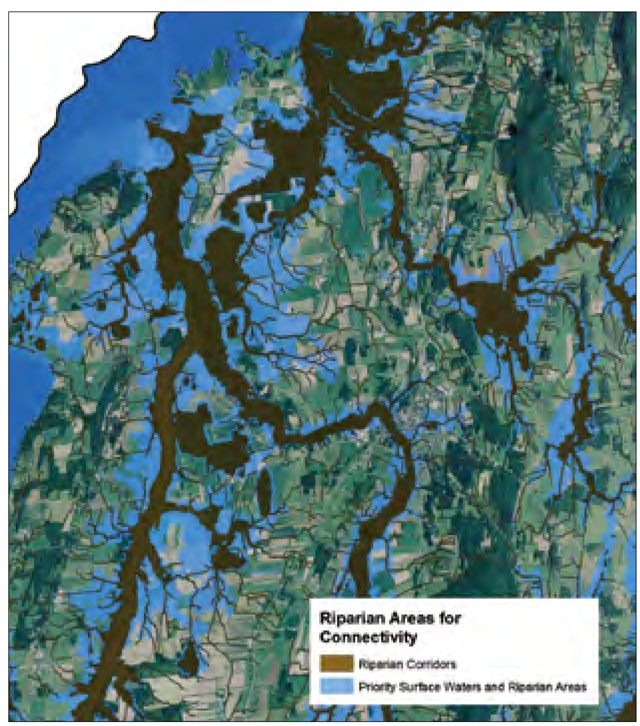
Like Interior Forest Blocks above, this information is a subset of the Habitat Blocks layers presented in Maps 3 and 6, and Connectivity Blocks have similarly been divided into highest priority and priority groups. While Interior Forest Blocks don't necessarily connect, highest priority Connectivity Blocks create a terrestrial network of forests that link all biophysical regions within the state. This incorporates the spines of the state's major mountain ranges, connections to unfragmented habitat outside Vermont, and interior forest blocks within fragmented biophysical regions that contain abundant rare species and significant natural communities. Small forest blocks are included as highest priority areas at pinch-points in the network that are critical for the continuation of the network. Priority areas provide a supporting buffer around the highest priority backbone and add alternative pathways for connectivity.

Riparian Wildlife Connectivity

This data matches the layer of the same name presented in Map 3. On Map 7, the entire layer is considered highest priority, due to the high diversity of species that use these areas. To reiterate, riparian wildlife connectivity refers to the connected network of riparian areas in which natural vegetation occurs, providing natural cover for wildlife movement and plant migration. This network extends state-wide and beyond. The combination of Riparian Areas for Connectivity and Connectivity Blocks provide the best available paths for linking wildlife habitat across the landscape, especially in highly fragmented areas of Vermont.

Surface Water and Riparian Areas

This information covers the same geographic area as the data called Surface Waters and Riparian Areas presented in Map 5. Here, however, the layers have been prioritized into highest priority and priority. Highest priority was given to all waterways themselves, including lakes, ponds, rivers, streams, and the valley bottoms in which they occur. The highest priority

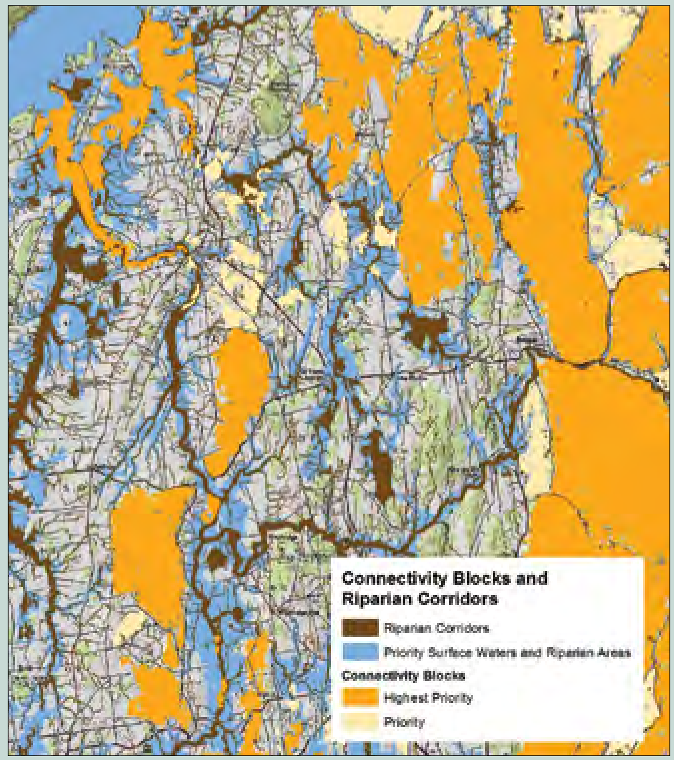


area also includes a buffer around each water body occurring on undeveloped land, with larger buffers for larger water bodies. Priority status was given to those riparian areas occurring in developed areas, even those for which some natural processes are currently limited in function. They are included here to be considered for conservation efforts or management that enhances ecosystem function.

There is substantial overlap between the areas covered by this layer and by Riparian Wildlife Connectivity. When used together, this layer appears as a buffer around the riparian corridors, outlining the habitats and land area needed to support those critical connections.

Landscape Connectivity: The Big Picture

To capture the complete regional network of connected lands, you can view Connectivity Blocks, Riparian Connectivity, and Wildlife Road Crossings together. To see local networks, you may also want to include Interior Forest Blocks.



Physical Landscape Diversity

These data are the same as in the layer of the same name presented in Map 4. On Map 7, the entire layer is considered highest priority. When viewing this map in BioFinder, you can determine whether a feature is rare, representative, or responsibility in addition to identifying the physical nature of the feature. To reiterate, these are the parts of the landscape that resist change—the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. While all are mapped as highest priority on these maps, a biologist may be able to provide additional information about how to incorporate physical landscape diversity into other priorities.

Landscape Priorities: Planning Considerations

Part II of this guide offers a detailed, step-by-step process for prioritizing natural resources information and bringing it into your planning framework. Here is a quick summary of some of the most important planning considerations:

- **Interior Forest Blocks:** Avoid fragmentation. Limited development on the margins of large forest blocks may not have significant adverse effects if it does not reduce connectivity between blocks and does not encroach on the block's interior. Forest management that maintains age structure is compatible with maintaining interior forest conditions.
- **Connectivity Blocks:** Avoid fragmentation. Maintain forest cover and limit development along the margins where blocks border one another, to allow for movement of plants and animals throughout the network.
- **Riparian Wildlife Connectivity:** Maintain a naturally vegetated area around the waterway. This may vary from 50 feet on each side of small streams to 300 feet on each side or larger rivers. Consider restoration of areas that are currently impacted.
- **Surface Water and Riparian Areas:** Maintain or restore natural vegetation in an area wide enough to maintain water quality, stabilize shorelines, provide shade, and maintain connectivity.
- **Physical Landscape Diversity:** Where possible, maintain or restore natural vegetation and limit development on rare and responsibility physical landscapes. Forest management is compatible, so long as forest structure is maintained. Rare, responsibility, and representative physical landscapes can also be used as a prioritization tool to strengthen the importance of other features.

Community and Species Priorities

What are Community and Species Priorities?

In the foreground of Map 7, in two shades of purple, are areas representing specific features on the landscape rather than the broad ecological patterns depicted in green. These are what we call "Species and Community Scale Priorities," and they are the lands and waters critical for maintaining individual species or groups of species identified as having a conservation need. In examining the areas highlighted, you may recognize outlines from Maps 3, 5 and 6; all data displayed here were also presented on one of those maps. Here, data have been prioritized, allowing a viewer to identify features as "priority" or "highest priority" according to a state ranking system.

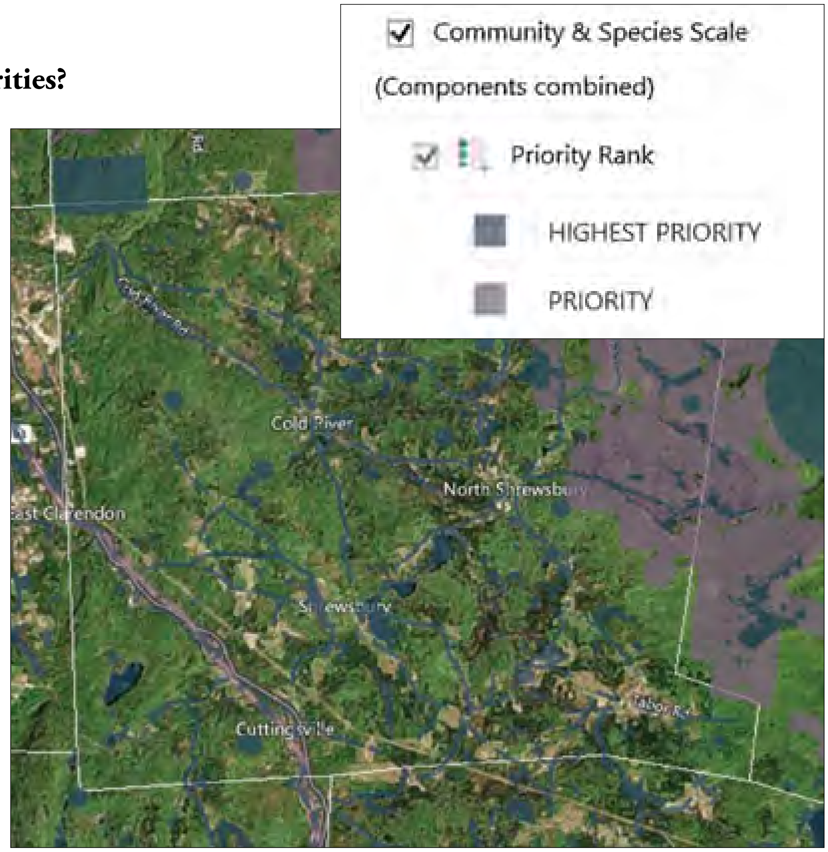
The datasets prioritized here include:

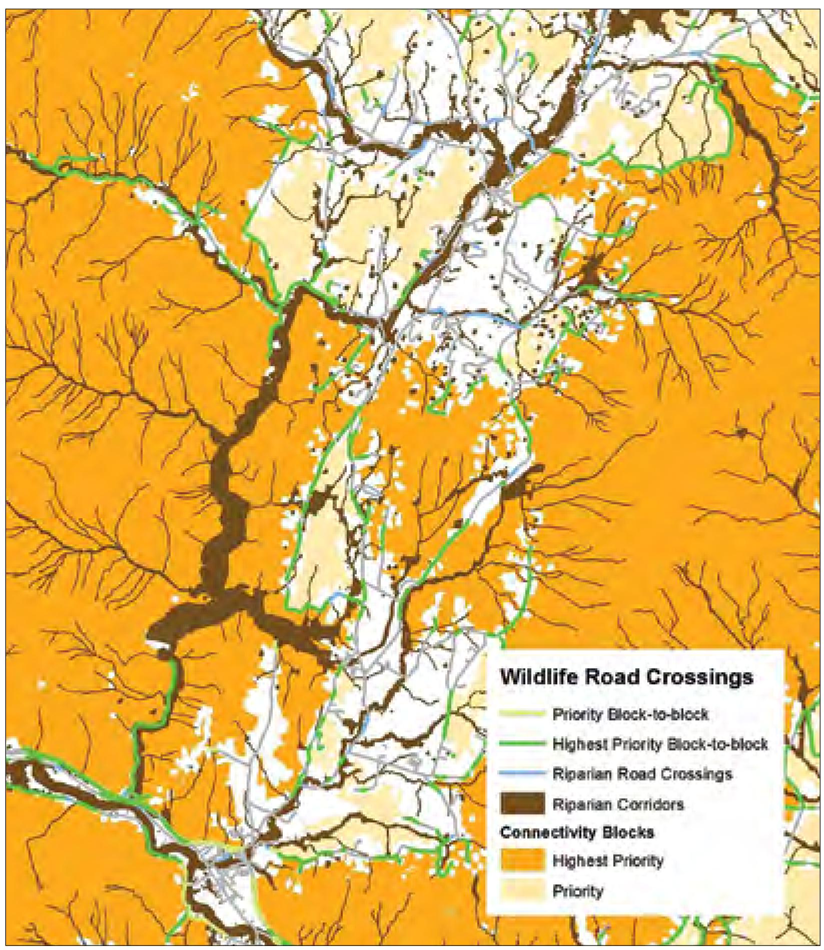
- Wildlife Crossings
- Representative Lakes
- Exemplary Surface Waters
- Vernal Pools
- Wetlands
- Rare Species
- Uncommon Species
- Rare Natural Communities
- Uncommon Natural Communities
- Common (Representative) Natural Communities
- Grasslands and Shrublands
- Mast Stands

Just as with landscape-scale priorities, these data have been divided between highest priority and priority.

Species and Community Priorities: Significance

The datasets included in this map are considered highly important for maintaining state and regional biodiversity. Of course, you may have information on other local important features, such as critical bat habitat, clayplain forest, turtle habitat, etc.—and many such datasets also contribute to local biodiversity. Included here are components that constitute priorities throughout the state. This list and





the locations covered are a terrific place to start; you can then add local data if it is available.

Species and Community Priorities: Map Interpretation

To create this map, Vermont Fish & Wildlife Department biologists assigned "priority" or "highest priority" status to wildlife crossings, surface waters, vernal pools, wetlands, rare and uncommon species, significant natural communities, grasslands, shrublands, and mast stands. In assigning this status, they took into account the regional context in which the element was found, meaning that an uncommon natural community of the same size and condition may have been treated differently in the Champlain Valley and the Northeast Kingdom. To learn more about how priorities were assigned for each component layer, visit the BioFinder website.

As you interact with this map, please remember that all data were collected for use at the state level. Some of these layers contain omissions, and these omissions may be critical when translating data into implementation measures. Wherever possible, the collection of field inventory information will enhance a community's understanding of these resources.

Species and Community Priorities: Planning Considerations

Please see planning considerations presented alongside individual datasets in Maps 3-6. In general, priorities at the species and community scales are no more or less important than those at the landscape scale, but they tend to be smaller, take up less space, and are therefore more vulnerable. Resources mapped as priorities at this scale are often incompatible with development or intensive land use.

Building on What You Have

Across Vermont, many communities have already identified areas as ecologically important, and they may differ in terminology or coverage than those put forth in this guide. In most communities, it will be worth comparing your maps to these, but it will likely make sense to build on what you have rather than to start over. If you would like assistance determining next steps, Vermont Fish & Wildlife Department's Community Wildlife Program may be able to help you.

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Advanced Natural Resources Inventory

©Tom Rogers

While we hope that your community has found useful information in the seven maps provided, we also recognize that every town in Vermont has a different set of values and a different landscape. Maps 1 through 7 have been created at the state level, and they feature data available across the state. On your local landscape, there may be additional components that contribute to the ecological story—the habitat of a species of interest, perhaps, or cultural features. Also, many of the datasets available across the state were created through the interpretation of aerial photos or other remote means. They have not been checked in the field, and some datasets omit important features.

As a community, you may want to think carefully about what information will most help you with your efforts, and then make sure the data you use are accurate to an appropriate scale. If you are most interested in landscape-scale conservation regarding forest fragmentation, habitat connectivity and climate resilience, for example, the data provided in this guide are likely sufficient, and an inventory is unlikely to reveal anything appreciably different. However, if your goals involve individual species or natural communities, it may well be worthwhile to invest in an inventory. The information provided on state-level maps of grasslands and shrublands, the functional extent of riparian areas, vernal pools, deer wintering areas, rare and uncommon species, wildlife road crossings, and mast stands are not comprehensive. A local inventory is much more likely to add to your understanding of these components. When determining implementation measures, we suggest that you begin at the landscape level and then learn more about these finer-scaled features.

That said, many communities could benefit from local inventory data. Collecting these data does generally come with a price tag, however, since it involves on-the-ground fieldwork and advanced computer analysis. While some field data can be gathered by volunteers with minimal professional

A Local Inventory: Where Do You Begin?

Each town has a unique set of needs and desires, but one of the biggest "bangs for your buck" may come from identifying natural communities across your town. This can be used to identify many components of wildlife habitat and other landscape features.

Natural Community: an interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. For example, the most common natural community type in Vermont is the northern hardwood forest.

guidance, other information is best collected by (or under the close supervision of) a natural resources professional. Towns may therefore want to start by prioritizing what additional information is needed. Even if it takes several years to collect the new information, it is generally a worthwhile effort; the reward is better planning for the future.

The following is a list of ideas (by no means exhaustive) of projects a town might undertake to get a better sense of what resources are present. A detailed inventory could include:

- Natural community mapping
- Water quality studies
- Wetland mapping
- Significant wildlife habitat assessment
- Agricultural lands assessment
- Managed forest lands inventory
- Undeveloped shorelines inventory
- Cultural features inventory (e.g., archaeological and historic sites, recreation areas, scenic areas, designated scenic roads)
- Unique geological resources mapping

In addition to the above, consider field-checking the map information from the Inventory Maps of this guide, considering questions such as: Do the streams in your town have fully functioning riparian areas? Which road crossing areas are most commonly used by wildlife? Are there current threats facing these important wildlife road crossing areas?

As you undertake your inventory, remember that while some landscape elements are not static, a map can depict only a snapshot in time. Development of a new building site may change the size of a habitat block, and land use and land cover of a given location change routinely due not only to human alterations but also because of natural succession as forests grow up and mature over time. In addition to seeking updates on BioFinder, inventories that you undertake in your community may also benefit from routine repetition. In some cases, the success of a planning goal even necessitates a map update! For example, if you implement strategies to restore or enhance riparian habitat, success may require that you update your riparian habitat map on a routine basis. Each map can then become a tool that helps you track progress.

Ultimately, it will be up to your town to decide which information is most important to you. It is by combining your knowledge of the local natural resources with your town's own goals and interests that you will be able to create a natural resource plan that you are able to successfully implement within your community.

Starting with Citizen Science

As you decide what data you need, it may be appropriate to use local, regional, or even national citizen science efforts to inform your planning. For example, the Vermont Center for Ecostudies maintains a Vermont Atlas of Life, in which citizens contribute sightings of birds (e-bird), butterflies (e-butterfly), and any species (inaturalist) to three separate map databases. Some towns conduct bioblitzes or other projects to recruit scientists and citizens to gather information about local biodiversity.

However, using citizen science data to inform the town planning or regulatory process needs to be done carefully. Often, several years of data are needed to ensure accuracy, and all data and methodologies should be reviewed by a professional before inclusion.

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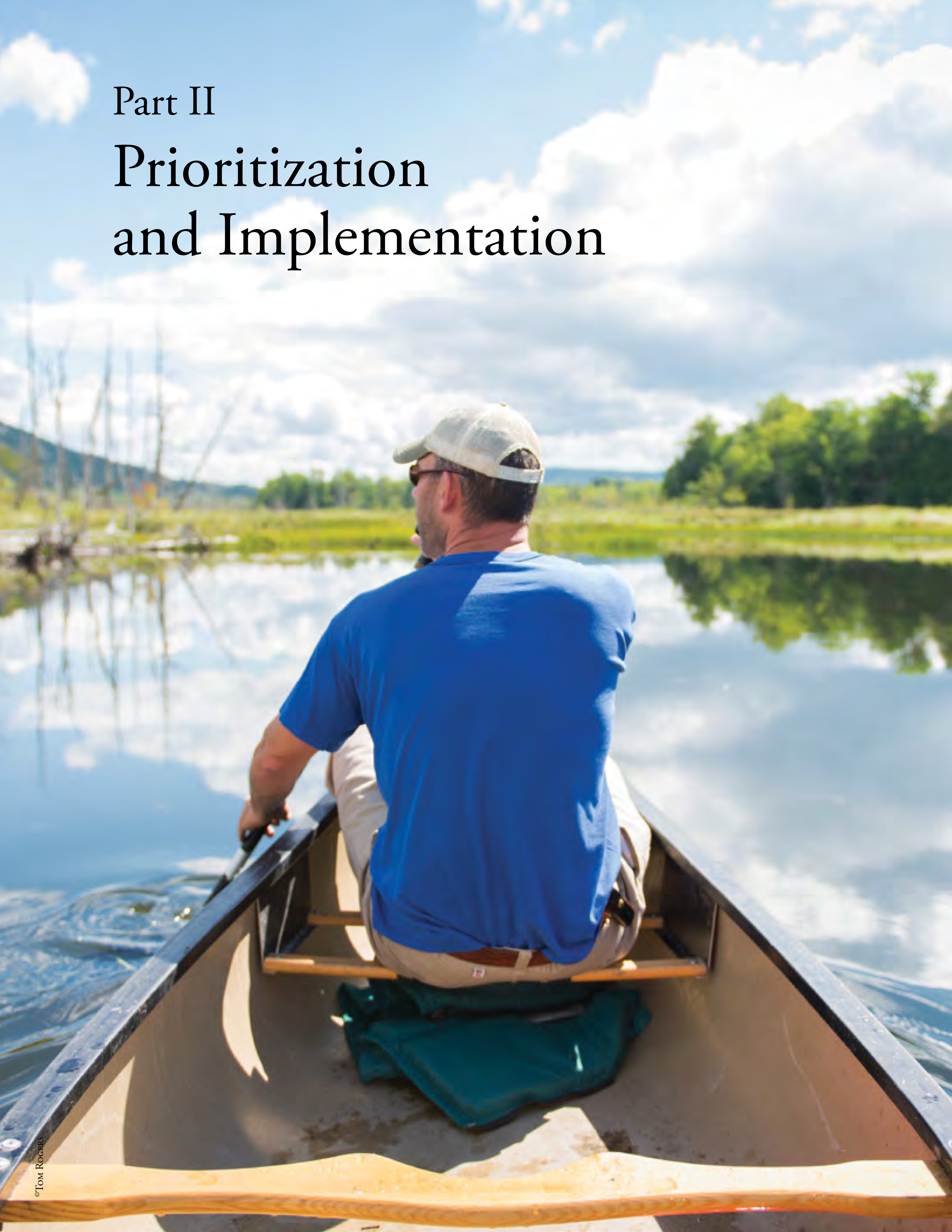
Part II
Prioritization and Implementation



Prioritization and Implementation

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At this point, you are equipped with valuable information about the natural heritage components present in your town. You have explored BioFinder, and you may have followed links to learn about tools you can use to implement your planning efforts. Hopefully, you are now more confident in your knowledge of local natural resources.

However, you are likely left with questions. Of the habitats present, what's most important? When implementing conservation measures, where should your community start? How do you prioritize? In short, what can you do with the inventory information presented in Part I?

Part II of this guide is intended to help your community answer such questions, going from "what's here?" to choosing appropriate implementation strategies. Just as in Part I, our approach to prioritization will focus on the use of maps. Unlike in Part I, we will go beyond ecological features to involve your human community—your most important asset in conservation planning. While we begin with the identification of ecological priorities, the process described in Part II is designed to look holistically at the needs of your town, placing ecological priorities into the context of other human values. By looking at this bigger picture your planning group will be able to choose conservation strategies that are embraced by the community and will effectively protect special places.

The following pages sketch out seven steps for using maps to identify ecological priorities and determine implementation strategies. These seven steps are divided into three sections as outlined in the table below:

Determining the Ecological Context
Step 1. Locate priorities at the landscape scale.
Step 2. Locate priorities at the species and community scale.
Step 3. Identify the components.
Including Community Values
Step 4. Identify areas of high public value.
Step 5. Compare ecological and community values.
Developing and Choosing Options
Step 6. Evaluate status and determine options.
Step 7. Evaluate and choose options.

While this process can be followed entirely using the hard copy of this guide and the associated maps of your town, use of the interactive BioFinder maps online is recommended. Part I took you through the "Inventory" section of BioFinder; now Part II will make use of the "Prioritization" theme. Please see Getting the Most out of the Maps in the introduction to this guide for more information.

We'll begin by identifying locations necessary for maintaining ecological function. With these in mind, we'll add values of the community before finally determining implementation strategies. By the end of this process, you should have a better sense of:

- Which locations are ecologically most important to include in conservation efforts,
- How ecological priorities compare with community values, and
- How to move from identifying priorities to taking action toward conservation.

Good luck!

©John Hall

Determining the Ecological Context

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Determining the Ecological Context

Step 1. Locate priorities at the landscape scale.

Step 2. Locate priorities at the species and community scale.

Step 3. Identify the components.

Including Community Values

Step 4. Identify areas of high public value.

Step 5. Compare ecological and community values.

Developing and Choosing Options

Step 6. Evaluate status and determine options.

Step 7. Evaluate and choose options.

While the maps in Part I of this guide highlight many ecologically important features, it can be difficult to determine just what to do with that knowledge. Chances are that a good percentage of your town's land area is covered by one feature or another, and protecting all areas highlighted by all inventory maps simply isn't feasible. As a planner, do you focus on habitat for wide-ranging species, or clean water? Vernal pools or rare physical landscapes? Clearly all are ecologically important, but their relative importance can't be compared. They are important for different reasons.

Luckily, there are methods of prioritizing that don't rely on choosing one component instead of another. Rather than focusing on individual landscape elements as we did in Part I, we will now help you identify priority locations. In other words, our approach in this section asks: Which locations in your town are most ecologically essential? In which areas would a substantial change in land use most impact the region's ecological function?

This concept of ecological function requires a holistic view. Instead of isolating components from one another, an ecologically functional landscape requires that features work together and processes are maintained. Safe wildlife road crossings are important only if high-quality habitat remains on either side of the road. A wetland or lake loses value if the stream flowing into it is impaired. When choosing conservation strategies, we must remember that protecting a vernal pool while ignoring the surrounding habitat defeats the purpose, just as impact to one section of river may affect water quality downstream, regardless of conservation measures implemented there.

To identify the locations most important for ecological function, we examine the ecological setting at two scales: the "landscape scale" and the "species and community scale."

Landscape scale priorities include forest networks, waterways and their floodplains, and significant physical landforms. They include the locations with the highest biodiversity and the areas that connect and protect these locations to provide resilience. They outline the habitat used by most Vermont species and allow for movement as the climate changes. While they cover substantial acreage in many Vermont towns, priorities at this scale focus on pattern, and they are generally compatible as working lands and with recreational activities. They can therefore be managed to accommodate many values of a community. Step 1 outlines these locations.

Step 2 zooms in to identify priorities at the species and community scale. These priorities are also important for maintaining biodiversity, but they tend to be smaller and more specific to a handful of species, so they can be overlooked at the landscape scale. These include the locations where rare plants and animals have been found, wetlands, or habitats like vernal pools or forests rich in wildlife food resources. At this closer scale, human activities are much more likely to interfere with function, and these locations should be handled with greater caution.

In Step 3 the inventory maps of Part I will be used in your planning efforts. Once you have identified priority locations in steps 1 and 2, you can look back at individual components to determine which are present in high-priority locations. Eventually, it is these components that will guide you toward particular conservation strategies.

Step 1: Locate Landscape Priorities

Let's start with the big stuff: the forest networks, the waterways, and the physical landforms that support them. These are the building blocks for nearly all ecological processes. By outlining these, we can effectively paint a picture of the locations most needed to maintain ecological function.

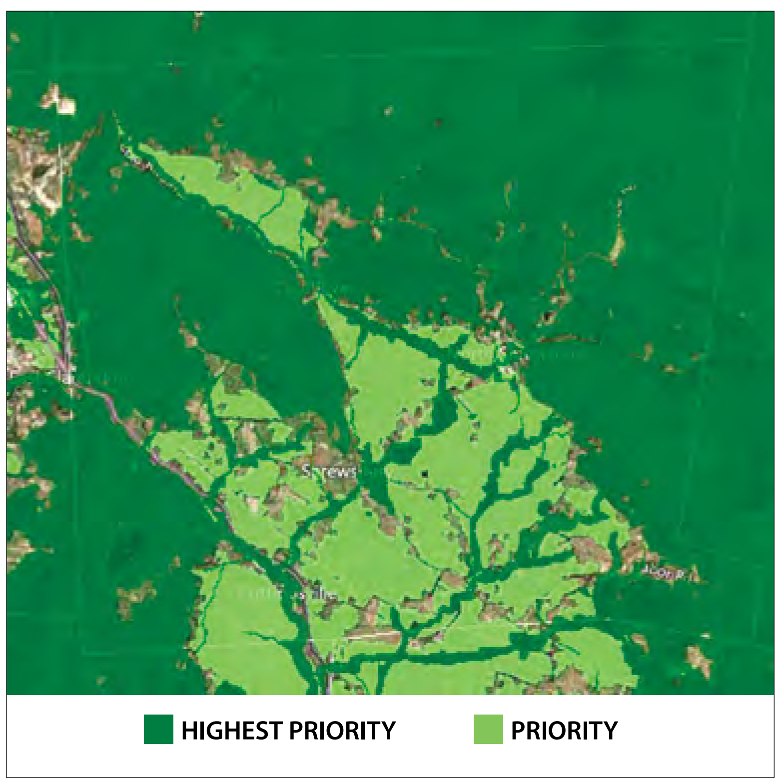
To the right, the map you see is the two-tone backdrop to Map 7. You can also find it in BioFinder, where you can identify which components constitute highlighted areas.

This map shows a network of the most important components included in the following datasets, categorized into "highest priority" and "priority" areas:

- Interior Forest Blocks
- Physical Landscape Diversity
- Connectivity Blocks
- Riparian Wildlife Connectivity
- Surface Waters and Riparian Areas

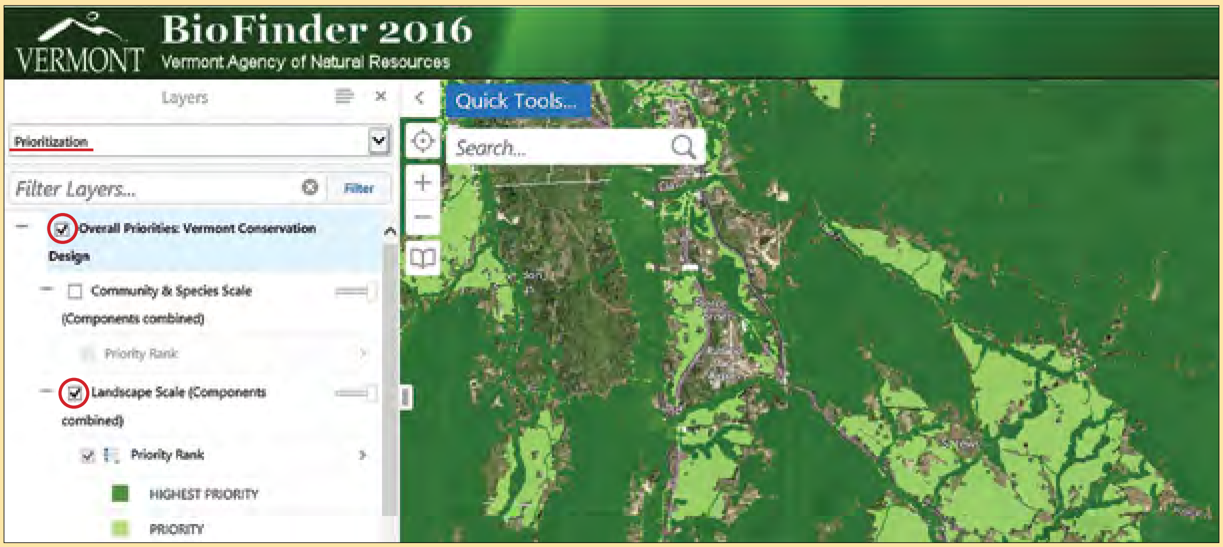
Instead of looking at each component individually, we use Step 1 to examine them en masse, identifying the network of lands and waters necessary to maintain Vermont's ecological function. By doing this, we can divide locations into three classes: highest priority, priority, and those that don't contribute significantly to the network. Together, this network encompasses the majority of Vermont species and habitats and provides resilience for a changing climate.

When prioritizing for conservation, consider focusing your strongest efforts on the areas mapped as highest priority on this map. Priority lands can be considered next, and those not mapped as either may be—ecologically—the best locations to focus development efforts. However, we won't get too involved in this now; we'll collect and evaluate possible implementation strategies in Step 5. To learn more about the data and scientific process that went into creating this layer, see Map 7.

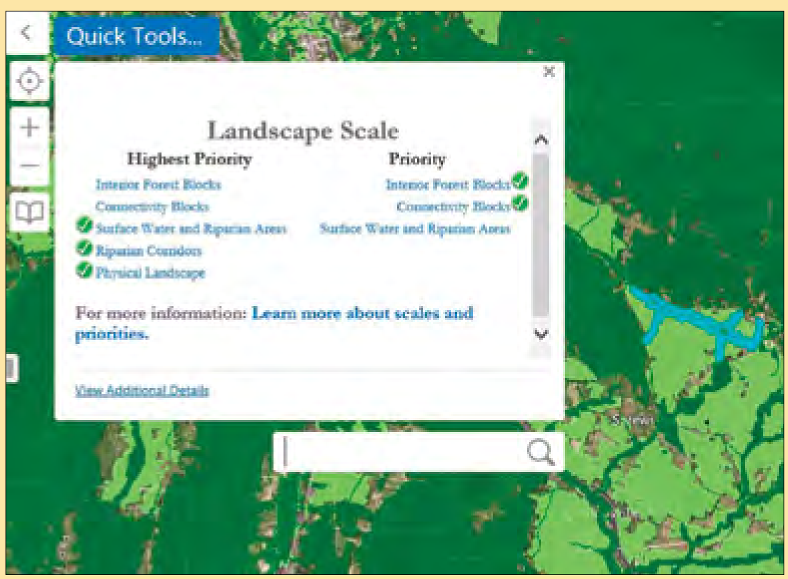


Using BioFinder in Step 1

1. Open the BioFinder map. Make sure the **Prioritization** theme is selected.
2. Double click on your area of interest to zoom in, and continue this process until you can see the entire area at the closest range possible.
3. Make sure that the box next to **Overall Priorities: Vermont Conservation Design** is checked, and also the box next to **Landscape Scale (Components combined)**. **Highest Priority** locations will appear in dark green, and **Priority** locations will appear in light green. Those areas on which you can still see the background aerial photo lack priority and highest priority known ecological components.
4. To see only the landscape scale priorities, click in any additional checked boxes to turn them "off."



BioFinder has a simple tool to help identify which components are most important at any chosen location within the network. With the map open on your screen, point your cursor at a location of interest. Click once on that location and an Identification Box will pop up.



This box provides information about all map layers that are turned on and mapped in your chosen location. When **Landscape Scale** priorities are turned on, all possible components are listed, with a check indicating presence.

From this box, you can learn more about each component by clicking on the component name. A separate tab will open in your browser with a document describing the component, its ecological importance, and information about how the component was mapped.

Mapping Landscape Priorities

In many towns, landscape priorities cover broad acreage. Mapped for their ecological importance, these lands also constitute much of Vermont's working and rural landscape.

While large-scale development or intensive human land use can diminish the ecological value of these areas, many human activities and land uses can be compatible, including thoughtful forest management, many forms of recreation, and even some carefully placed development. Generally speaking, strategies seeking to avoid fragmentation and encourage working forests are compatible solutions.

Step 2: Locate Community and Species Priorities

Now, let's zoom in. While landscape priorities give us the network in which most ecological interactions occur, some species or habitats are so small or have such specialized needs that they are worth protecting where they occur, even if they are not located within the landscape network. In Step 2, we add those habitats important to species and communities of conservation concern in Vermont. While often small in area, these locations are equally important for maintaining regional biodiversity and healthy fish and wildlife populations. For example, wildlife crossings are locations where wide-ranging mammal species such as bear, bobcat, and fisher are most likely to traverse roads as they travel to meet daily or seasonal dietary needs or disperse to find mates. If these crossing areas do not remain available, some populations may not persist even where other habitat needs are present.

You can identify these locations, as mapped by Vermont biologists at the state level, using Map 7 or in BioFinder, where components have been categorized as "Highest Priority" or "Priority." This information is displayed on the printed maps atop the areas identified in Step 1.

The areas mapped at this scale include the following:

- Wildlife Road Crossings
- Vernal Pools
- Wetlands
- Grasslands and Shrublands
- Mast Stands
- Rare Species
- Uncommon Species
- Rare Natural Communities
- Uncommon Natural Communities
- Common Natural Communities[1]

As mentioned in Part I of this guide, these datasets represent what we know is present, but there are certainly omissions. For example, we have not inventoried every parcel in the state for every rare species.

As you examine the locations of resources on this map, pay special attention to where they fall in relation to the landscape scale network in Step 1. When community and species priorities are located within larger blocks of forest or water, they can be used to elevate the priority ranking of that larger block. Many strategies for conserving the larger blocks will then benefit the community and species priorities, too. We'll go into detail on choosing possible strategies in Step 6.

Where community and species priorities are located outside the network identified in Step 1, your community may want to consider separate conservation strategies. Because community and species priorities generally encompass much smaller acreage, they are often more vulnerable. For some, a seemingly minor

Defining Scale

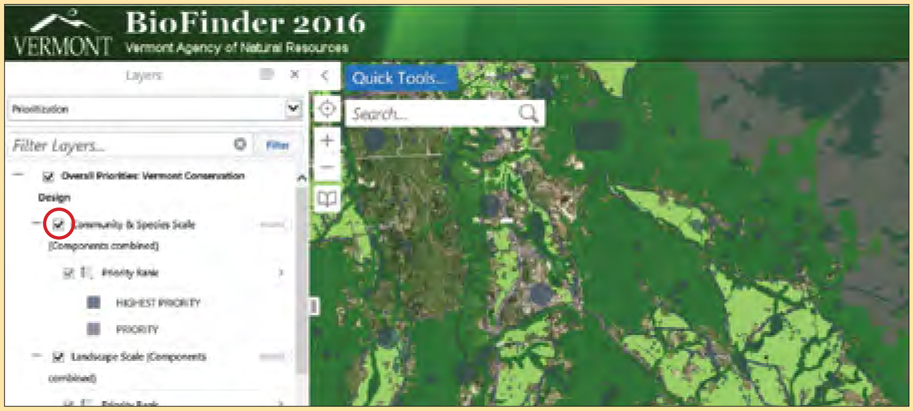
The "**Community Scale**" refers to the scale at which assemblages of plants and animals interact with one another, with their physical environment, and with the natural processes that commonly affect them. For example, a wetland would be included at this scale due to its association with particular physical features, plants, and wildlife that function together as a community.

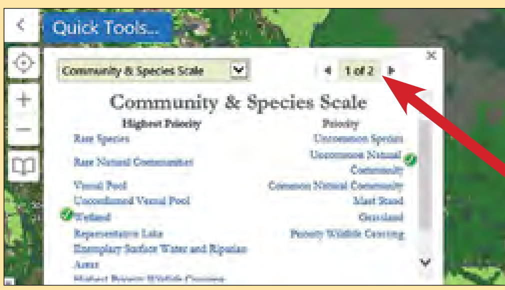
The "**Species Scale**" includes those habitats necessary for the survival of specific fish, wildlife, and plants. For example, wildlife crossings are locations where wide-ranging mammal species such as bear, bobcat, and fisher are likely to cross roads as they travel to meet their daily or seasonal dietary needs, disperse to find mates, or fulfill other requirements. While small in size relative to community or landscape-scale features such as wetlands or forest blocks, these locations are essential for maintaining biodiversity across the state or region.

change in land use could wipe out an entire patch of habitat—a vernal pool, for example, or a mast stand. And although the components themselves may cover little acreage, the processes altered by a single loss may change food webs, impact disease regimes, or alter migration or dispersal patterns across the ecosystem. Where Community and Species scale priorities fall outside Step 1 priorities, they are therefore generally places to consider focusing more direct conservation measures, due to their sensitivity.

Using BioFinder in Step 2

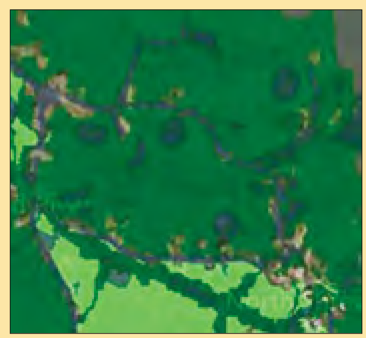
1. After conducting Step 1, click in the box next to **Community & Species Scale (Components combined)**. Priorities at this scale will appear in blue and purple, on top of the landscape network from Step 1 in green.





2. Once again, click on a point of interest to learn more. When more than one layer is turned on and found in the selected area, the Identification Box creates a separate "page" of results for each layer. In this example, two layers are present, indicated by the **1 of 2** symbol in the top, right corner of the box. Click on the arrows to move between pages of results.

Now, examine where priorities at the two scales overlap. When community and species scale features fall within the **highest priority** landscape network (in dark green, such as in the image to the right,), conservation of the landscape network in this location is likely to conserve the important species and habitats within it, and additional conservation measures may be unnecessary.



Where community and species scale features fall within a **priority** (light green) landscape block (as in the image on the left), you may want to consider elevating the importance of the entire block to consider it a highest priority area.

Where community and species scale features fall outside the network mapped in Step 1 (pictured on the right), you may want to consider conservation measures that specifically target these resources when you get to Step 6.

Using Local Inventory Data in Step 2

If you have local inventory data, Step 2 is the place to include it. Regardless of the scope of your inventory, we recommend first identifying landscape-scale networks (Step 1), and then using local information to fill in gaps or to evaluate how well Step 1 includes important local features.

With the help of a natural resources professional, your inventory information can be combined with state-level community and species scale data to provide a clear picture of priority local resources.

Step 3: Identify the Components

In Steps 1 and 2, the primary goal was to identify locations of ecological priority within the municipal planning area. Before identifying appropriate conservation strategies, it's now time to determine which resources are present in each important area. We can then use these resources to create a map of ecological priorities that will be more helpful for municipal planning. This is important because conservation strategies are not universally appropriate for all resources. Both riparian areas and mast stands may constitute priority locations, but we wouldn't generally conserve them using the same methods.

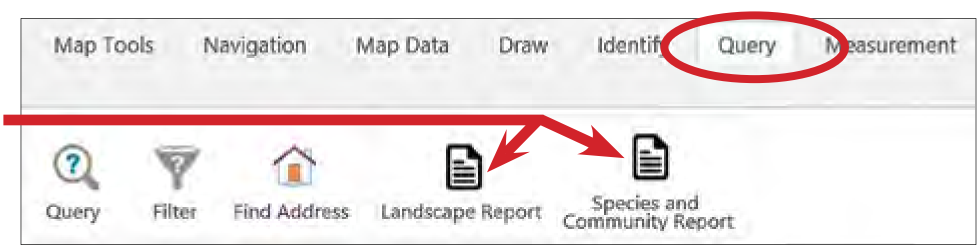
To identify components, have BioFinder and/or Part I of this guide handy. If you are comfortable using online technology, using BioFinder for this step is recommended.

Start with landscape priorities, as seen in Step 1. Using BioFinder or by flipping back and forth between the maps in Part 1, which components are most prevalent in the "highest priority" network? Interior forest blocks? Surface water? Important physical landscapes? Does adding "priority" areas contribute additional components? Make a list or chart. Then repeat the process with community and species priorities.

To help you with this process, BioFinder can generate reports quantifying all the components present in a defined area, such as a town.

To access these reports, open the toolbox by clicking the tools symbol in the top, right-hand corner.

Open the **Query** tab, where you can select either a **Landscape Report** or a **Species and Communities Report.**



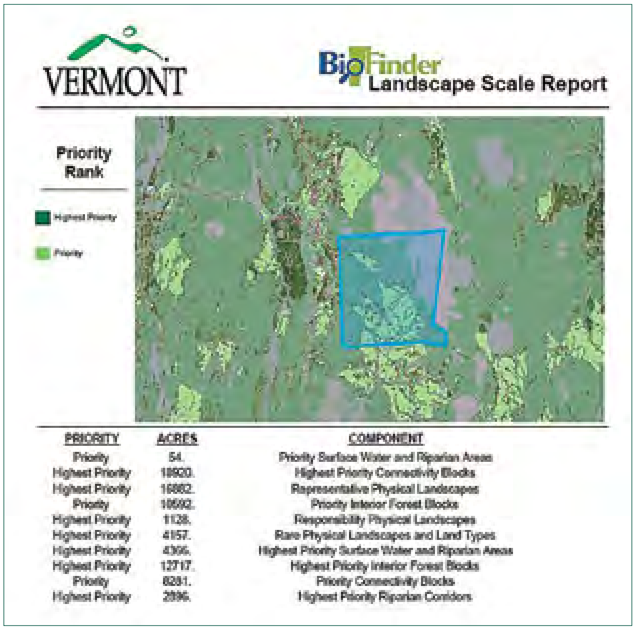
In generating a report you will be given an option to either draw an outline of your area of interest or upload a shapefile. If you already have a digitized map layer that outlines your area of interest (a shapefile), this is the easier option. However, you can also use your cursor to click around the edges of your target area until you have captured the entire area, double-clicking to finish the shape.

You can choose to see the report as a pdf or an excel file. In either case, the report lists all components present in the area outlined, the level of priority, and the acreage covered by each.

In some cases, the acreage covered by different components can give you a sense of where to focus your efforts. For example, if you have substantial acreage in connectivity blocks, you may want to spend some effort thinking of the best ways to avoid fragmentation of and between these blocks. However, there are some components for which acreage is an inappropriate measure of priority. For example, vernal pools are almost never large, and yet they remain an important contributor to biodiversity. Reports can therefore be extremely helpful in simply providing a list of components to look at when considering conservation strategies. Limited attention should be placed on the acreage covered by each, particularly on the Species & Communities Report.

You may find that dividing priority components into broad categories will make your list easier to use. For example, the landscape network in most Vermont towns can be divided into forests and waters. Outside these forests and waters, there may be a few isolated resources located in small patches of forest, agricultural fields, or residential areas. Dividing the landscape into categories may make it easier when identifying conservation strategies in Step 6; a town may use one set of strategies within forest areas, another in waterways, and a third to conserve isolated ecological features.

Once you have created your list of components, review them to be sure you understand what they are and their implications for land use, using Part I of this guide, *Conserving Vermont's Natural Heritage*, or other sources. Take extra care to understand those features


VERMONT

BioFinder Landscape Scale Report

Priority Rank

Highest Priority

Priority

PRIORITY	ACRES	COMPONENT
Priority	54.	Priority Surface Water and Riparian Areas
Highest Priority	18920.	Highest Priority Connectivity Blocks
Highest Priority	16882.	Representative Physical Landscapes
Priority	10692.	Priority Interior Forest Blocks
Highest Priority	1128.	Responsibility Physical Landscapes
Highest Priority	4157.	Rare Physical Landscapes and Land Types
Highest Priority	4366.	Highest Priority Surface Water and Riparian Areas
Highest Priority	12717.	Highest Priority Interior Forest Blocks
Priority	8281.	Priority Connectivity Blocks
Highest Priority	2896.	Highest Priority Riparian Corridors

An example of a Landscape Report in a pdf format.

that came up multiple times on your lists or cover large expanses within your community.

Once you fully understand the suite of components at play in your community, it is time to create a map of ecological priorities. For many communities, these maps can be based directly on the state priorities maps, or by incorporating local data into state maps. For some communities, however, it will be important to first refine priorities. For example, the land in some communities is mapped almost entirely as "highest priority" at the landscape scale. In this case, it is important to recognize the crucial role your local lands and waters play in maintaining Vermont's ecological function. However, this information is unlikely to help you in prioritizing local conservation or planning efforts. Other towns contain few or no highest priority features. In either case, there are some locations in your community that play a more critical ecological role than others.

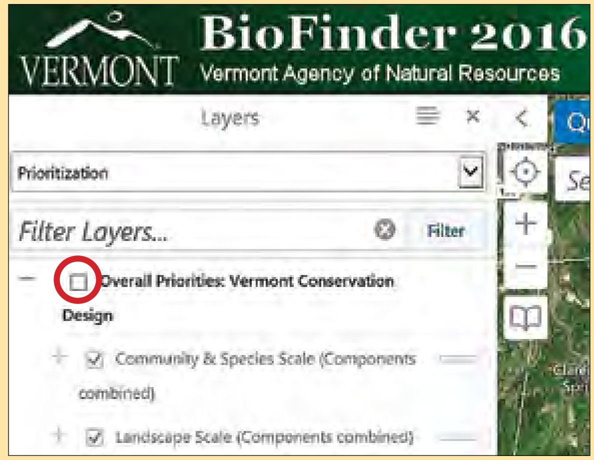
Rare and Uncommon Species Mapping

As you identify important components, you will find that many rare and uncommon species are mapped by a round circle. This circle is not an accurate representation of the land covered by the species; it is merely a dot surrounding the approximate location in which the species was found. When considering conservation strategies, identifying the habitat in which the species occurs will have more merit.

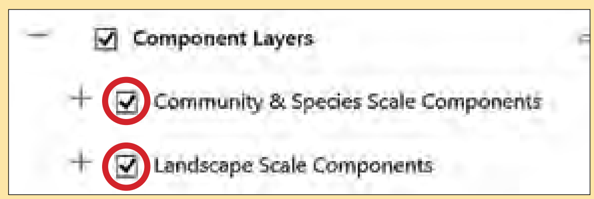
Using BioFinder in Step 3

To see components individually:

1. Un-check the box next to **Overall Priorities**: *Vermont Conservation Design* to turn it off.



2. Check the boxes next to **Community & Species Scale Components** and/or **Landscape Scale Components**, under **Component Layers**, to turn them on. Be sure the **Component Layers** box is also checked.



3. Click the + next to each category to display a list of individual components that can be turned on or off.

4. Explore!

In these cases, one way to further prioritize is to place a higher priority on locations with many overlapping components. You can think of these as hotspots—places in which many important ecological components co-occur. Wetlands are important. Interior forests are important. Rare physical features are important. Locations in which all of these important components are present may have even higher ecological value than those with just one component. If you find that the basic prioritization of Steps 1 and 2 did not provide you with as much variation as you would like, you can place the highest priority on these hotspots of overlap. They can also be terrific starting places around which to focus efforts or rally community support.

If you choose to re-prioritize, it is important to remember that this step focuses only on ecological prioritization. Human values will be incorporated in Steps 4 and 5. For some communities, it may tempting to eliminate some areas from the priorities map based on a value judgment of what is most important. We encourage you to resist this temptation, ensuring that your determination of which features to include is based on a scientific process.

Priorities: Lands and Waters with Many Functions

Many highest priority areas are important not only ecologically but also for forestry, recreation, scenery, rural enterprises, and many other human uses. When mapping landscape scale priorities, keep in mind that conservation of these areas can include diverse strategies, both non-regulatory and regulatory, and can often support these human land uses in addition to ecological values.

We'll discuss these strategies in Step 6. Some towns may find it appropriate to include high percentages of their land area in these highest priority areas, but conserve them with a low regulatory standard or a non-regulatory strategy.

Before completing Step 3, you should have a map that outlines the ecological priorities within your community.

At this point, it is time to involve your community as you decide how to move forward.

Need Help?

The Community Wildlife Program at Vermont Fish & Wildlife Department may be available to provide technical assistance to your community as you undertake this process. For more information please visit:

vtfishandwildlife.com/get-involved/partner-in-conservation/community-wildlife-program

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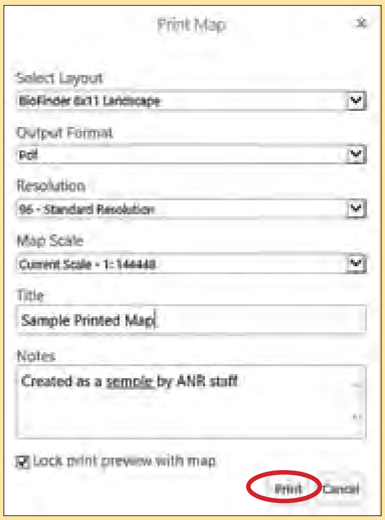
Using BioFinder to Print a Map

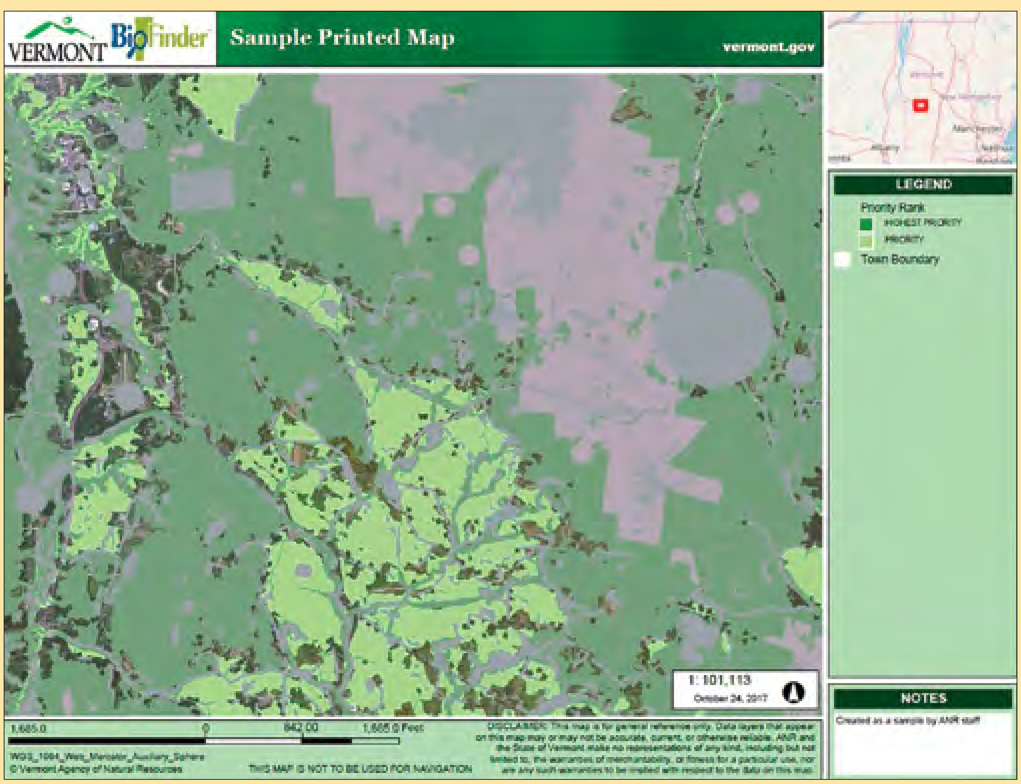
1. Open the **Map Tools** tab, inside the **Toolbox**.

2. Select **Print**.



3. Fill out the form that appears in the left panel. Click **Print.**

4. Your map will be generated, and a link will be provided.



Additional Mapping Options: *BioFinder includes many additional tools that can help you select your own priorities and create your own maps. See links for tips and tutorials from the BioFinder Home Page, or seek technical assistance from Vermont Fish & Wildlife Department's* ***Community Wildlife Program*** *to learn more.*

Including Community Values

©Vermont Fish & Wildlife Department

Determining the Ecological Context	
	Step 1. Locate priorities at the landscape scale.
	Step 2. Locate priorities at the species and community scale.
	Step 3. Identify the components.
Including Community Values	
	Step 4. Identify areas of high public value.
	Step 5. Compare ecological and community values.
Developing and Choosing Options	
	Step 6. Evaluate status and determine options.
	Step 7. Evaluate options and choose strategies.

For many communities, the biggest challenge to protecting natural resources is finding consensus among citizens. As mentioned in the introduction to this guide, most Vermonters support the protection of the state's wildlife and other natural resources; discrepancies are more often about the methods for achieving this vision rather than the vision itself. If measures to protect our natural heritage are to be successful, it is therefore crucial to involve the community throughout the planning process, listening to and understanding the values and concerns of citizens while also ensuring that the community understands the resources and implementation measures discussed.

In natural resources planning, disagreement about methods sometimes stems from a feeling that citizens must choose between supporting natural resources or other values, such as economic development, transportation, or maintaining a working landscape. As you begin your natural resources planning process, it is important to emphasize that much of the time, this is not actually a choice that needs to be made. Protection of important ecological resources can often be done while supporting other values, and sometimes conservation can even enhance these other values. When addressed together, wildlife habitat, working forests, recreation, and scenic beauty can be complimentary values occurring within the same geographic area. Keeping in mind the information you collected in Steps 1 through 3, the goal of this section is to provide you with ideas for incorporating the values and goals of citizens into your natural resources

Keeping the Community Involved

In your planning, we suggest involving your community and, in particular, any landowners who might be impacted by the information you are collecting as much as possible throughout the process. As you learn about local natural resources, make the information easily available and encourage residents to join in your meetings. Ask for residents' opinions frequently and be sure to integrate their feedback into your work.

planning efforts. Then you can design strategies that reflect both the ecological realities of the landscape and your community's values.

Community involvement, which usually includes education, is an essential piece of this. Natural resources planning efforts are less likely to be successful if a community does not fully understand where the ecological risks and benefits are and, more importantly, why it matters to them and the place they call home. However, public participation needs to be about more than just education; equally important is a process by which citizens can share ideas, needs, and opinions with one another and provide input into planning efforts. While the best tools for instigating communication may vary from one community to the next, you might consider:

- Surveys
- Interviews
- Coffee talks
- Suggestion boards in public places
- Community values mapping (described below)
- Conversations, however formal or informal (including online forums)

You'll need to decide on the best strategy or strategies for your community. Remember that some individuals may be more directly impacted by your decisions than others. Engagement with the entire community is important; we recommend specifically directing outreach to landowners affected by any proposed conservation or regulatory changes.

In some cases, there may even be opportunities for community involvement in natural resource inventories or other data collection efforts, and there are success stories of this throughout the state. For example, the Salisbury Conservation Commission developed a volunteer program to map wildlife road crossings. In some cases, citizens can join established volunteer efforts to learn more about their local landscape, such as Vermont's Vernal Pool Mapping Project.[2]

Whatever the technique, think creatively about ways to involve your community prior to asking for their vote on a regulatory implementation measure. As you involve them, also learn about their values, remembering that participation is about engagement. What does your community care about? Ecological conservation efforts generally work only when they are supported alongside diverse community values. No matter what your goals may be for your area's natural resources, it is worth spending the effort to get to know your community.

©Tom Rogers

Combining Science and Community Involvement

The *Community Heart and Soul Guide*, by the Orton Family Foundation, outlines an approach to planning that includes the community in the entire process. Their approach is designed for use in small or rural communities and may work well in many Vermont towns. When combined with real, scientific data in your planning process, this approach can be a powerful tool for natural resources planning. The guide is available as a free download at www.orton.org/heart-soul.

The Vermont Agency of Natural Resources offers an educational course that blends the approach of *Community Heart and Soul* with sound science. Learn more about the course, entitled *Caring for Natural Resources—Taking Action in Your Community*, through Vermont Fish & Wildlife Department's Community Wildlife Program.

Step 4: Identify Areas of High Community Value

Whatever your method for assessing your community's values, the next step is to compare your ecological priority maps with the values of your community. This will be easiest if you can capture the values of your community geographically, identifying where values are located on a map. Because there is no precise method for delineating the boundaries of a human value, these mapping efforts are not intended to be exact representations. By their very nature, they can show only rough estimates of human value. Even so, visualizing community values, however vaguely, can be an important filter when conducting natural resources planning efforts.

Mapping Community Values

While you could try to place results of surveys, interviews, suggestion boards, or conversations onto a map, community values mapping is a tool that has been used by numerous towns across Vermont to geographically capture the places most valued by local citizens. While some alterations may be necessary to best match the needs of your community, the basic procedure is as follows:

First, organizers invite community members to a public forum and divide participants into small groups. Each group is given a map of the local area and a set of colored markers. Participants are then asked a single question: "What do you love about this place?"

Community members use markers to outline locations of personal value on the maps. Within each group, participants are asked to categorize and color-code the values they map. Categories could include, for example:

- ► Scenic areas
- ► Ecologically important areas
- ► Economically important areas
- ► Working lands (agriculture, forestry, and so on)
- ► Recreational places
- ► Hunting and fishing
- ► Historic and community resources
- ► Anything else—there is no limit to the possible values included!

At the end of the activity, organizers are left with a series of maps, marked up with a community's special places. These maps can then be digitized, one value group at a time. Once all value groups are digitized, they can be overlaid onto a single map that allows for comparisons of locations representing many values and those representing few.

This map is helpful in identifying locations of diverse value to a community. Areas of substantial overlap tend to be places of common ground; people love them for many different reasons. For planning purposes, you may find these to be areas of consensus

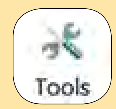
Using BioFinder in Step 4

While BioFinder is intended for mapping ecological resources, the program has tools that allow users to draw their own map layers, which you may want to use in Step 4.

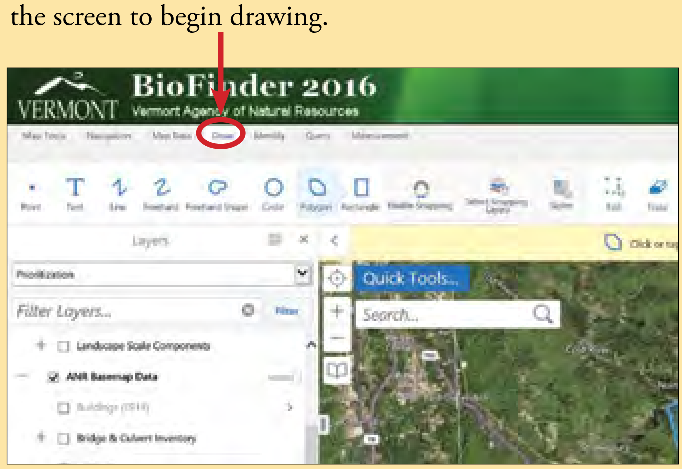
For example, if you document locations of community value on paper maps, you can use BioFinder to digitize your findings.

Open BioFinder and go to the default **Prioritization** theme. Zoom to your location of interest. Turn off all layers, or use just basemap data that will help you locate landmarks.

Open the toolbar by pressing the symbol in the top, right corner.



Select the **Draw** menu, and then choose a tool. Click on the screen to begin drawing.

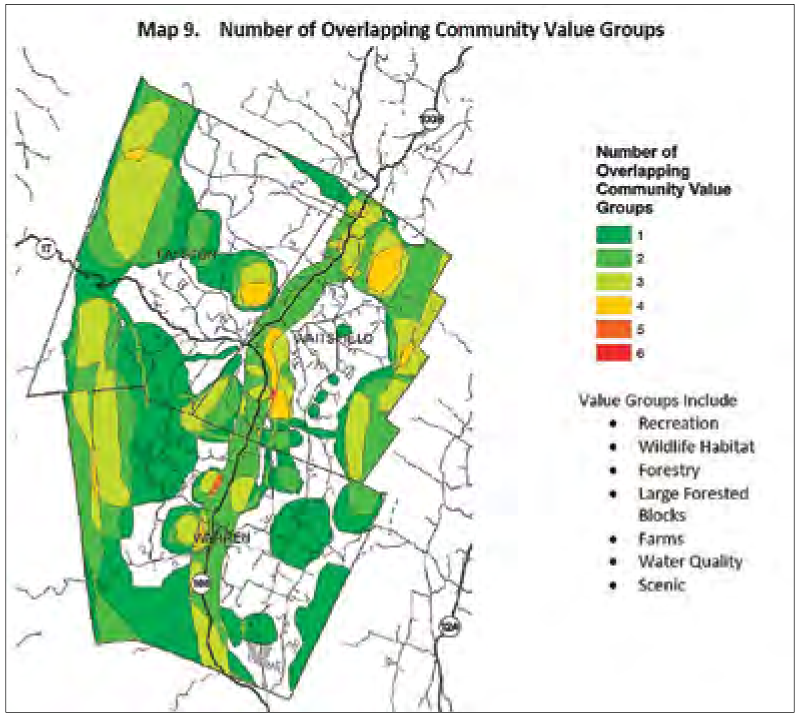


If you need to edit or erase errors, find those tools on the toolbar. When you are finished drawing, click **Export Drawings** to save your work. You can import your file back into BioFinder, share it with other people, or import it into a desktop mapping application.

Please note that BioFinder's drawing tools are not intended to provide precise boundaries.

or opportunity; people are likely to support efforts that maintain the present-day integrity of the place.

It is worth keeping in mind that when using data from community values mapping, or any data reflecting a community's stated values, the community doesn't necessarily have all the information needed to make informed decisions. For example, rare plants are unlikely to come up in community values mapping, even though biologists know how important they are for maintaining biological diversity. Even a citizen who specifically values biodiversity is unlikely to outline all local rare plant habitat during a community values mapping event.



This map, from a Community Values Mapping session in the Mad River Valley, shows the number of community values groups identified in each location across the region.

Before finalizing your priority maps, you may therefore want to consider areas in which science could further inform the community about issues that aren't already at the forefront. These maps can be useful for planning efforts, but they are just as important in determining a community's level of knowledge of their own ecological landscape. Similarly, the values of a community may change after educational efforts take place or simply as demographics change over time.

At its core, however, this activity is about capturing a community's story. Before deciding on actions aimed at protecting particular places, values mapping captures both the "where?" and the "why?" Where are our community's special places? Why do we care about them? Why would we miss these places if they were to disappear? These questions provide the justification for what you end up doing.

If you would like to map your community's values but don't think a public forum will be successful in your town, there is room for flexibility in the approach. For example, you could mail out a survey with a simple, attached map and ask citizens to send responses by mail. Be creative! Whatever the data collection method, mapping the values of your community can be a useful tool when it comes time to evaluate strategies, since you will have a much more secure vision of what is special to your community.

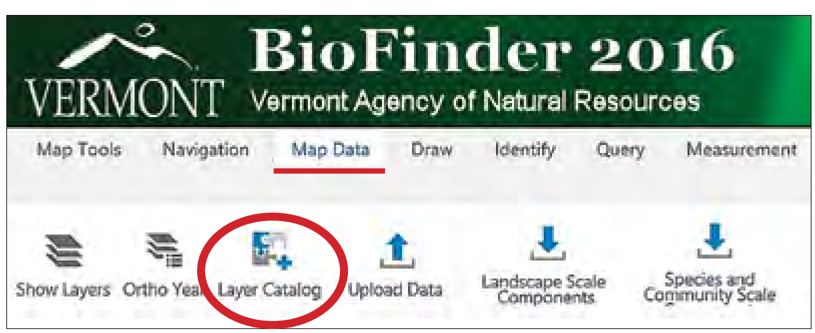
Collect Other Map Information to Represent Community Values

The method above is a technique for geographically capturing a community's values and goals, but you can also use a less direct method by identifying topics of value to citizens and then, where possible, finding maps that represent the values.

Using Existing Map Data

The Natural Resources Atlas contains numerous map layers that represent topics of interest to communities. You can also import these maps into BioFinder, using the **Layer Catalogue** tool. For example, you might look at:

- Trails
- Water quality data
- Flood hazard areas
- Agricultural soils
- Drinking and groundwater information
- Waste management information
- Erosion hazard data



This is only a small sample of the many layers that your community could examine, but these maps can be terrific filters to aid in putting community goals and values on a map using existing data.

Other Considerations

You may also want to consider mapping the following—or other values—although you won't likely find existing, state-level map data available.

- Farms
- Working forests
- Historic areas
- Views or scenic areas

Once you have collected information about the values of your community members, create a map that allows you visualize where these special places are located. While you may not be able to draw exact boundary lines for many values, capturing even a rough picture of the geographic distribution of values can be a powerful prioritization tool.

Step 5: Compare Ecological and Community Values

At this point, you have two prioritization maps: one features ecological priorities, and the other highlights the values of your community. It's time to put these together to create a single map.

A skilled cartographer can use a professional mapping program—or BioFinder or the Natural Resources Atlas—to do this digitally. However, you can create a rough approximation by drawing on a paper map of your town. Such a map can still help you decide where to place your efforts, even if you can't use it for some implementation measures.

Start by outlining the areas of consensus, including those locations that came out as priorities on both ecological and community values maps. When later choosing implementation strategies in Steps 6 and 7, these may be the first places to focus your conservation efforts, because everyone agrees: these places are special. In these locations, protection of the area's present ecological values will likely also protect community values.

You can think of these areas of overlap as representing locations with potential allies—user groups that value a place for a particular reason. These reasons may be diverse: mountain biking, hunting, bird watching, walking, for scenic values, for economic potential through forestry, and so on. Users may support conservation efforts, so long as the strategies used maintain ecological function and these other values.

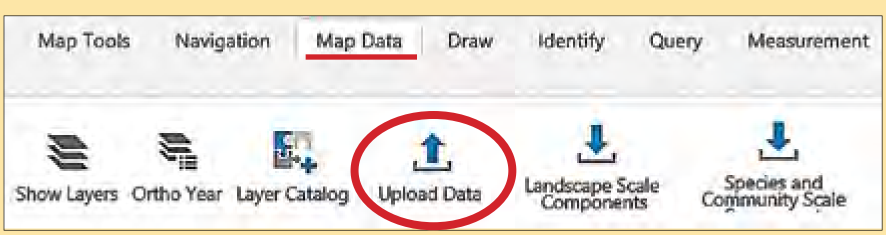
As you identify areas of overlap between your maps, think about the community values represented. Are the community values and ecological priorities compatible with one another? If so, consider involving user groups in the conservation planning process.

In some cases, overlapping values could also represent potential conflict. For example, a forest used by hunters and mountain bikers at the same time might be dangerous. Any action steps involving these lands may need to involve additional discussion or even conflict resolution, which could be as easy as awareness or a slight change in land management.

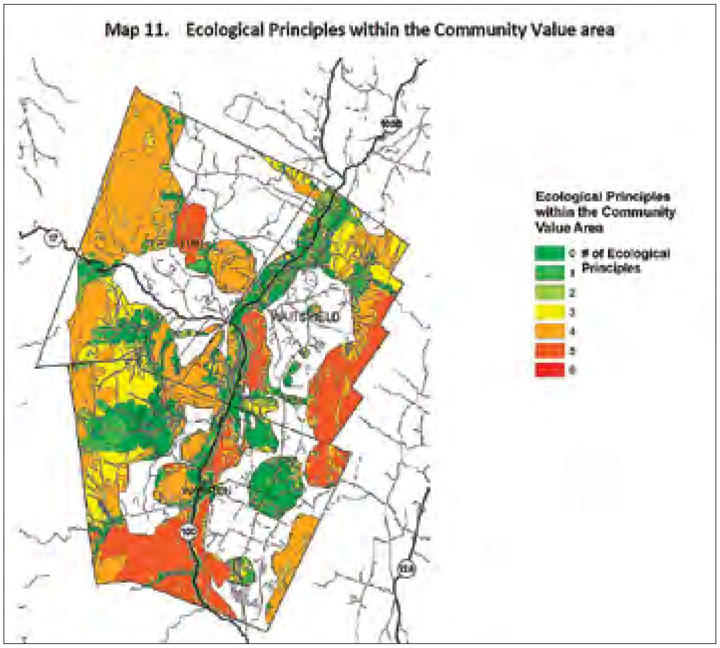
Next, outline any areas that are of high community value that don't appear on ecological priority maps. For these, identify the ecological components present just as we did in Step 3 and consider whether these components contribute to the place's special value to citizens. For example, if a popular bike trail is next to the water, protecting the quality of that water may enhance the resource for community enjoyment. Even if you decide to protect these community priorities

Using BioFinder in Step 5

If you were able to digitize your maps of community values in Step 4, you can simply import them into BioFinder to compare. To import, go to the **Map Data** toolbar, and select **Upload Data.**



Find your file, name it, and give it a symbol. Then turn on **Landscape Scale** and **Species and Community Scale** priorities—or upload whatever ecological priority maps your community has developed—and compare!



On this map, community values identified within the Mad River Valley have been combined with ecological priorities. All colored areas were identified as having community values, and the map also maintains the region's ecological prioritization scheme. While the ecological prioritization method displayed is somewhat different than the one described in this guide, the method of combining community and ecological values can be the same.

through methods not based on their underlying natural resources, it is beneficial to recognize the value of these places during the planning process.

Now look at those locations identified as having priority or highest priority ecological values but that did not appear on your community values mapping efforts. These locations fall into several categories, so they are worth carefully examining. When high values don't align, it may mean that your community will have tougher choices. Measures to protect ecologically important places may be a more difficult sell in the community.

However, you may decide that some of these ecological features are still worthy of the highest level of protection. Rare species, as mentioned earlier, rarely appear on community values maps, even in communities in which citizens place high value on the protection of rare species. In many cases, these resources are so small or specific that people don't even know they exist.

You may also decide that these are places to focus education or outreach efforts before making decisions about implementation measures. In the example above, it may be that the community is unaware of the ecological feature or its important ecological function, and that education would increase the community's value of the resource.

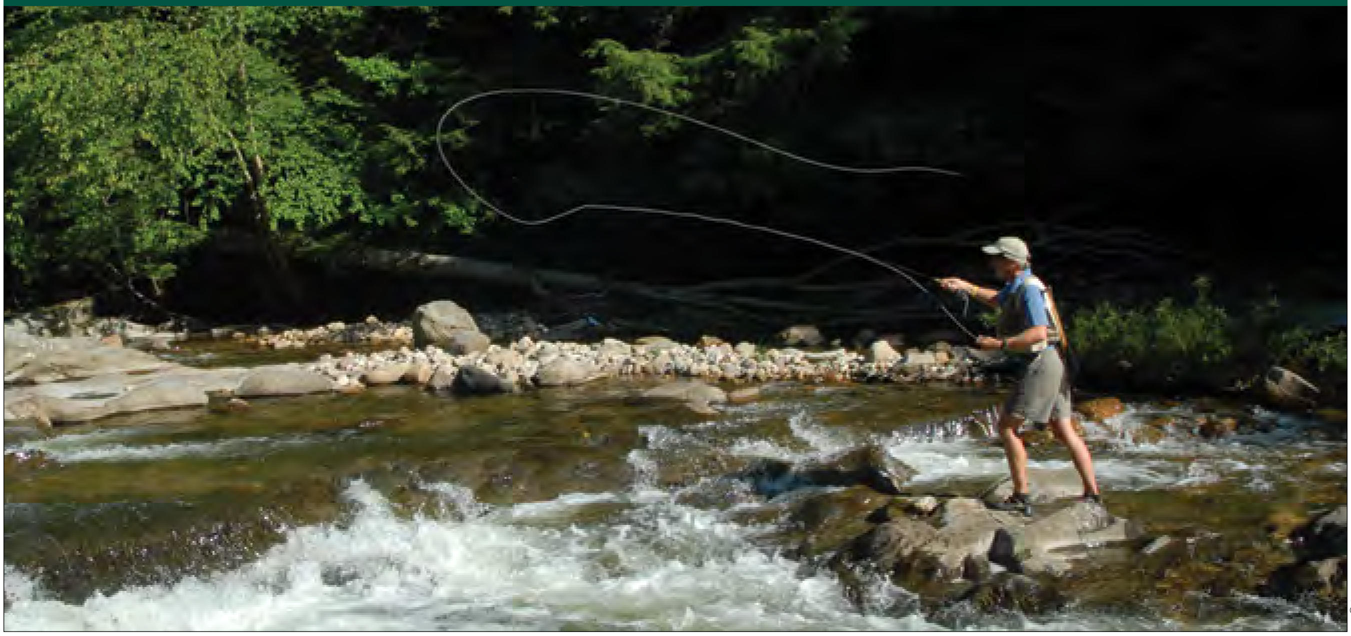
It could also be that these locations simply aren't starting places for conservation strategies in your community, regardless of ecological importance. If this is your decision, however, remember that these locations have been highlighted as priorities in state and regional efforts to map the lands necessary to maintain ecological function. Loss of ecological function at the landscape scale doesn't occur in a vacuum; it can have direct effects on other places and ecological systems that a community does value. Also, the community may not realize how something they value (such as wildlife, clean water, or the local economy) is affected if another feature (like forest blocks) are impacted.

When you complete Step 5, you should have a map that highlights the places of combined ecological and community value in your community. Like the other maps in this section, you may decide to break these locations into "highest priority" and "priority," or you can be creative and come up with another option that works for your community.

The town of Charlotte considers the following as **Areas of High Public Value**, combining ecologically important areas with locations representing other community values:

1. Land in active agricultural use.
2. Primary (prime & statewide) agricultural soils.
3. Steep slopes (equal to or in excess of 15%).
4. Flood hazard areas.
5. Surface waters, wetlands and associated setback and buffer areas.
6. Shoreland setback and buffer areas.
7. Special natural areas.
8. Wildlife habitat.
9. Water supply source protection areas (SPAs).
10. Historic districts, sites and structures
11. Scenic views and vistas.
12. Conserved land on adjacent parcels.

Developing and Choosing Options


©Sandy Macys

Determining the Ecological Context
Step 1. Locate priorities at the landscape scale.
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Including Community Values
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Step 5. Compare ecological and community values.
Developing and Choosing Options
Step 6. Evaluate status and determine options.
Step 7. Evaluate options and choose strategies.

At this point, you should have a clear geographic idea of the locations of high value to your community, based on both ecological and community values. Now you can think critically about how to best strategize for the protection of some places, and perhaps the development of others, based on real data.

Step 6: Evaluate Status and Determine Options

Before choosing strategies, you'll need to take stock of what you have. You've identified locations of high community value. Now, look at the current protection status of these locations.

Recognizing Conservation

Do any of your priority locations occur on permanently conserved land? To check, compare your map of combined ecological and community values with the protected lands depicted on Map 1, the Conservation Basemap, in Part I of this guide. Remember that a conservation easement limits development but may or may not provide guidelines for management or protection of specific resources.

Are there federal, state, or regional regulations/programs already in place that will protect the resource? If so, how do the goals of these programs line up with what your community would like to achieve? Significant wetlands, for example, are subject to the

Vermont Wetlands Rules, which regulate certain uses and activities, but some towns may want to achieve somewhat different goals for local wetlands. For more information about individual ecological components, see Part I of this guide.

Next, review your town or regional plan and bylaws. Do these currently offer protection for your priority resources? If so, are you satisfied with the level and type of protection offered?

For some resources, it may be helpful to check whether properties located within priority areas are enrolled in the Use Value Appraisal Program (Current Use).[3] This program is one of Vermont's premiere conservation programs and enables private landowners to maintain their property in productive forest rather than subdividing and developing it, thus contributing to Vermont's forest products and working land economies as well as providing all the other benefits to the public and the environment associated with forests. County foresters with the Vermont Department of Forests, Parks and Recreation are a great source of information about this program. These lands can be seen on Map 1 of the Inventory Theme in BioFinder.

If any of your priority locations are already well protected, your planning efforts in these areas can be minimal, allowing you to focus your energy elsewhere.

Visualizing Change

You may also find it helpful to think about the level of risk faced by priority resources. In Vermont, development generally occurs gradually. In rural areas, it may be on the scale of only a few parcels per town per year, a pace that appears slow but that can have substantial effects over time. Of course, slow growth doesn't mean that your planning work is unimportant. Some would argue that it is precisely because development takes place so slowly in Vermont that every choice matters and contributes to the overall landscape we end up with.

Evaluating Your Town Plan and Bylaws

Vermont Natural Resources Council's Resilient Communities Scorecard will take you through a series of questions to produce a score for how well your community already protects the environment and local natural resources. Based on this score, it lists suggestions for next steps. While based on somewhat different criteria than this guide, it provides a great starting point. Try it out: vnrc.org/wp-content/uploads/2013/06/III.pdf.

Resources for Implementation

Because the focus of this guide is on mapping natural heritage features, the detail included in the remainder of this guide is limited. The entire implementation process is described briefly to enable planners to take the information included in Part I's inventory maps and effectively implement conservation strategies.

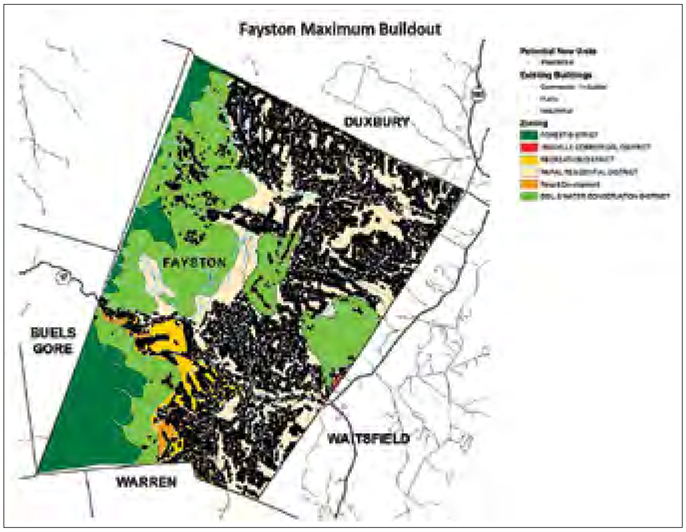
The same process is described in detail in a course periodically offered by Vermont's Agency of Natural Resources, entitled *Caring for Natural Resources—Taking Action in Your Community*. In addition, you may want to supplement this section with other resources or create your own strategies. For example, the Vermont Agency of Commerce and Community Development's *Planning Manual* can aid you in creating an effective municipal plan that follows state statutes. As mentioned earlier, *Community Strategies for Vermont's Forests and Wildlife* and *Conserving Vermont's Natural Heritage* may also be helpful.

One way to visualize future growth from routine development is to create a build-out model. This advanced computer mapping technique (which requires the aid of a skilled cartographer) is used to envision different development scenarios. A basic build-out model asks, "Based on current zoning, how many new units could be built in your town?" You can also use this method to test proposed regulations to see what the resulting maximum development would look like on a map. You can learn more about build-out models in *Community Strategies for Vermont's Forests and Wildlife*, on page 13.

Buildout can be used to compare the impact of different regulatory proposals. If we added a 50-foot buffer to all streams in town, how many fewer units could be built compared to current zoning?

Using BioFinder in Step 6

While you will certainly want to use more resources than just BioFinder for this step, BioFinder does have some useful datasets that might help. For example, conserved lands are located in the **Inventory** theme, under Map 1. Lands enrolled in **Use Value Appraisal (Current Use)** can be found in the same place.



This build-out model of Fayston is from the 2011 Communities, Forest, and Wildlife Project in the Mad River Valley. It shows a 50-year maximum buildout scenario based on current zoning.

What about a 200-foot buffer? Scenarios could include anything from natural resources extraction to the development of energy structures, expansion of industrial activities to global issues like climate change.

For each scenario, evaluate (if possible) potential impacts to the areas of combined ecological and community value. What acreage could be lost to development? As you begin this discussion, keep in mind that some potential threats to areas of high value may be assets to other community or ecological goals. Where this is the case, your community may need to make tough choices between conflicting values. Regardless, recognizing the potential threat to areas of value is the first step toward making informed decisions.

The goal here is to double check your priorities. Highly valued places with existing protections may become lower priorities for action than those places that are unprotected and face high development pressure. You may want to take some time to re-assess your priorities.

At this point, you are ready to develop strategies to protect your special places!

Brainstorm

It's now time to brainstorm action steps you could take to maintain the values of priority areas.

Start with the places that have now emerged as highest priority for conservation. Compare these with your list of ecological components from Step 3. Does your list of components still represent the areas of highest priority?

For each component, create a list of both regulatory and non-regulatory actions that would maintain the values of these lands and waters. To help you with this step, the chart in Appendix A matches possible conservation strategies with ecological components. Part I of this guide has additional information on each component. Of course, these charts are not comprehensive; you may have additional ideas! At this point, consider everything.

Mirroring Step 3, strategies can be divided by scale. First, consider strategies that will protect landscape scale patterns such as maintaining large networks of forest habitat and waterways. Because landscape-scale components cover substantial acreage, these same lands are often used as working forests, recreational areas, scenic vistas, and for other forms human enjoyment. Therefore, the most effective strategies often consider both human and ecological values of this land.

Next, list strategies that will conserve those resources excluded from the landscape patterns above. For example, a vernal pool located in a small patch of forest may not be included in the forest network you considered above, but it remains an important resource. Such community and species–scale elements are generally more ecologically sensitive, and successful strategies often involve encouraging intensive human activities in other locations.

If you have not already done so, we now suggest reading through *Community Strategies for Vermont's Forests and Wildlife* for more information about tools used to protect priority natural resources. The Vermont Agency of Commerce and Community Development's *Planning Manual*[4] has information on more general planning strategies and statutes that are not specific to natural resources.

The Community Planning Toolbox

On the Vermont Natural Resources Council website, the **Community Planning Toolbox** provides information about planning, implementation tools, and case studies from within Vermont. Learn more at: vnrc.org/resources/community-planning-toolbox.

Strategies for Connecting Residents to Community Resources

Many communities have found that outdoor education and exploration are effective strategies for connecting residents to community resources. For example, the Middletown Springs Conservation Commission held monthly, family-friendly walks in their town forest to see and discuss a variety of conservation-related topics. Read more at vtconservation.com/success-stories/sullivan-education-woods-monthly-walks

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Step 7: Evaluate and Choose Options

After brainstorming possible strategies you could use to maintain the values of priority places, it is time to evaluate your list and choose those options that best match your community's needs, values, and ecological context. Most likely, you will end up choosing not a single solution but a package that works together to address identified needs—even if you take on only one strategy at a time. Below, we offer considerations as you put together this package.

Addressing Needs and Realities

As you begin the evaluation process, the first step is to think carefully about exactly what each option would involve. We recommend maintaining a worksheet in which you document the following. For each potential strategy,

- How well does it protect or enhance the natural resource needs you have identified?
- How well does it support community values?
- How much effort will it take to complete?
- How much will it cost?
- Are people needed to implement the strategy? If so, are these people available?

Thinking carefully about this information will help you identify which options are realistic in your community. You also want to be sure that the options you choose do, in fact, help the ecological and/or community needs you are trying to address.

The Importance of Communication

Remember to involve your community throughout this process; don't wait until you have chosen a strategy to communicate your efforts with citizens!

Finding Common Ground

In the previous steps, you identified first ecological priorities, then community priorities, eventually combining these into a single map of areas with high public value. As you evaluate strategies, consider options that satisfy diverse interests simultaneously. For example, strategies aimed at maintaining working forests are often effective at conserving forest wildlife habitat, too. Similarly, riparian areas are important not only for the conservation of wildlife habitat but also for water quality and flood resilience. A single conservation strategy could effectively protect multiple values.

Make a Plan

Once you have evaluated your range of options, it is time to choose those that seem most appropriate for your community and turn your decisions into a plan of action.

Your action plan could include the following:

1. **Action Steps:** What strategies do you propose implementing? Again, this probably isn't a single solution but a collection of strategies that work together to achieve your goals.
2. **Rationale:** What needs do these actions satisfy? Why did you choose this group of options over others? What community values are supported by your chosen solutions?
3. **Assign a Leader or Leadership Team:** Who will head up your efforts? The Planning Commission? The Conservation Commission? A watershed association? For each strategy, you can assign a point person and list supporters.
4. **Tasks:** Lay out the specific tasks associated with your chosen strategies.
5. **Timeline:** Identify a likely timeframe for each task

and for the overall project. (Keep in mind that the overall project may take a long time—and that's okay!)

6. **Milestones:** Will there be key accomplishments that you can celebrate along the way?
7. **Resources:** Are there existing financial resources you can put toward the project? People who will be involved? Other resources?

As you get started, you also need to think about funding. Do you already have the needed finances for your project? If not, you might consider:

- Municipal Planning Grants[5]
- Local conservation funds
- Fundraisers (letters to individual donors, public events, etc.)
- Collaboration with a partner with related goals (a land trust, private landowner, foundation, etc.)
- Other grants

For many communities, creating an action plan is not an easy process. However, if you have gone through the rigorous prioritization process above, your decisions will be based on data, and you will be able to provide a solid rationale for your decisions. In the end, you may not be able to accomplish everything that has been set on the table, and there may be places in which you have to choose from among divergent priorities. However, making these tough decisions by taking into account a diversity of information and perspectives is what will give your plan a strong foundation.

Good luck!

Regional Planning Commissions

Throughout your process, don't forget that your Regional Planning Commission can be a valuable resource! Regional Planning Commissions assist individual member municipalities with their planning processes and work cooperatively to address regional challenges. They also work with non-profits, state and federal agencies, businesses, and others to implement programs or projects to address local and regional needs. See the Vermont Association of Regional Planning Commissions (www.vapda.org) for additional information.

Need Help?

The process outlined above was developed by the Vermont Fish & Wildlife Department's Community Wildlife Program, and we're happy to provide additional guidance:

- Contact the Community Wildlife Program, Vermont Fish & Wildlife Department. See www.vtfishandwildlife.com/get-involved/partner-in-conservation/community-wildlife-program for more information about the program.

For aid with the development or implementation of planning-related work, Vermont Natural Resources Council may be able to provide assistance. For more information, visit:

- Forests and Wildlife Program: vnrc.org/programs/forests-wildlife/
- Sustainable Communities Program: vnrc.org/programs/sustainable-communities/

For technical assistance related to planning and regulatory tools, the Regional Planning Commissions are a valuable resource.

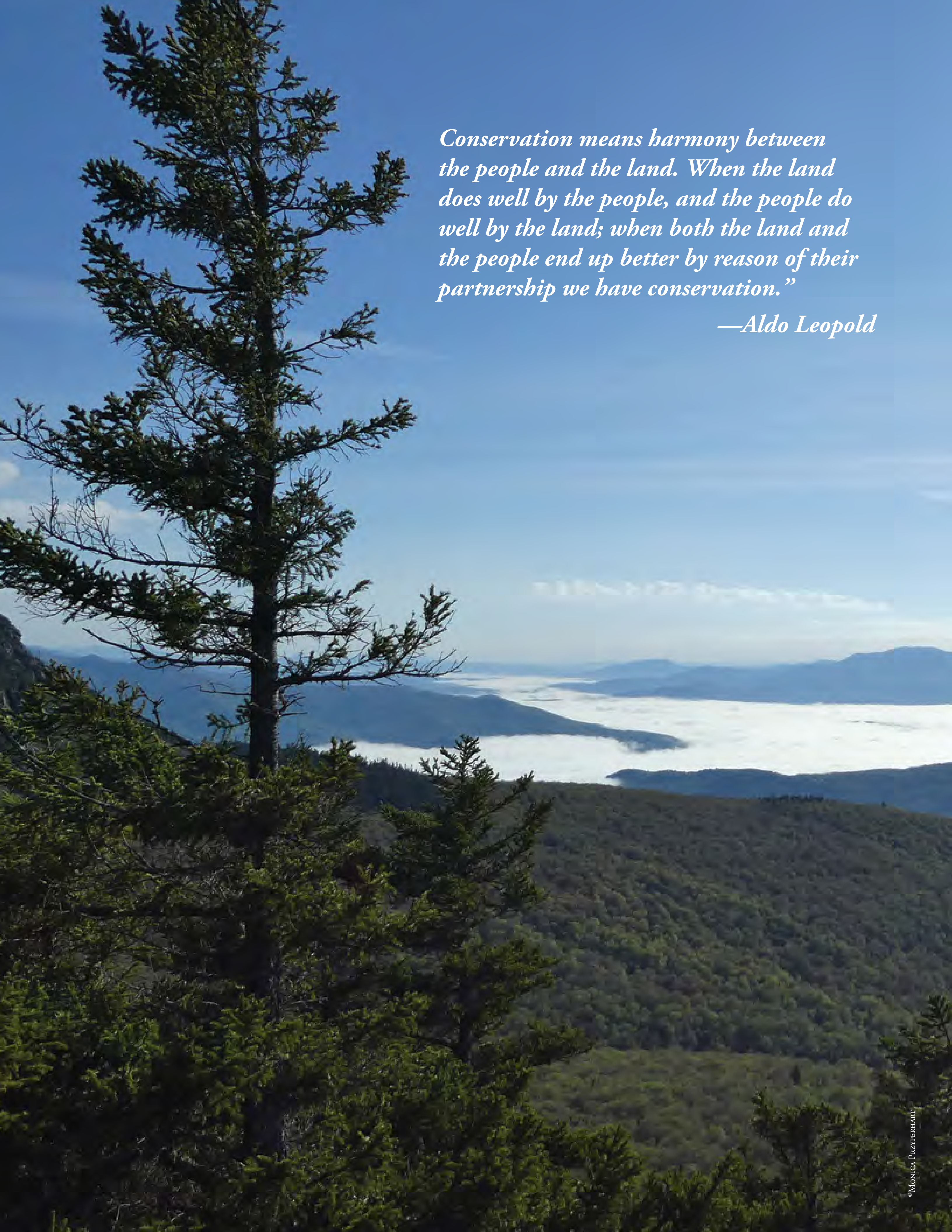
- See www.vapda.org for a list of contact information for all of Vermont's Regional Planning and Development Agencies.

Using BioFinder in Step 7

The maps you've been using in BioFinder may continue to provide guidance in Step 7. However, please remember that many of the data layers available on BioFinder should be field verified before being used for specific implementation strategies. In particular, please be sure that regulatory boundaries are reviewed by a skilled cartographer who can assure that data are being used at an appropriate scale.

Conservation Success Stories

See what other towns have done! The Association of Vermont Conservation Commissions has compiled an online archive of activities completed by Vermont towns that achieve a variety of conservation-related goals. The archive details accomplishments, challenges and keys to success for each project, along with contact information for those involved. Find these stories at vtconservation.com/view-stories



Conservation means harmony between the people and the land. When the land does well by the people, and the people do well by the land; when both the land and the people end up better by reason of their partnership we have conservation.”

—Aldo Leopold

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Appendix A: Strategies and Components

The chart spanning the next several pages matches ecological components with appropriate regulatory and non-regulatory protection strategies. More information about most strategies can be found in *[Community Strategies for Vermont's Forests and Wildlife.]*

Scale	Component	Conservation Goal	Conservation Strategies	
			Nonregulatory Strategies	*Regulatory Strategies*
ALL	General strategies for baseline protection	**Seek additional information**	Conduct field inventories and improve maps.[1]	
		Protect the resource	Adopt language in the town plan, including statements about what resources are important, and policies on how they should be managed, protected, and restored.	Check clarity of definitions in zoning bylaws and update if needed.[2]
			Conduct targeted outreach to landowners that connects them with resources on their land and options for managing these resources.[3]	Review standards in zoning (subdivision, CU, or use standards), and update if needed.[4]
			Provide citizen educational opportunities.	Review purpose statements in zoning and update if needed.
			Establish a Conservation Commission.[5]	
			Create or expand a Conservation Fund for Special Projects.[6]	Establish or improve subdivision regulations.[7]
			Encourage landowners to enroll in Current Use.[8]	
			Encourage residents to conserve land containing important features.[9]	Review minimum lot size requirements to determine whether lot sizes and site design requirements support the natural resource goals of each zoning district (i.e., 2- to 5-acre lot sizes can cause fragmentation even if open space remains.)
			Work with neighboring communities and/or the regional planning commission to plan for natural resources protections at a regional scale.	
			Create or expand a Town Forest.[10]	

Scale	Component	Conservation Goal	Conservation Strategies	
			Nonregulatory Strategies	*Regulatory Strategies*
LANDSCAPE	**Forest (Interior Forest and Connectivity Blocks)**	**Provide stewardship of forestland**	Encourage residents to work with a forester to create forest management plans.[11]	Establish an impact fee program.[12]
			Encourage enrollment in Current Use (or local tax stabilization program).[13]	
			Connect landowners with supporting organizations, such as Vermont Coverts,[14] Vermont Woodlands Association,[15] the Natural Resources Conservation Service,[16] or your local Natural Resources Conservation District.[17]	
		Avoid fragmentation	Encourage residents to enroll in Current Use (or local tax stabilization program).[18]	Allow a greater development density in defined growth areas (like village or commercial districts) than in rural land (through a Forest, Conservation, or Rural Residential Zoning District).
			Encourage citizens to engage in estate planning.	Establish or expand a Wildlife Habitat or Wildlife Corridor Overlay District.
			Encourage residents to conserve their forestlands in important areas.[19]	Establish building envelopes, clearing standards, or limits on driveway length in bylaws to limit the impact of development.
			Create or expand a Town Forest.[20]	Establish road and trail standards.[21]
				Review rural residential-type districts to determine whether lot sizes and site design requirements allow for continued function of rural land (i.e., 2- to 5-acre lot sizes can cause fragmentation even if open space remains.)

<table>
<tr><th rowspan="2">Scale</th><th rowspan="2">Component</th><th rowspan="2">Conservation Goal</th><th colspan="2">Conservation Strategies</th></tr>
<tr><th>Nonregulatory Strategies</th><th>Regulatory Strategies</th></tr>
<tr><td rowspan="8">LANDSCAPE</td><td rowspan="2">Forest (Interior Forest and Connectivity Blocks)</td><td rowspan="2">Provide support for working forests</td><td>Encourage residents to enroll in certification programs that promote long-term support for land management.[22]</td><td>Institute local forest products purchasing policy (for municipal purchases).</td></tr>
<tr><td>Encourage support for businesses that use local forest products.</td><td>Ensure that regulations include standards that allow for continued access to working forests and associated infrastructure (e.g., log landing areas).[23]</td></tr>
<tr><td rowspan="6">Physical Landscape Diversity</td><td rowspan="6">Include physical landscapes in conservation efforts</td><td colspan="2">Protect forest blocks and waterways that contain important physical landscapes (see Forest Blocks above and Surface Waters and Riparian Areas below).</td></tr>
<tr><td>Compare maps of physical landscape diversity to conserved lands. Prioritize under-represented features in conservation efforts.</td><td rowspan="5">When feasible, locate building envelopes outside physically diverse areas.</td></tr>
<tr><td>Encourage land conservation among owners of physically diverse land.[24]</td></tr>
<tr><td>Encourage owners of physically diverse land to enroll in Current Use (or local tax stabilization program).</td></tr>
<tr><td>Conduct planning efforts so as to avoid development in these areas.</td></tr>
</table>

Scale	Component	Conservation Goal	Conservation Strategies	
			Nonregulatory Strategies	*Regulatory Strategies*
LANDSCAPE	**Surface Water and Riparian Areas**	**Protect surface waters and riparian areas**	Support the creation of River Corridor Easements[25] (conservation easements that allow rivers to change course naturally, without human interference).	Require forested riparian buffers in the general standards section of your bylaws, to apply in all districts, or in River Corridor bylaws, if you have them.[26]
				Establish standards for minor activities (footpaths, etc.) acceptable within the riparian area.
			Connect landowners to incentives programs for wildlife-friendly management practices, such as through USDA or USFWS Partners for Fish and Wildlife.	Add standards in subdivision regulations or zoning (River Corridor, Flood Hazard, Lakeshore Overlay, or Forest District) that require clustering or setting back development away from riparian areas, river meanders, or floodplains.
				Require minimum setbacks from waterways in zoning and subdivision regulations.
				Adopt town road management standards to comply with Vermont's Clean Water Act.[27]
		Enhance Riparian Quality	Assist landowners in restoring riparian habitats.[28]	Require restoration of riparian habitat in site plan or subdivision review by designating "no-mow" zones, allowing for regeneration of woody vegetation, or by planting native species.
			Create an invasive species control program.[29]	
			Connect landowners to incentives programs, such as through USDA or USFWS Partners for Fish and Wildlife.	
		Maintain Water Quality	Assist landowners in reducing stormwater runoff.[30]	Recommend or require vegetated buffers to filter pollutants before they reach waterways.
			Encourage residents and businesses to reduce use of chemical lawn care products.	
			Identify ways to reduce flood damage to major infrastructure.[31]	
			Support public awareness of the *Acceptable Management Standards for Maintaining Water Quality of Logging Jobs in Vermont*.[32]	

Scale	Component	Conservation Goal	Conservation Strategies	
			Nonregulatory Strategies	*Regulatory Strategies*
LANDSCAPE	Grasslands and Shrublands	**Ensure that management is compatible with wildlife**	Practice management compatible with nesting birds on town-owned grasslands (the fields around schools or recreation fields, etc.).[33]	In site plan review, require that developments follow sound grassland bird management guidelines.[34]
			Connect landowners to incentives programs for wildlife-friendly management practices, such as USDA,[35] USFWS Partners for Fish and Wildlife,[36] or the Bobolink Project.[37]	
			Establish a monitoring program for grassland birds.	
		Maintain or protect habitat	Ensure that grasslands and shrublands are represented in local conservation efforts.	
COMMUNITIES AND SPECIES	Wildlife Road Crossings	**Protect habitat around wildlife crossings**	Encourage residents to conserve their land through conservation easements, particularly when crossings are part of larger parcels that have additional conservation values.[38]	Require vegetated buffers around wildlife crossings in the general standards section of your bylaws, to apply in all districts.[39]
			Connect landowners to incentives programs, such as through USDA or USFWS Partners for Fish and Wildlife.	
			Encourage residents to enroll in Current Use.[40]	
			Encourage residents and businesses to manage their land so as to leave vegetation right up to the road.	Adopt road management standards to allow vegetation to remain up to the road.

Scale	Component	Conservation Goal	Conservation Strategies	
			Nonregulatory Strategies	*Regulatory Strategies*
COMMUNITIES AND SPECIES	Wildlife Road Crossings	**Limit fragmentation**	When conducting planning efforts, consider wildlife road crossings and connectivity blocks together.	Establish or improve a Conservation District.[41]
				Establish or improve a Wildlife Corridor or Wildlife Habitat Overlay District that includes both areas of habitat and important wildlife road crossings.[42]
				Review or establish an access management plan, and consider limiting curb cuts in important wildlife crossing areas through site plan review or other standards within the zoning.[43]
		Reduce danger to humans and wildlife	Work with road officials to provide appropriate signage (to educate drivers) and install structures to guide animals to cross in safer areas (under bridges, on straighter road segments, etc.).	Establish traffic rules that ensure the safety of humans and wildlife along town roads on which wildlife are most likely to cross.
			As needed, upgrade culverts and road infrastructure to VTrans standards. VTrans requires that all crossings include full-width banks and natural, at-grade bottom substrates to facilitate aquatic and terrestrial organism passage.*	Adopt road management standards to avoid guardrails, the removal of roadside vegetation, or deep roadside ditching in crossings wherever possible.
	Species and Natural Communities (Rare, Common, or Representative)	**Protect significant species and natural communities**	Protect habitat blocks that contain important species, habitats, or natural communities (see Forest Blocks above).	
			Encourage landowners to conserve land that supports rare or uncommon species or natural communities.[44]	Create a Conservation or Wildlife Habitat Overlay District that protects significant wildlife habitat and a surrounding buffer.[45]
			Encourage landowners to enroll in Current Use and enroll eligible areas as Ecologically Significant Treatment Areas (ESTAS).[46]	
			Create or expand a Town Forest.[47]	
		Manage invasive species	Provide landowners with opportunities to learn about management options for invasive species.[48]	Adopt a mowing policy in which town roadsides with invasive species are mowed before they go to seed.

* See: www.floodready.vermont.gov/improve_infrastructure/roads_culverts

Scale	Component	Conservation Goal	Conservation Strategies: *Nonregulatory Strategies*	*Regulatory Strategies*
COMMUNITIES AND SPECIES	**Species and Natural Communities**	**Restore degraded habitat**	Connect landowners with incentives programs (USDA, USFWS, etc.) that aid in restoring significant natural communities or habitat.[49]	
	Vernal Pools	**Protect vernal pools and associated amphibian populations.**	Protect habitat blocks that contain vernal pools (see Forest Blocks above).	
			Write management plans for town-owned land designed to protect vernal pools.[50]	Require buffers in the general standards section of your bylaws, to apply in all districts.[51]
				Create a Wildlife Habitat Overlay District that includes vernal pools and surrounding habitat[52]
			Improve maps of vernal pools.	Encourage subdivision and site plan designs in zoning or subdivision regulations that cluster development away from vernal pools.[53]
				Require minimum setbacks in zoning or subdivision regulations.
				Seek to add vernal pools as Class II wetlands on inventory maps (where they are often missing).
		Protect or restore forested habitat between vernal pools	Include a map in your town plan to show possible dispersal corridors between pools.	
			Target high priority corridors in land conservation efforts.	

Scale	Component	Conservation Goal	Conservation Strategies: Nonregulatory Strategies	Conservation Strategies: Regulatory Strategies
COMMUNITIES AND SPECIES	Wetlands	**Protect wetlands and surrounding habitat**	Encourage residents and/or businesses to conserve their wetlands through conservation easements.[54]	Petition for reclassification of significant wetlands to Class I. If wetlands are not mapped, seek to add them as Class II wetlands on inventory maps.[55]
			Encourage residents to enroll their wetlands in Current Use, in an Ecologically Significant Treatment Area (ESTA).[56]	Require buffers through the general standards section of your bylaws, to apply in all districts.[57]
			Encourage landowners to work with a foresters to choose forest management practices that protect wet soils and fragile species.	Require development design that clusters development away from wetlands and their buffers in subdivision and zoning regulations.[58]
			Support public awareness of Vermont's Wetlands Rules.[59]	Incorporate minimum setbacks from wetlands in zoning and subdivision regulations.
		Restore wetlands	Restore wetlands on town-owned lands.[60]	Create town road management standards to maintain and restore natural vegetation and hydrology.[61]
			Connect landowners with incentives programs (USDA, USFWS, etc.) to aid in restoring wetland habitat.[62]	
	Mast Stands	**Protect mast stands**	Protect habitat blocks that contain mast stands (see Forest Blocks above).	
			Encourage residents to conserve forestland through conservation easements.[63]	*Establish or improve a Wildlife Habitat Overlay District.
			Connect landowners with educational resources, such as landowner habitat management guidelines[64] or mast production area guidelines.[65]	
			**Improving inventory information is necessary before implementing any of the regulatory strategies above. State-level maps do not provide enough spatial accuracy for these actions.*	

<table>
<thead>
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</thead>
<tbody>
<tr><td rowspan="7">COMMUNITIES AND SPECIES</td><td rowspan="3">Mast Stands</td><td rowspan="3">Protect mast stands</td><td>Connect landowners with incentives programs (particularly USDA) to aid with possible financial and technical assistance.[66]</td><td>*Establish development design standards that cluster development away from mast stands and a surrounding buffer.[67]</td></tr>
<tr><td>Encourage residents to enroll in Current Use, using Ecologically Significant Treatment Areas (ESTAs)[68] or working with a forester to plan for the long-term health of the mast stand.</td><td>*Require buffers around mast stands.</td></tr>
<tr><td colspan="2">*Improving inventory information is necessary before implementing any of the regulatory strategies above. State-level maps do not provide enough spatial accuracy for these actions.</td></tr>
<tr><td rowspan="4">Local Wildlife Resources (Deer Wintering Areas, Clayplain Fragments, Bat Habitat, etc.)</td><td rowspan="4">Protect wildlife resources</td><td colspan="2">Protect habitat blocks that contain important resources (see Forest Blocks above).</td></tr>
<tr><td>Encourage residents to conserve their land through conservation easements.[69]</td><td>Establish or improve a Wildlife Habitat Overlay District.[70]</td></tr>
<tr><td rowspan="2">Encourage residents to enroll their land in Current Use, using Ecologically Significant Treatment Areas (ESTAs) in appropriate locations[71] or working with a forester to plan for the long-term health of the resource.</td><td>Establish development design standards that cluster development away from resources.[72]</td></tr>
<tr><td>Require buffers around these resources.</td></tr>
</tbody>
</table>

One Size Doesn't Fit All

When considering any of the strategies in this chart, remember each can be adapted to match the needs and personality of your community. For example, when we say, "Encourage residents to conserve their land," one town might create a community recognition award for residents who conserve their land, while another might write letters to landowners of areas identified as high priorities and describe potential conservation opportunities. There is room for creativity in any approach!

Glossary of Terms

100-year flood: A flood having a 100-year recurrence interval. Calculated according to historical data about rainfall and stream stage for a particular location, the probability that a specific river will reach a particular water level is once in 100 years. In other words, a flood of this magnitude has a 1 percent chance of happening in any year. *(Adapted from the USGS Water Science School website, at www.water.usgs.gov/edu/100yearflood.html.)*

The **100-year floodplain** is therefore all the land inundated by a 100-year flood.

A

Aerial photo: A photograph taken from an aircraft.

Orthophoto or orthophotograph: An orthophoto is an aerial photo that has been matched with mapping coordinates so that locations align geographically with other maps.

B

Bat hibernaculum: A place, usually a cave or a mine, that provides a constant temperature and protection for winter bat hibernation *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Biodiversity: The variety of life in all its forms and all the interactions between living things and their environment. Biodiversity is measured at the following levels: ecosystem, landscape, community, species, and genetic. *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

BioFinder: This online mapping resource is both a database and mapping tool for identifying Vermont's lands and waters supporting high priority ecosystems, natural communities, habitats, and species. The most comprehensive assessment of its kind in Vermont, BioFinder was developed by the Agency of Natural Resources and partners to further our collective stewardship and conservation efforts. The resource highlights an interconnected network of forests, streams, and physical landscape features that drive Vermont's ecological function. It can be found at anr.vermont.gov/maps/biofinder

Biophysical region: Biophysical regions divide Vermont into areas with like physical features. Each of these regions shares similarities in climate, bedrock, geologic history (glacial deposits, flooding, etc.), topography, land use history, and hydrology (water flow patterns). When conducting planning, these biophysical regions can be used as a lens through which to assess conservation priorities. For example, what may be a common species in one biophysical region of Vermont may be rare in another. In the area in which it is rare, conserving habitat for that species may be a way to preserve biodiversity.

Buffer: An area managed in a way that shields an ecologically sensitive area—a stream or wetland, for example—from the direct impacts and influences of human activities. Buffers reduce the contrast between the type of management applied to the sensitive area (generally somewhat hands-off) and the surrounding, more human-altered matrix. Generally, a buffer is managed to retain forest or other natural habitat, although it can be compatible with some human activities.

When used in a mapping context, a buffer refers to the area within a specified distance of a chosen feature on the map. For example, buffer of 10 feet can be applied to the mapped centerline of a chosen section of stream, to depict the approximate width of the stream.

C

Clayplain forest: Clayplain forest is a unique natural community that grows on the clay soils of the Champlain Valley. It is dominated by oaks and hickories, and prior to European-American settlement, it was the dominant forest type in the Champlain Valley. Because the deep, rich, soils and flat topography provided ideal agricultural lands, most clayplain forests were cleared and are now quite rare.

Climate change: Refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. *(From the Environmental Protection Agency January 19, 2017 website)*

Community scale: In the context of this guide, the community scale includes the components and process that occur between groups of plants and animals as they interact with one another and with their physical environment. For example, mast stands are described at this scale because they are associated with a particular set of physical features, plants, and wildlife that function together as a community.

Community values mapping: This phrase refers to a specific community-driven planning and mapping exercise intended to identify and rank locations of high public value within particular geographic boundaries. The product of the exercise is a GIS-based map depicting community values that can be integrated with other map data, such as comparisons with locations of high ecological value.

Component: In this guide, we use component to refer to general categories of natural heritage elements found on a landscape. These can be natural or cultural and may include physical landforms, land cover, water resources, vegetation types, human land use, cultural boundaries, wildlife resources, and more. Each inventory layer in Part I of this guide represents a separate landscape component.

Connectivity: Ecologically, this refers to the capacity of individual species to move between areas of habitat via corridors and linkage zones (Meiklejohn et al.)

In this guide, we also use the word to indicate the degree to which similar landscape elements are connected to each other so as to facilitate the movements of organisms and ecological processes between them *(adapted from Staying Connected Initiative definition)*.

We refer to **landscape connectivity** as a network that links large blocks of contiguous, unfragmented habitat (**interior forest blocks**) with those forested habitat blocks that have good cover but are not large enough themselves to maintain populations of wide-ranging species (**connecting blocks**). While interior forest blocks provide the principle home areas for many species, connecting blocks are necessary for wildlife movement. At a fine scale, **riparian connectivity** and **wildlife road crossings** are also key to this connected network, without which there can be little genetic exchange between populations. Read more about connectivity in *Conserving Vermont's Natural Heritage*, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf starting on page 48.

Connectivity block (or **connecting habitat**)**:** Connecting habitat links larger patches of habitat within a landscape, allowing the movement, migration, and dispersal of animals and plants. Riparian areas along streams and rivers, strips of forest cover between developed areas, and even hedgerows/ fencerows all represent potential connecting habitat for wildlife and other organisms. Sometimes these habitats are called corridors even though they are not always linear, as the term implies. *(Adapted from Staying Connected Initiative definition.)*

Conservation: The careful preservation and protection of something; especially planned management of a natural resource to prevent exploitation, destruction, or neglect. (*From the Merriam-Webster Online Dictionary www.merriam-webster.com/dictionary/conservation.*)

In this guide, we keep our use of the word broad, including any strategy that can aid in the protection or thoughtful use of the natural landscape to maintain or enhance its healthy condition.

Conservation easement: A voluntary, legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows landowners to continue to own and use their land, and they can also sell it or pass it on to heirs. The limits of the conservation easement 'run with the land,' meaning that even if the land is inherited or sold the restrictions stay in place. *(Land Trust Alliance definition, found at www.landtrustalliance.org/what-you-can-do/conservation-options)*

Conservation fund: A dedicated pot of money that can be used for conservation projects. These can be raised in response to an immediate opportunity or they can be put into a reserve fund so that money is available when opportunities arise in the future, serving as a "savings account" that can be carried forward into future fiscal years. The most common method in Vermont of raising money for a conservation fund is through a direct appropriation at Town Meeting. *(Adapted from Community Strategies for Vermont's Forests and Wildlife, found at www.vnrc.org/wp-content/uploads/2013/08/VNRC-Forestland-Conservation-10-1-links.pdf)*

Conservation planning: Conservation planning is the foundation of any community's efforts to protect the natural resources and values that are important to a community. For Vermont towns, this can take the form of either a stand-alone natural resources and open space plan (which must then be incorporated into the town plan by reference) or chapters in the municipal plan that address natural resource concerns. Effective conservation planning begins with high quality data and broad community input, includes clearly articulated and measurable objectives, and lists a series of implementation steps. *(From Vermont Natural Resources Council website, at www.vnrc.org/resources/community-planning-toolbox/tools/conservation-and-open-space-plans/)*

Conservation subdivision: A method for promoting conservation by requiring creative development design that allows for the same number of homes to be built as in a standard subdivision, but in a less land-consumptive manner. At least 50 percent of the remaining land is permanently protected and added to an interconnected network of open space. *(Adapted from Community Strategies for Vermont's Forests and Wildlife, found at www.vnrc.org/wp-content/uploads/2013/08/15.-Subdivision-Regulations.pdf)*

Conservation zoning districts: Typically encompass areas defined by the presence of one or more natural features such as blocks of productive forest land, important wildlife habitat, wildlife corridors and crossing areas, rare plant communities, high elevations, scenic ridgelines, steep slopes, wetlands, riparian and water source protection areas. A conservation district can limit development and impose standards to protect locally significant resources, for example, to avoid forest fragmentation, or to ensure that the design and siting of development minimizes adverse impacts to identified resources. *(From Community Strategies for Vermont's Forests and Wildlife, found at www.vnrc.org/wp-content/uploads/2013/08/12.-Conservation-Zoning-Districts.pdf)*

Conserved land: In this guide, we use the phrase conserved land to refer to land protected in some way from development. This includes private land placed under a conservation easement, private land owned by a conservation organization (such as The Nature Conservancy or other land trust), or public land on which restrictions have been placed to prohibit development. In the case of conservation easements, certain land use rights—generally including the right to develop—have been sold or donated by a landowner to a land trust or other entity. These restrictions on land use are tied to the deed to the land, so that future owners are bound by the same legalities as current.

While we use the phrase conservation to include a much broader range of activities (see entry above), we define conserved land as only that land with permanent or semi-permanent restrictions.

Contiguous habitat: Contiguous habitat is an area of forested land with either no roads or low densities of class III or IV roads and little or no human development. Contiguous forest areas may have various age classes of forest cover and, in fact, may be composed of other habitat types such as wetlands or old meadows that are part of the overall contiguous habitat complex. Ideally, these areas are connected with other similar areas so that the animals that use them can move freely to other forested areas and habitats. *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Critical habitat: Refers to a specific geographic area(s) that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection. Critical habitat may include an area that is not currently occupied by the species but that will be needed for its recovery. *(From U.S. Fish & Wildlife Service website, at www.fws.gov/endangered/what-we-do/critical-habitats-faq.html*

Current Use Program: Vermont's Use Value Appraisal (UVA) Program (also known as Current Use) enables eligible private lands where owners practice long-term forestry or agriculture to be appraised based on the property's value of production of wood or food rather than its residential or commercial development value. The Department of Taxes, Division of Property Valuation and Review (PV&R) is the lead agency, but the County Foresters help to administer the Forestry Use Value Appraisal portion of the program. *(From fpr.vermont.gov/forest/your_woods/use_value_appraisal, with more information available at the same site.)*

D

Deer wintering yard or **Deer wintering area:** White-tailed deer in Vermont live near the northern limit of their range in eastern North America. To cope with Vermont's severe climatic conditions, deer have developed a survival mechanism that relies upon the use, access, and availability of winter habitat. These habitat areas are known as deer wintering areas, deer winter habitat or, more commonly, "deer yards." Deer winter habitat is defined as areas of mature or maturing softwood cover, with aspects tending towards the south, southeast, southwest, or even westerly and easterly facing slopes. Here, the snow tends to be shallower after big storms, and deer can "yard-up" without wasting energy. *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Development: In this guide, we use the phrase development to include buildings and area cleared around buildings, parking areas, lawns, gravel pits, construction, engineering or mining operations, and any material change to the use of land.

Development review standards: Requirements, found in a zoning bylaw or subdivision regulation, which a proposed development must meet. *(From Community Strategies for Vermont's Forests and Wildlife, at vnrc.org/wp-content/uploads/2013/08/11.-Writing-Standards-for-Development-Review.pdf)*

Digital mapping: The process of collecting data and creating a virtual image that represents a particular geographic area.

In some cases, physical maps can be digitized to create a virtual image that is visually identical to the physical map. With the aid of a Geographic Information System (GIS), the digital map can then be geographically matched with other data in order to conduct spatial analyses. Many digital maps, however, originate through the interpretation of virtual data such as aerial photographs, radar, or other remote sensing techniques.

Disturbance: In ecological terms, disturbance is an event or force, of nonbiological or biological origin, that brings about mortality to organisms and changes in their spatial patterning in the ecosystems they inhabit *(From Encyclopedia Britannica, at www.britannica.com/science/ecological-disturbance)*. Examples include wind, floods, disease, fire, climate phenomena, and many forms of human land use.

E

Early successional habitats: Young trees and shrubs, often occupying recently disturbed sites and areas such as abandoned farm fields, provide unique and important habitat for many wildlife. Some of the tree and shrub species that colonize abandoned agricultural land and disturbed sites include grey birch, dogwood, aspen species, cherry, willow, and alder. Due to the propensity of these plant species to quickly colonize disturbed sites, they are often referred to as pioneer species. *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Ecological function: The ability of plants and animals to thrive, reproduce, migrate, and move as the climate changes, and the ability of natural ecosystems to function under natural processes. Ecological function is served by high-quality terrestrial and aquatic habitat, natural connections across the landscape, a wide variety of habitat features from low elevation to high, clean water, and healthy rivers, streams, lakes, ponds, and wetlands. *(Learn more from the Vermont Conservation Design report, found at vtfishandwildlife.com/conserve/vermont-conservation-design)*

In this guide, mapping the ecologically functional landscape is also a process used to determine ecological priorities for conservation efforts. This method identifies the features most important for maintaining landscape function, including interior forest blocks, connectivity features, surface waters and riparian areas, and physical landscape diversity, and links them together.

Ecological hotspot: Hotspots are specific locations on the landscape with high ecological value. In this guide, we use the phrase to describe locations where multiple important ecological components occur in the same geographic area. In other words, wetlands, large interior forest blocks, and rare physical features are all important on their own, but locations in which all of these (or other) important features are present can be considered hotspots with an even higher ecological value. In these locations, conservation efforts are likely to have a high ecological payback.

Ecologically Significant Treatment Areas (ESTAs): This is a designation used by Vermont's Use Value Appraisal (Current Use) program to recognize areas particularly sensitive to forest management practices. These include old forests, state-significant natural communities, rare, threatened and endangered species, riparian areas, forested wetlands and vernal pools. While most forest land enrolled in Use Value Appraisal must be actively managed for timber or regeneration, those lands qualifying as ESTAs may be excluded from this requirement.

Endangered species: The term endangered generally refers to species whose continued existence as a viable component of the state's wild fauna or flora is in jeopardy.

A **threatened species** is one whose numbers are significantly declining because of loss of habitat or human disturbance, and unless protected will become an endangered species. *(The above are both Vermont Fish & Wildlife Department definitions, found at vtfishandwildlife.com/conserve/conservation-planning/endangered-and-threatened-species)*

Extinct species: A species no longer in existence.

Extirpated species: A species no longer surviving in regions that were once part of their range. *(The above two definitions are from the U.S. Fish & Wildlife Service Glossary, at www.fws.gov/Midwest/endangered/glossary/index.html)*

Extirpated species can be considered to be locally extinct.

Endangered Species Act of 1973: Aims to provide a framework to conserve and protect endangered and threatened species and their habitats. By providing states with financial assistance and incentives to develop and maintain conservation programs, the Act serves as a method to meet many of the United States' international responsibilities to treaties and conventions such as the Convention on International Trade of Endangered Species of Wild Fauna and Flora and the Western Hemisphere Convention. *(From the U.S. Fish & Wildlife website, at www.fws.gov/international/laws-treaties-agreements/us-conservation-laws/endangered-species-act.html)*

Enduring features: Also called **Physical features** or **Physical landscapes**, enduring features are the parts of the landscape that resist change. They are the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. They remain the same even when changes in land cover and wildlife occur. They remain the same as plants and animals move, and they remain the same even as the climate changes. *(From Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Extirpated species: A species no longer surviving in regions that were once part of their range. [Locally extinct.]

Endangered: The classification provided to an animal or plant in danger of extinction within the foreseeable future throughout all or a significant portion of its range.

Extinct species: A species no longer in existence [anywhere].

(All definitions from U.S. Fish & Wildlife Service Glossary, at www.fws.gov/Midwest/endangered/glossary/index.html)

F

Field inventory or field assessment: These phrases are used in this guide to describe a natural resources evaluation process that takes place in the location of interest. We use these phrases to distinguish from those inventories and assessments that are conducted remotely, such as from the interpretation of aerial photos or from radar data-collection techniques.

Fluvial erosion hazard: Fluvial (or river-related) erosion hazards refer to major streambed and streambank erosion associated with the often catastrophic physical adjustment of stream channel dimensions (width and depth) and location that can occur during flooding. Fluvial erosion becomes a hazard when the stream channel that is undergoing adjustment due to its instability threatens public infrastructure, houses, businesses, and other private investments.

A **fluvial erosion hazard area** includes the stream and land adjacent to the stream. It identifies an area where stream processes may occur that enable the stream to re-establish and maintain a stable slope and dimensions over time. Boundaries attempt to capture lands most vulnerable to fluvial erosion in the near term and indicate the type, magnitude, and frequency of fluvial adjustments anticipated during flood events.

Floodplain: An area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding. For planning purposes, a floodplain can be considered to be the land inundated by water during a flood event. Since floods can be of varying levels of magnitude, a floodplain is often identified by the frequency with which it floods. For example, the 100-year floodplain is the land inundated by water on an average of once every hundred years; a flood of this magnitude has a one percent chance of occurring in any given year.

Fragmentation: When roads, land clearing, development, or other land uses divide forests, waterways, or other natural habitats into smaller and smaller areas, the process is called fragmentation. Depending on the location and scale, fragmentation can negatively affect plant and animal species, wildlife habitat (called habitat fragmentation), and water quality.

G

Geographic Information System (GIS): This phrase refers to computer mapping tools and resources. When digital information is geographically referenced (meaning that the information is linked to specific places on the earth, using a system such as Latitude/Longitude) it can be used to create map layers as well as to perform analyses and even model hypothetical situations ("what if?" scenarios). *(From Vermont Center for Geographic Information webpage, at www.vcgi.vermont.gov/resources/what_is_gis)*

Grassland: Grasslands are open lands dominated by grasses, sedges, and other low vegetation, with few trees or shrubs. Grasslands can include wetlands with low vegetation, too, as well as land actively managed by people such as hay fields. In fact, most of Vermont's grasslands are associated with current or past agricultural practices. Over time, most grasslands naturally grow woody vegetation and become shrubland, and these shrublands in turn become forest if left unmanaged. Vermont's grasslands are therefore inherently ephemeral. Still, they provide important habitat to many species, especially birds.

H

Habitat block: Habitat blocks are areas of at least 20 acres of contiguous habitat that are unfragmented by roads, development, or agriculture. Vermont's habitat blocks are primarily forests, but they also include wetlands, rivers and streams, lakes and ponds, cliffs, and rock outcrops. Forests included in habitat blocks may be young, early-successional stands, actively managed forests, or mature forests with little or no recent logging activity. The defining factor is that there is little or no permanent habitat fragmentation from roads, agricultural lands and other forms of development within a habitat block. For the purposes of this guide, a Class 3 road is considered a fragmenting feature, but a Class 4 road is not.

Hydrography: The science of surveying and charting bodies of water, such as seas, lakes, and rivers. *(From the Oxford Online Dictionary, found at www.oxforddictionaries.com/us/definition/american_english/hydrography)*

I

Impervious surface: In an ecological context, this phrase refers to surfaces that are impenetrable to water. It is generally used in the context of surface water and runoff, referring to structures such as roads, parking lots, rooftops, heavily compacted soils, etc. that change the flow of water by prohibiting infiltration into the soil. In areas with a high density of impervious surfaces, the resulting runoff after a rainfall or snowmelt event can be associated with the overloading of a stormwater system or other drainage challenges.

Impact fee program: A regulatory tool in which developers are required to pay a fee toward the protection or restoration of town-owned open space lands, forests, parks, or recreation areas in exchange for developing land identified by a community as important.

Interior forest block: A subset of habitat blocks, these are areas of the most highly contiguous forest and other natural habitats that are unfragmented by roads, development, or agriculture. While most of what is defined as Vermont's interior forest blocks are primarily forests, they may also include wetlands, rivers and streams, lakes and ponds, cliffs, and rock outcrops. Interior forest blocks may comprise young, early-successional stands, actively managed forests, or mature forests with little or no recent logging activity; the defining factor is that there is little or no permanent habitat fragmentation from roads, agricultural lands and other forms of development within an interior forest block.

L

Land cover: Records the natural landscape as surface components: forest, water, wetlands, urban, etc.

Land use: Documents human uses of the landscape: residential, commercial, agricultural, etc.

Landscape scale: This guide categorizes ecological components into three scales: the **Landscape scale**, the **Community scale**, and the **Species scale**. In this context, the Landscape scale refers to those habitats that extend across town, regional, and even state boundaries—forest networks, waterways, and physical landforms—that are the basic building blocks for ecological processes. This scale is used to capture a sense of overall ecological function of a region as a whole, without consideration for the needs of individual natural communities or species.

Land trust: A private, nonprofit organization that conserves land either through land acquisition or by acquiring conservation easements. The land trust is then responsible for the stewardship of this land in perpetuity, either through active management or by ensuring that the terms of a conservation agreement are upheld.

Land use: Documents human uses of the landscape: residential, commercial, agricultural, etc.

Land cover: Records the natural landscape as surface components: forest, water, wetlands, urban, etc.

Lowland: In this guide, lowlands include the valleys, meadows, and floodplains that surround the state's larger rivers, lakes, and wetlands. They are distinguished from uplands, which are the hills, ridges, and mountains.

M

Management plan: In this guide, management plan refers to a blueprint for the way land and associated water resources will be treated in the future, including both short-term and long-term goals and activities. Usually, management plans are created at the scale of an individual property.

Map layer: In this guide, each distinct dataset that appears on a map is referred to as a layer or map layer. For example, we could digitally create a map that includes the location of conserved lands, wetlands, surface water, and vernal pools. Each of these individual datasets would be considered a layer.

Mast: The fruit and seeds of shrubs and trees that are eaten by wildlife. Hard mast refers to nuts (especially those of beech and oak trees), whereas soft mast refers to berries and fruits of a number of species (such as black cherry, raspberry, blackberry, and apple).

Mast Stands: While most forested areas contain at least a few mast producing trees and shrubs, forests producing significant concentrations of mast are much less common. In BioFinder, a beech or oak Mast Stand exhibits bear scarring on at least 15-25 tree trunks and/or shows some evidence of use by bears. These mast production areas are important to myriad wildlife species and crucial to the survival of Vermont's black bear population.

Monitoring program: Ecological monitoring programs are generally established in order to derive knowledge about how the plants, animals, natural processes, air, water, or soil present in an area change over time. These changes may be studied to assess the way processes or populations fluctuate naturally over time, or they may be established in order to measure the impact of a particular change, such as a flood event or a new development. They include a systematic sampling process in which data is collected and then analyzed.

Municipal plan (or **Town plan**)**:** A plan written by a town or municipality to provide a framework toward attaining community aspirations through public investments, land use regulations, and other implementation programs such as a state-designated downtown or village centers, business improvement districts, or land conservation programs. It can also qualify the community for state grants to fund improvements or receive specialized technical assistance. *(From the Vermont Agency of Commerce and Community Development's Planning Manual, at www.accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/DHCD-Planning-Manual-Module1.pdf)*

N

Natural area: While this term is sometimes used to identify only those areas supporting populations of rare or endangered species or uncommon physical landscapes, this guide uses the phrase to describe any area that is managed in a way that allows natural processes to predominate, with minimal human intervention.

Natural community: An interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. These assemblages of plants and animals repeat across the landscape wherever similar environmental conditions exist. *(Adapted from Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)* More information about natural communities can be found in *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont*, by Elizabeth Thompson and Eric Sorenson.

Rare natural community: The Vermont Fish & Wildlife Department uses a ranking scheme that is part of the national Natural Heritage methodology to describe the relative rarity of natural community types in Vermont. The range is from S1 (very rare) to S5 (common and widespread). S1 and S2 natural community types are considered rare for BioFinder.

Uncommon natural community: S3 and S4 natural community types are considered uncommon for BioFinder. While these natural community types are generally uncommon naturally, since their soils are uncommon, some have been made more uncommon by the conversion of habitat for agricultural or development purposes.

Common natural community: Using the same ranking system, S5 communities are considered common.

Significant natural community: Only those natural communities considered significant at the state level are mapped in BioFinder and the maps associated with this guide. In addition to the rarity ranking described above, all mapped natural communities are also assigned a quality rating that ranges from A (excellent) to D (poor) based on size, condition, and landscape context. Occurrences of rare natural communities are considered significant when their quality is ranked A, B, or C. Uncommon natural communities are significant when they have a quality rank of A or B. Only A-quality occurrences of common natural communities are considered significant. *(Adapted from ANR's "Guidelines for the Conservation and Protection of State-Significant Natural Communities," at anr.vermont.gov/sites/anr/files/co/planning/documents/guidance/VFWD%20Natural%20Community%20Conservation%20Guidelines%2010-21-2004.pdf)*

Natural cover: Any type of vegetation that wildlife can use for shelter. This includes forest, wetland, and shrubs. Developed land, roads, crops, grasslands, and pasture are not considered natural cover.

Natural heritage: All the natural resources valued by a place's residents and visitors. In many Vermont communities, these include forests, clean waters, vibrant fisheries, healthy wildlife populations, rare species, significant natural communities, and biodiversity. *(Adapted from Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Natural resources: Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain. *(From the Oxford English Dictionary, www.oxforddictionaries.com/us/definition/american_english/natural-resources)*

In this guide, the phrase is used broadly to include any feature of the natural landscape valued by our human communities in any way. In addition to economic gain, this can include cultural, ecological, personal, and other means of assessing value.

Natural Resources Atlas: This publicly available online mapping resource is intended to provide geographic information about environmental features and sites. In addition to map navigation tools, the Atlas allows users to link to documents, generate reports, export search results, import data, search, measure, mark-up, query map features, and print PDF maps. It was created by Vermont's Agency of Natural Resources and can be found at *anr.vermont.gov/maps/nr-atlas*.

Non-regulatory tool: In this guide, we use this phrase to describe strategies for implementing planning goals that do not involve bylaws or legal requirements. In a land use context, examples include encouraging the creation of land stewardship or management plans, education initiatives, and incentives programs.

A **regulatory tool** is a strategy for implementing planning goals that does involve bylaws or other legal processes. Examples include defining standards for a development review process, establishing zoning districts or subdivision regulations, and the creation of road and trail policies.

O

Orthophoto or **orthophotograph:** An orthophoto is an aerial photo that has been matched up with mapping coordinates so that specific locations align geographically with other maps, taking a flat photograph and adjusting it for the curvature of the earth.

Aerial photo: A photograph taken from an aircraft.

Overlay District: A resource-based zoning district that is superimposed over underlying zoning districts to limit the impacts of development on resources that have been identified for special consideration. Since overlay districts follow the resource, they may apply to only a portion of a parcel, allowing development on land outside of the overlay district, while protecting resources on land within the district. *(Adapted from Community Strategies for Vermont's Forests and Wildlife, at vnrc.org/wp-content/uploads/2013/08/14.-Overlay-Districts.pdf)*

P

Palustrine: Wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens. *(from U.S. Fish & Wildlife definition at www.fws.gov/wetlands/Documents/classwet/palustri.htm)*
In locations near the ocean, the word can also include tidal areas with low salinity.

Patch (as in **Vegetation Patch** or **Habitat Patch**): In this guide, the term patch refers to a relatively small area of intact vegetation or habitat surrounded by something different, often development, agriculture, or other human-influenced environments, although the surrounding area could simply be a different type of vegetation or habitat. Patches often provide resources or refuge to certain wildlife species but often lack sufficient size or condition to act as these species' core habitat.

Physical landscape: Physical landscapes (also called enduring features) are the parts of the landscape that resist change. They are the hills and valleys, the underlying bedrock, and the deposits left behind by glaciers. They remain largely unchanged when changes in land cover and wildlife occur, as plants and animals move, and even as the climate changes. In this guide and on the Natural Resources Atlas, physical landscapes are represented as **Rare**, **Responsibility** and **Representative**.

Rare physical landscapes are those that cover less than 4.5 percent of Vermont's land area. These represent rarity in the physical landscape.

Responsibility physical landscapes are those that may be common in our region, but they are rare overall. For example, calcium-rich landscapes are fairly typical in much of Vermont, but because they are rare in a larger regional context, species requiring these areas rely heavily on our landscape for their continued presence.

Representative physical landscapes are particular examples of more common physical landscape types, selected because they are in the best condition and/or have the largest patch size compared to others of the same type.

Protected area: A geographically defined area designated or regulated and managed to achieve specific conservation objectives. *(From the Convention on Biological Diversity, found at www.cbd.int/protected/pacbd/)* While specific objectives may change between one place and another, development is generally limited or prohibited.

R

Rare species: A rare species of plant or animal is one that has only a few populations in the state and that faces threats to its continued existence in Vermont. The Vermont Fish & Wildlife Department uses a ranking scheme to describe the relative rarity of species in Vermont, using a national Natural Heritage methodology. The range is from S1 (very rare) to S5 (common and widespread). Species are assigned a rarity rank based on the number of known individuals, the population size statewide, and the degree to which the populations are threatened. Rare species are generally considered to be those with twenty or fewer populations statewide, whereas **uncommon species** are generally considered those with more than 20 but 80 or fewer populations statewide.

Regional Planning Commission (RPC): A body that provides planning guidance and structure for numerous member municipalities within a defined area of Vermont. RPCs create regional plans that identify areas and activities of regional significance or potential impact, promote coordination between member municipalities, and provide guidelines for municipal planning activities. They also advise those municipalities in their individual planning processes, provide technical and legal assistance for creating and implementing municipal plans and related bylaws and implementation activities, and review municipal plans for compliance with state and regional regulations, among other activities. Learn more at www.vapda.org/.

Regulatory tool: In this guide, we use this phrase to describe strategies for implementing planning goals that involve bylaws or other legal requirements or processes. Examples include defining standards for a development review process, establishing zoning districts or subdivision regulations, and the creation of road and trail policies.

A **non-regulatory tool** is a strategy for implementing planning goals that do not involve bylaws or legal requirements. In a land use context, examples include encouraging the creation of land stewardship or management plans, education initiatives, and incentives programs.

Restoration: In ecology, this word refers to the process of "re-establishing the structure, productivity and species diversity of the forest originally present. In time, ecological processes and functions will match those of the original forest." (*Lamb and Gilmour 2003, found at cmsdata.iucn.org/downloads/rehabilitation_and_restoration_of_degraded_forests.pdf*)

Riparian area: The word riparian literally means "of, or pertaining to, the bank of a river or lake." Riparian areas are ecosystems comprised of streams, rivers, lakes, wetlands, and floodplains that form a complex and interrelated hydrological system. These ecosystems extend up and down streams and along lakeshores and include all land that is directly affected by surface water (Quoted from Verry et al., 2000).

Riparian ecosystems are generally high in biological diversity. They are "characterized by frequent disturbances related to inundation, transport of sediments, and the abrasive and erosive forces of water and ice movement that, in turn, create habitat complexity and variability…resulting in ecologically diverse communities" (Quoted from Verry et al., 2000).

Riparian wildlife connectivity: This phrase refers to lands along streams, rivers, lakes and ponds used by wildlife and plants to move. Sometimes these areas are called **riparian corridors** even though they are not always linear, as the term implies. Also see **habitat connectivity**.

River easement: A conservation easement that allows a river to change its course naturally over time, without human interference.

Runoff: Surface runoff is water from rain, snowmelt, or other sources that flows over the land surface. When runoff flows along the ground, it can pick up soil contaminants such as petroleum, pesticides, or fertilizers that become discharge or overland flow. *(Excerpted From Science Daily's Reference Terms, found at www.sciencedaily.com/terms/surface_runoff.htm)*

S

Satellite imagery: An image captured from a satellite. There are several types of satellite images. Some are basic photographic images (see aerial photo or orthophoto) that capture the visible landscape from above. Some use other technologies, such as infrared sensors, which measure the heat emitted from different parts of the land or atmosphere. In addition to being used purely as visual images, some satellite images can be analyzed or interpreted to suggest other data, including elevation, land cover, weather, and much more.

Setback: For municipal planning and implementation purposes, a setback is a distance between a structure or land use activity and a feature such as a property line, road, or a natural element like a riverbank, vernal pool, or forest. In standards or bylaws, municipalities can require a minimum or maximum setback from a defined feature to achieve a particular planning goal.

Shrubland: These are areas dominated by low, dense shrub vegetation such as dogwood, willow, tall grasses, and sedges. They are often associated with the margins of grassland habitats and are influenced by human activities such as agriculture or active land management, as well as by natural disturbances.

Grassland: Grasslands are open lands dominated by grasses, sedges, and other low vegetation, with few trees or shrubs. Grasslands can include wetlands with low vegetation, too, as well as land actively managed by people such as hay fields. In fact, most of Vermont's grasslands are associated with current or past agricultural practices. Over time, most grasslands naturally grow woody vegetation and become shrubland, and these shrublands in turn become forest if left unmanaged. Vermont's grasslands are therefore inherently ephemeral. Still, they provide important habitat to many species, especially birds.

Species assemblage: A group of species that share similar ecological or habitat requirements and are likely to be found together.

Species richness or **Biological richness:** The number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species. Species diversity is one component of the broader concept of biodiversity. *(From the Encyclopedia of Earth, found at www.eoearth.org/view/article/156216/)*

Species scale: This guide categorizes ecological components into three scales: the **Landscape scale**, the **Community scale**, and the **Species scale**. In this context, the species scale refers to those habitats necessary for the survival of specific fish, wildlife, and plants. For example, wildlife crossings are locations where bear, bobcat, fisher, and other wide-ranging species are most likely to cross roads as they travel to meet daily or seasonal dietary needs, disperse to find mates, or fulfill other requirements. While they tend to be small in size, species-scale components are essential for maintaining biodiversity by supporting species with a known conservation need in the state or region.

Standards (as in Road or Trail Standards)**:** In the context of planning, standards are defined sets of principles that guide the implementation of a plan or its associated bylaws. Standards generally include a list of recommended or required practices for achieving a particular goal.

Stewardship: This word is often used in the context of land use planning and management to refer to the manner in which we care for land. Rather than referring to any specific practices, stewardship encompasses an ethic of responsible land use that includes a thoughtful evaluation of land use activities and their impacts to natural features and human communities.

Subdivision regulation: A regulatory strategy used to guide the pattern of development within a community. Subdivision regulations evaluate the impact of land subdivision on natural resources, allowing communities to control both the configuration of lots and the location and extent of site disturbance, site improvements, and the future location of development, roads, building sites, and supporting infrastructure within lots. *(Adapted from Community Strategies for Vermont's Forests and Wildlife, at www.vnrc.org/wp-content/uploads/2013/08/VNRC-Forestland-Conservation-10-1-links.pdf)*

Substrate: The surface or material on which an organism or ecosystem lives.

Succession: Ecological succession refers to more-or-less predictable and orderly changes in the composition or structure of an ecological community. Succession may be initiated either by formation of new, unoccupied habitat (e.g., a lava flow or a severe landslide) or by some form of disturbance (e.g. fire, severe windthrow, logging) of an existing community. *(From Science Daily's Reference Terms, at www.sciencedaily.com/terms/ecological_succession.htm)*

Surface water: In this guide, BioFinder, and the Natural Resources Atlas, surface water includes all areas inundated by water (rivers, streams, lakes, and ponds). When surface water appears as a map component, it includes the entire valley bottom in which a river or stream has migrated over time and in which flooding is expected.

Surficial materials (or **Surficial geology**): This phrase is used to describe the sands, gravels, clays, peats, and other deposits found on top of the bedrock as a result of either glacial activity or post-glacial events like flooding. Bedrock and surficial geology together have a profound influence on the soils in which Vermont's plants grow. *(Adapted from Conserving Vermont's Natural Heritage, at vtfishandwildlife.com/sites/fishandwildlife/files/documents/Get%20Involved/Partner%20in%20Conservation/Conserving_Vermont's_Natural_Heritage.pdf)*

Examples of surficial materials include till—piles of rocks and debris left behind by glaciers that cover most of the bedrock in the state—and the deep clay deposits of the Champlain Valley left by post-glacial lakes.

T

Tax stabilization program: A program in which a municipality enters into a contract with owners, lessees, or operators of land in order to promote a particular goal, such as forestry and open space preservation. These contracts can be written to stabilize taxes in a variety of ways: by fixing property values, tax rates, or the amount or percentage of annual tax assessed. *(Adapted from Community Strategies for Vermont's Forests and Wildlife, at www.vnrc.org/wp-content/uploads/2013/08/VNRC-Forestland-Conservation-10-1-links.pdf)*

Threatened species: A species whose numbers are significantly declining because of loss of habitat or human disturbance, and unless protected will become an endangered species. *(From Vermont Fish & Wildlife Department website, at vtfishandwildlife.com/conserve/conservation-planning/endangered-and-threatened-species)*

An **endangered species** generally refers to a species whose continued existence as a viable component of the state's wild fauna or flora is in jeopardy. *(Also from Vermont Fish & Wildlife Department website)*

Town forest: Land owned by a municipality in order to protect a water supply, produce timber, provide recreation opportunities, supply affordable firewood, maintain wildlife habitat, or other purposes fulfilling a municipality's goals. (*Adapted from Community Strategies for Vermont's Forests and Wildlife, at www.vnrc.org/wp-content/uploads/2013/08/VNRC-Forestland-Conservation-10-1-links.pdf*)

Town plan (or **Municipal plan**): A plan written by a town or municipality to provide a framework toward attaining community aspirations through public investments, land use regulations, and other implementation programs such as a state-designated downtown or village centers, business improvement districts, or land conservation programs. It can also qualify the community for state grants to fund improvements or receive specialized technical assistance. *(From the Vermont Agency of Commerce and Community Development's Planning Manual, at www.accd.vermont.gov/sites/accdnew/files/documents/CD/CPR/DHCD-Planning-Manual-Module1.pdf)*

U

Uncommon Species: These are defined by the Natural Heritage Inventory of the Vermont Fish & Wildlife Department as facing a "moderate risk of extinction or extirpation due to restricted range, relatively few populations or occurrences (often 80 or fewer), recent and widespread declines, or other factors."

Rare species face a higher risk of extirpation and generally have 20 or fewer populations statewide. The Vermont Fish & Wildlife Department uses a ranking scheme to describe the relative rarity of species in Vermont, using a national Natural Heritage methodology.

Upland: An area of high or hilly land. In this guide, uplands are distinguished from the lowlands which are the valleys, meadows, and floodplains that surround rivers, lakes, or wetlands.

Use Value Appraisal: Vermont's Use Value Appraisal (UVA) Program (also known as Current Use) enables eligible private lands where owners practice long-term forestry or agriculture to be appraised based on the property's value of production of wood or food rather than its residential or commercial development value. The Department of Taxes, Division of Property Valuation and Review (PV&R) is the lead agency, but the County Foresters help to administer the Forestry Use Value Appraisal portion of the program. *(From fpr.vermont.gov/forest/your_woods/use_value_appraisal, with more information available at the same site)*

V

Vermont Conservation Design: This phrase refers to a map-based blueprint for conservation developed by the Vermont Fish & Wildlife Department to aid in prioritizing the protection and enhancement of ecological function across Vermont. This blueprint maps the priority and highest priority network that together maintains the ecologically functional landscape, based on the identification of connections between large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. When conserved or managed appropriately to retain or enhance ecological function, this network will sustain Vermont's natural legacy into the future.

Vernal pool: Vernal pools are small, ephemeral pools that occur in natural basins within upland forests. They typically have no permanent inlet or outlet streams and generally last only a few months and then disappear by the end of summer, although some pools may persist in wet years. The periodic drying prevents the establishment of fish populations, supporting a specialized assemblage of species that can include amphibians, insects, mollusks, and other invertebrates.

W

Water quality: Water quality measurements can contain diverse components. Assessments could include measures of bacteria levels, the concentration of dissolved oxygen, quantities of solids suspended in the water, algal growth, heavy metals, herbicides, or pesticides. Whether water quality is "good" or "bad" depends on the intended use of the water; water for human consumption may have a different threshold of each measurement than natural ecosystems. However "poor" water quality can pose risks for both human and ecosystem health, if these thresholds are exceeded.

Water resource: Typically, a water resource is a source of water that is useful or potentially useful in some way.

In this guide, the phrase includes all surface water: streams, rivers, lakes, ponds, wetlands, and vernal pools.

Wetland: Wetlands are vegetated ecosystems characterized by abundant water. Wetlands include the vegetated, shallow-water margins of lakes and ponds and the seasonally flooded borders of rivers and streams. They occur in an amazing diversity of topographic settings across the landscape, including basins, seepage slopes, and wet flats. All wetlands have three characteristics in common. First, all are inundated by or saturated with water during varying periods of the growing season. Second, they contain wetland or hydric soils, which develop in saturated conditions and include peat, muck, and mineral soil types. Finally, wetlands are dominated by plants that are adapted to life in saturated or inundated soils. Vermont's wetlands range in size from vernal pools and seeps that may be a few hundred square feet or less to vast swamps and marshes occupying thousands of acres along Otter Creek and Lake Champlain.

Swamps are wetlands dominated by woody plants, either trees or shrubs.

Marshes are wetlands dominated by herbaceous plants.

Fens are peat-accumulating open wetlands that receive mineral-rich groundwater.

Bogs are also peat-accumulating wetlands but are isolated from groundwater or surface water runoff by deep peat and therefore receive most of their water and nutrients from precipitation.

Vernal pools are small, isolated, seasonally inundated wetlands typically surrounded by upland forests.

A wetland complex is an area that includes two or more wetlands in close proximity that influence one another in function. The complex area usually includes the riparian areas that connect each wetland to the next.

Wide-ranging species: A species whose movements extend across a large geographic area. Some wide-ranging species move these distances on a regular basis, as when maintaining a large home range to access a variety of food sources (e.g. black bear). Others may move only seasonally (e.g. with a moose that inhabits different habitat types in summer and in winter).

Wildlife: Definitions of wildlife vary to a surprising degree. In this guide, we generally include both animals and plants in our definition, although the phrase often places emphasis on animals more than plants. In terms of wildlife management, fish and other aquatic organisms are often separated when referring to wildlife, with the word emphasizing terrestrial organisms, as in the agency title "Vermont Fish & Wildlife Department." While these words are sometimes separated for practical management purposes, the agency recognizes fish as a component of wildlife, and fish should be assumed to be included in this guide's use of the word.

Wildlife corridor: Components of the landscape that provide a continuous or near continuous pathway that may facilitate the movement of target organisms or ecological processes between areas of core habitat.

Wildlife road crossings: In general, these are locations where animal wildlife are likely to cross roads. In this guide, this phrase often refers to an assessment of structural components, since data on actual wildlife movement is scarce. These structural assessments consider locations where there is forest and/or other natural vegetation on both sides of a road, an absence of guardrails, a gentle gradient, and other roadside factors to predict the ease of movement for a variety of wildlife species. While this assessment is not specific to particular species, it offers a generalized sense of where the greatest variety of species is likely to move. See also **habitat connectivity**.

Working forest: This phrase refers to forests that generate economic benefits. This usually indicates timber but can also include products such as maple syrup, Christmas trees, or other forest products.

Z

Zoning: Zoning bylaws are a regulatory strategy used by local governments to manage land use by defining districts where different uses—houses, car dealerships, day care centers, outdoor recreation, and much more—can occur. Zoning bylaws also regulate physical characteristics of development within each district such as lot sizes, setbacks, and septic system requirements. *(Adapted from www.vnrc.org/wp-content/uploads/2013/08/VNRC-Forestland-Conservation-10-1-links.pdf)*

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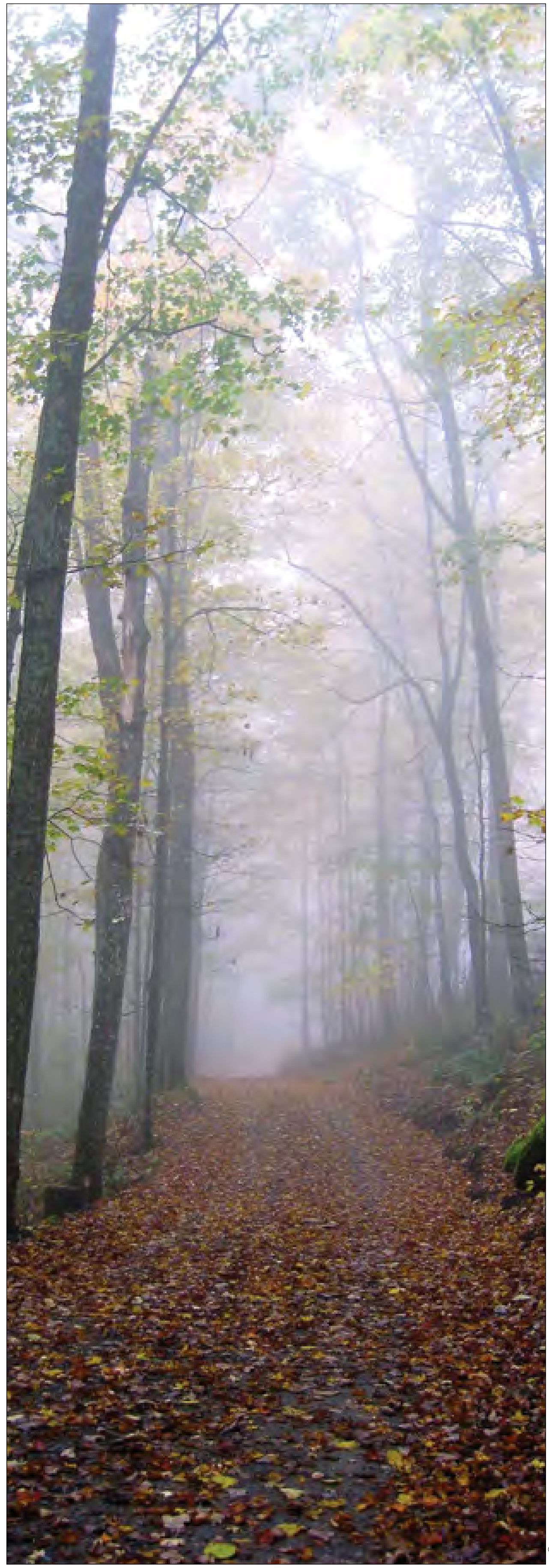

End Notes

Map 2: Land Cover

[1] There are two land cover data sources available in Vermont: the Coastal Change Analysis Program (C-CAP), displayed here, and the National Land Cover Database (NLCD). The two databases are similar in many ways, and both are equally useful. We chose C-CAP because it is stronger at differentiating between wetland types, but planners with mapping experience who have different goals in mind, identifying agricultural land for example, may prefer NLCD.

Map 3: Forest Pattern

[1] See https://legislature.vermont.gov/assets/Documents/2016/Docs/ACTS/ACT171/ACT171%20Act%20Summary.pdf for more information about Act 171.

[2] Contact Vermont Fish & Wildlife Department's Community Wildlife Program for more information on conducting field inventories.

[3] The Bobolink Project has management guidelines for grassland birds at www.bobolinkproject.com/docs/NRCS_Grassland_leaflet.pdf.

[4] EQIP or other NRCS programs may be available to assist some landowners with these practices. Delaying mowing until after the nesting season is one common practice to help grassland birds.

[5] See www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/ for more information about United States Department of Agriculture programs.

[6] See www.fws.gov/lcfwro/pdf/PFW1.pdf for more information about the Partners for Fish & Wildlife Program in Vermont.

[7] See www.bobolinkproject.com/docs/NRCS_Grassland_leaflet.pdf.

[8] See www.fpr.vermont.gov/forest/your_woods/mgmt_plans for more information about management plans.

[9] See www.vpic.info/Publications/Reports/Implementation/ImpactFees.pdf to learn more about impact fee programs.

[10] See www.fpr.vermont.gov/forest/your_woods/use_value_appraisal for more information about the Use Value Appraisal (Current Use) program in Vermont.

[11] See www.vtcoverts.org/ to learn more about Vermont Coverts.

[12] See www.vermontwoodlands.org/ for more information about the Vermont Woodlands Association.

[13] See www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/ for more information about NRCS in Vermont.

[14] See www.vacd.org/conservation-districts/ for more information about Vermont's Natural Resources Conservation Districts.

[15] See page 22 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using the Current Use program in planning.

[16] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserving land as a community strategy.

[17] See page 31 in *Community Strategies for Vermont's Forests and Wildlife* for more information on town forests.

[18] See page 63 in *Community Strategies for Vermont's Forests and Wildlife* for more information on Road and Trail Standards.

[19] See page 16 in *Community Strategies for Vermont's Forests and Wildlife* for more information on certification programs.

[20] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* for more information on writing standards for development review.

Map 5: Water

[1] The full citation for this book is: Chase, V., L. Demming, and F. Latawiec. 1995. *Buffers for Wetlands and Surface Waters: A Guidebook for New Hampshire Municipalities*. Concord, NH: Audubon Society of New Hampshire.

[2] DEC's Rivers Webpage has links to many resources, at www.dec.vermont.gov/watershed/rivers.

[3] DEC's Lakes and Ponds Webpage has links to many resources, at www.dec.vermont.gov/watershed/lakes-ponds.

[4] More information about writing clear definitions can be found on page 68 in *Community Strategies for Vermont's Forests and Wildlife*.

[5] See www.dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_RiverCorridorEasementGuide.pdf for more information about River Corridor Easements.

[6] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[7] Town Road Management Standards can be found at www.dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program. Following these standards is required by statute.

[8] See www.fpr.vermont.gov/sites/fpr/files/About_the_Department/Rules_and_Regulations/Library/Riparian%20Final%20Guidelines%20(signed%20copy)_resized.pdf for the guidelines used by the Vermont Agency of Natural Resources in riparian areas of ANR-owned lands.

[9] More information on invasive species can be found at www.anr.vermont.gov/about_us/special-topics/invasive-species.

[10] Find resources about Green Infrastructure for Homeowners at the Vermont Department of Environmental Conservation website.

[11] See www.floodready.vermont.gov/improve_infrastructure.

[12] Acceptable Management Standards for Maintaining Water Quality of Logging Jobs in Vermont is available at www.fpr.vermont.gov/about_us/rules_regulations/amps.

[13] Learn more about the Vermont Wetland Rules at www.dec.vermont.gov/watershed/wetlands/jurisdictional/rules.

[14] More information about writing clear definitions can be found on page 68 in *Community Strategies for Vermont's Forests and Wildlife*.

[15] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[16] See www.dec.vermont.gov/watershed/wetlands for more information on Vermont Wetlands.

[17] See www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf for more information on ESTAs.

[18] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[19] See pages 41-62 in *Community Strategies for Vermont's Forests and Wildlife.*

[20] See Vermont's Wetlands Rules at www.dec.vermont.gov/watershed/wetlands/jurisdictional/rules.

[21] See www.dec.vermont.gov/watershed/wetlands/protect/restore for information about wetlands restoration.

[22] See page 63 in *Community Strategies for Vermont's Forests and Wildlife* for more information on road management standards.

[23] For more information, contact your regional NRCS office.

[24] Learn more about the National Wetlands Inventory at www.fws.gov/wetlands/.

[25] The Vermont DEC Wetlands Section webpage is at www.dec.vermont.gov/watershed/wetlands.

[26] See www.fpr.vermont.gov/forest/your_woods/mgmt_plans for more information about management plans.

[27] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[28] See page 50 in *Community Strategies for Vermont's Forests and Wildlife* for more information about Overlay Districts.

[29] More information about zoning and subdivision regulations is available on pages 41-62 of *Community Strategies for Vermont's Forests and Wildlife*.

Map 6: Wildlife Resources at the Community and Species Scales

[1] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[2] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[3] See www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[4] Overlay Districts are described on page 50 in *Community Strategies for Vermont's Forests and Wildlife*.

[5] More information about writing clear definitions can be found on page 68 in *Community Strategies for Vermont's Forests and Wildlife*.

[6] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[7] See pages 41-54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about strategies involving zoning.

[8] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[9] See www.anr.vermont.gov/about_us/special-topics/invasive-species for more information about invasive species.

[10] Landowner incentives programs include those found at www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/, www.fws.gov/lcfwro/pdf/PFW1.pdf, www.vtfishandwildlife.com/get-involved/partner-in-conservation/eqip-for-wildlife-habitat, or www.fpr.vermont.gov/forest/your_woods/cost_share.

[11] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[12] See pages 41-54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about strategies involving zoning.

[13] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[14] Learn more about town forests on page 31 of *Community Strategies for Vermont's Forests and Wildlife*.

[15] More information about writing clear definitions can be found on page 68 in *Community Strategies for Vermont's Forests and Wildlife*.

[16] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[17] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[18] See pages 41-54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about strategies involving zoning.

[19] Learn more about Access Management at www.vnrc.org/resources/community-planning-toolbox/tools/access-management/.

[20] Learn more about improving culverts and road infrastructure at www.floodready.vermont.gov/improve_infrastructure/roads_culverts.

[21] See pages 41-54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about strategies involving zoning.

[22] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[23] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[24] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

Determining the Ecological Context

[1] The Common Natural Communities category captures several elements that appear in Part I as their own entities, including deer wintering habitat.

Including Community Values

[2] Learn more about the Vernal Pool Mapping Project and the Vermont Center for Ecostudies at www.vtecostudies.org/projects/forests/vernal-pool-conservation/vermont-vernal-pool-mapping-project/.

Developing and Choosing Options

[3] Learn more about Vermont's Use Value Appraisal program at www.fpr.vermont.gov/forest/your_woods/use_value_appraisal.

[4] The *Planning Manual* is available online at www.accd.vermont.gov/community-development/town-future/municipal-planning-manual.

[5] Learn more about Municipal Planning Grants at www.accd.vermont.gov/community-development/funding-incentives/municipal-planning-grant.

Appendix A: Strategies and Components

[1] Contact Vermont Fish & Wildlife Department's Community Wildlife Program for more information on conducting field inventories, at www.vtfishandwildlife.com/get-involved/partner-in-conservation/community-wildlife-program.

[2] More information about writing clear definitions can be found on page 68 in *Community Strategies for Vermont's Forests and Wildlife*.

[3] See www.vtfishandwildlife.com/learn-more/landowner-resources for resources available through Vermont Fish & Wildlife Department. Vermont Department of Forests, Parks, and Recreation has additional resources at www.fpr.vermont.gov/forest/your_woods.

[4] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[5] For more information, see www.vtconservation.com/about-conservation-commissions/.

[6] See page 31 in *Community Strategies for Vermont's Forests and Wildlife* for more information about Conservation Funds and Town Forests.

[7] See page 54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about subdivision regulations.

[8] See www.fpr.vermont.gov/forest/your_woods/use_value_appraisal for more information about Vermont's Use Value Appraisal program.

[9] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[10] See page 31 in *Community Strategies for Vermont's Forests and Wildlife* for more information about Conservation Funds and Town Forests.

[11] See www.fpr.vermont.gov/forest/your_woods/mgmt_plans for more information about management plans.

[12] See www.vpic.info/Publications/Reports/Implementation/ImpactFees.pdf to learn more about Impact Fees.

[13] See www.fpr.vermont.gov/forest/your_woods/use_value_appraisal for more information about Vermont's Use Value Appraisal program.

[14] The Vermont Coverts website can be found at www.vtcoverts.org/

[15] See www.vermontwoodlands.org/ for the Vermont Woodlands Association webpage.

[16] See www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/ for the Vermont NRCS webpage.

[17] See www.vacd.org/conservation-districts/ to learn more about Natural Resources Conservation Districts across Vermont.

[18] Learn more about Local Tax Stabilization on page 22 of *Community Strategies for Vermont's Forests and Wildlife*.

[19] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[20] See page 31 in *Community Strategies for Vermont's Forests and Wildlife* for more information about Conservation Funds and Town Forests.

[21] More information about road and trail policies can be found on page 63 in *Community Strategies for Vermont's Forests and Wildlife*.

[22] See page 16 in *Community Strategies for Vermont's Forests and Wildlife* for strategies to sustain working forests.

[23] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[24] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[25] To learn more about River Corridor Easements, see www.dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_RiverCorridorEasementGuide.pdf.

[26] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[27] Town Road Management Standards can be found at www.dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program. Following these standards is required by statute.

[28] See www.fpr.vermont.gov/sites/fpr/files/About_the_Department/Rules_and_Regulations/Library/Riparian%20Final%20Guidelines%20(signed%20copy)_resized.pdf for the guidelines used by the Vermont Agency of Natural Resources in riparian areas of ANR-owned lands.

[29] Learn more about invasive species at www.anr.vermont.gov/about_us/special-topics/invasive-species.

[30] Find resources about Green Infrastructure for Homeowners at the Vermont Department of Environmental Conservation website.

[31] See www.floodready.vermont.gov/improve_infrastructure.

[32] Learn more about acceptable management practices at www.fpr.vermont.gov/about_us/rules_regulations/amps.

[33] EQIP or other NRCS programs may be available to assist some landowners with these practices. Delaying mowing until after the nesting season is one common practice to help grassland birds.

[34] See www.bobolinkproject.com/docs/NRCS_Grassland_leaflet.pdf.

[35] See www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/.

[36] See www.fws.gov/lcfwro/pdf/PFW1.pdf for a brochure about the Partners for Fish & Wildlife program in Vermont.

[37] See www.bobolinkproject.com/docs/NRCS_Grassland_leaflet.pdf.

[38] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[39] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[40] See www.fpr.vermont.gov/forest/your_woods/use_value_appraisal for more information about Vermont's Use Value Appraisal program.

[41] Conservation zoning is described on page 41 in *Community Strategies for Vermont's Forests and Wildlife*.

[42] Overlay districts are described on page 50 in *Community Strategies for Vermont's Forests and Wildlife*.

[43] Learn more about Access Management at www.vnrc.org/resources/community-planning-toolbox/tools/access-management/.

[44] Information about conservation easements is available on page 25 in *Community Strategies for Vermont's Forests and Wildlife*.

[45] See pages 41-54 in *Community Strategies for Vermont's Forests and Wildlife* for more information about strategies involving zoning.

[46] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[47] See page 31 in *Community Strategies for Vermont's Forests and Wildlife* for more information about Conservation Funds and Town Forests.

[48] Learn more about invasive species at www.anr.vermont.gov/about_us/special-topics/invasive-species.

[49] A few incentives programs can be found at www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/, www.fws.gov/lcfwro/pdf/PFW1.pdf, www.vtfishandwildlife.com/get-involved/partner-in-conservation/eqip-for-wildlife-habitat, or www.fpr.vermont.gov/forest/your_woods/cost_share.

[50] Information about management plans can be found at www.fpr.vermont.gov/forest/your_woods/mgmt_plans.

[51] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[52] Overlay districts are described on page 50 in *Community Strategies for Vermont's Forests and Wildlife*.

[53] See pages 41-62 in *Community Strategies for Vermont's Forests and Wildlife*.

[54] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[55] See the Vermont Department of Environmental Conservation's Wetlands page at www.dec.vermont.gov/watershed/wetlands.

[56] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

[57] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[58] See pages 41-62 in *Community Strategies for Vermont's Forests and Wildlife*.

[59] Find Vermont's Wetlands Rules at www.dec.vermont.gov/watershed/wetlands/jurisdictional/rules.

[60] Learn more about wetland restoration at www.dec.vermont.gov/watershed/wetlands/protect/restore.

[61] More information about road and trail policies is available on page 63 in *Community Strategies for Vermont's Forests and Wildlife*.

[62] For more information, contact your regional NRCS office.

[63] See page 25 in *Community Strategies for Vermont's Forests and Wildlife* for more information on using conserved land as a community strategy.

[64] For example, see *Landowner Guide: Habitat Management for Lands in Vermont*, available at www.vtfishandwildlife.com/about-us/fish-wildlife-store.

[65] See www.vtfishandwildlife.com/sites/fishandwildlife/files/documents/Conserve/RegulatoryReview/Guidelines/Management_Guidelines_for_Optimizing_Mast_Yields_in_Beech_Mast_Production_Areas.pdf for guidance on optimizing mast yield.

[66] For more information, contact your regional NRCS office.

[67] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

[68] Learn more about ESTAs through Vermont Department of Forests, Parks, and Recreation. Eligible land is described at www.fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Your_Woods/Library/Forest%20Land%20Eligibility%20and%20Definitions.pdf.

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[72] See page 36 in *Community Strategies for Vermont's Forests and Wildlife* about writing standards for development review.

Mapping Vermont's Natural Heritage

A Mapping and Conservation Guide for Municipal and Regional Planners in Vermont

For more copies of the manual, please contact us at: (802) 828-1000 or visited www.vtfishandwildlife.com for an electronic version

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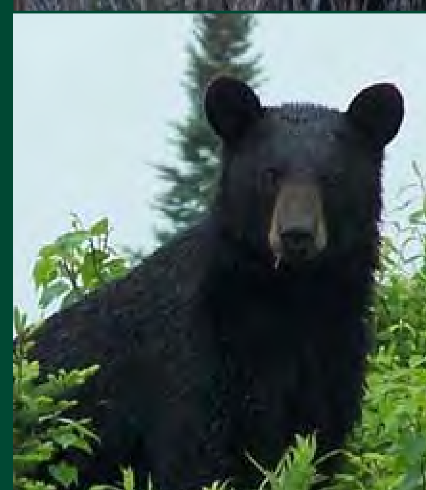
VERMONT FISH & WILDLIFE

BIG GAME MANAGEMENT PLAN 2010 - 2020

CREATING A ROAD MAP FOR THE FUTURE



VERMONT
FISH & WILDLIFE DEPARTMENT
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Most of the programs described in this report are funded through the *Federal Aid in Wildlife Restoration Program*. This program was initiated in 1937 as the Federal Aid In Wildlife Act and created a system whereby taxes are paid on firearms, ammunition and archery equipment by the public who hunts. Today this excise tax generates more than one hundred million dollars each year that are dedicated to state wildlife restoration and management projects across the United States. The state of Vermont uses these monies for acquiring land, and for restoring and managing wildlife. These excise tax dollars, coupled with state hunting license fees have been the predominate source of money funding the successful restoration and management of Vermont's wildlife resources.

Vermont Fish & Wildlife Department

Agency of Natural Resources

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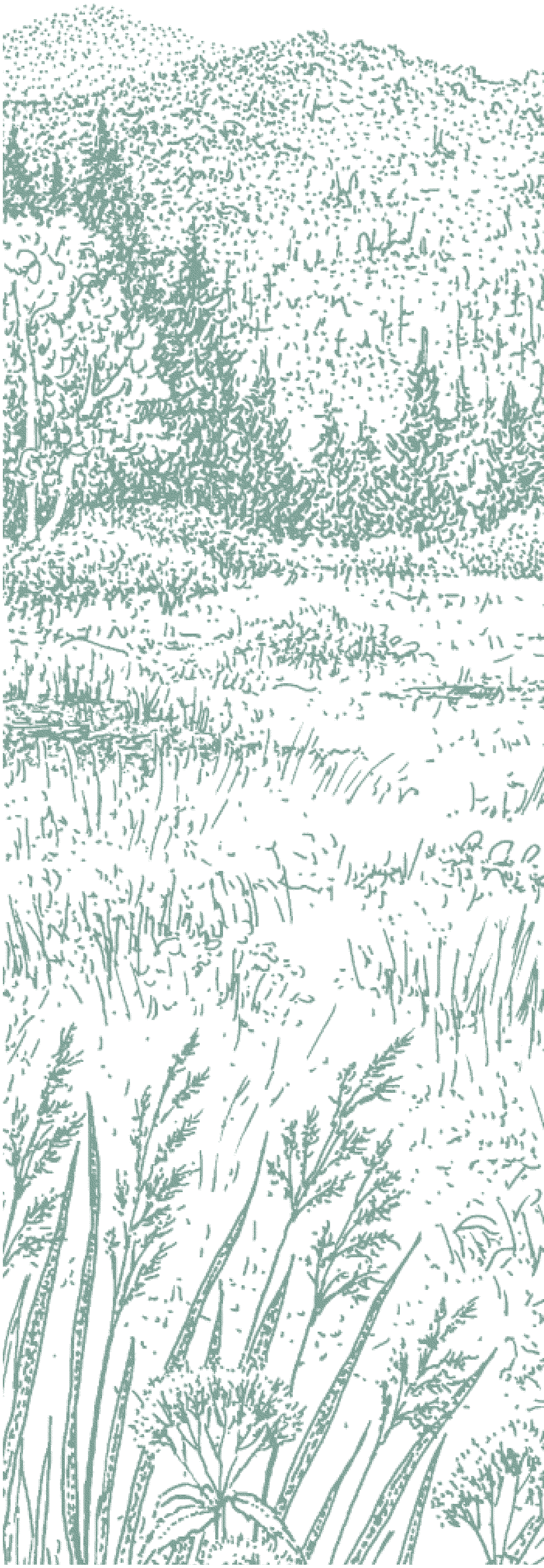
The MISSION of the Vermont Fish & Wildlife Department is the conservation of fish, wildlife, plants and their habitats for the people of Vermont.



Vermont's Big Game Management Plan

Creating a road map for the future.

I am very pleased to announce the completion of the 2010 – 2020 Vermont Big Game Management Plan. This plan will guide the Vermont Fish & Wildlife Department in its conservation and management of the state's deer, moose, black bear, and wild turkey populations during the next ten years. These four big game species provide tremendous hunting opportunities in Vermont as well as countless hours of wildlife viewing for all Vermonters who love and enjoy wildlife.

This big game management plan is the culmination of a long and deliberative process that melded the science of wildlife management with the interests of Vermont residents. This plan could not have been successfully completed without the benefit of citizens that responded to our surveys, attended our public meetings, and provided their comments, concerns, and ambitions for the future of our big game species. I also would like to acknowledge all Department staff who worked so very hard putting it together and listened to the views of Vermonters. They also had to deal with the tedious tasks involved in preparing the numerous drafts that led to this final document.

In the end, I am confident the implementation of this Vermont Big Game Management Plan will assure that deer, moose, black bear, and wild turkey management will improve and ensure that these species will be enjoyed in this state for generations to come.

Wayne A. Laroche

Wayne A. Laroche, *Commissioner*
Vermont Fish & Wildlife Department
December 2009

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Wild animals, or wildlife, by Vermont law, belong to the people of Vermont. Conserving and managing Vermont's wildlife resources on behalf of the public are obligations of the Vermont Fish &Wildlife Department. The Department has a long history of managing Vermont's big game species. This long-range management plan will help identify goals, and management objectives to insure that conservation needs of the species and the interests of the public are effectively addressed. Below is an overview of the management issues, goals and strategies for each big game species.

2010-2020 White-tailed Deer Management Issues, Goals, and Strategies

ISSUE 1. Habitat Loss and Assessment

GOAL: To monitor changes in habitat quality and quantity and perform public outreach regarding habitat management techniques, so concerned citizens may help to secure their deer herd's future.

Management Strategies

1.1 Update inventory of deer wintering areas for local, regional, and state habitat planning and protection efforts.

1.2 Stress the importance of habitat conservation with outreach efforts to various segments of the public such as farmers, educators, hunters, forest managers, and land planners.

1.3 Work closely with foresters and entomologists to prevent, manage, and eliminate the threat of the hemlock woolly adelgid.

ISSUE 2. Population Goals

GOALS: 1) Maintain deer densities using regional population objectives.

2) Monitor biological characteristics of habitat and deer that can change in response to deer herd size through time.

3) Adjust antlerless deer harvests to alter population levels as necessary to achieve population objectives.

Management Strategies

2.1 Maintain and evaluate regional population goals, established during this planning period, that are based on deer densities that recognize a lower limit that is unsatisfactory to the public and an upper limit that is ecologically unsustainable.

2.2 Monitor deer herd health by collecting body condition data from hunter-harvested and road-killed deer.

2.3 Consider establishing habitat suitability criteria to define areas of suitable deer habitat within WMUs so that consistent and reliable density estimates can be made while allowing for habitat area estimate updates as new land-cover maps become available.

2.4 Evaluate bowhunter surveys to better estimate regional buck:doe and fawn:doe ratios; compare fawn production estimates to autumn fawn:doe ratios to estimate summer fawn survival, and use buck:doe ratios to estimate adult doe population through reference to the unbiased buck population estimate.

2.5 Continue remapping and surveying deer wintering areas so that available habitat is quantified and localized winter deer density is better documented.

2.6 Work with foresters to develop data-driven methods for assessing localized deer overabundance problems that might lead to development of localized deer management methods. Data must provide measures of forest condition.

2.7 Provide outreach to landowners regarding methods that may minimize damage and encourage reduction in locally overabundant deer populations. Investigate feasibility of a formal program to connect hunters with landowners to address locally overabundant deer populations.

2.8 Develop strategies to maintain enough big game registration stations to make big game reporting convenient for hunters.

2.9 Seek statutory changes to realign boundaries of select WMUs.

ISSUE 3. Hunter Satisfaction and Antler Point Restrictions

GOAL: Employ biologically responsible, socially responsive, and adaptive management of the deer herd.

Management Strategies

3.1 Collect adequate yearling buck data (weights, antler beam diameter, and number of points) from the youth hunt to detect and track any changes in the buck population resulting from the current antler-point restriction (two points-on-one-antler minimum), and evaluate biologically acceptable alternatives if needed.

3.2 Evaluate a model assessment using genetic data to examine the likelihood of altering the genetic diversity of the buck population via the current antler restriction.

3.3 Inform the hunting public about deer management issues and results of antler-point restrictions and gather input concerning deer management and hunter satisfaction.

ISSUE 4. Bag Limits

GOAL: Provide suitable utilization of deer as food and provide opportunity to hunt deer in a way that maximizes potential for effective deer population management but does not overstress the heavily harvested buck population.

Management Strategies

4.1 Provide the public with ample opportunity to harvest white-tailed deer for food and other utilitarian purposes.

4.2 Advocate for an appropriate deer bag limit that allows maximum hunter opportunity while achieving deer population management strategies.

ISSUE 5. Muzzleloader and Archery Season Modifications

GOAL: Provide suitable opportunity to hunt deer in a way that maximizes the potential for effective deer population management but does not interfere with hunters during youth weekend or rifle and other fall hunting seasons.

Management Strategies

5.1 Evaluate feasible options to expand antlerless deer-only hunting opportunities prior to the regular rifle season. These options will include, but are not limited to, an early muzzleloader season, expanded archery season, and increases in archery bag limits.

5.2 During the fall and winter of 2009-2010, survey public opinion on the various management options to achieve antlerless harvest objectives prior to the rifle season and develop a proposal of recommended hunting season changes for the Vermont Fish and Wildlife Board in 2010.

ISSUE 6. Captive Deer Hunting/ Deer Farming/ Cervid Importation

GOAL: Implement new captive hunting regulations and work with other state agencies to minimize the chance of introducing and transmitting diseases via captive deer.

Management Strategies

6.1 Evaluate the effectiveness of the captive hunting facility regulation.

6.2 Work with the Agency of Agriculture, Foods, and Markets and the deer farming industry to promote and enforce disease free importation and husbandry practices.

ISSUE 7. Disease Surveillance and Management

GOAL: Monitor disease issues and respond when necessary to protect the health of wildlife and/or humans.

Management Strategies

7.1 Work with associated branches of government (for example, Agency of Agriculture, Department of Health) to monitor and control disease agents and deer populations where and when it is appropriate.

7.2 Contribute to the national Chronic Wasting Disease (CWD) surveillance effort.

7.3 Monitor the progress of Hemorrhagic Disease as it moves toward the Vermont border.

7.4 Work closely with the Agency of Agriculture to ensure dairy farms and domestic deer farms maintain their tuberculosis-free status.

7.5 Investigate a prohibition on the use of deer-urine-based scent lures and, if appropriate, implement a public informational effort on the justification.

7.6 Inform Vermonters as to the gravity of CWD and repercussions if introduced into our environment through the dissemination of Vermont's CWD Response Plan.

ISSUE 8. Locally Overabundant Deer Populations

GOAL: Promote awareness that hunting is the only practical option to reduce localized overabundant deer populations.

Management Strategies

8.1 Demonstrate the effectiveness of archery hunting to reduce locally overabundant deer in Vermont's suburban environments.

8.2 Provide communities with up-to-date and comprehensive information on deer overabundance and consider community views when deciding how to best manage deer problems in suburban, agricultural, and forested areas.

8.3 Encourage communication and cooperation between antlerless deer hunters and landowners that seek relief from locally overabundant deer.

ISSUE 9. Two-year Regulation Cycle

GOAL: Consider a more efficient two-year regulatory cycle that allows for annual adjustments when environmental factors deem it appropriate.

Management Strategies

9.1 Provide outreach to legislators, board members, and hunters to develop an understanding of the rationale behind deer management and proposed actions to improve management.

9.2 Evaluate the benefits and deficiencies of implementing a two-year regulation cycle for deer season recommendations.

2010-2020 Moose Management Issues, Goals, and Strategies

ISSUE 1. Regional Population Goals

GOAL: To maintain regional populations of healthy moose at or below cultural carrying capacity.

Management Strategies

1.1 Maintain a statewide fall post-hunt population of between 3,000 and 5,000 moose.

1.2 Maintain a sex ratio of between 40 to 50 bulls per 100 adults (moose of at least age-class one).

1.3 Maintain an adult age-class distribution of at least 25% of at least age-class four.

1.4 Maintain an average ovulation rate of more than 1.15 for cows age class of at least three.

1.5 Assess relative moose habitat condition of individual WMUs or regions of the state using forest inventory data and a GIS-based Habitat Suitability Index Model.

1.6 Reduce and maintain WMU E moose densities to 1.75 moose per square mile (approximately 1,000 moose post-hunt).

1.7 Reduce and maintain WMU D2 moose densities to 1.0 moose per square mile (approximately 600 moose post-hunt).

1.8 Allow slow population growth in WMUs I, L, P and Q while not exceeding one moose per square mile.

1.9 Stabilize moose population in other WMUs at current levels.

ISSUE 2. Moose / Human Conflicts

GOAL: To minimize motor vehicle/moose collisions and other forms of damage caused by moose.

Management Strategies

2.1 Develop and implement a policy for Department response to "nuisance" moose.

2.2 Continue to cooperate with the Vermont Agency of Transportation (VTRANS) to erect warning signs at traditional moose highway crossings.

2.3 Cooperate with VTRANS in implementing roadside brush-clearing projects to improve visibility at the most dangerous moose crossings, when feasible.

2.4 Cooperate with VTRANS to investigate the use of new technology that may help reduce moose/ vehicle collisions.

2.5 Continue with annual press releases to remind motorists of moose hazards during seasons of increased moose movements.

ISSUE 3. Moose Hunting Opportunities

GOAL: To maximize quality moose hunting opportunity.

Management Strategies

3.1 Provide quality moose hunting opportunity in all WMUs where feasible.

3.2 Coordinate with large property owners to enhance moose hunter access.

3.3 Provide information to hunters on how they can share moose meat with needy households throughout Vermont.

3.4 Conduct outreach efforts prior to any significant reduction in total permit numbers made in response to moose population changes.

3.5 Provide public opportunity to harvest moose for food and other utilitarian purposes.

3.6 Maintain and improve hunter satisfaction by managing a preference point lottery system.

3.7 Propose to implement a limited special archery-only moose hunting opportunity.

ISSUE 4. Moose Viewing

GOAL: Provide safe and quality moose viewing opportunity.

Management Strategies

4.1 Construct at least one moose observation tower with a parking area near a state highway in the Northeast Kingdom region and investigate other locations in other regions.

4.2 Include moose in a guide to wildlife viewing sites on the Department's website.

ISSUE 5. Moose Habitat

GOAL: Maintain necessary habitat to support 3,000 to 5,000 moose on a sustained basis.

Management Strategies

5.1 Implement field studies to investigate, measure, and monitor the degree of moose and deer browsing within selected WMUs.

5.2 Provide natural resource professionals and landowners with moose habitat management guidelines.

ISSUE 6. Deer-Moose Competition and Forest Impacts

GOAL: Balance the nutritional needs of regional moose and deer populations with the need for adequate forest regeneration.

Management Strategies

6.1 Develop a study to assess the carrying capacity for moose and deer on Vermont's forestland.

6.2 Develop a decision making process that assists managers in determining the appropriate mix of moose and deer densities for a given WMU based on cultural and ecological factors.

2010-2020 Black Bear Management Issues, Goals, and Strategies

ISSUE 1. Bear Population Size and Distribution

GOAL: Identify an appropriate bear population objective that ensures the viability of a wild, free-ranging bear population, provides for hunting opportunities, and satisfies human social expectations and tolerances for nuisance bear occurrences.

Management Strategies

1.1 Update and re-evaluate Vermont's black bear population model to reflect the most current harvest and biological parameter data available.

1.2 Evaluate and develop hunting season structures that align population estimates with biological data, habitat limitations, and public satisfaction data to sustain a bear population between 4,500 and 6,000 animals.

ISSUE 2. Bear Habitat Conservation

GOAL: Maintain a no net loss of function and value of existing bear habitat.

Management Strategies

2.1 Maintain and enhance habitat protection efforts through Act 250, wood-to-energy harvest review, work with town and regional planning commissions, land acquisition, and other conservation methods.

2.2 Provide technical assistance in managing for critical bear habitat in the Use Value program.

2.3 Revise and update "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" to include habitat management recommendations for black bears.

ISSUE 3. Human/Bear Conflicts

GOAL: Minimize the overall number of negative interactions occurring between bears and humans to achieve acceptable levels of human safety and social acceptance.

Management Strategies

3.1 Update statewide policy for handling black bear/human conflicts.

3.2 Improve and disseminate outreach/education materials and messages for minimizing human/bear conflicts.

3.3 Monitor bear/human conflicts and explore new strategies for reducing the number of complaints from the public.

3.4 Use permitted houndsmen with trained bear hounds to haze bears and keep them wary of humans.

ISSUE 4. Bear Management Strategies and Season Structure

GOAL: Optimize public hunting opportunity for the utilization of bears for food and other appropriate purposes and ensure hunter satisfaction within biologically sustainable regulations.

Management Strategies

4.1 Hunting season management strategies and season structure will be evaluated and adjusted to maintain the population goal of 4,500 to 6,000 bears. Changes in hunting season structure will consider, when necessary, the use of season length, regionalization, or incremental changes to season bag limits to achieve population goals.

4.2 Work with partner organizations on issues related to bear management as they are raised throughout the management plan period and develop specific strategies to address them. Such strategies may range from legislative changes to educational efforts.

2010-2020 Turkey Management Issues, Goals, and Strategies

ISSUE 1. Turkey Population

GOAL: To adequately assess Vermont's wild turkey populations and trends.

Management Strategies

1.1 Annually collect and assess turkey harvest data to determine trends as well as summer/fall turkey sighting survey data in order to direct future management decisions.

1.2 Conduct the public annual Internet turkey brood survey along with the Department staff summer turkey survey.

1.3 Continue the turkey program's investigation into the genetic variability and structure of the statewide population.

1.4 Evaluate new wild turkey population estimation methods and models for use in Vermont.

1.5 Evaluate the use of a public Internet survey to assess winter flock sightings.

ISSUE 2. Public Satisfaction with Current Population Levels

GOAL: Assess public and hunter satisfaction with current turkey population levels and management program.

Management Strategies

2.1 Provide statewide spring bearded-bird-only seasons (including the Youth and regular May season) and limited fall either-sex hunting seasons in WMUs that can sustain a fall harvest so as to provide for population stability.

2.2 Prioritize high quality spring hunting over additional fall harvest opportunity.

2.3 Manage fall turkey harvests through changes in fall hunting season length within WMUs depending upon stability or growth of three-year average spring harvest densities, except in WMU A Champlain Islands where inadequate forest cover exists to sustain a fall firearm harvest.

ISSUE 3. Fall Turkey Hunting

GOAL: To provide appropriate opportunity for sustainable fall hunting while maintaining current levels of high quality spring turkey hunting.

Management Strategies

3.1 Provide public opportunity to harvest wild turkey for food and other utilitarian purposes.

3.2 Facilitate healthy, abundant spring turkey populations that are stable using modest, fall hunting seasons/bag limits to control the population. When the three-year spring average harvest density reaches the specific threshold value, liberalization of fall hunting in a WMU may be called for (initiate shotgun seasons, extend gun seasons).

3.3 Consider reducing the current guideline for the threshold as to when fall gun hunting opportunities could be initiated in a new WMU, from the three-year average spring harvest density of one bird per square mile, to an average harvest density of .75 bird per square mile.

3.4 Lengthen the current fall seven-day shotgun season to a nine-day season.

3.5 Expand the fall shotgun season to include WMUs H1, D1, and B with a nine-day shotgun season.

3.6 Expand the fall archery turkey season, coinciding with the opening of the deer archery season, to allow archery hunting statewide.

3.7 Investigate establishing a new separate "Fall Gun Season Only" tag.

ISSUE 4. Wild Turkey/Human Conflicts

GOAL: To minimize and manage agricultural damage and nuisance turkey incidents.

Management Strategies

4.1 Provide property owners with access to coordinated services of personnel trained to deal with nuisance turkey issues including wildlife biologists, game wardens, and USDA Wildlife Services staff to assist with nuisance complaints via technical guidance/assistance on techniques to minimize/discourage damage.

4.2 Conduct follow-up site visits to nuisance complaint sites when necessary and provide hazing equipment to help ameliorate persistent nuisance situations.

4.3 Solicit assistance from local volunteers through the Vermont Chapter of the National Wildlife Turkey Federation (NWTF) to help provide on-the-ground assistance to landowners via hazing and behavior modification efforts.

4.4 Assist USDA Wildlife Services staff with development of educational materials to inform and educate farmers about techniques for minimizing conflicts.

4.5 Compile and evaluate wild turkey damage complaint reports from farmers, state game wardens, biologists and wildlife service personnel to document problems, management approaches and results.

4.6 Develop/modify a standard set of protocols/guidelines/solutions to perceived and actual conflicts caused by wild turkeys (nuisance animals, agricultural damage).

ISSUE 5. Turkey Habitat Management and Conservation

GOAL: To encourage conservation and appropriate habitat management practices to support and sustain Vermont's wild turkey population.

Management Strategies

5.1 Continue efforts on wildlife management areas and other public lands to provide habitat demonstration areas to promote appropriate commercial and noncommercial vegetation management practices beneficial to turkeys and other wildlife. This includes the use of prescribed fire and other management practices to establish and maintain long-term mast production areas.

5.2 Provide technical information and assistance regarding turkey habitat management to private landowners and other land managers, town planning commissions via staff biologists, habitat demonstration projects, LIP and WHIP program lands, etc.

5.3 Update the "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" and make this document available on the Internet and in published copy as well.

5.4 Work with the NWTF regional biologists and chapter volunteers on development of the North American Wild Turkey Management Plan.

5.5 Work with partnering organizations on high priority projects and issues.

ISSUE 6. Perception Regarding the Interaction Between Deer and Wild Turkeys, Ruffed Grouse and Wild Turkeys, and Various Predators and Wild Turkeys

GOAL: To improve the public's knowledge, awareness, and understanding of the role of the wild turkey and its interactions within the ecosystem.

Management Strategies

6.1 Promote sound scientific principles regarding inter-species competition and predator-prey relationships through a variety of outreach methods including public speaking events, web-based information and links, and print and broadcast media.

ISSUE 7. Developing and Maintaining an Informed Public is Crucial to the Management Success of the Wild Turkey Project.

GOAL: To ensure continued information exchange and program acceptance by keeping the general public, state and federal agencies informed on the status of the wild turkey resource in Vermont.

Management Strategies

7.1 Disseminate wild turkey project information to the public/media professionals via biological reporting stations, teacher workshops, private and public landowner visits/conferences, slide/video presentations, mail correspondence, popular and technical reports, etc.

7.2 Use the Department's library to fill all public requests for its video production "The Wild Turkey in Vermont" as well as its wildlife study guide "The Wild Turkey Education Kit."

7.3 Continue involvement with standing professional committees, regulatory bodies and cooperative agreements with nongovernmental organizations to assist the Department with meeting the goals and objectives of this plan.

BIG GAME PLAN - INTRODUCTION

Managing Wildlife — A Public Trust

Under federal and state law the management of wildlife falls under the concept of public trust, which means that it is considered a resource that must be preserved and protected for public use. Unlike Europe's feudal system during the Middle Ages, wildlife does not belong to a royal family or a government. Nor can individuals possess wild animals as a commodity as pets or farm animals. The Public Trust Doctrine, based on English Common Law and upheld by the United States Supreme Court, is the principle upon which natural resources, such as wildlife, are conserved in the public interests and for reasonable use by current and future generations. The Vermont Fish & Wildlife Department (the Department) is obligated to conserve and manage Vermont's wildlife resources on behalf of the public. Vermont law entrusts the stewardship and management of wildlife resources to the Department in accordance with the Public Trust Doctrine to ensure this principle is carried out.

The principle of wildlife as a resource that is managed in public trust by state and federal governments is the foundation of what is known as the North American Wildlife Conservation Model. The Model holds that by placing wildlife in the public trust the value that is derived is not merely personal profit. The motive for harvesting wildlife is not one of simple profit as it was in the nineteenth century when market hunting was rampant, but instead, one of broad public benefit and sound and sustainable wildlife and habitat management. This Model has served wildlife and the public well for more than 100 years. As a result, game species such as the four big game species featured in this plan have flourished. Under this Model, the public is involved in the decision-making process, and for this reason, it has been embraced across North America. In keeping with these basic principles of wildlife management and conservation in North America, the mission of the Department is "…the conservation of fish, wildlife, plants, and their habitats for the people of Vermont."

About This Plan

To carry out this mission the Department's long-range management plan identifies issues, goals, and strategies that insure that a balance between the conservation needs of the species and the interests of the public is effectively addressed. The plan has three major objectives:

- Conserve, enhance and restore Vermont's natural communities, habitats, and plant and wildlife species along with the ecological processes that sustain them.
- Provide a diversity of safe and ethical fish- and wildlife-based activities and opportunities that allow hunting, fishing, trapping, viewing, and the utilization of fish, plants, and wildlife resources consistent with the North American Wildlife Conservation Model.
- Maintain safe fish- and wildlife-based activities while limiting harmful human encounters with fish and wildlife species, and provide general public safety service incidental to our primary fish and wildlife duties.

Management of Vermont's four big game species has been combined into a single, comprehensive big game plan. This will provide the public with easy access to all information related to big game management. It will also help ensure that a more comprehensive assessment of the overlapping and divergent management needs of each big game species are holistically considered and coordinated to improve overall management. In addition, the process of developing a single, comprehensive big game management plan is more cost effective and efficient than four separate planning efforts.

The Process for Developing The "Ten-Year Big Game Management Plan"

This plan is based on currently available and relevant biological and ecological data associated with each of the four big game species and their habitats. A survey of 1,000 randomly selected Vermont residents was also conducted to gather public opinion related to deer, moose, bear and wild turkey management. Respondents were asked their views on many topics such as habitat protection, game species population size preferences, and property damage from wildlife (results of the survey can be found on the Department's website: www.vtfishandwildlife.com/library/)

A series of open house style public meetings were held in five locations around the state during the summer of 2008 and a web page was developed to allow people to discuss issues and offer opinions to Department staff. This was followed by two public meetings and a month-long public comment period to allow Vermonters to submit opinions regarding draft management plans. Approximately 200 people attended the meetings, wrote letters and e-mails, used the on-line comment option, or made phone calls to express their views. The majority of comments pertained to deer management, with comments varying widely across the topics of season lengths, bag limits, and appropriate antler point restrictions. All of the comments were reviewed and considered by the Department and, as much as possible, assimilated into commonly voiced themes. While biologically responsible wildlife management must come before public opinions, there will always be aspects of wildlife management that can be decided by public sentiment. From the beginning, public feedback steered many aspects of the Department's ten-year planning efforts, and public feedback will continue to help shape our goals and objectives. Provided below are summaries of the issues raised by the public in response to the draft plans for each of the big game species.

White-tailed Deer

The Department received input on several potential strategies to address the need to harvest more female deer in select parts of the state. First, where female deer are locally overabundant, it may be desirable to encourage bow hunters to fill a second, or even third, archery tag by taking an antlerless deer. This could be achieved by liberalizing the archery bag limit to three deer, with one of these possibly being a buck. All hunters would still be subjected to the annual bag limit that is currently three deer. The option to "tag-out" with three deer during archery season and forfeiting further deer hunting in Vermont in that calendar year would be the choice of the hunter if he or she were successful during this season. It is also noteworthy that additional archery tags may help manage localized deer populations where firearm ordinances restrict the ability to harvest antlerless deer during the Youth Weekend and muzzleloader seasons.

Second, there was considerable interest voiced for an early antlerless-only muzzleloader season that would occur sometime before the regular rifle season. Such a season would only be open to those individuals holding an antlerless-deer permit for muzzleloader hunting. Although the Department is sensitive to the various concerns expressed by hunters, landowners, and other nature enthusiasts regarding this policy, the Department needs to explore ways to harvest more antlerless deer in some areas when and where consecutive mild winters allow the deer herd to grow beyond our ability to control it with existing antlerless deer hunting seasons. A brief antlerless-only early muzzleloader season is a method to consider with other potential benefits from removing more antlerless deer earlier in the season.

Because of increased interest in an early muzzleloader season and antler-point restrictions, a survey on these topics was circulated at the July public hearings. As recommended by some of the attendees, the survey was also posted on the Department's website. The survey response was substantial, numbering nearly 600 submissions. Additional public surveys that solicit opinions on the use of early muzzleloader season and/or the archery season to achieve female deer harvest objectives will guide the Department's management approaches in the future.

The public provided mixed reviews of a special crossbow season or allowing crossbows during the archery season. Given the consideration of other, more popular antlerless harvest enhancements, such as the early muzzleloader season and a lengthened archery season, the use of crossbows as an additional hunting implement does not appear to be supported by the public at this time.

In preparing the final plan, there were two areas in particular that appeared to require further scientific documentation. Participants requested more information about chronic wasting disease (CWD), how it is transmitted, and what it means for CWD-free and CWD-infected deer populations. Of particular interest was how this might apply to deer-urine-based scent lures. Although widespread live-testing for CWD still remains unfeasible with high probabilities of false-negative results (indications of a disease-free animal when it is actually infected), methods to detect the infectious protein (prion) in animal fluids is advancing. As a result of these advancements, recent studies have found the CWD-causing prion in urine and other excretions and body parts of infected deer. In this final plan we provide additional and current references to pertinent scientific literature and results on this subject.

The other topic needing more supporting documentation was the issue of antler-point restrictions. Again, we provide additional sources of information cited in the text. Many of the studies cited are available as complete documents on the Internet. Copyrighted studies on the Internet appear as abstracts that may be purchased through the journal in which they are published.

Moose

Among the persons commenting on the Department's website, seven made comments related to the draft moose plan. The only issue that drew much attention was the proposed special archery season for moose; six people expressed support for this season, and none were opposed.

The other major issue where public input was specifically solicited in the plan was the proposed management for slow growth of the moose population in the central and southern "mountain" wildlife management units (WMU) of I, L, P, and Q. Only one web comment addressed this issue, and it was in favor of the proposed direction.

Six written moose comment forms were collected from open houses held in July, 2009. Five of these were in support of the special bow season and one was opposed. Similar levels of support (seven in favor, one opposed) were voiced at the May, 2008 open houses. None of the comments addressed population desires for the southern mountains, except for one respondent who desired fewer moose in WMUs H1, H2, D1, D2.

Six respondents commented on the moose lottery. One liked the present system; two thought it was unfair because some families have won multiple times while others have never won. One individual thought bonus points should be earned during the three-year waiting period, one wanted a two-year wait instead of three-years, and one person felt applicants should possess a Vermont hunting license before they could enter the lottery.

Black Bear

Two bear management issues received the most comment from 15-20 respondents. The first was opposition to a regulation requiring minimum registration standards for bear hunting guides or hunting guides in general as a means to address concerns for fee-for-bear hunting. Some felt it would diminish a person's opportunity to earn money or offer a potential mentoring experience for an inexperienced hunter. Others felt a guide registration system did not address the fee-for-bear hunt guiding concerns.

The second most frequent comment concerned nuisance bear situations, especially those involving birdfeeders. Most felt the Department had a good message regarding the removal of feeders but needed to be more aggressive with its advertisement and insistence with compliance. Beehive owners expressed some concern about higher bear populations in the Champlain Valley where apiaries are numerous. The consideration of regional management zones for bear seasons may be an appropriate tool for addressing this concern.

Several respondents wrote to say the bear population was "about the right size," or that it appeared to be growing, and the population goal was appropriate. Others felt the population was too high in parts of the state and suggested managing bear populations by regions to address these differences, while still others felt the bear population was too low.

Comments were received regarding opposition to bear hunting, especially with the aid of dogs. The Department believes it cannot achieve and maintain the proposed bear population objectives without the use of regulated hunting of these animals.

Wild Turkey

A number of substantive comments were received during the public comment period for the draft wild turkey management plan. These comments ranged from suggestions for a variety of spring and fall hunting season expansion proposals to "maintaining the status quo" to comments on the availability of check stations for reporting harvest. The general focus of comments pertained to the opportunity to expand fall hunting opportunity. One comment of interest suggested a separate fall bird tag to enable hunters to harvest a fall bird who might not otherwise participate in the spring season. A second comment of interest suggested opening the fall season concurrently with archery deer season to permit greater opportunity to hunt turkeys.

Historical Perspective

The following is a brief overview of the historical influences on wildlife in Vermont. It traces some of the most important elements of early land use activity and cultural trends that have affected the state's wildlife and its habitat.

Prior to European colonization in North America in the early 1600s, human activity affected the landscape very little. Native Americans did not have the technology, other than fire, with which to create landscape-level changes in their environment. Thus, sporadic, naturally occurring events such as hurricanes, earthquakes, and wild fires were the primary forces affecting large geographical areas. Even these major events merely served to set back forest communities to earlier stages of ecological succession. With seed stock and soil still in place the forest communities were always capable of replacing themselves.

Indigenous tribes hunted, fished, trapped, and tended corn fields and small gardens on the banks of major rivers throughout Vermont and New England. Some species of fish and wildlife were very abundant. The passenger pigeon, for example, was so plentiful that it was reported the birds “blacken the sky” with their numbers and broke tree branches when they set down to roost. This single species accounted for 25 to 40% of all birds living in the United States. According to some records, there were 3 billion to 5 billion passenger pigeons at the time Europeans began arriving on the continent. Ducks, geese, deer, moose, and many other species were also plentiful. For native communities wildlife was a primary source of sustenance and socially and culturally important. But just as today, wildlife populations fluctuated through the years and varied with the seasons, and there were times of wildlife scarcity.

The balance between wildlife and human activity, however, changed dramatically in the 1800s with the influx of European settlers. Following establishment of the colonies, the human population increased steadily in Vermont. Just prior to Vermont becoming the fourteenth state, its population was estimated at 85,425. Over the course of the following ten years, the population doubled to 154,465. Just 50 years later, it doubled again (Table 1.1). European settlers changed the wildlife equation in several important ways.

Unregulated market hunting and hunting wildlife for profit rather than for subsistence contributed to a rapid decease in many species. Another factor was the settlers’ demand for lumber and firewood, as well as land to convert to agricultural use. Throughout Vermont’s early history the landscape has shifted with changes in farming – from sheep to dairy farming, from grass crops to a corn crop. But on a larger scale, farming transformed the land from forests to open pastures. At one point in our history, the land went from 95% forested to 63% nonforested, eliminating most or nearly all suitable habitat for some species. This, along with the unregulated harvest of wildlife, took a significant toll on many wildlife populations that depended on forestland habitat. By the mid-1800s, many of the species that had been very abundant began to decline or disappear from the landscape. The passenger pigeon, mountain lion, wild turkey, moose, and wolf became extinct, while deer and bear populations were limited to forested remnants of the state.

As early as 1847, famed conservationist and resident of Woodstock, Vermont, George Perkins Marsh remarked on the speed with which this transition to a nonforested landscape occurred. The ecological damage sustained by farming and logging, noted Marsh, was “too striking to have escaped the attention of any observing person.” Governor Urban M. Woodbury angrily proclaimed before the State Legislature in 1894, “Owners of timber lands in our state are pursuing a ruinous policy in the method used in harvesting timber.” The Governor recognized that the deterioration of forestland in Vermont also meant an insecure future for the state’s major industry: lumber and wood products. “There is no more valuable crop produced from the land than timber,” Woodbury commented in the same speech. “Every decade will see timber more valuable and it is of great importance to the state as a whole... that some measure should be adopted to lessen the wanton destruction of our forests.” Although Marsh and Woodbury were early observers of the fact that Vermont’s economy was tied to the resources and aesthetic qualities of its forests, public awareness and concern regarding the effect of certain land practices on the natural environment did not fully emerge until the turn of the twentieth century.

As concern for the loss of species took root among citizens in Vermont and across North America, actions began to be taken to restore the wildlife species that had been lost. Deer were one of the first species to be protected by state laws. In 1865, the hunting of deer in Vermont became illegal and remained so for the next 32 years. During this period,

Table 1.1 Vermont population from US Census Bureau statistics 1790 - 2005.

Year	1790	1800	1850	1900	1950	2005
Population	85,425	154,465	314,120	343,641	377,747	623,050

seventeen white-tailed deer were transplanted from New York into the state, which provided breeding stock that rebuilt the deer herd. The most important change, however, that lead ultimately to successful restoration of white-tailed deer and other species was the abandonment of farms that allowed the land to revert back to forests. The combination of improving habitat conditions, legal protection, and lack of significant mortality factors other than winter conditions resulted in a rapid recovery of the deer population. The rapid success of this restoration effort led to the opening of a limited, regulated deer hunting season in October of 1897.

As Vermont entered the era of active wildlife management, the deer population continued to grow as habitat expanded and improved. Throughout the first half of the twentieth century, deer numbers increased and their range expanded. During this time of restoration, a bucks-only harvest regulation was used to maximize the growth rate of the deer population. Because only bucks were harvested for a period of more than fifty years, the buck-only harvest restriction moved from being a population management tool to becoming a Vermont deer hunting tradition.

The white-tailed deer population responded well to the bucks-only regulation and expanded so quickly that in less than 50 years the buck harvest grew from 103 deer in 1897 to more than 4,000 deer in 1940. So rapid was the population growth that by 1946 wildlife biologists had already begun to observe negative impacts on habitat quality caused by large numbers of deer. In this same year, the Department released the publication "The Time is Now" as an attempt to inform the people of the new situation and the problems that the future would hold if growth of the deer population was not limited. Biologists recognized that the harvest of female deer was the only way to control total deer numbers. Unfortunately, Vermont's bucks-only harvest tradition had become well established by this time and the hunting public would not accept harvests of female deer as the solution.

This difference of opinion engendered an infamous period of deer management in Vermont that became known as the "deer wars." Over the next nearly 50 years, public outcries occurred on and off as biologists attempted to implement deer management changes. Although most deer hunters today recognize the importance of harvesting female deer to limit growth of the deer herd and protect deer habitat, deer management remains an area of great public concern and continued contention.

The other three big game species did not recover as quickly as the deer. Bear populations recovered slowly for several reasons. Livestock owners considered them a nuisance. Not only was bear hunting unregulated, but Vermont state law offered bounties for animals that were killed from 1831 until 1941. The first laws limiting the harvest of bears were not implemented until about 1950. Rapid recovery of forest habitat along with limited harvest of bears proved to be a boon to black bear recovery. Black bears are now distributed throughout most of Vermont.

Moose also may have completely vanished from Vermont at one point. When a young bull was shot in March 1899, at Wenlock (now Ferdinand) in Essex County, the local newspaper reported it as "a strange animal" and "the last moose in Vermont." The shooting was actually illegal because the 1896 Legislature had established a closed hunting season on moose. Moose recovery lagged behind deer and bear due to a lack of suitable forest and wetland habitat. But as the forestlands recovered and wetland habitat expanded with the return of beaver populations, moose habitat also expanded. The Department estimated that in the early 1960s about 25 moose existed in Essex County. The moose population grew steadily over the next 30 years. By the 1990s, moose were abundant enough to support a limited, controlled regulated hunt.

In 1993, the Department issued 30 moose permits in Essex County and conducted the first regulated moose hunt in the state's history. Today, the moose population has fully recovered and has reached a level where regulated hunting is a tool needed to keep the population in balance with its habitat and to protect private property and public safety. The Department's current management aims are to keep the moose population in balance with available habitat and to provide abundant hunter harvest and citizen viewing opportunities.

By the mid-1800s, wild turkey was another species that had disappeared from the Vermont landscape. Thirty-one wild turkeys from New York were stocked into Vermont in 1969 and 1970. From this point on, the turkey population grew so fast that the first modern turkey hunt was established only three years later in 1973. Less than 40 years later, the turkey population has expanded throughout the state and continues to grow in numbers with record harvests occurring annually. Today these birds can be found in nearly every town of the state with a total population thought to number approximately 50,000 to 55,000 birds. This was an unexpected outcome. Early biologists believed that Vermont's long winters and deep snows would limit the distribution of wild turkeys to the Champlain and Connecticut River Valleys where winters are less severe, acorns are plentiful, and agriculture provides a source of winter food. Wild turkeys proved to be more adaptable than anticipated, however, and today they are found even along the Canadian border in Essex County. In fact, wild turkeys have expanded their range across the border into Quebec, Canada.

The twenty-first century begins with approximately 75% of Vermont's landscape being forestland. A half-century of science-based regulation has restored many wildlife species, including game species. Conservation and management issues, however, still confront our deer, moose, bear, and wild turkey populations. Although these issues more often relate to overabundance than to scarcity and recovery, they are no less daunting. The issues surrounding our wildlife in this century are now focused on maintaining wild and robust populations in balance with their habitats while providing abundant opportunity for the public to use and enjoy. Today the issues we face involve an ever expanding human population and the activities that accompany it (Table 1.1). Bears in backyards, moose in urban areas, turkeys damaging agricultural feed crops, and deer eating the next generation of forests have now replaced the old issues of wildlife scarcity. The loss and fragmentation of habitat associated with development presents new challenges to the conservation and management of deer and other species of Vermont's wildlife. If land ownership in Vermont continues to be divided into ever smaller parcels, available space to hunt and opportunity to access game will become an increasing challenge.

The Benefits of Fish and Wildlife Based Outdoor Opportunities

Hunting, fishing, and trapping are important outdoor activities culturally, socially, economically, and ecologically. These activities conducted under regulated seasons provide for sustainable utilization of fish and wildlife resources statewide. Currently 30% of Vermonters fish or hunt (over 80,000 hunters and 121,000 anglers), a higher participation rate than skiing (19%). Recent surveys report that Vermont is third nationally (behind Alaska and Maine) in per capita participation by the public in hunting, fishing, trapping, feeding and observing wildlife. Over 600,000 pounds of white-tailed deer, 192,000 pounds of moose, and 15,000 pounds of black bear meat are harvested annually from the forests and wetlands of Vermont. Wildlife related outdoor activities accounted for 5% of Vermont's gross state product in 2001, with nearly $300 million spent on fishing and hunting alone. These expenditures particularly benefit rural areas of the state and occur when tourism is typically low in Vermont. Within the context of this ten-year plan, the Department examines four of Vermont's big game species with the goal of managing these as assets to perpetuate into the future for the various cultural, social, economic, and ecological values they bring to the state of Vermont.

Management Issues of General Concern

1. ***Habitat Loss.*** Loss of critical habitat, such as deer yards and bear feeding areas, can occur as a consequence of development that fragments habitat as well as results in mortality from increased animal movement and motor vehicle collisions. Maintaining an adequate supply of quality, inter-connected habitats in a variety of forms (for example, young forests or wetlands) that sustains viable wildlife populations is one of the most significant conservation challenges given today's issues of sprawl and parcelization of land. For example, it is estimated that a black bear in Vermont requires 10,000 acres of land to successfully meet its annual life needs. Therefore, it is essential that sufficient habitat be maintained, managed and connected through travel corridors in order to sustain a healthy, productive population of black bear.

2. ***Hunter Demographics.*** During the last 100 years, regulated hunting has served to effectively provide people with food in terms of a sustainable, renewable wildlife resource and a continuous opportunity to be afield pursuing game. It has also served as a highly effective tool to regulate population size to levels that are compatible with habitat limitations and human expectations. Nationwide, hunters have declined over the past decade while the general population has grown (U.S. Department of Interior 2006). While the national average for annual hunting participation declined to only 5% (U.S. Department of Interior 2006), it was

14% in Vermont (Duda et al., 2007). About 41% of Vermonters have hunted at some time (Duda et al., 2007), indicating that hunting remains an important tradition here. Concern remains that reduced numbers of hunters may make it difficult to harvest enough deer to control the population in the future.

Since 1997, various youth hunting seasons for big game have been established to promote opportunities for youth to participate in hunting under the mentorship of an adult hunter. Youth Weekend seasons now exist for deer and wild turkey. Interest and support among adult hunters for these programs remains high.

3. ***Public Access to Land.*** Private lands remain very important to most Vermont hunters. One study estimated 30% of Vermonters still travel less than five miles one-way to hunt deer (Duda et al., 2007). Public lands open to hunting are under various ownerships and are distributed widely across Vermont with a total of more than 800,000 acres under state or federal management. The Vermont Agency of Natural Resources manages more than 333,000 acres of this total as wildlife management areas, state forests, and state parks. The Agency also holds easements on over 123,000 acres of conserved commercial forestlands that guarantee public access. The Green Mountain National Forest and Silvio Conte National Wildlife Refuge comprise most of the federally owned public lands in the state.

   The value of private lands for hunting and other public access is recognized by laws ranging from Vermont's strict landowner liability laws to statutes granting landowners who own at least 25 acres a preferred status for receiving antlerless deer muzzleloader permits. Because of the latter, the Department is opening up more private land for hunting by offering these landowners first choice in the kind of permits that are issued for hunting on their land. The Department encourages hunters to ask permission and be respectful of private lands even when lands are not posted to ensure that Vermont's heritage of free access to private lands for hunting may continue indefinitely.

4. ***Privatization of Wildlife.*** Privatization of wildlife resources threatens fair chase hunting wherever it occurs. When private landowners erect high fencing and charge a fee for the opportunity to hunt, the privatization of a public wildlife resource has occurred. Access for pay or lease hunting systems that restrict land access to those having the money to pay for it is a similar but less direct form of privatization. As demonstrated in much of Texas, lease hunting systems result in reduced hunting pressure and an inability for state wildlife agencies to manage overabundant deer populations (Haskell 2007). In accordance with the founding principles of this nation and the state of Vermont, it is the Department's responsibility to prevent privatization of Vermont's public wildlife resources and ensure the public's right to hunt.

5. ***Human-Wildlife Conflicts.*** The Department faces increasing conflicts between humans and wildlife. The four big game species present unique cases involving nuisance and other human conflicts. The Department addresses these issues in a consistent fashion for big game species in accordance with the following principles: Protection of human health and safety is first. Second, we must handle the animal involved responsibly when it must be confronted, displaced/removed from the scene, or euthanized. When these two guidelines are met, public acceptance is usually achieved.

6. ***Loss of Big Game Check Stations***. These facilities perform a vital data collection service to the Department and provide a convenient means for hunters to legally register their game. The number of check stations has steadily decreased during the last ten years to a point where some hunters now have to drive 30 or more miles to legally report their game. There are a number of reasons for the decline including the time required to record a harvested animal, the small fee received for the effort, and change in ownership of stations. While hunters and others visit the check stations during hunting seasons and make purchases of materials, goods, and products, in some instances the agents believe this ancillary business is insufficient to cover the costs of participating as a reporting station. Big game registration and sale of licenses are a tremendous benefit to the Department and to the hunting public. The Department is examining a variety of strategies to correct this situation.

7. Access to Game. As Vermont's population approaches 650,000, land continues to be developed and subdivided into smaller parcels, resulting in less available habitat for wildlife and fewer opportunities for hunters to access private land. Houses and people now occupy areas that were once open to hunting, posing a safety risk that limits the area where hunters may use their firearms. Posting no trespassing signs on private property also limits the amount of lands available for hunting. To stem the loss of access to game, the Department remains committed to public land acquisition programs (for example, Forest Legacy) that contribute to the acreage available for public hunting. The Department also recognizes the increasing negative impacts of a third-party fee for hunting on private lands. In these cases, individuals or groups of individuals lease hunting privileges to a sought-after hunting location from a landowner and charge clients for the exclusive use of the land. Or the landowner charges a select few directly for use of the land. In either case, access to game is just as restricted as if the land were developed or posted. This reduces hunting opportunity for the hunter without the financial means to buy into the hunting privilege. Examples of this have been readily seen with waterfowl hunting and more recently with bear and deer hunting. As the willingness to pay to hunt increases more and more opportunity will be lost to the general hunting public. Furthermore, the redistribution of hunting pressure due to fee hunting will likely become inconsistent with game species management goals.

Enacting rules against fee for hunting may appear to be a simple solution, but private property rights require that this type of response be carefully weighed before moving in the direction of regulation. It is also important to distinguish the difference between a fee for hunting versus a fee for a guided hunt. The former involves restricting access to hunting land while the latter, as in the case of moose hunting guides, offers a service but does not prevent non-paying hunters access to hunting space. Efforts need to be increased during the next ten years to address the fee–for-exclusive-hunting tide. These efforts must include outreach towards landowners by the Department, organized sporting groups and individual hunters.

8. Wildlife Management Unit (WMU) Realignment. Wildlife management unit boundaries were established in 1979 to regulate deer harvest on a geographical basis where deer densities mirrored the effects of habitat quality and winter severity. Since that time, WMUs have been applied to the management of moose and wild turkey populations on a regional basis. Bears range across such large areas of land that individual WMU boundaries have lesser value as a management tool. Groups of WMUs, however, can be established that may provide feasible opportunities to manage this species on a regional basis.

Unit boundaries, however, do not in every case align with natural boundaries of population abundance of big game species, particularly deer. To more effectively manage deer populations, it is necessary to periodically reassess and realign unit boundaries. A detailed description of the proposed changes in WMU boundaries is provided in Chapter 2, "Deer Management Plan," Issue 2 Population Goals. It is important to note any realignment of WMU boundaries will apply to all big game species.

Habitat loss and an aging hunter population are significant barriers to meeting the goals of this plan and to wildlife conservation in general. The economic and social forces affecting these changes are diverse and will be part of the Department's focus in addressing these new conservation challenges. The Department will consider a variety of opportunities to address these issues including but not limited to the following:

- Increase hunter recruitment and participation through a variety of strategies, such as introducing families to safe shooting through workshops sponsored by 4-H.
- Develop outreach materials for private landowners to introduce them to the wildlife management services offered by the Department, the rules and regulations concerning hunting on private property, and acquaint them with the traditions of Vermont's rural culture associated with hunting.
- Improve hunter access to land through a variety of strategies including creating

incentives to reduce parcelization of private property.

- Ensure that Project WILD, Project WET, and Project Learning Tree materials are in the hands of all elementary school teachers.
- Improve and expand hunter education opportunities through a variety of strategies including creation of a mentored hunting program.
- Help adjacent landowners form a community-based land access program to expand hunter access to land.
- Expand habitat management and conservation programs on public and private land to benefit big game and other wildlife species.
- Continue to raise public awareness of and appreciation for the benefits of sustainable harvest of wildlife for food as a renewable natural resource that is good for people and the environment.

Time line of important dates in Vermont Wildlife Management	
1609	Champlain.
1640-1760	French Canadians slowly begin early European colonization in Champlain Valley.
1761-1791	English colonization of Vermont rapidly expands.
1791	Vermont becomes the 14th state, there are 85,425 people living in the state (1790 Census), landscape is 80% forested. State
1800	US Census reports there are 154,465 people living in Vermont.
1831	First bounties for bear are enacted by State Legislature.
1865	US Civil War ends, over 300,000 people live in Vermont, state is 37% forested, it is illegal to hunt deer.
1887	The last known native catamount is killed in Barnard.
1897	30-day season.
1904	The forebear of the Vermont Fish & Wildlife Department is created.
1941	Bear bounties repealed.
1946	“The Time is Now” written by Department biologists in response to rapidly growing deer herd.
1950	In 100 years Vermont population has grown very little, 377,747 people reside in the state.
1951	First regulation of bear harvest.
1953	First archery season is held.
1962	First sections of Interstate Highway System completed (Montpelier to Burlington).
1963	Limited antlerless permits issued.
1969	First wild turkeys (17) are reintroduced in Pawlet.
1970	Statewide land-use and development law (Act 250) passed.
1973	First wild turkey hunt held in parts of Addison and Rutland Counties. 579 permitted hunters harvest 23 birds.
1979	Modern deer management era begins, antlerless permits are issued by Wildlife Management Units (WMUs).
1986	First muzzleloader deer season is held in December.
1990	First Deer Management Plan is written.
1993	First regulated moose hunt in Vermont history held in October, 30 permits are issued.
2003	First Youth Day deer season is held the Saturday before regular deer season.
2005	to 2 points on one side.
2008	Vermont is 75% forested, 625,000 people live in the state, ten-year planning cycle begins for deer, moose, bear, and wild turkey populations.

WHITE-TAILED DEER

I. Management History

WAYNE LAROCHE

Catastrophic conditions in both the deer population and habitat had already developed by the time Vermont's modern-day management program had begun in 1963. Buck-only deer hunting, which had been the tradition since 1897, allowed the deer population to grow rapidly and reach the biological carrying capacity (Seamans 1946, Garland 1978, Miller and Wentworth 2000). In Windham, Windsor and Rutland counties, the deer herd reached an overabundant and unhealthy state during the 1940s. The sporadic and small antlerless harvests between 1963 and 1970 removed less than 5% of the total deer herd (estimated at 250,000 deer). This proved to be insufficient to curtail growth and prevent the herd's impending collapse. As had occurred in other deer populations in other parts of the country earlier in the century, the consecutive harsh winters of 1969 and 1970 severely affected the health and abundance of Vermont's deer herd, which was already compromised by years of chronic overpopulation. In poor physical condition and without a sufficient nutrition base, Vermont's deer population would continue to fluctuate in response to winter conditions throughout the 1970s. Although reduced to only half of its former size through the 1970s, the deer population of about 120,000 animals lacked the vigor and supporting habitats to rebound. Allowing the habitat to recover by holding the deer population at a low or moderate level was the only realistic solution to the chronic infirmity within the population created by the long-term over use of deer habitats.

In 1979, the Department began an ambitious deer population recovery effort. This effort occurred in three phases. During the first phase, the deer population was intentionally reduced to a level even below what remained after the winter mortality of the late 1970s. The second phase through the mid-1980s maintained the population at a relatively stable, low-density level to allow habitats to recover their ability to support a larger deer population. The third phase allowed for a gradual increase in the population to sustain annual deer harvests of 15,000 to 20,000 animals, while monitoring measures of herd health. By and large, this plan was successful. The habitats recovered and measurements of deer health such as antler beam diameter, weight, and reproductive rate improved (Table 2.1, Fig. 2.1).

Table 2.1 Reproductive rates of incidentally-killed adult (at least one year-old) female deer examined during winters in Vermont.

Year	# Doe	# Pregnant	Percent Pregnant	# Live Fetuses	# Fetuses per Doe
1963	99	82	83%	121	1.22
1966	115	97	84%	122	1.06
1972	139	121	87%	188	1.35
2001	121	115	95%	199	1.64
2004	78	72	92%	110	1.41
2008	119	108	91%	172	1.45
1963-72*	353	300	85%	431	1.22
2001-08	318	295	93%	481	1.51

*From Garland (1978)

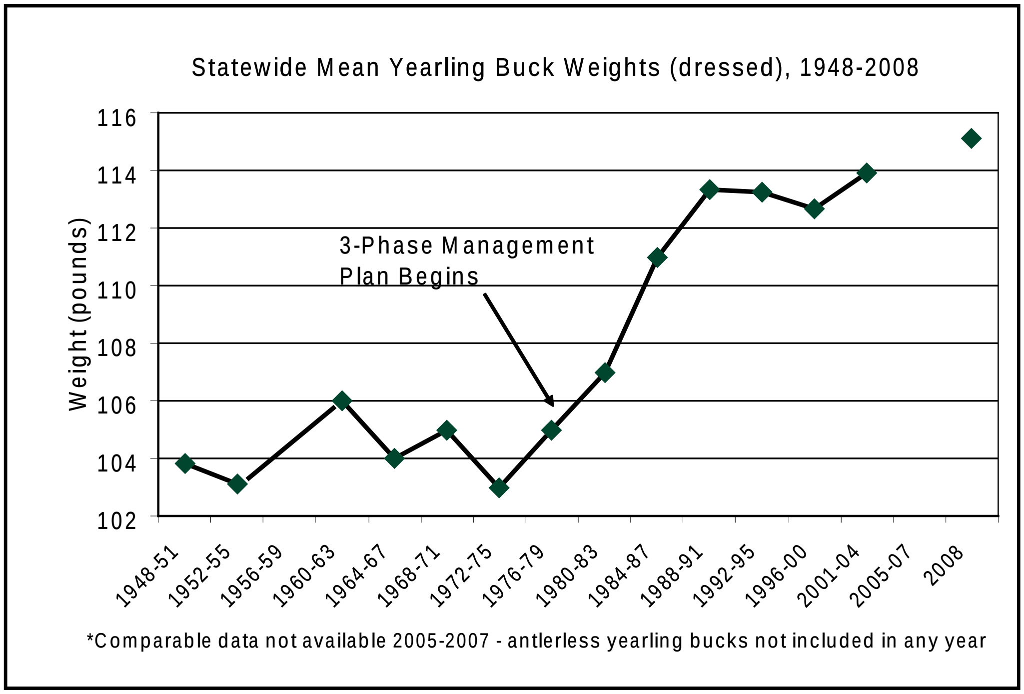

Figure 2.1 Statewide mean-average yearling buck weights (dressed) 1948–2008. In 2008, biological check stations were held during youth weekend, so biologists could again get weight data that were representative of the population, because spike-antlered deer can still be taken during youth weekend.

Improvements did not come without a cost, however. The decade of the 1980s saw some of the smallest buck harvests since 1946. Legislation was passed in 1990 that prevented antlerless deer seasons from occurring during the November rifle season. Given this new constraint, the Department set out to make adjustments as to how deer management would be conducted in the years to come. Because the adult females drive the reproductive potential in a deer herd, effective population management means managing the number of does.

Responding to this challenge, the Department moved to involve the public more deeply in deer management decisions than ever before. Based on buck harvest objectives derived from averages of the 1970s and the results of a general public survey, a draft management plan was presented to interested citizens. The plan contained information about historic buck harvests, deer health statistics, and population trends through time on a WMU basis. The first deer management plan concluded with a selection of harvest objectives (within parameters set by the Department) that considered views of the public. With these objectives in hand, the Department proceeded to make annual antlerless harvest recommendations based on regional harvests. With antlerless deer numbers now being controlled using archery, muzzleloading, and youth hunters, the question remains: will the existing season structure and harvest limits be sufficient to take enough does in the future to prevent excessive population growth during mild winters? The answer may be most of the time, as long as multiple consecutive mild winters do not occur. Some of the time, however, it may be necessary to take additional measures to ensure that the deer herd does not become overly abundant.

During the 1990–1995 planning period, buck harvests increased significantly. Light antlerless harvests and mild winters during three of the five years of this planning period were largely responsible for this rapid response. Buck harvests met, or consistently exceeded, the harvest objectives in 15 of the 24 WMUs during this time. On a statewide basis, the statewide harvest objective was exceeded twice, and twice was within 1% of the objective. The overall size of the deer population increased as indicated by the 45% increase in buck harvest. Although the 1996 deer population estimate was between 120,000 and 140,000 animals, the health indices of antler beam diameter and body weight did not decline. Yet, continued growth at the pace experienced during the 1990s would have put the future of the deer herd and its habitats at risk. Indeed, a modest decline in yearling buck weights in the late 1990s (Fig. 2.1) preceded another herd decline resulting from severe winters in 2001 and 2003. The difference this time was that habitat had improved through the 1980s, and the herd was in better overall physical condition to rebound rapidly during this current decade (see data on following page).

1997-2006 Plan Accomplishments

In addition to seeking a balance between human demand for deer and the environmental consequences of too many deer, the Deer Management Plan for the State of Vermont 1997-2006 had five specific tasks to address.

➤ **Task 1.** ***Protect Deer Yards***

❖**Action:** Given the importance of deer wintering areas (DWAs) to the state's deer herd, the Department has vigorously defended against the loss of wintering habitat to human development. This is done through Vermont's land-use and development law known as Act 250, which requires an evaluation of a project's impacts on wildlife habitat. As a result, the Department worked with developers to modify development plans to lessen the impact to wintering deer. During this plan period, Department biologists reviewed 971 impacting deer wintering area projects, totaling 25,542 acres, and of these 91% (23,338 acres) were protected as part of the Act 250 regulatory process (Table 2.2).

Because only a small percentage of land development in the state actually requires an Act 250 permit, the majority of development is regulated at the local level or not at all. When consulted, the Department worked closely with town and regional planning bodies to assure DWA protections were incorporated at the local level.

➤ **Task 2.** ***Population/Buck Harvest Objectives/ Adequate Antlerless Harvests***

❖**Action:** Balancing the demands of the people for more deer with the demands of the forest for fewer deer is the continual dilemma every northeastern fish and wildlife management agency faces. During the 1997-2006 planning period, the Department established an annual total buck harvest objective of 11,650. It was estimated that a buck harvest of this size would be generated by a deer population density of 18–20 deer per square mile. Assuming the buck harvest to be directly related to the overall deer population, it would serve as a good indicator of when the deer population increased or decreased. With this goal each year the Department would recommend an antlerless permit allocation distribution by WMU to adjust for population growth or loss resulting primarily from the previous year's harvest and winter severity index (WSI). Table 2.3 illustrates the relationship between the change in buck harvest (and assumed change in deer population) and the corresponding change in antlerless permit numbers.

➤ **Task 3**. ***Antlerless Permit Application Process***

❖**Action:** A prominent concern expressed by hunters prior to the 1997-2006 plan was the ability of an individual to make multiple applications for an antlerless permit thereby increasing his or her odds of being drawn. Recognizing that this issue of fairness was very important to a majority of hunters, the Department recommended to the Vermont Fish and Wildlife Board a regulation change that limited an individual to one antlerless permit application. This change became effective for the hunting seasons of 1997.

➤ **Task 4**. ***Promoting Hunting Culture***

❖**Action:** Although a free youth hunting license had been available since 1993, Vermont's downward trend in sales continued to follow the national decline. Growing concern for the decrease in the number of hunter served as an impetus to advance a youth hunting opportunity (Fig. 2.2). With the support of the deer hunting community, the Vermont Legislature passed a measure designating the Saturday before the regular deer season as Youth Hunting Day. The first Youth Hunting Day occurred in 1997. Seeking to expand the opportunity for youth, especially considering all of the alternative activities available to them on a Saturday, the Legislature expanded the Youth Season to include Sunday as well. The first youth weekend was held in 2003. Early enthusiasm for youth hunting reached its peak in the year 2000. It was followed by a period of decline mirrored by adult participation. This suggests that factors beyond

Table 2.2 Summary of Act 250 DWA acres with Department involvement (1997-2006).

Year	# Projects involving DWA	Total Wintering Area Acres	Acres Impacted	Acres Conserved or Protected	Pct. Acres Protected per Year
1997	89	3,087	266	2,821	91%
1998	115	3,132	348	2,784	88%
1999	114	3,281	281	3,000	91%
2000	107	2,154	198	1,956	91%
2001	78	1825	205	1620	89
2002	116	3,484	180	3,304	95%
2003	132	2,888	222	2,666	92%
2004	94	2,169	270	1,899	88%
2005	92	2,125	265	1,860	88%
2006	112	3,222	174	3,048	94%

1997-2006 Plan Accomplishments (continued)

Table 2.3 Buck harvest, antlerless harvest, and WSI relationship for the period 1997-2006.

	1997	1998	1999	2000	2001	2002	2003	2004	2005*	2006*
Buck Harvest	12,596	12,641	11,907	12,610	9,409	11,023	9,194	7,648	4,956	7,805
Antlerless Harvest	7,240	7,427	7,876	7,888	5,602	5,609	5,334	4,277	3,590	4,877
Winter Severity	37.3	29.9	35.6	34.0	73.3	23.6	83.9	62.2	44.7	15.2
*New antler point and bag limit regulations in effect										

a special hunting season, perhaps the same influences from suburbanization that adult hunters are faced with, are affecting young hunter recruitment and retention (Fig. 2.3). In 2009, the Vermont General Assembly removed the Vermont residency requirement. This now allows any eligible youth to participate in the Youth Hunting Weekend as long as he or she has obtained landowner permission and is accompanied by an adult with a valid Vermont hunting license.

The Department also initiated several other successful programs and activities that encourage hunting, outdoor activities, and appreciation of our forests and wildlife. The "Outdoors Woman" and "Outdoor Family" programs were aimed at educating and exposing women and families to outdoor sports and skills. The Department partnered with the Vermont Outdoor Guides Association to sponsor a yearly "Doe Camp" to introduce women to outdoor hunting skills. A two day retreat, "The Future of Hunting in Vermont" at Castleton State College in 2006, brought together over 80 people from many youth organizations, sporting groups, and academic and government institutions to discuss challenges and solutions associated with barriers to hunting and recruiting new hunters. And finally, the Department created a pilot project called "Working for Wildlife" that establishes partnerships with sporting clubs to work on projects associated with habitat improvement, landowner relations, and conservation education.

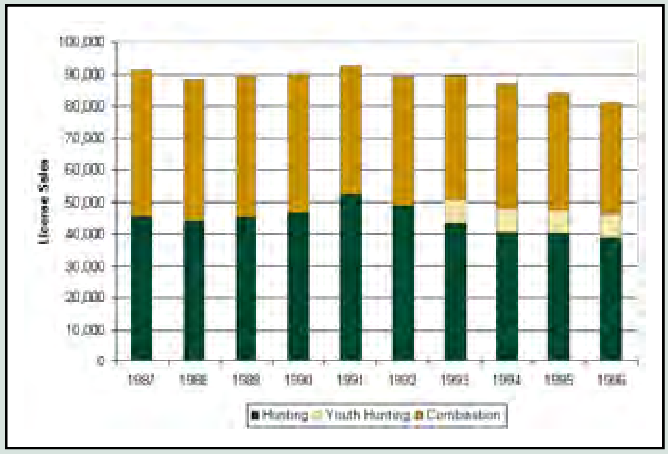

Figure 2.2 Resident hunting license sales, 1987–1996.

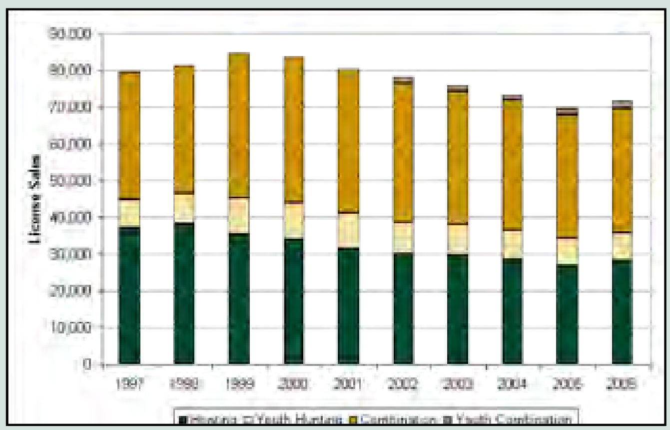

Figure 2.3 Resident hunting license sales during the 1997-2006 deer management plan period.

➤ **Task 5. *Quality Deer Management (QDM)***

❖**Action:** Vermont deer hunters with an interest in hunting older-aged bucks (3.5 years or more) with well-developed antlers approached the Department during the development of the 1997-2006 Deer Management Plan. According to the definition used in the management plan, Quality Deer Management (QDM) is described as a management technique used to shift the age structure of the buck population from one dominated by young (1.5 years old) males to a population with a higher proportion of older-aged (at least 3.5 years old) bucks.

To further assess these components and develop an objective approach for designing a QDM program that was intended to balance deer population and habitat and increase the numbers of older bucks, the Department assembled a nine-member panel of deer hunters in January of 1998. Following their

1997-2006 Plan Accomplishments (continued)

seven months of research and deliberations, the QDM advisory panel identified 14 elements to be included in the QDM program (Table 2.4) and four possible alternatives (Table 2.5).

The panel recognized the implementation challenges and the significant amount of effort required to make institutional changes to a long-standing traditional deer season. To avoid making premature decisions about deer season changes, the panel recommended that strong, broad-based support of hunters and landowners be present before implementing any changes in season format. The panel also recommended that QDM be implemented at the WMU level and not vary in design from one unit to another.

Upon being presented with these recommendations, the Department decided first to assess hunter satisfaction. Results of the 1998 survey indicated most respondents (63%) indicated they were "Very Satisfied" or "Satisfied" with their deer hunting experience in the last five years (Table 2.6). Hunters preferred to retain the then current deer hunting season format (one 3-inch antler minimum) over any QDM restrictions that might be implemented by a 57% to 41% margin, with 2% reported as "Undecided."

Following a review of what the QDM panel produced and the hunter opinion survey, it was decided to table further consideration of any changes to the season format. However, following poor hunting seasons in 2001, 2003, and 2004 related to the severe winters of 2001 and 2003, hunter satisfaction decreased significantly. Another hunter satisfaction survey was completed in 2003 to assess interest in "QDM," or what was then being labeled as "Comprehensive Deer Management" (CDM).

Results of the 2003 survey indicated that, in general, since 1998 more hunters were still satisfied with their deer hunting in Vermont than those who were not (42% "Satisfied" vs. 31% "Dissatisfied"). However, when compared to the 1998 survey where 63% were "Satisfied" vs. 20% "Dissatisfied", there clearly had been a shift towards greater dissatisfaction. When asked of their support for greater antler restrictions to protect more young bucks, 66% supported and 24% opposed this idea with 10% reporting "neutral" (VFWD 2004).

With the results of the survey showing hunters' support for increasing the proportion of bucks afield, the Department renewed its effort to meet this goal. A series of public hearings were held, and the Fish and Wildlife Board was given authority by the Legislature to set deer hunting regulations, with the exception of the November rifle season, as they do for all other fish and wildlife species.

An antler-point restriction regulation to promote CDM was put into effect by the Board beginning with the 2005 hunting seasons. The new hunting regulation also reduced the annual bag limit from three deer to two and redefined a legal buck to a deer having at least two points on one side. The points were defined as the terminal point and one other point measuring at least one inch from the main beam.

Table 2.4 Elements of QDM , by relative importance, identified by the QDM advisory panel.

1. Hunter participation
2. Ecological integrity
3. Recruitment of young hunters
4. Ease of implementation
5. Endorsement of residents in WMU
6. Quality of hunting experience
7. Balanced Buck:Doe ratio
8. Balanced age structure
9. Maximum sustainable yield
10. Acceptance by the nonhunting population
11. Increased body weight of individual deer
12. Increased antler size on bucks
13. Equal hunting opportunity for all hunters
14. Genetic improvement of the deer herd

Table 2.5 Methods for QDM implementation recommended by the QDM Advisory Panel.

1. Retain the current season structure. The present hunting seasons include the elements of QDM and can be defined by the individual hunter.
2. Restrict the buck harvest by changing the definition of a 'legal buck' from a deer with at least one, 3-inch antler, to a deer with at least 3 antler points.
3. Restrict the annual bag limit from 3 deer of either sex (with appropriate permits) to 3 deer with no more than 1 buck per year.
4. Restrict the annual bag to one deer per year and include antlerless deer, by permit, as part of the 1 deer bag.

Table 2.6 1998 and 2003 survey results for the distribution frequency (%) of hunting satisfaction.

	1998	2003
Very Satisfied	17.3	5.8
Satisfied	46.1	35.7
Neutral	16.9	26.8
Dissatisfied	13.8	23.8
Very Dissatisfied	5.9	7.9

II. 2010-2020 White-tailed Deer Management Issues, Goals, and Strategies

Many Vermonters would like to have more deer than is advisable under the new deer density objectives, and many others would like to have fewer. The rationale for the deer density objectives are provided in the supporting text that follows. Ultimately, the proper balance maintains ample harvests of deer as well as forest products over the long term. It is apparent that localized deer management issues are mounting in Vermont and methods are needed to support more localized deer management to relieve foresters, gardeners, and farmers from locally overabundant deer populations. The overall goal of deer management in Vermont is to manage Vermont's deer herd to sustain viable populations consistent with biological, social, and economic considerations.

ISSUE 1. Habitat Loss and Assessment

GOAL: To monitor changes in habitat quality and quantity and perform public outreach regarding habitat management techniques, so concerned citizens may help to secure their deer herd's future.

White-tailed deer populations vary widely through time and space in response to varying habitat and landscape conditions as well as weather, hunting intensity, predators, and disease. Changes in any of these factors complicate the ability to track deer populations, but the factors most important in determining population size are habitat conditions and winter severity. Hunting, as a form of predation, can be used as a tool to control the deer population in Vermont as long as enough does can be taken.

Optimum deer habitat has been described as a mosaic of fields and forests (Halls 1984). In areas with high quality habitats, deer can live in an area as small as one square mile. Within this area, the diversity and arrangement of plant species provide a setting for deer to feed, bear young, and find shelter and concealment. The greatest concentrations of deer in Vermont are found in agricultural areas of the state (having the highest carrying capacity for deer) with a mix of field and forest. Reduced numbers of deer occur in remote aging forestlands, especially in large blocks of forests at high elevations where diversity and quality of food plants are reduced and extreme snow depths frequently occur. For these reasons, Vermont's lower elevation areas tend to have higher densities of deer. The differences in both the habitat quality and the density of deer in different areas of the state are the reason and basis for the state being divided into wildlife management units.

Deer wintering areas, or "DWAs," are habitats that provide shelter for deer in periods of extreme cold and deep snows. These areas are usually comprised of stands of softwood tree species, such as hemlock, spruce, fir, cedar, and pine, and they range in size from less than 100 to more than several thousand acres. Within these critical areas, combinations of vegetative and topographic factors create micro-climates that favor survival of deer through the harshest season of the year. These areas are essential to the survival of our deer during severe winters. Wintering areas do not usually change significantly from year to year and may be used by many generations of deer over many decades if appropriate habitat conditions are maintained. Deer exhibit a great deal of fidelity to individual wintering areas. When cover is removed, deer don't always move to another area and are more likely to succumb to harsh weather.

Department wildlife biologists first identified and mapped Vermont's deer wintering areas during the 1960s and updated the maps in the mid-1980s. Since that time, Vermont has lost some of this important habitat to residential development and even more has been affected by winter recreational trails and logging. The Fish & Wildlife Department biologists endeavor to protect and enhance deer wintering areas through negotiations with land developers during the Act 250 land use regulatory process by working with municipal and regional planners to recognize these areas as being sensitive habitats and by coordinating with landowners, foresters, and loggers to maintain and improve conditions within these essential wintering habitats. The Department uses strict guidelines for logging and maintaining DWAs on state-owned Wildlife Management Areas and has recently updated the "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" (VFWD 2009) designed to provide guidance for interested landowners.

In addition to being concerned with the habitat losses caused by people, the Department is also closely monitoring the spread of invasive plant and insect species that could affect deer habitats. One species that has potential to alter large amounts of deer wintering habitat is the hemlock woolly adelgid. This insect kills eastern hemlock. If this insect becomes established in Vermont, it could have far reaching effects on the state's hemlock-dominated forests and DWAs. Hemlock trees provide superior cover for wintering deer. Department biologists are closely monitoring the occurrence of this harmful insect with help from state foresters. There is some concern that warmer winters and extended growing seasons may allow the movement and colonization of this tree pest northwards up the Connecticut River valley.

Management Strategies

1.1 Update inventory of deer wintering areas for local, regional, and state habitat planning and protection efforts.

1.2 Stress the importance of habitat conservation with outreach efforts to various segments of the public such as farmers, educators, hunters, forest managers, and land planners.

1.3 Work closely with foresters and entomologists to prevent, manage, and eliminate the threat of the hemlock woolly adelgid.

ISSUE 2. Population Goals

GOALS: **1) Maintain deer densities using regional population objectives.**

2) Monitor biological characteristics of habitat and deer that can change in response to deer herd size through time.

3) Adjust antlerless deer harvests to alter population levels as necessary to achieve population objectives.

Deer Density

Vermont statutory law states that "an abundant, healthy deer herd is a primary goal of fish and wildlife management" (Title 10 V.S.A. §4081(c)). This is the foremost charge of deer population management in Vermont. The deer herd is kept healthy by preventing overabundance with carefully planned antlerless deer harvests.

The population density of a deer herd affects the general health of the animals, the sustainability of its habitat, and the probability of human and animal conflict. The following discusses the factors that the Department considers when setting management objectives: the sex ratio between bucks and does and biological and cultural carrying capacities. It also discusses how the Department gathers data that is used to determine deer harvests.

Sex Ratio

Adult white-tailed deer females typically produce twin fawns if summer and autumn nutrition are adequate (Ozoga and Verme 1982, DelGiudice, et al. 2007). If successful, the Department's management strategy should maximize the reproductive potential of does. Sex ratios that are highly skewed in favor of does can result in does remaining barren through the first estrous thus delaying pregnancy for the entire year because there are too few bucks to tend all does (Mysterud et al. 2002). The gregarious nature of female deer and coursing nature of breeding bucks typically allow a sex ratio of one buck to three does to be sufficient to breed all does in a population (Table 2.1; Demarais et al. 2000). Populations that are heavily hunted require more does than bucks in order

Table 2.7 Number of road-killed adult (at least 1 year-old) male and female deer registered by game wardens in Vermont

Year	# Males	# Females	# Females per Male	# Males per 100 Females
1971	274	1,057	3.86	25.9
1972	414	1,394	3.37	29.7
1973	419	1,252	2.99	33.5
1974	381	1,095	2.87	34.8
1975	361	1,208	3.35	29.9
1976	318	1,091	3.43	29.1
2000	434	1,244	2.87	34.9
2001	325	1,225	3.77	26.5
2002	257	974	3.79	26.4
2003	299	1,010	3.38	29.6
2004	255	889	3.49	28.7
2005	299	953	3.19	31.4
2006	357	1,012	2.83	35.3
2007	459	1,149	2.50	39.9
2008	471	1,239	2.63	38.01
1971-76*	2,167	7,097	3.28	30.5
2000-05	1,869	6,295	3.37	29.7
2006-08	1,287	3,400	2.64	37.9

*From Garland (1978) describing a period of buck-only hunting.

to produce the excess of offspring needed to sustain harvests.

Many hunters in Vermont believe that there are too few bucks to completely breed all does. Statewide data from deer road-kills has consistently demonstrated that a sex ratio of a little over three does per buck exists in Vermont (Table 2.7). Sex ratios can also be estimated from survival estimates determined from age data. White-tailed does commonly live many productive years in Vermont (Fig. 2.4) while bucks typically live only a few years (Fig. 2.5). In general, does have about 75–85% annual survival while annual survival of bucks is about 25–40%. Model results confirm the road-kill estimates that before the antler restriction (AR) in 2005, statewide prehunt sex ratios were about 3.25 does per buck.

Increased yearling survival following the AR has changed the buck to doe ratio. Prehunt sex ratios are now estimated to be about 2.75 does per buck state-wide. With more than 50% of legal bucks harvested annually, it is expected that the number of does per buck increases post-harvest. Localized differences are expected to always exist around the state.

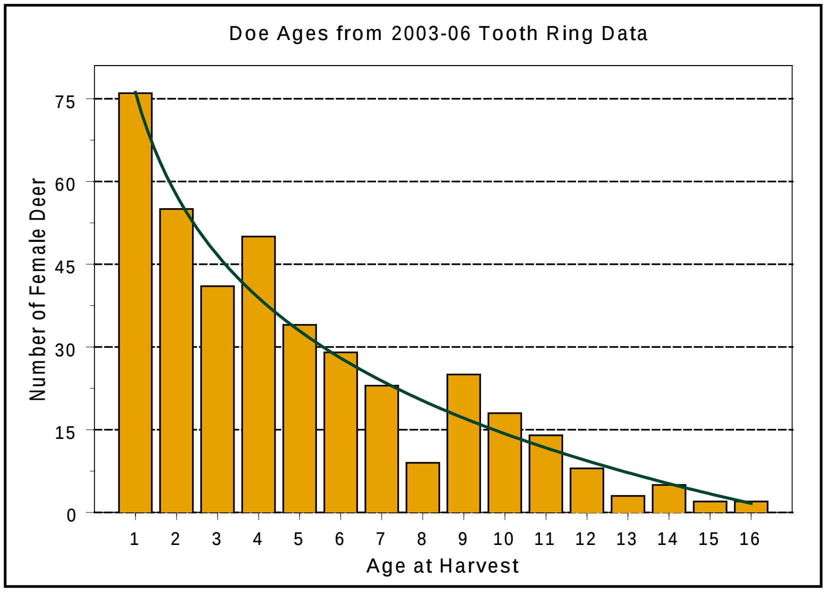

Figure 2.4 Laboratory-determined ages of 427 female white-tailed deer from the 2003–2006 annual Vermont harvests.

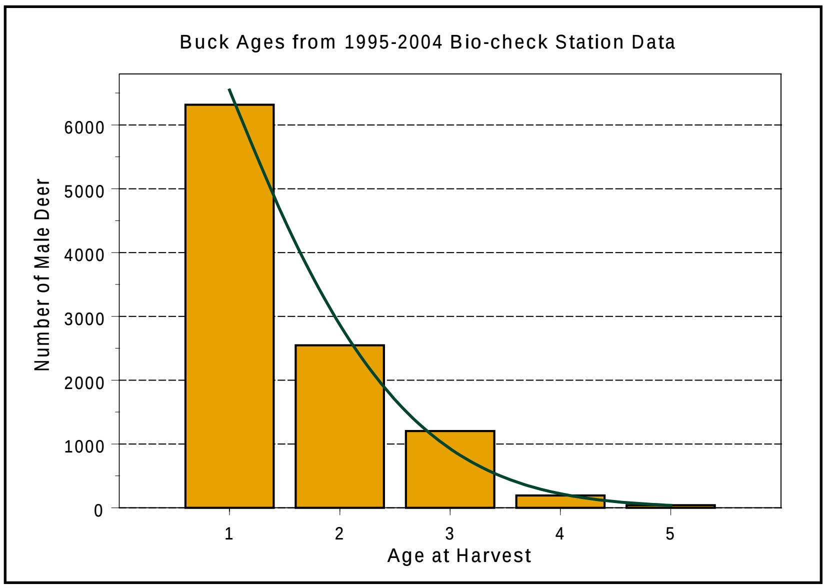

Figure 2.5 Ages of 10,300 male white-tailed deer from 1995–2004 as determined by Vermont biologists at check stations during the opening weekend of rifle season.

Biological and Cultural Carrying Capacities

In determining the optimal size of the deer herd, biologists consider the concept of carrying capacity — biological and cultural. The term biological carrying capacity (BCC) refers to the maximum number of animals that an environment can support without detrimental effects. The quality and quantity of available habitat determines the BCC. The cultural carrying capacity (CCC) is more subjective. It is determined by assessing the values people place on wildlife versus the liabilities created by overabundant wildlife populations. While BCC has only an upper limit, CCC has both an upper and lower limit because most people desire that there not be too few, but not too many deer to cause damage. Hunters and the general public want enough deer to satisfy their hunting and viewing desire while too many cannot be ecologically sustained and are considered to be a nuisance to humans.

Biological Carrying Capacity and Maximum Sustainable Yield

When deer herds approach or exceed an area's biological carrying capacity, the animals' health is affected. Wildlife managers have determined that deer herds managed at densities below BCC are healthier and in balance with their habitat. This concept of maximum sustainable yield (MSY) is the point within the biological carrying capacity curve when the density of a herd is in balance with its habitat and when fawn recruitment is at its maximum level. A population at BCC recruits as many fawns as it loses adults, so it has no harvestable surplus. At MSY there are fewer deer overall in a population. Does produce more fawns (Table 2.1, pg 10), and fawns have a much better neonatal and overwinter survival.

Deer and their habitats are unhealthy when at a BCC level, but healthy and productive near MSY. This principle is particularly important in northern environments where body condition of deer going into winter can be critical to over-winter survival and where the existence of too many deer can do extensive damage to wintering habitats. Managing near MSY, rather than BCC, helps minimize the boom and bust cycle of the deer herd in Vermont and can be expected to sustain greater deer harvests in the long term (Fig. 2.6). A healthy deer herd with healthy habitats can recover from bad winters or over harvesting much faster than a deer herd and habitat in poor condition.

Cultural Carrying Capacity

Owing to their beauty and athleticism, deer populations are often too low to meet the general public's desire to view these animals. From a cultural perspective, when deer populations become too large, conflicts such as damage to landscape flowers and shrubs, agricultural and forestry losses, deer-vehicle collisions, and transmission of human pathogens, such as Lyme disease, can occur. In these cases a deer population may be below its biological carrying capacity (BCC), posing little threat to the long-term sustainability of their habitats, but at the same time above its cultural carrying capacity (CCC)if property losses or disease prevalence are deemed too high. Deer populations can also be below CCC when hunters and other outdoor enthusiasts feel that they see too few deer.

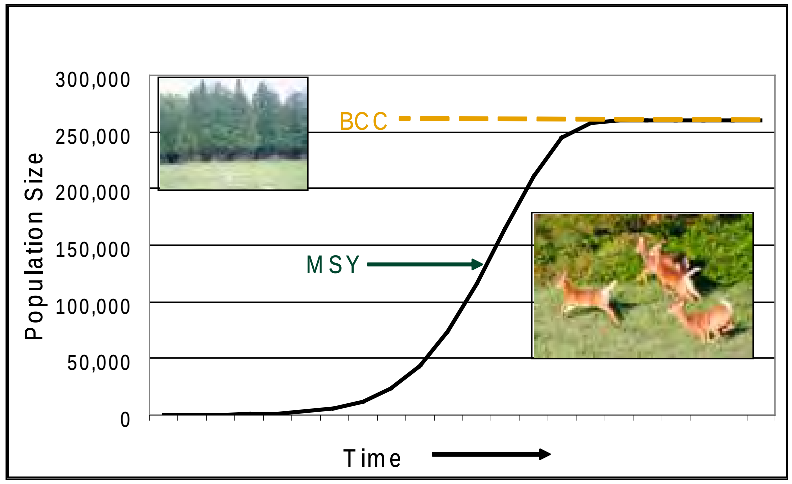

Figure 2.6 Deer population size and growth rate at biological carrying capacity (BCC) versus maximum sustainable yield (MSY)

To find the proper balance between the highs and lows of CCC, the Department conducted a public opinion survey in 2007 to assess the people's deer abundance preferences (Fig. 2.7). The assessment was analyzed at many different levels including, where one lived, one's gender, and whether or not one hunted. The results of the survey suggest that nearly half of all Vermonters are generally satisfied with the number of deer in their county. Thirty-two percent of the respondents felt the deer population should be increased with only 5% of respondents feeling the deer population should be decreased. Fifteen percent either "did not know" or had "no opinion."

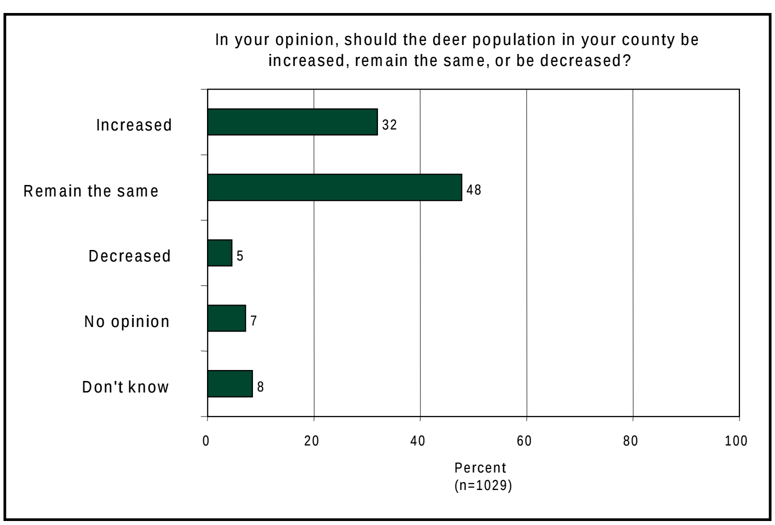

Figure 2.7 Vermont public's opinion regarding deer population change over the next ten years

When the response to deer population change is analyzed by subgroups, similar interests were found. Of those who said they had hunted in the past five years, 66% felt the deer population should be increased and 27% felt it should remain the same. Of those who did not hunt during the last five years, 22% felt the deer population should be increased and 54% felt it should remain the same. Greater Chittenden County residents were more likely (58%) to want deer populations to remain the same than their more rural counterparts. This suggests that the deer population may be approaching CCC in Vermont's most populous county. On the other hand, more people (48%) in the Northeast Kingdom (Orleans, Caledonia, and Essex counties) want more deer. This suggests that deer numbers are not near the CCC in that region of the state.

When asked about property damage from wildlife, 14% of the respondents indicated they had suffered a loss to their automobile and 21% had incurred loss of landscape, ornamental or vegetable garden. But when these respondents were compared with those who had not incurred any damage of any kind, responses were remarkably similar for both groups when asked about their opinions of deer population size. Forty-six percent of the respondents incurring damage felt the deer population should remain the same while 48% of respondents that had not incurred any damage felt the same way. These data suggest that, in general, the upper CCC limit, with localized exceptions, is not currently an important issue to the Vermont public.

Responsible deer management dictates that a deer herd's relation to BCC be considered before CCC is considered. In this circumstance, biological measures (for example, birth rates, antler development) inform the Department about the deer population goals. In most of Vermont, deer population goals, as measured by deer per square mile, can currently be achieved through traditional regulated hunting seasons. In cases where deer numbers are below BCC, but CCC demands fewer deer, traditional hunting seasons may not always be effective in satisfying CCC. In some cases, population goals may need to be described in terms other than deer per square mile, for example: motor vehicle collisions, Lyme disease rates, or number of crop damage complaints. These measures may need to be used to set population goals in some local areas if Vermont's deer and human populations continue to grow. Special methods to reduce deer numbers, such as those described in the "Locally Overabundant Deer Populations" section, could be required in the future.

Cultural carrying capacities will likely become increasingly important in the future as a consideration in setting deer density objectives in parts of Vermont where the human population density is growing fastest. In Connecticut where high deer densities (greater than 50 per square mile) are associated with high incidence rates of Lyme disease, CCC may require long-term deer density objectives to be set as low as 10 deer per square mile (Kilpatrick and LaBonte 2007). This is a situation that may be preventable in Vermont if we are able to maintain densities at or below 20 deer per square mile in regions such as Bennington County that are prone to Lyme disease (see Vermont Health Department statistics for Lyme disease cases in Vermont). Reduction in deer densities may reduce the abundance of Lyme disease-carrying ticks (Ixodes scapularis). Very few ticks were found in Maine where deer densities were lower than 18 per square mile (Wilson et al. 1990, Rand et al. 2003, 2004). On the other hand, total elimination of deer can lead ticks to feed more intensively on rodents and result in higher densities of disease-positive nymph-stage ticks (Perkins et al. 2006). Once again, finding the proper balance between too many and too few deer seems to be the best way to ensure that a healthy ecosystem exists with a minimum of human conflicts.

Body Condition and Deer Densities

The number of deer per square mile that Vermont's landscapes can support is a value that shifts across the landscape and through time as habitat quantity and quality change. Often deer themselves are a main cause of this change as they degrade habitat when they become too numerous. Thus, biologists usually rely on biological measures of the deer themselves, such as reproductive rates, weights, and yearling antler beam diameters, to gauge the relationship between the deer herd and their habitat.

Population objectives going forward should be based not only on deer harvest numbers but also on the body condition of deer. Many states and deer management systems monitor deer herd characteristics, such as reproductive rates, yearling antler beam diameter, and fawn weights to track population health (Miller and Wentworth 2000, Williamson 2003) (Fig. 2.8). These data can be used to measure the impacts of and changes in deer populations that follow severe winters (Fig. 2.9). Although tracking changes in the body condition of deer provides a way of recognizing times when there is a need to harvest more deer, it is often after damage to habitat has already occurred. Changes in body condition of deer do not provide a means to determine how many deer should actually be harvested (Fig. 2.10).

In the long-run, if deer harvests are tailored to ensure that deer body condition remains good, deer will weigh more and winterkill will not be as great during severe winters. Deer in good condition will also produce at an optimal recruitment rate that is just above intermediate levels of abundance relative to BCC (Miller and Wentworth 2000; Fig. 2.6). This management strategy will dampen the boom and bust cycle of deer in Vermont.

It appears that a sustainable harvest of deer having good body condition may be approximately the harvest level that occurred in the mid-1990s, and again in 2008. This is a total deer harvest of approximately 17,000 deer per year (Fig. 2.11). Vermont has never sustained annual harvests of 20,000 deer for very long. Harvest of 20,000 deer per year in Vermont, given current hunting pressure and deer reproductive potential, is probably indicative of an overabundant deer herd. Buck harvests frequently exceeded deer management objectives in the late 1990s following a series of mild winters. Lessons from the 1990s and scientific studies suggest that perhaps 20% of does may need to be harvested during times of mild winter in order to stabilize herd growth when winters fail to do so (Dusek et al. 1989, Giles and Findlay 2004). Historically, less than 10% of adult does have been harvested annually in Vermont. Regional estimates are made using the same method. Adding up these regional estimates results in a total deer population estimate that is very similar to the estimate calculated above for the whole state (Table 2.9 pg 26, Fig. 2.12).

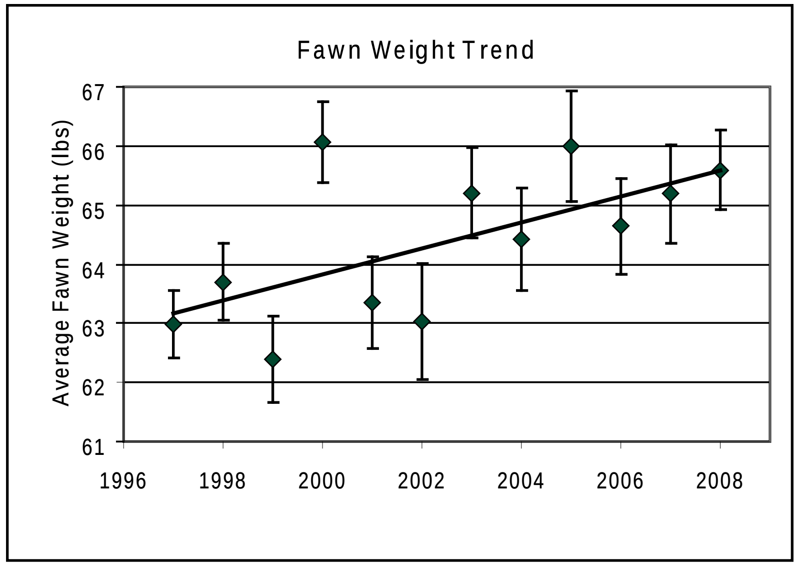

Figure 2.8 Annual average fawn weights (with 95% confidence limits) as reported by hunters to check stations from 1997–2008. All years exclude fawns reported over 99 pounds. The decadal trend-line minimizes the distance between the annual points and the line itself. With bio-check stations now during youth weekend, the Department will investigate the use of fawn weights as a more sensitive indicator of herd health, similar to the use of yearling buck weights.

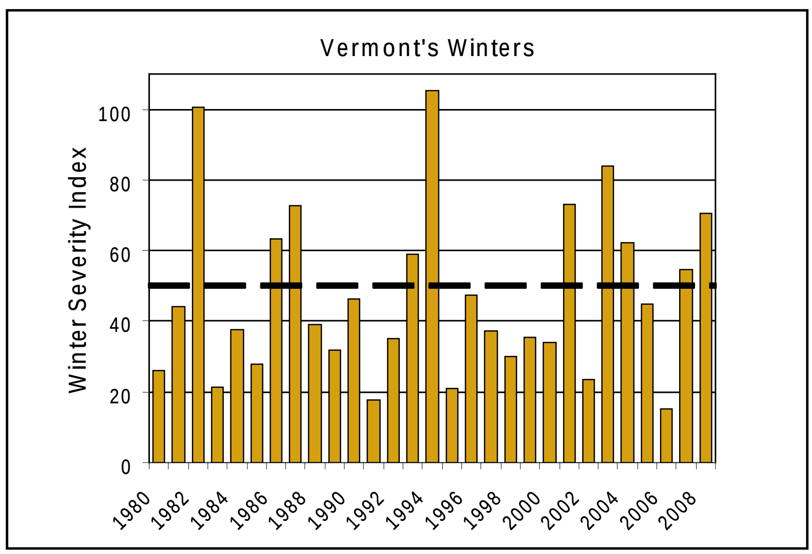

Figure 2.9 Statewide winter severity indices (WSI) in Vermont from 1980–2008. The horizontal dashed line equals a long-term average of about WSI=50. From 1 December through 15 April, one point per day is given when snow depth is at least 18 inches, and a point is given when temperatures drop below 0°F. The Department maintains 38 volunteer weather stations statewide.

Habitat and Deer Densities

White-tailed deer play a significant role in the ecology of Vermont's forests. As herbivores (plant eaters), they disperse seeds and as prey, they allow other species to survive. The influence of deer in our forests is considered so significant that researchers and wildlife managers regard them as a "keystone" species in the Northeast. Deer browsing has profound implications for the structure and function of forested ecosystems. If deer were removed from the system, a wide variety of changes would ripple through the forest. However, overabundant deer populations can also be a negative force within the forest ecosystem.

Deer densities vary throughout North America as well as within Vermont and are largely in response to habitat and weather conditions that affect reproductive and survival rates and food availability (Halls 1984, Crête 1999). Young forests provide better habitat for white-tailed deer than old-growth forests. A mix of field and forest is more favorable

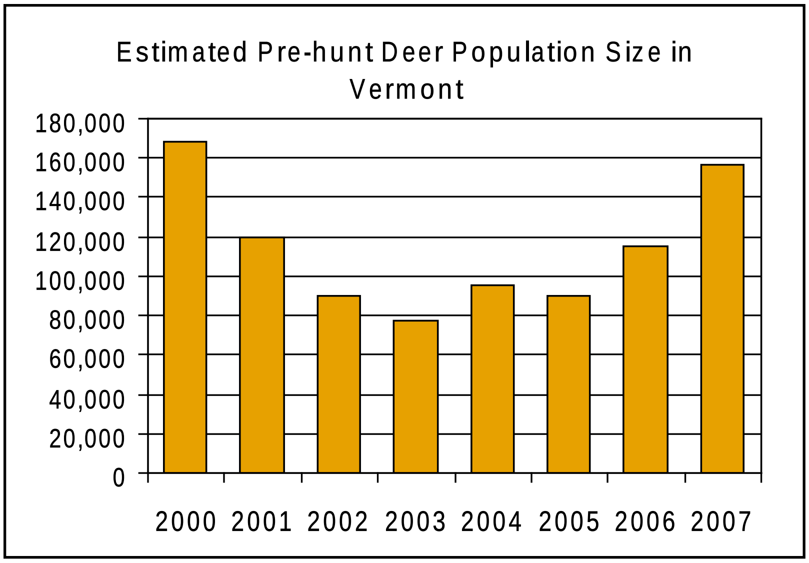

Figure 2.10 Pre-hunt total deer population estimates (+/- 15%) for Vermont from 2000–2007. Rapid population growth from 2005–2007 demonstrates tremendous growth potential of Vermont's healthy deer herd given a mild winter as in 2006 and restricted antlerless deer harvests.

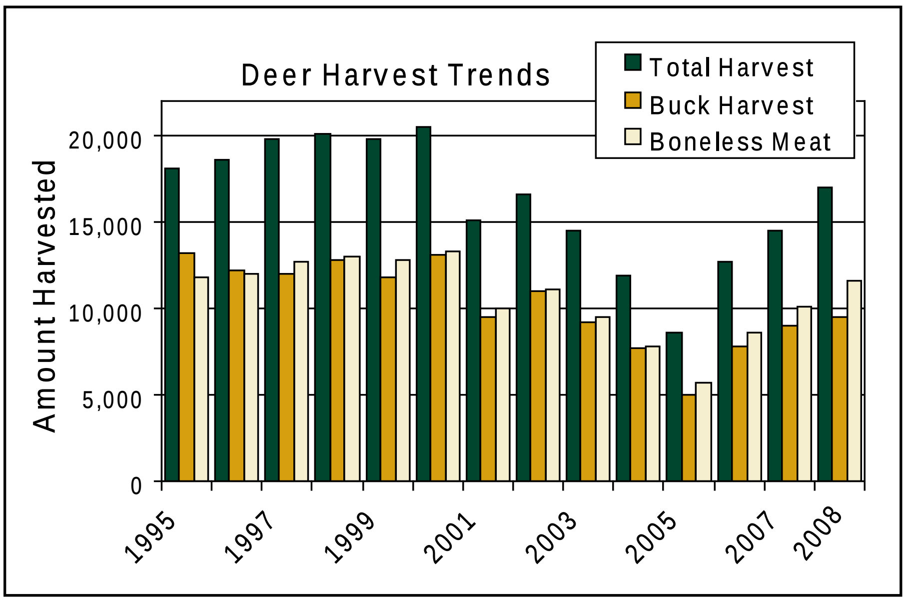

Figure 2.11 Annual total deer and antlered buck harvests in Vermont from 1995–2008. Boneless meat is represented as 100s of pounds, so the ten-thousand-line equals one-million pounds of meat. Pounds of boneless meat assume that hanging weight (skin, head, and feet removed) is 75% of field-dressed weight and edible meat is 75% of hanging weight.

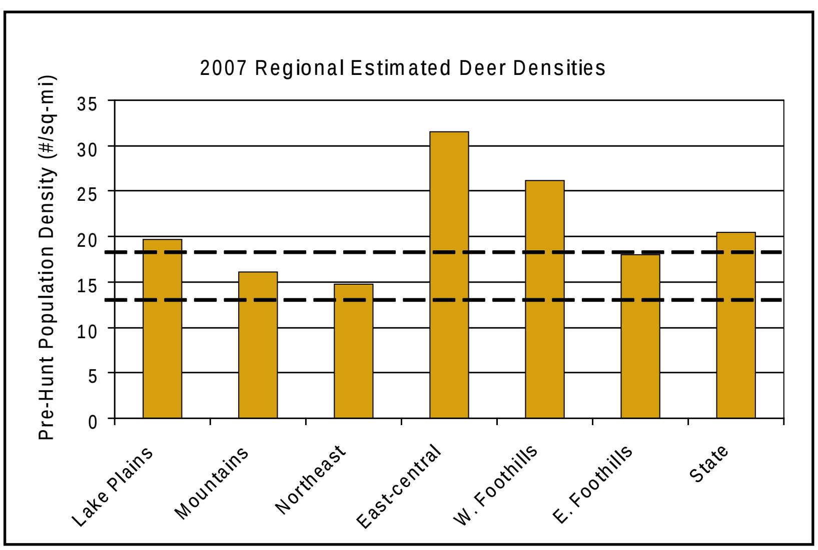

Figure 2.12 Regional pre-hunt deer population density estimates for Vermont in 2007 (see Table 2.9) in relation to statewide upper and lower population density objectives (i.e., horizontal dashed lines near 13 and 18 deer per square mile).

than large unbroken forest tracts. For instance, deer at similar density will have less impact on forest vegetation and habitat condition in areas having some agricultural croplands compared to areas that are entirely forested (Horsley et al. 2003). Areas having greater and more prolonged snow loads during winter can be expected to have greater winter-kill than in areas having less snow. For these and other reasons, sustainable deer densities vary throughout North America and within Vermont. Thus, it is sensible to manage deer to achieve various deer density objectives regionally throughout Vermont in accordance with climate and habitat conditions that are influenced by soil type, topography, weather, and human land-use practices.

Optimal deer density varies across the landscape and through time. Studies from northeastern North America have found that general patterns associated with deer density, however, do exist. Since the mid-1900s, deer density in much of the eastern United States, including southern Vermont, has been high enough to negatively impact forest vegetation. Long-term deer densities exceeding 20 per square mile are capable of altering forest plant communities, threatening endangered plant species, reducing ground-level hiding cover and forage for other wildlife species, and reducing abundance of nesting birds (McShea and Rappole 2000, McGraw and Furedi 2005, Côté et al. 2006). At densities greater than 20.5 deer per square mile, managed forest habitats in northwestern Pennsylvania were altered enough to exclude many songbird species (DeCalesta 1994).

Forest conditions, including deer forage availability, at any point in time are related to past as well as current land and forest management practices. Forest management practices affect the capacity of the forest to accommodate deer. Certain forestry practices may be used to encourage forest regeneration in locations where deer browsing is of concern. For example, one study recommended increasing the size of clear-cuts to larger than two acres as a way to provide for sufficient forest regeneration by producing more than the deer could eat (Akins and Michael 1995). Indeed, more research is needed on forest management practices that are effective in the presence of deer. Researchers have found that northern Pennsylvania hardwood forests were able to successfully regenerate with no shift in tree species composition at deer densities of 13–21 per square mile as long as suitable “deer forage” was at least moderately abundant (Marquis et al. 1992). On the other hand, when deer food availability was high, successful forest regeneration occurred at deer densities as high as 21–31 deer per square mile (Marquis et al. 1992). Agricultural lands interspersed with forest lands enhance the availability of suitable forage for deer and can increase the density of deer that can be sustained without impacting forest regeneration. A deer density of 18 deer per square mile was suggested to ensure regeneration of desired tree species in the absence of agricultural influences (Tilghman 1989).

Following the end of Vermont’s state-wide deer reduction campaign of the 1980s, deer numbers increased through the 1990s and once again reached high densities in many parts of the state even with increased antlerless harvests. In some parts of the state, deer populations grew to levels that again began to impact forest regeneration. In southeastern Vermont, deer have consumed much of the palatable and merchantable hardwood regeneration of oak, maple, and ash. In addition, the region has experienced a proliferation of invasive species that are not palatable to deer such as buckthorn and barberry. As a result, both the invasive species and deer browsing on the more limited food supply have compounded the impacts on the native forest species. Similar effects, although not as dramatic, may be observed in other parts of the state (Fig. 2.12). For these reasons, the densities of deer that the habitat can support in southeastern Vermont may be more limited than in other parts of the state.

Deer density in any given area typically changes with the seasons. In northern climates, the onset of snow and colder temperatures force deer to vacate their larger summer and fall ranges and concentrate in higher densities in deer wintering areas. Quantity and quality of both winter and nonwinter deer habitat, as well as severity of weather conditions, determine the density of deer that any region can sustain through time. Good summer feeding conditions result in bigger and fatter deer that survive winter better. Good winter habitat minimizes thermal and other stressors that burn energy and result in mortality.

Because optimum deer density varies depending upon regional conditions, any determination of optimal deer density objectives for Vermont should be based upon data that considers both summer and winter habitat while accounting for regional differences in winter severity, winter habitat condition and availability, and the land use considerations of landowners. Applying all of these factors in managing for a pre-determined prehunt summer and autumn deer density objective is a method that will best provide for optimal body condition as deer go into Vermont's unpredictable winters. This is the best way to minimize boom and bust deer density cycles.

Wildlife Management Unit (WMU) Realignment

Antlerless deer harvests began being regulated by WMU in 1979 under a permitting system allocating permits to hunt in the 17 newly formed WMUs, which are defined in state statute. Seven of the WMUs were separated by the Legislature into two sub-units in 1983. Changes in deer populations and a reassessment of existing habitat conditions warrant refining the boundaries of select WMUs in order to facilitate more effective management of the deer population in the WMU. Revisions being considered are described below and illustrated in the map (Fig. 2.13).

a. Adjust the boundaries of the WMUs in southeastern Vermont to more accurately reflect the difference between the Connecticut River Valley habitat and the habitat associated with the physiographic region. This would merge WMUs M1 and O1 to form the Eastern Foothill unit (new WMU M) and WMUs M2 and O2 to form the Connecticut River unit (new WMU O). WMU Q would have I-91 as an easterly boundary in the town of Guilford. East of I-91 would become part of WMU O.

b. Extend the boundary of J2 northward to US Route 2 to remove an agricultural area from WMU E because habitat in agricultural areas is generally more productive than that found elsewhere in Essex County. Combine the remaining mountainous portion of H2 with H1 to form a new WMU H.

c. Merge WMUs K1 and K2. The area of K1 is too small to yield harvest numbers large enough to be effectively used in scientific data analyses. These two WMUs closely resemble the habitat types of their respective neighboring WMUs and can be included into a new WMU K.

d. Move a portion of the boundary between WMU D1 and D2 to the east to put more of the Lake Memphremagog agricultural lands into WMU D1, which is most similar in land use and habitat condition.

Data Gathering

In order to allocate permit numbers and direct other management actions at the WMU level, data sources such as hunter sighting rates, antlerless tag fill rates, and local observations are used to fine-tune management actions. For example, some property owners would like the Department to manage overabundant deer at the level of individual properties (for example, extra doe permits for landowners). This could be an option for dealing with localized problem areas having high deer densities. However, any system would need to be scientifically credible, practical, effective, and consistent with the overall deer management strategy. Should such a system be devised it should be based on data measured from vegetation, not by sightings of deer (Mitchell et al. 1997, Augustine and DeCalesta 2003). The Department has found that localized problems of deer overabundance can often be dealt with by getting landowners to provide access to their land and work with hunters to take antlerless deer during archery, muzzleloader, and youth seasons.

Vermont has recently begun using a "mark-recapture" method for deer population estimation. Coupled with new buck:doe ratio data collected from road-killed deer and fawn:doe ratios determined through bow hunter observations, deer biologists are improving their ability to estimate annual deer population composition and density at the state-wide and regional level. Because smaller amounts of data have less predictive power than larger amounts of data, it has now been determined that current data at the WMU level is not sufficient for these techniques to be used to make accurate population estimates at the WMU level. For this reason, WMUs having the most similar deer densities are being grouped into regional units for regional population estimation purposes (for example, Northeastern Highlands, Lake Champlain Valley).

The following provides an example of how the deer population numbers for the state of Vermont can be estimated. Analysis of deer age data (Figs. 2.4 and 2.5) determines that Vermont has a statewide prehunt buck:doe ratio of 1:2.75. Age data reveals that yearling bucks make up about 52% of the antlered buck harvest. Approximately 50% of all yearling bucks have spike antlers as determined by data collected by biologists at check stations prior to 2005 (26% of total buck population has spikes). Thus, a prehunt legal buck population in 2007 of 19,286 indicates a total buck population of about 26,062

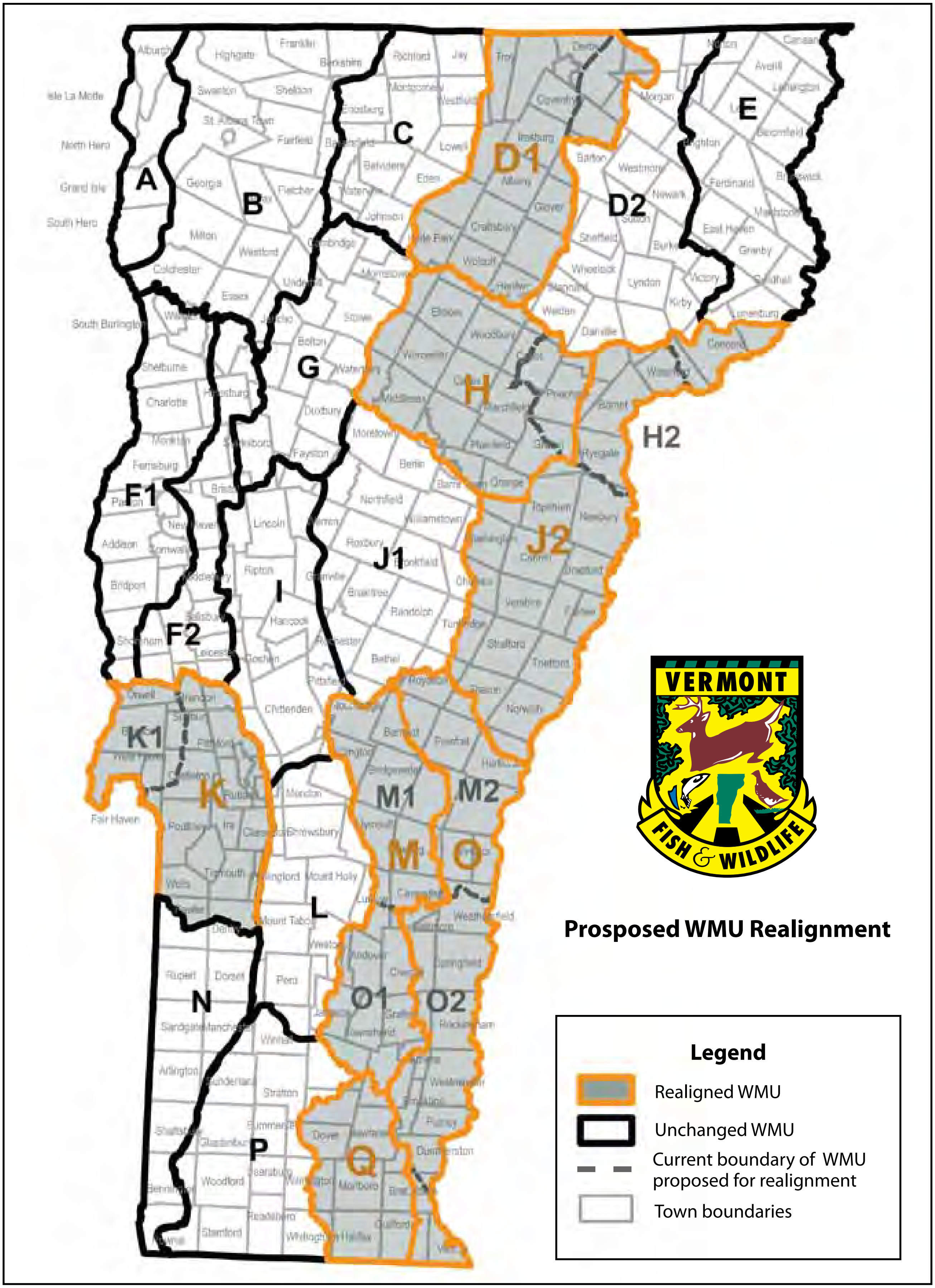

Fig. 2.13 Current and proposed WMU boundaries

if spike-antlered yearlings are included (Table 2.8). Given an estimate of 2.75 does per buck, the adult doe population is estimated to be 71,670 does. In 2007, 4,484 adult does were harvested amounting to 6% of the adult doe population. Assuming 1.5 fawns are produced per does of at least 1 year-old (Table 2.1) and assuming a 55% fawn survival rate through early autumn (Ballard et al. 1999, Haskell et al. 2007), there would have been about 59,130 fawns in the deer herd prior to harvest in 2007. The summer fawn survival estimate is the most uncertain of the estimates used in this model. However, by combining these estimates, it is possible to estimate the total prehunt deer population for 2007 which adds up to about 157,000 (±20,000 90% CI; Fig. 2.10), or 20.5 deer per square mile of deer habitats.

The Department currently also uses the mark-recapture technique to estimate prerifle hunt legal buck population size (results in Tables 2.8 and 2.9). The Department's technique is essentially a removal model where probability of "recapture" is set to zero. The deer are in a sense "marked" when they are registered at the check station during the 16-day rifle season when the hunter reports the WMU and day that the deer was harvested. By combining this data with daily hunter effort estimates gathered from hunter surveys, the mark-recapture model can be used to estimate the daily probability that a deer will be harvested, and ultimately, the number of deer that remained after the annual harvest. Adding the number of deer harvested to number of deer estimated as not harvested yields a prerifle-hunt population estimate of legal bucks. This application of the mark-recapture method may be uniquely applicable to Vermont for three reasons: 1) mandatory registration of all legally harvested deer ensures that a very complete accounting of actual harvest exists; 2) an adequate return rate of hunter effort surveys exists (demonstrating Vermont hunters' dedication to sound deer management); and 3) the harvest rate of bucks during the rifle season often exceeds 50% of the total buck population (Table 2.8). All three of these conditions must be met for this technique to produce valid results. At this time, Vermont may be the only state that meets all of these conditions.

It is the Department's goal to make deer management in Vermont as scientific and data-driven as possible, but this effort will at times be limited by staff and other resources. Professional judgment provided by Vermont's wildlife biologists will always be necessary to augment the hard science of wildlife management.

Deer Density Objectives

Based upon the information gathered on the issues presented above, the Department intends to set prehunt deer density objectives for each of the regions in Vermont. These will serve as a baseline from which to work in the future (Table 2.10). In setting these density objectives, it is recognized that they must vary even within a region of the state. For example, the northeastern part of the state may sustain a total deer density of 13 deer per square mile. However,

Table 2.8 Population estimates ("N-hat") of legal bucks in Vermont before the rifle harvest and then corrected for bucks taken in earlier seasons to get pre-hunt estimates. Total harvest rates respond to population size and license sales, and post-hunt buck populations may be important to consider for wintering deer. In all years, post-hunt numbers presented assume no sources of mortality during hunting seasons other than registered harvests.

Year	Pre-rifle Legal Buck N-hat	Rifle harvest	Rifle harvest rate	Early youth and archery bucks	Pre-hunt Legal Buck N-hat	Total buck harvest	Total harvest rate	Post-hunt N-hat	Post-hunt N-hat with spikes
2000	22,428	10,256	0.46	1,816	24,244	13,120	0.54	11,124	11,124
2001	16,102	7,588	0.47	1,123	17,225	9,522	0.55	7,703	7,703
2002	11,619	8,720	0.75	1,428	13,047	10,956	0.84	2,091	2,091
2003	9,575	6,868	0.72	1,623	11,198	9,196	0.82	2,002	2,002
2004	12,283	5,594	0.46	1,420	13,703	7,654	0.56	6,049	6,049
2005*	8,263	3,957	0.48	728	8,991	5,002	0.56	3,989	7,833
2006	11,395	5,964	0.52	1,319	12,714	7,807	0.61	4,907	9,733
2007	17,979	6,839	0.38	1,307	19,286	8,955	0.46	10,331	16,873

*Antler restriction changes definition of a legal buck for 2005–2007, excluding spike-horns from the initial buck population estimate (N-hat) and other estimates until the final post-hunt column.

Table 2.9 Prerifle season legal buck population estimates (N-hat) by region in 2007 and then corrected for bucks taken before the rifle season for pre-hunt estimates. Note variable harvest rates and pre-hunt density estimates among regions. Final pre-hunt estimated population density includes all bucks, does, and fawns as described in the text. Total state "Buck N-hat" estimate (and following population estimates) is the sum of models run for each region separately; it does not exactly match the model for the state as a whole (Table 2.8), but it is close and well within the 95% confidence intervals.

Region	WMUs	Buck N-hat	Rifle harvest	Rifle harvest rate	Mi2	Rifle harvest/ Mi2	Early youth and archery bucks	Pre-hunt bucks	Pre-hunt density (bucks/ mi2)	Total buck harvest	Total buck harvest rate	Estimated population pre-hunt density
Lake Plains	A,B,F1,F2	2,102	1,251	0.595	1,001	1.25	317	2,419	2.42	1,731	0.716	19.6
Mountains	C,G,I, L,P	3,675	1,062	0.289	1,930	0.55	158	3,833	1.99	1,376	0.359	16.1
Northeast	D1,D2,E	2,625	1,037	0.395	1,539	0.67	172	2,797	1.82	1,333	0.477	14.8
East-central	H1,H2, J1,J2	5,668	1,645	0.290	1,542	1.07	316	5,984	3.88	2,131	0.356	31.5
Western Foothills	K1,K2,N	2,005	1,008	0.503	685	1.47	200	2,205	3.22	1,302	0.590	26.2
Eastern Foothills	M1,M2, O1,O2,Q	2,461	828	0.336	1,178	0.70	144	2,605	2.21	1,082	0.415	18.0
State	All	18,536	6,831	0.369	7,874	0.87	1,307	19,843	2.52	8,955	0.451	20.5

Table 2.10 Deer population density objectives by Vermont regions for the planning period of 2010-2020.

Region	WMUs	Deer Habitats (mi²)	Density Goal Range (deer/mi²)		Population Goal Range (deer/mi²)	
Lake Plains	A,B,F1,F2	1,001	16	21	16,000	21,000
Mountains	C,G,I,L,P	1,930	13	18	25,100	34,750
Northeast	D1,D2,E	1,539	10	15	15,400	23,100
East-central	H1,H2,J1,J2	1,542	15	20	23,100	30,800
W. Foothills	K1,K2,N	685	15	20	10,300	13,700
E. Foothills	M1,M2,O1,O2,Q	1,178	10	15	11,800	17,700
State	**All**	**7,874**	**13**	**18**	**101,700**	**141,100**

WMUs D1, D2, and E may be able to sustain deer densities of 18, 13, and 8 deer per square mile, respectively. Densities will even vary locally within WMUs. The Department recognizes that it cannot manage deer densities directly at any local small scale level. One of the working assumptions underlying small scale deer management in Vermont and other states is that many hunters, especially archers, will congregate in localized areas having higher deer densities within WMUs. This assumption is substantiated by harvest data from Vermont towns.

From previous experiences, the Department can set population goals that include regional deer densities. Statistical advancement in wildlife science made in recent years now allows for accurate estimates of deer density without incurring the high costs. Fine-tuning regional population estimates to small scale WMU-level estimates will be possible using data such as antlerless tag fill rates and hunter sighting rates of deer. The Department will be attempting to track deer densities at the state, regional, and WMU levels using a variety of methods that include the following:

1) Population estimation models using harvest and hunter effort data
2) Catch-per-unit-effort prehunt population estimation
3) Road-kill data for adult sex ratios, reproductive rates, and fawn recruitment through winter to provide necessary data for various analyses
4) Bow hunter surveys to determine autumn buck:doe and fawn:doe ratios and sighting rates
5) Rifle hunter surveys to gather deer sighting rate data

6) Age data to assist in determination of survival estimates and sex ratios

7) Change-in-ratio methods using road-kill data

A well established tenet of deer population biology is that altering survival rates of adult females is the most effective way of altering the trajectory of a deer population (Gaillard et al. 2000, Haskell and Ballard 2007). Only by regulating the antlerless deer harvest, 80% of which is typically made up of adult does, will it be possible to meet Vermont's deer population density objectives.

Maintaining Vermont's deer population density at ecologically sustainable levels is the only way to ensure the health and vigor of Vermont's deer herd, native forest, and necessary deer habitats (for example, deer yards). A deer herd in balance with its habitat will have few negative impacts on other wildlife species, the forest and agricultural industries, and will minimize conflicts with people. It will, it is hoped, also prevent periodic boom and bust cycles of deer abundance that have characterized the history of deer in Vermont.

This overall message is not new and cannot be over-emphasized. It has been widely promoted by the Department since at least the mid-1900s (Seamans 1946). Because prehunt population density estimation can only occur after data from the autumn deer seasons and because the impact of the oncoming winter is unpredictable, the task of determining appropriate antlerless harvest objectives for the next fall is a necessarily reactive process. While winter may always be an unpredictable factor, the development of predictive population models is expected to improve through time with additional data and experience. It is hoped the future will provide the tools to make deer management more proactive than reactive.

Management Strategies

2.1 Maintain and evaluate regional population goals, established during this planning period, that are based on deer densities that recognize a lower limit that is unsatisfactory to the public and an upper limit that is ecologically unsustainable.

2.2 Monitor deer herd health by collecting body condition data from hunter-harvested and road-killed deer.

2.3 Consider establishing habitat suitability criteria to define areas of suitable deer habitat within WMUs so that consistent and reliable density estimates can be made while allowing for habitat area estimate updates as new land-cover maps become available.

2.4 Evaluate bowhunter surveys to better estimate regional buck:doe and fawn:doe ratios; compare fawn production estimates to autumn fawn:doe ratios to estimate summer fawn survival, and use buck:doe ratios to estimate adult doe population through reference to the unbiased buck population estimate.

2.5 Continue remapping and surveying deer wintering areas so that available habitat is quantified and localized winter deer density is better documented.

2.6 Work with foresters to develop data-driven methods for assessing localized deer overabundance problems that might lead to development of localized deer management methods. Data must provide measures of forest condition.

2.7 Provide outreach to landowners regarding methods that may minimize damage and encourage reduction in locally overabundant deer populations. Investigate feasibility of a formal program to connect hunters with landowners to address locally overabundant deer populations.

2.8 Develop strategies to maintain enough big game registration stations to make big game reporting convenient for hunters.

2.9 Seek statutory changes to realign boundaries of select WMUs as proposed above.

ISSUE 3. Hunter Satisfaction and Antler Point Restrictions

GOAL: Employ biologically responsible, socially responsive, and adaptive management of the deer herd.

The Department continually monitors deer hunter opinions. Although opinions will vary widely among hunters, collecting their observations and views is a useful "tool" in managing the deer herd. The Department gains insight into the "will of the people" via five annual public meetings held in the spring as well as through many public outings at reporting stations, sporting shows, game clubs, and various other venues. Daily contacts between state game wardens and the public also provide rapid feedback from the public to the Department. Since 1999, the Department's annual hunter effort surveys and periodic opinion polls have provided both general and specific feedback that may be focused on some pressing, current issue. In recognizing the value, and absolute necessity of listening to the people, the Department has made it a goal to continue to improve methods for public input.

Hunter Satisfaction

Generally, the effects of winter severity on the deer herd correlate with changes in deer population density. Data since 1970 demonstrate that fluctuations in rifle season buck harvests have fairly predictably paralleled changes in winter severity (Fig. 2.14). This suggests that winter severity has continually influenced deer density in Vermont.

Anecdotal feedback from hunters, as well as increased license sales in 2007 and 2008, suggest hunter satisfaction has improved greatly since 2006. As the deer population rebounded, hunters have seen more deer and harvests have increased (Fig. 2.15). While biologists understand that perhaps the single greatest influence on hunter satisfaction is how many and how often deer are seen, there is a growing interest in the qualitative characteristics of Vermont's deer population.

Antler Point Restrictions

In 2005, Vermont established a new antler restriction (AR) designed to "spare" a larger portion of yearling bucks and allow them to mature to an older age. Although this regulation was intended to change the age structure of the buck population by increasing the proportions of bucks in older age classes, it also slightly increased the total number of bucks and ratio of bucks to doe.

Prior to establishment of Vermont's antler restriction regulation, about 50% of each year's crop of yearling bucks in Vermont were spike-horns. This regulation protected these yearlings and resulted in a surge of two-year-old bucks and smaller increases in other age classes (Fig. 2.16).

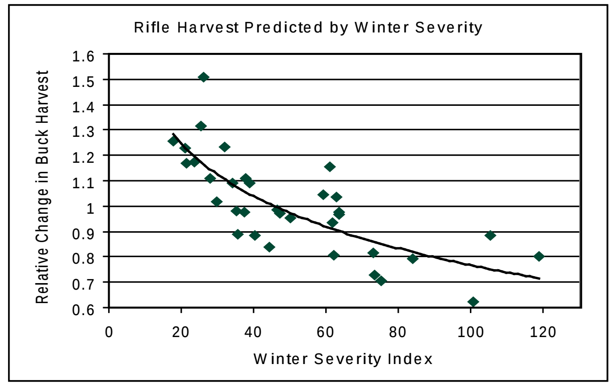

Figure 2.14 Relative annual change in rifle season harvest from one year to the next predicted by winter severity in Vermont from 1970–2004.

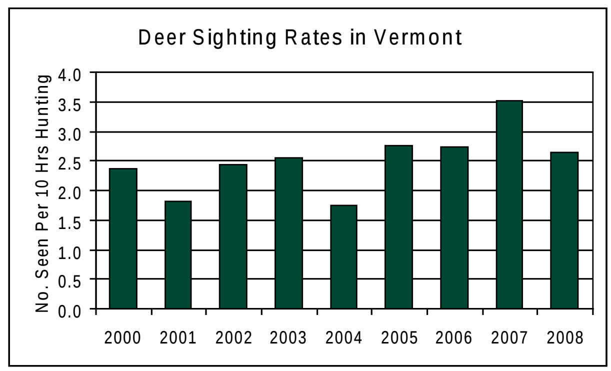

Figure 2.15 Number of white-tailed deer seen per 10 hours of hunting time as reported by Vermont hunters from 2000–2008.

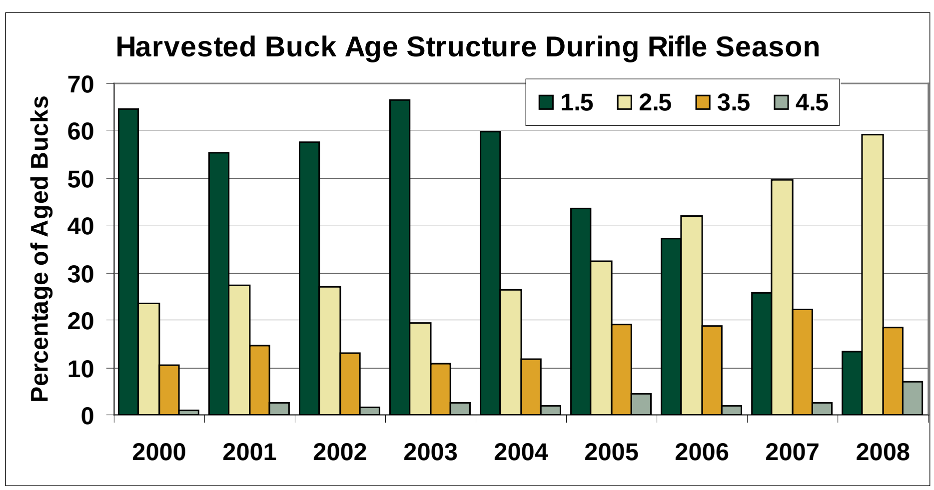

Figure 2.16 Age structure of bucks sampled by Department biologists during opening weekend of rifle seasons 2000–2007 as determined by tooth wear and replacement. Buck sample (n=248) for 2008 taken from buck heads submitted by cooperating meat-cutters during rifle season for disease testing.

Not only have older buck populations increased under the new AR but the weights of harvested bucks have increased. Before the antler restriction, the average field-dressed weight of bucks checked by biologists was 125 pounds. By 2007, the average weight increased to 138 pounds. In 2007 9,000 bucks were harvested yielding 117,000 pounds more of field-dressed deer and 50,000 pounds more of edible deer meat than the same number of bucks harvested in 2003.

For the first time, the quality (that is, the antler and/or body size) of deer has begun to compete with the quantity of deer as a driver of satisfaction among Vermont hunters. The Department continually monitors social acceptance and biological integrity of the statewide antler restriction experiment. Already, new concerns related to the "quality of deer" have surfaced as some hunters and scientific publications have expressed concern that protecting the smaller yearlings from harvest could have an effect on the gene pool of the deer herd (Harmel et al. 2001, Strickland et al. 2001, Coltman et al. 2003, Demarais et al. 2005, Festa-Bianchet 2007, Coltman 2008). There are, however, several reasons why, at least in the short term, adverse effects on the gene pool are not likely:

1. Does contribute 50% to genetic recombination.
2. Twin fawns have different sires about 20% of the time, and in general, it is normal for small bucks to breed does (Sorin 2004).
3. Mature and heavy does tend to breed early, which may occur before the rifle season when most bucks are harvested (Haskell et al. 2008).
4. Dominant male deer are polygamous, they breed many does, which may mean they breed early and sire disproportionately more male than female offspring (Gomendio et al. 2006, Roed et al. 2007).

Also, many confounding environmental factors, such as food availability and winter severity, can affect antler size and shape, particularly deer population density as it relates to nutrition (Harmel et al. 2001, Williamson 2003, Keyser et al. 2005, Gomez et al. 2006, Strickland and Demarais 2008).

The Department has not yet conducted thorough research into the issue of deer population genetics to be able to determine whether this issue needs to be addressed. Prudence dictates that we monitor the results of this statewide experiment closely for signs of change. Future research and knowledge may suggest the need to modify the antler restriction to better manage for the future.

The youth deer hunt has become particularly important as a source of unbiased data on bucks. Because youths can take any yearling buck, data from the youth hunt provides a sample of the entire yearling buck population and provides data that is comparable to data collected during seasons before the antler restriction. By comparing data from pre- and post-AR harvests, it will be possible to detect any changes that may result from the antler restriction that might have some potential future effect on the deer herd. Based on assessment of pre-AR data, the current AR of two points on one side protects about 50% of yearling bucks while an AR of three points on one side would protect about 90% of yearlings. In the future, a three-point on one side AR could be considered if genetic issues were found to be of concern or if hunter preference for older aged bucks was to increase.

The antler restriction has worked to slightly increase the age structure of bucks because it has increased yearling survival rate during the hunting season, a time when yearling bucks are most vulnerable to mortality. The antler restriction is not expected to increase the number of four-year old or older bucks because the harvest rate of two-year old and older bucks remains high. In the future, some modification of the current restriction to three-points on one side, some slot limit, or other regulation to achieve desired harvest and population objectives may be appropriate.

There are also ways other than antler restrictions that can be used to increase survival rates of bucks. Alternatives include several ways to restrict hunting opportunity of bucks, such as reduced seasons, restrictive weapons, and reduced bag limits (see Issue 4: Bag Limits). The main cause of mortality of Vermont bucks, 76% of the total buck harvest, is during the rifle buck season when, in fact, only one buck can be taken. Even if there was a need or hunter support to change this proportion, it would require a legislative change. The rifle deer season is set by statute and cannot be changed by the Fish and Wildlife Board. The Department will remain open to the use of all effective methods understanding that implementation is dependent on public acceptance.

Management Strategies

3.1 Collect adequate yearling buck data (weights, antler beam diameter, and number of points) from the youth hunt to detect and track any changes in the buck population resulting from the current antler-point restriction (two points-on-one-antler minimum), and evaluate biologically acceptable alternatives if needed.

3.2 Evaluate a model assessment using genetic data to examine the likelihood of altering the genetic diversity of the buck population via the current antler restriction.

3.3 Inform the hunting public about deer management issues and results of antler-point restrictions and gather input concerning deer management and hunter satisfaction.

ISSUE 4. Bag Limits

GOAL: Provide suitable utilization of deer as food and provide opportunity to hunt deer in a way that maximizes potential for effective deer population management but does not overstress the heavily harvested buck population.

One of the Department's objectives is to provide as much opportunity as is sustainably possible to hunt, fish, trap, and view wildlife in Vermont. In particular, restoring and increasing hunting opportunities and participation is one our foremost goals during this planning period that follows a period in which hunter participation has declined.

Vermont's bag limit of three deer per calendar year has been a topic of some controversy among hunters since the poor deer season of 2001. Despite data consistently demonstrating the three-deer bag limit has very little effect on the overall harvest (Table 2.11), hunters were able to persuade the Fish and Wildlife Board to reduce the bag limit to two deer for the purpose of increasing the size of the deer population. The real impact of this action was a reduction in hunting opportunity and a reduction in the amount of time hunters spent afield. An unintended consequence of the change was a reduction in the number of female deer harvested because hunters did not wish to sacrifice an opportunity to hunt bucks during the rifle season by taking antlerless deer.

As history demonstrates, the third deer provided additional opportunity and an incentive for hunters to go deer hunting while very few deer, especially

Table 2.11 Percent of successful hunters harvesting 1, 2, or 3 deer for the period 2000 – 2008.

Year	1 deer	2 deer	3 deer	Deer Harvest
2000	83%	14%	3%	20,498
2001	83%	15%	1%	15,065
2002	85%	13%	2%	16,261
2003	88%	10%	2%	14,528
2004	90%	8%	2%	11,925
2005	93%	7%	X	8,546
2006	92%	9%	X	12,682
2007	89%	11%	X	14,516
2008	84%	15%	2%	17,046

bucks, were actually ever bagged as a third deer. Returning to a three deer limit in 2008, once again, afforded Vermont hunters more days afield and improved the harvest of does.

Management Strategies

4.1 Provide the public with ample opportunity to harvest white-tailed deer for food and other utilitarian purposes.

4.2 Advocate for an appropriate deer bag limit that allows maximum hunter opportunity while achieving deer population management strategies.

ISSUE 5. Muzzleloader and Archery Season Modifications

GOAL: Provide suitable opportunity to hunt deer in a way that maximizes the potential for effective deer population management but does not interfere with hunters during youth weekend or rifle and other fall hunting seasons.

While hunter participation in the rifle season has remained consistently high at 88% over the past decade, participation in alternative seasons has increased. Hunter participation in the muzzleloader season increased from 32% in 1996 to 43% in 2007 while participation in archery also increased from 27% to 33% (Duda et al. 2007). One survey found that more Vermont deer hunters (48%) preferred the muzzleloader season occurring after the rifle season than those who preferred a season occurring before the rifle season (30%).

The timing and length of the archery season or any proposal for an early muzzleloader season should be carefully considered given the need for a special youth weekend before the rifle season and the interests of landowners. Since there is already a heavy harvest of bucks in Vermont, any early muzzleloader season should be tailored to the task of controlling doe numbers. Archery hunters tend to hunt from tree-stands more than muzzleloader hunters whose weapons have greater range. Many muzzleloader hunters prefer the late season because it provides greater likelihood that snow will be on the ground to improve tracking and visibility of deer.

The Department plans to enhance efforts to gather and use archery deer hunter observation data under the assumption that archers in tree stands observe deer at closer range and will be able to provide reliable observations, such as fawns per doe and buck to doe ratios. If these data prove useful, it will benefit all deer hunters.

Many Vermonters have expressed the opinion that more antlerless deer should be harvested before the November rut and December muzzleloader seasons suggesting that an early season could reduce the amount of browse consumed by 1,500 or more antlerless deer that would otherwise be harvested five or six weeks later. Most antlerless deer are currently being taken during early archery and youth seasons prior to the existing muzzleloader season. Taking more antlerless deer early in the season may be desirable.

One way to do this is to open a weekend or a few days to antlerless-only muzzleloader hunting prior to the regular rifle season, which could increase the number of antlerless deer taken before the regular rifle season. It is possible that this might also increase muzzleloader participation and the fill rate of antlerless deer tags as well as improve the Department's ability to manage Vermont's deer herd in areas where deer densities are high. The challenge is to create an early muzzleloader season without disturbing hunters participating in the other seasons — youth weekend, archery, turkey, small game, and rifle. This is a task that would require careful research and considerable input from the various user groups. The same arguments could be made for expanding the archery season. Many of the same challenges would also need to be addressed.

Because the Department relies on archery and muzzleloader hunters to harvest antlerless deer, it is prudent to regain their participation and ensure an

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ability to manage deer densities in Vermont. Archery and muzzleloader license sales declined from 74,193 in 2000 to 36,322 in 2005 as deer populations and hunting opportunity declined. Numbers rebounded to 43,585 in 2007 as deer numbers and opportunity again increased. In addition, longer archery seasons in neighboring states of New Hampshire, Massachusetts, Maine, and New York may have contributed to the decline in archery hunters in Vermont. It seems wise to investigate potential conflicts between seasons in neighboring states and then to assess how the situation in these states encourages or discourages nonresident participation in Vermont's early archery season.

Other means of increasing archery participation are through expanding archery season length or increasing archery season bag limits. Both strategies enhance the ability to harvest antlerless deer where needed, including areas with locally overabundant deer populations or where firearm ordinances restrict opportunities to harvest antlerless deer during the youth weekend or muzzleloader season.

Petitions to the Fish and Wildlife Board and the Department have asked for consideration to make crossbows legal for general use in Vermont and to expand archery seasons. Currently, only individuals who can show evidence of a physical disability that restricts the ability to draw a compound bow are permitted to use crossbows in Vermont. While legalizing the use of crossbows during the archery

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season could increase the Department's ability to harvest does, mixed public response to the concept, however, suggests that this harvest management tool should be deferred until it is determined that other, more popular harvest strategies will not achieve population objectives.

In 2005 baiting and feeding deer was made illegal after a lengthy regulatory process involving a great deal of public involvement. When deer are baited or fed, there are serious concerns of disease threat and improper feeding methods that are actually detrimental to deer. This practice also alters the natural digestive system and movement patterns of deer. Although there are still hunters who want to bait deer, the Department believes baiting poses a threat to the health of Vermont's deer herd and does not want to reopen this issue.

Management Strategies

5.1 Evaluate feasible options to expand antlerless deer-only hunting opportunities prior to the regular rifle season. These options will include, but are not limited to, an early muzzleloader season, expanded archery season, and increases in archery bag limits.

5.2 During the fall and winter of 2009-2010, survey public opinion on the various management options to achieve antlerless harvest objectives prior to the rifle season and develop a proposal of recommended hunting season changes for the Vermont Fish and Wildlife Board in 2010.

ISSUE 6. Captive Deer Hunting/ Deer Farming/ Cervid Importation

GOAL: Implement new captive hunting regulations and work with other state agencies to minimize the chance of introducing and transmitting diseases via captive deer.

In 1986, Vermont passed legislation authorizing the inclusion of certain deer species in agriculture as part of a modern, diversification effort. Fallow deer and red deer were identified as domestic deer species and were legalized to import, possess, and propagate in Vermont the same as any domestic farm animal. Since then, fallow deer, red deer, and elk have been legally imported for agricultural purposes and have been propagated at captive hunt facilities.

The concern with introducing other deer species centers on the potential for spreading disease. Since 1986, Chronic Wasting Disease (CWD) has emerged as a new disease on the national front that threatens Vermont's deer herd. CWD is a disease of the central nervous system similar in nature to "Mad Cow Disease." There is no known vaccine or cure and always results in the death of animals that contract it. This disease cannot be detected in live animals until the disease symptoms have appeared. One of the more troubling characteristics of CWD is that it can lie dormant in an individual animal for years before symptoms appear. Thus, the presence of the disease can go undetected until years after an animal has been transported to a new farm or location.

Animals infected with CWD can be brought into the state by deer farmers, captive hunt facility owners, and even an unsuspecting hunter who has legally harvested a deer or elk from outside of Vermont. The state has established laws and regulations governing the transportation and importation of live deer as well as deer carcasses and other cervids from states where CWD is known to occur. The Agency of Agriculture, Food, and Markets regulates animals used for agricultural purposes and the Department of Fish & Wildlife enforces the regulations that govern any animal imported or possessed for the purposes of hunting. These regulations prescribe veterinary inspections, health certificates, and other measures that mediate the threat of CWD.

Before 2000, CWD was thought to be mostly concentrated in parts of Colorado and Wyoming, but more extensive surveillance has resulted in discovery of CWD in 12 additional states and 2 Canadian provinces. Long-distance movement of the disease has most likely been due to the transport of captive deer and elk (Williams et al. 2002, Sigurdson and Aguzzi 2007, Miller 2008). Recent scientific research strongly suggests that CWD can be transmitted through ingesting feces from infected animals. Scientists also believe that it is transmitted through animal-to-animal contact and through contact with an environment that has been contaminated with the infectious prion (a mutant protein). Scientists believe the spread of the prion occurs via lymph tissues, blood, saliva, feces, and urine and can persist in soils for years. For this reason scientists are concerned that if a captive deer has the disease and escapes from a facility, the disease can spread to free-ranging deer populations with devastating results. (Miller and Williams 2003; Miller et al. 2004; Seeger et al. 2005; Mathiason et al. 2006, 2009; Johnson et al. 2007; Andrievskaia et al. 2008; Gonzalez-Romero et al. 2008; Safar et al. 2008; Sigurdson 2008; Angers et al. 2009; Haley et al. 2009; Maddison et al. 2009; Race et al. 2009).

Given the history of CWD-prevalence among captive deer herds, it seems prudent to address the spread of captive deer urine across the landscape. The risk of establishing any new disease into Vermont's native deer and moose population is of great concern to the Department. The eradication of any disease from free-ranging wildlife is nearly impossible and extremely costly. The potential loss of these animals and a way of life enjoyed by many Vermonters is incalculable. The Department believes that prevention is the only suitable option for dealing with CWD.

Management Strategies

6.1 Evaluate the effectiveness of the captive hunting facility regulation.

6.2 Work with the Agency of Agriculture, Foods, and Markets and the deer farming industry to promote and enforce disease free importation and husbandry practices.

ISSUE 7. Disease Surveillance and Management

GOAL: Monitor disease issues and respond when necessary to protect the health of wildlife and/or humans.

According to state statute, "…the protection, propagation control, management and conservation of fish, wildlife, and fur-bearing animals in this state is in the interest of the public welfare, and that safeguarding of this valuable resource for the people of the state requires a constant and continual vigilance" (Title 10 V.S.A. §4081(a)). As human and deer populations expand or are transported with relative ease, the risk of disease transmission increases and with it the Department's ability to fulfill its statutory charge. Some diseases do not present a serious consequence to wildlife or humans. However, some diseases associated with deer such as chronic wasting disease (CWD), Lyme disease, hemorrhagic disease (HD), tuberculosis (Tb), and babsiosis, present risks to humans, as well as deer.

CWD, as discussed in Issue 6, is a fatal disease of the nervous system that afflicts white-tailed and mule deer, elk, and moose. It has no known cure or vaccine and can have a long incubation period. Hemorrhagic disease is a deer disease that is common in the Southeast and the Midwest. Twenty years ago the disease was only known to exist south of Pennsylvania and New Jersey (Davidson and Nettles 1997). In 2007, confirmed cases of HD were reported in Albany County, New York, in the Hudson River drainage basin that extends into southwestern Vermont. Although HD is well understood, it is not a disease that can be readily managed. It is a viral disease that is transmitted by a small biting midge fly, often called "no-see-ums." The disease occurs in warm months. As the first frosts of autumn occur, the disease abates as the flies die off for the season. Deer often survive HD, but it can cause localized, periodic, and sometimes heavy mortality. This is a disease that will bear watching in the future as global temperatures change and result in the northward spread of the vector of this disease.

One of the Department's goals is to "limit harmful or fatal human encounters with fish and wildlife species, and provide general public safety service incidental to our primary fish and wildlife duties." Lyme disease, babsiosis, and Tb are capable of crossing from wildlife over to other species including humans. Although cattle are more closely associated with Tb distribution in North America, deer are capable of sustaining this bacterium in the wild and acting as a reservoir, having the potential to infect and re-infect cattle and human populations. Michigan has spent millions of dollars attempting to eradicate Tb from cattle and wild deer populations. This case is a clear example of how once a disease enters wild animal populations, it is nearly impossible to eradicate.

The incidence and distribution of Lyme disease in Vermont has steadily increased in the last decade and shows no signs of abating. This disease is caused by a mycobacterium transported by a complicated relationship between black-legged ticks, white-footed mice, and deer. Populations of all three of these species have grown as the landscape has become more suburbanized, creating favorable habitats for these species in close proximity to concentrated human populations. Lyme disease infection begins with a tick bite that transmits the bacteria. The site of the bite often erupts into a "bulls-eye" rash that sometimes is accompanied by fever. As the rash soon disappears, the individual may believe that he/she has no disease. The disease, however, has merely moved to the next stage, which can lead to debilitating joint disease in humans and dogs if left untreated.

The use of urine from captive deer as a scent lure is legal in Vermont. Given the possible presence of CWD in captive deer that appear healthy and excretion of infectious prions in urine (see Issue 6 and References for citations of supporting scientific literature), it may be prudent to address the spread of captive deer urine across the landscape where disease-free native deer could contact the infectious agent. With recent advances in prion-detection methods, it is now unquestionable that scent lures originating from captive deer urine and used by hunters pose a risk of introducing CWD into CWD-free areas such as Vermont. Artificial, or synthetic, scents pose no such risk and have been commercially available since at least 2004.

Vermonters may be unaware of the seriousness of this particular disease issue and how it is transmitted from captive deer to wild populations. Dissemination of the Department's CWD Response Plan may help educate the public. The plan includes identification of a CWD-positive free-ranging deer (deer or moose) and calls for total extermination of free-ranging deer within a five-mile radius for several years – that area is equal to 79 square miles or about two Vermont towns. If infected deer continue to be found in the area, the control-area radius is then extended to ten miles – an area equal to 314 square miles. This is standard protocol among CWD-free states and provinces in North America. This disease has the potential to greatly impact populations of deer, deer hunters, and deer watchers alike — it is not to be taken lightly.

Management Strategies

7.1 Work with associated branches of government (for example, Agency of Agriculture, Department of Health) to monitor and control disease agents and deer populations where and when it is appropriate.

7.2 Contribute to the national CWD surveillance effort.

7.3 Monitor the progress of Hemorrhagic Disease as it moves toward the Vermont border.

7.4 Work closely with the Agency of Agriculture to ensure dairy farms and domestic deer farms maintain their tuberculosis-free status.

7.5 Investigate a prohibition on the use of deer-urine-based scent lures and, if appropriate, implement a public informational effort on the justification.

7.6 Inform Vermonters as to the gravity of CWD and repercussions if introduced into our environment through the dissemination of Vermont's CWD Response Plan.

ISSUE 8. Locally Overabundant Deer Populations

GOAL: Promote awareness that hunting is the only practical option to reduce localized overabundant deer populations.

Ordinances in urban and suburban communities may restrict normal hunting activities, which prompt landowners to also post land against hunting. Deer, however, can live and propagate successfully in many of these environments. Without natural or human predation, deer populations grow quickly. This overabundance often results in increased foraging on agricultural or residential plantings, deer-vehicle collisions, and incidences of Lyme disease (McShea et al. 1997, Schwabe and Schuhmann 2002). As Vermont's human population continues to grow, the


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expanding suburban setting will cause deer-human conflicts to become more and more common.

There are a variety of nonlethal and lethal options for mitigating conflicts with human residents and managing overabundant white-tailed deer in suburban environments (DeNicola et al. 2000). Nonlethal measures include trap and transfer, fencing, sulphur-based plant sprays, and other aversive measures such as noise makers and flashing lights. Trap and transfer methods incur many risks ranging from injury to captured animals to impacts upon the social stability of receiving deer populations. All of these nonlethal methods are impractical for alleviating localized deer overabundance problems (Buck et al. 2009).

Lethal measures include a myriad of controlled hunting strategies that limit the hunter's location, time of day, and implement (for example, bow-and-arrow, crossbow, muzzleloader, or shotgun). Implements that have a limited discharge range, for example, bows, are perceived by the public as being more acceptable for use in close proximity to buildings and people. Alternative hunting strategies can also effectively and safely reduce deer numbers. Experience from urban areas in other states has demonstrated that most residents who opposed alternative hunts before implementation actually came to support the hunts once they were applied successfully (Deblinger et al. 1995, Frost et al. 1997, Mitchell et al. 1997, McDonald et al. 1998, Kilpatrick and Labonte 2003).

Archery hunters have proven to be an effective general management tool for deer in Vermont and in other states as a way to control suburban deer populations (Kilpatrick and Walter 1999, Kilpatrick and Labonte 2003). Suburban residents may be more supportive of alternative hunts when they are allowed to restrict hunting activity on their own property and when archery hunters involved in the hunt have completed a state-certified hunter safety course including a test for shooting proficiency (Kilpatrick et al. 2007). In 2006, there were 19,173 archery permits sold in Vermont resulting in a harvest of 2,553 deer for an overall success rate of 13%, which is similar to that for rifle hunting. Of the 2,553 deer harvested during the 2006 archery season, 59% were adult does. As previously discussed, increasing the harvest of adult does is the most effective way to reduce a deer population when this becomes the desired management objective.

Management Strategies

8.1 Demonstrate the effectiveness of archery hunting to reduce locally overabundant deer in Vermont's suburban environments.

8.2 Provide communities with up-to-date and comprehensive information on deer overabundance and consider community views when deciding how to best manage deer problems in suburban, agricultural, and forested areas.

8.3 Encourage communication and cooperation between antlerless deer hunters and landowners that seek relief from locally overabundant deer.

ISSUE 9. Two-year Regulation Cycle

GOAL: Consider a more efficient two-year regulatory cycle that allows for annual adjustments when environmental factors deem it appropriate.

As a means to reduce costs of deer management, increase management continuity, and make regulations more consistent from year to year for hunters, the Department will investigate the feasibility of a two-year regulatory cycle instead of the one-year cycle it now operates. This could save time and money developing and printing deer hunting regulation changes every year. This approach is used in other states, New Hampshire, for example.

Management Strategies

9.1 Provide outreach to legislators, board members, and hunters to develop an understanding of the rationale behind deer management and proposed actions to improve management.

9.2 Evaluate the benefits and deficiencies of implementing a two-year regulation cycle for deer season recommendations.

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MOOSE


WAYNE LAROCHE

I. Management History

In the 1700s when New England was beginning to be settled, the Vermont landscape was 95% forest. As forest dwellers, abundant moose populations roamed freely. Early town records and explorers' accounts indicate that the animal was widely distributed throughout Vermont. The French Canadians and Abenaki Indians who raided Deerfield, Massachusetts, in 1704 cached meat from 20 moose at a site on the Connecticut River near Brattleboro to provide food for their return march home to Canada (Williams 1707). An Abenaki hunter who lived near Crystal Lake in Barton also told of killing 27 moose and many beaver in that vicinity in the winter of 1783-1784 (Collins 1903).

Native Americans and European colonists killed moose opportunistically throughout the year for food. As Vermont's population grew the unregulated hunting of moose played a part in their disappearance from the state by the nineteenth century. Probably of far greater importance, however, was the loss of moose habitat when the native forests were converted to agricultural lands. This land conversion (forest into fields) began in about 1800 and peaked by 1880 after which only 37% of Vermont remained forested. By the late nineteenth century Vermont's remaining woodlands were concentrated along the higher elevations of the Green Mountains and in Essex County. Moose had become so rare that when a young bull was shot in March 1899, at Wenlock (now Ferdinand) in Essex County, newspaper reports called it "a strange animal" and "the last moose in Vermont."

During the twentieth century, hill farms went out of business on a vast scale. Forests gradually covered hard-won fields, and moose began to reappear in Vermont. By the 1960s, 25 moose were thought to exist in Essex County. By 1980, forests covered 80% of the land area of the state, and moose numbers had increased to a point where they were regularly seen in Essex County. Moose were also observed in neighboring counties. The absence of predation on moose by mountain lions and wolves, as well as by humans allowed rapid population growth. By 1990, moose were abundant enough to support a limited, regulated hunt. The size and age structure of the moose population approximated populations in areas of North America where regulated hunting was routine.

Modern moose management began in Vermont in 1992 with the adoption of the state's first plan that used biological data derived from studies conducted in the state and the results from studies conducted on moose in nearby states and provinces of Canada. Public opinion was solicited via a series of public meetings held throughout the state during 1991 and 1992.

Vermont's first modern moose season was a three-day hunt held in 1993 in wildlife management unit (WMU) E in which 30 permits were issued and 25 moose were taken. In 1995 the season was expanded to include a second area, D2, and the season was lengthened to four days including a weekend. WMU E was subdivided into two parts prior to the 1996 season in order to distribute the moose harvest more uniformly across this area. In the new units E1 and E2, some of the hunters were issued antlerless-only licenses in order to achieve an equal adult sex ratio in the harvest and to take cows to stabilize the size of the herd by reducing the number of young moose entering the population in those WMUs. Antlerless-only permits have been issued in these units every year since 1996. Four additional units were opened to moose hunting in 1997.

Table 3.1 Vermont Moose Season Results 1993 - 2008

YEAR	PERMITS ISSUED	MOOSE HARVESTED	% HUNTER SUCCESS	UNITS OPEN
1993[1]	30	25	83	E
1994	40	28	70	E
1995[2]	75	61	81	D2, E
1996[3]	100	78	78	D2, E1, E2
1997	165	100	61	Above plus C, D1, H1 & H2
1998	165	97	59	
1999	200	120	60	Above plus G, I & J1
2000	215	137	64	
2001	229	155	68	
2002	365	221	61	Above plus B, J2, L, M1 & P
2003[4]	440	298	68	Above plus O1
2004	833	539	65	Above plus Q
2005[5]	1,046	640	61	
2006	1,115	648	58	
2007[6]	1,251	592	47	Above plus M2
2008	1,251	605	48	
Totals	**7,520**	**4,344**	**58**	

[1] 3-day, mid-week season.
[2] Season lengthened to 4 days and opening day moved to Saturday.
[3] Antlerless-only permits issued for the first time. WMU E split into subunits E1 and E2.
[4] Season lengthened to 6 days.
[5] Season split into two 6-day periods; antlerless permit holders in D2, E1 & E2 hunt 2nd week.
[6] Second season lengthened to 9 days.

No changes were made in the 1998 moose season because the Department was in the midst of drafting a new ten-year Moose Management Plan. Public comment concerning the new plan was obtained via mail and telephone surveys, open houses, public meetings, and written comments. To expand public benefits, the final plan called for further expansion of the area open for moose hunting whenever appropriate. Continued growth of the moose herd has resulted in expansion of moose hunting into a total of 17 WMUs, with 78% of the state open to regulated moose hunting.

By the early 2000s, the moose population in WMU E was causing significant damage to forest regeneration. Estimated moose densities were nearly double the target levels set in 1996, yielding population densities of about 1.75 moose per square mile. Moose densities well over 3 per square mile in WMU E were overbrowsing forest regeneration, not only to their own detriment, but also to the detriment of other wildlife species that utilize low growing trees and shrubs for food and cover. Landowners, especially large industrial forestland owners whose livelihood and investment depends on a healthy and growing forest, were especially anxious to see moose densities reduced.

Large increases in permit numbers issued in units E and D2 were prescribed for the 2004 season (Table 3.1) in an attempt to move toward the goal of returning the moose density in these areas to their 1996 and 1999 levels, respectively. By this time, moose had approached the biological carrying capacity of the habitat.

Today, moose hunting in Vermont is regulated by a special license that limits the permit holder to a specific WMU. A moose harvest objective is determined each year for each WMU, and a specific number of licenses are issued to achieve target harvests. The license allows a party of up to two hunters, and an optional guide, to take a single moose during a season held in mid- to late-October. Hunters are selected by random draw from a large pool of applicants who apply prior to the license drawing. Licenses are either-sex or limited to cows and calves as necessary to achieve area-specific population goals (Table 3.1)

GINNY GARRISON

1998-2007 Plan Accomplishments

Vermont's second moose management plan was adopted in 1998 and incorporated biological data on the herd gathered between 1980 and 1997 along with public input. The results of the public input revealed that Vermonters generally wanted to see more moose statewide while wanting to stabilize populations in the Essex County area. Vermonters desired the benefits of a healthy moose population, but they also expressed serious concerns regarding moose/vehicle collisions and the upward trend in human conflicts with moose.

The ten-year moose management plan adopted in 1998 was designed to address the interests and concerns of the public and strive for a healthy, expanding moose population in balance with its habitat. The objectives and accomplishments of that plan are summarized below.

➤ **Objective 1.** ***To maintain a healthy, viable moose population in Vermont.***

Vermont's statewide moose population was estimated at 2,100 animals in 1997. This objective included six strategies:

Strategy 1.1 *Maintain a minimum fall population of at least 500 moose.*

❖**Action:** The Department estimated that the state-wide moose population following the 2007 moose hunt was about 4,000 animals. This number more than met the minimum objective of 500, but in the Northeast Kingdom region of the state the moose population grew at a rate that was unsustainable ecologically.

Strategy 1.2 *Maintain an adult sex ratio of 40 – 60 bulls per 100 adults.*

❖**Action:** Harvest and mortality reports provide the information on the sex ratio and age structure of Vermont's moose population. This data suggested that the adult male to female sex ratio was very close to a normal, 50:50.

Strategy 1.3 *Maintain an adult age-class distribution of at least 25% greater than age four.*

❖**Action:** The Department kept track of nonhunting, or "incidental," mortalities occurring within the moose's "biological year" to determine an age-class distribution. The biological year (BY) for moose begins June 1, at the time of the annual birth pulse of calves, and ends May 31 of the following year. Figure 3.1 illustrates the age structure of Vermont's moose population over a five year period. Although the graph has a normal shape or curve, the percentage of younger moose, age classes one through three, declined from 71% in the early 1990s to 58%. This is likely due to the decrease in reproductive rate noted earlier resulting from increased moose density. Forty-two percent of these moose were more than four years of age.

❖**Strategy 1.4** *Continue to monitor various biological indices, such as carcass weight, beam diameter, ovulation rate, and occurrence of parasites.*

❖**Action:** The Department monitored the health of the moose herd throughout the state and found the physical condition of the animals was deteriorating. Biologists found that over the previous nine years Vermont's cow moose ovulation rates had dropped dramatically (Fig. 3.2). Other indicators of the moose herd's health were the decline in the dressed carcass weight of yearling bulls and the smaller beam diameter for yearlings (Fig 3.3 and 3.4). These trends strongly indicated that the moose herd was exceeding its BCC in some parts of the state, most notably in WMUs E1 and E2. Biologists also watched for diseases and health related issues caused from two common parasites, the winter tick and the roundworm. There were, however, no apparent health effects from either of these parasites during this period.

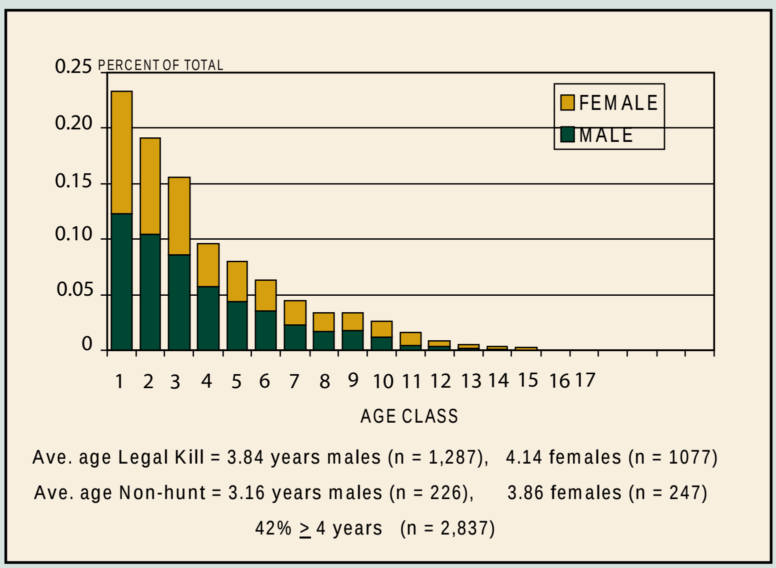


Figure 3.1 VT moose ages for legal and non-hunting mortalities for calendar years 2003 –2007.

1998-2007 Plan Accomplishments (continued)

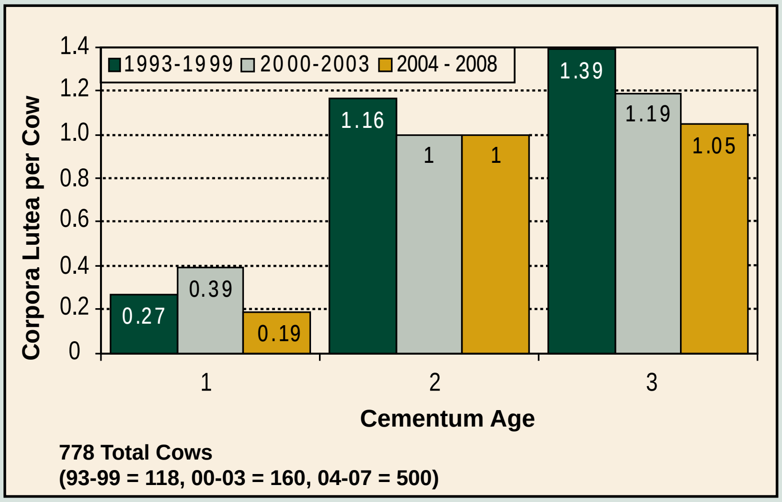


Figure 3.2 Comparison of ovulation rates for legally harvested cows from three time periods

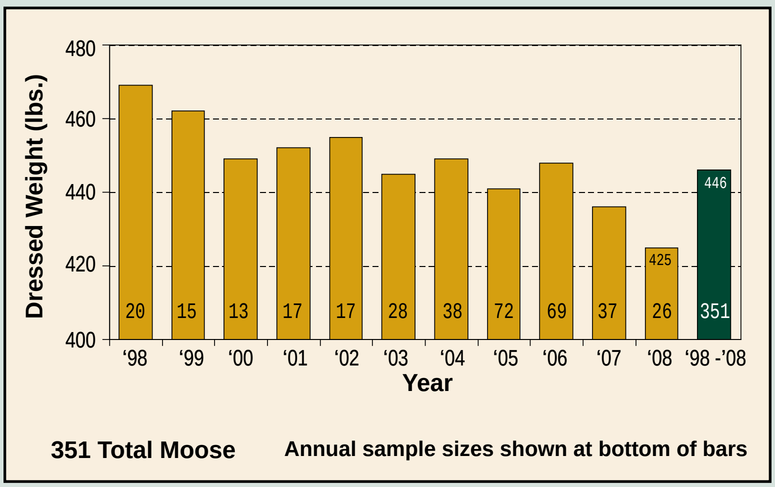


Figure 3.3 Yearling male carcass weight from Vermont moose harvests.

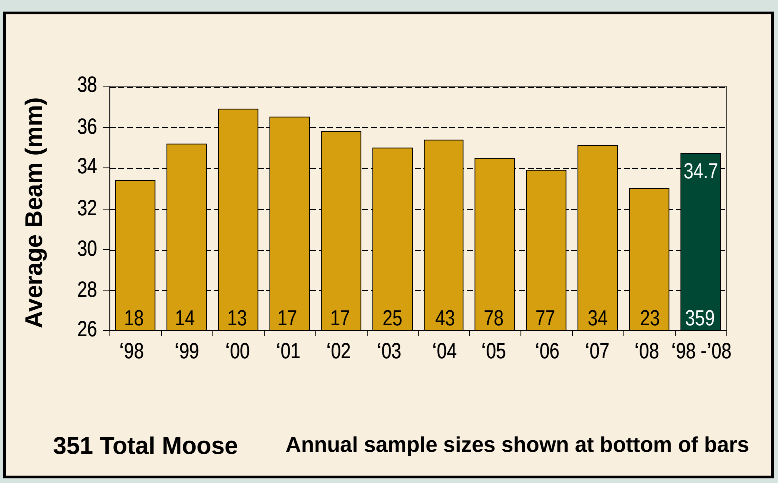


Figure 3.4 Yearling beam diameter from Vermont moose harvests.

Strategy 1.5 *Develop a model to assess relative moose habitat suitability at the WMU or regional level throughout the state.*

❖**Action:** The Department assisted a graduate student at the University of Vermont (UVM) who modified a moose habitat suitability index (HSI) model that was used to evaluate moose habitat in WMUs E and I (Koitzsch 2000). The HSI values (1.0 equals ideal habitat) were estimated to be 0.64 and 0.34 for WMUs E and I, respectively. The Department expanded use of this model and sought funding and partnerships with research institutions to perform this work.

Strategy 1.6 *Consider implementing field studies to investigate and monitor moose browsing in selected WMUs.*

❖**Action:** With the assistance of staff biologists, a UVM graduate student investigated the incidence of moose bark stripping on mountain ash throughout the state (Scharf and Hirth 2000). This study found that one third of mountain ash trees in northern regions were wounded by moose bark stripping. Also, forest inventories conducted on 85,000 acres of private timber lands in Essex County indicated 25% of the plots were browsed, 68% of which were heavily browsed.

➢ **Objective 2.** ***To provide for the controlled growth of Vermont's statewide moose population in all WMUs except for the Northeast Kingdom region where population stabilization is desired.***

Strategy 2.1 *Continue to utilize annual, mid-October, regulated moose hunts to stabilize the moose population in WMUs E1, E2, and D2 at 1996 levels.*

❖**Action:** The 1998 moose plan called for stabilization of the moose populations in the

1998-2007 Plan Accomplishments (continued)

Northeast Kingdom region. Density goals were about 1,000 moose in WMU E and 400 in WMU D2. Improved moose estimation methods revealed that the number of permits was still too few to achieve the objectives. Data gathered by the Department produced estimates of moose densities above the goals and continued evidence that moose were overbrowsing their range in the Northeast Kingdom.

Permit numbers for this region continued to increase during the plan period, partly in response to declining hunter success rate which made it necessary to issue more permits in order to meet harvest objectives, and partly in response to the need to expedite population reductions to protect forest habitat.

Strategy 2.2 *Continue to utilize regulated moose hunts to slow rate of growth of the moose population in WMUs C, D1, H1 and H2.*

❖ **Action:** Moose hunting first occurred in WMUs C, D1, H1, and H2 in 1997. The combined population estimate for these units had remained relatively stable since 2001 at about 700 moose.

Strategy 2.3 *Utilize regulated moose hunts to slow rate-of-growth of the moose population in WMUs G, J1, and I beginning in 1999.*

❖ **Action:** Moose hunting was initiated in WMUs G, J1, and I in 1999. The estimated moose population for these units increased from 290 (2001) to 370 (2004) and has since been successfully reduced to an estimated current population of 300 moose.

➤ **Objective 3. *To maximize benefits from Vermont's moose population within acceptable social and biological limits.***

The Department continued to work toward balancing an abundant moose population and sustainable habitat with protection of the forest and prevention of conflicts with humans. During this planning period, the Department employed several strategies. These strategies involved regulating hunting, working with landowners to open access to hunting, and promoting habitat management through public outreach, education, and activities.

Strategy 3.1 *Continue with annual moose hunts in WMUs C, D1, D2, E1, E2, H1, and H2*

Strategy 3.2 *Open WMUs G, J1, and I to limited hunting beginning in 1999.*

Strategy 3.3 *Annually evaluate the potential for regulated moose hunting opportunities in other WMUs.*

❖ **Action:** All three of these strategies from the 1998 moose plan were implemented through regulation.

Strategy 3.4 *Coordinate with large property owners to find ways to enhance moose hunter access.*

❖ **Action:** The Department worked with large industrial forest landowners in the Northeast Kingdom to facilitate the opening of gates during the moose season and with the Vermont Horse Council and the Vermont Department of Forests, Parks & Recreation to facilitate the use of draft horses to haul moose carcasses out of roadless areas.

Strategy 3.5 *Promote the "Hunters Sharing the Harvest" program to moose hunters as a way of providing moose meat to needy households throughout Vermont.*

❖ **Action:** The Department annually provided a 50-page guidebook to each moose hunting permit holder that included a description of the "Hunters Sharing the Harvest Program" and listed some examples of local food shelves that could store and distribute moose venison to their patrons. (There is currently no organized program or system to track donations.)

Strategy 3.6 *Cooperate with natural resource professionals and landowner organizations in dissemination of moose habitat management guidelines.*

❖ **Action:** In 1995, the Department, in cooperation with the Vermont Department of Forests, Parks & Recreation, published a booklet entitled: "A Landowner's Guide - Wildlife Habitat Management for Vermont Woodlands" (Regan and Anderson 1995). This publication, which includes a chapter on moose habitat, was made available to state biologists, private consulting foresters, and landowners through forest management workshops.

Strategy 3.7 *Develop and implement educational displays explaining Vermont's moose management for use at fairs, outdoor shows, and moose check stations.*

❖ **Action:** In 2001 the Department produced five sets of a seven-panel poster-board display covering many aspects of moose life history and management. These sets have since been used annually at moose weighing stations and in other outreach venues.

Strategy 3.8 *Construct at least two moose observation towers*

1998-2007 Plan Accomplishments (continued)

with parking areas near state highways in the Northeast Kingdom region, contingent on funding partnerships with the private business sector, regional chambers of commerce, and/or governmental tourism agencies.

❖**Action:** The Department began work in 2006 on siting and designing a moose viewing tower off State Highway 105 in the Essex County town of Ferdinand.

Strategy 3.9 *Cooperate with a private interest in the publication of a "Vermont Moose Watcher's Guide."*

❖**Action:** A professional wildlife photographer and author from Maine published the "Moose Watchers Handbook" in 2001, which included directions to popular moose viewing sites in Maine, New Hampshire, and Vermont (Silliker Jr. 2001).

➤ **Objective 4.** ***To minimize negative interactions between humans and moose.***

Strategy 4.1 *Utilize annual limited-entry moose hunts to either stabilize or slow the growth rate of regional moose populations as noted above under Objective 2.*

❖**Action:** The number of nonhunting moose mortalities steadily increased through the early part of the past ten years. Nonhunting moose mortalities during the last several years have seemed to decrease in the face of increased numbers of permits. Many of these mortalities (41%) occurred in the Northeast Kingdom units of D2, E1, and E2.

Strategy 4.2 *Develop and implement a policy for Department response to "nuisance" moose by 2000.*

❖**Action:** To address damage caused by moose to livestock fencing, maple sap tubing, and Christmas tree plantations, a Commissioner's rule was enacted in 1996 that under certain conditions allows a landowner suffering property damage to shoot the moose. To try to avoid this situation, the Department assisted the United States Department of Agriculture, Wildlife Services office in Berlin, Vermont, in developing an informational brochure describing possible ways to curb moose damage.

The Department also developed a protocol for sick or diseased moose that posed a potential hazard to public safety. These situations can arise when sick moose wander into urban areas, farmyards, or busy highways. A Department protocol for dealing with all "nuisance" moose still needs to be completed in the next planning period.

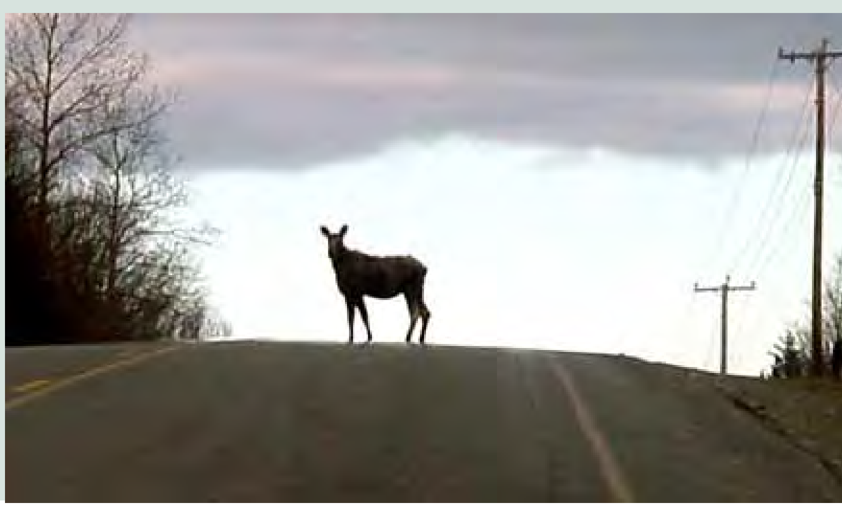
Strategy 4.3 *Continue to cooperate with the Vermont Agency of Transportation (VTrans) to erect warning signs at traditional moose highway crossings.*

Strategy 4.4 *Cooperate with the VTrans in implementing at least three roadside brush-clearing projects to improve visibility at the most dangerous moose crossings, where feasible.*

❖**Action:** The Department worked with VTrans to evaluate several methods of reducing moose/vehicle collisions. VTrans considered the advice of the Department for the placement of moose crossing signs and the clearing of roadside brush adjacent to frequently used road-side salt licks in order to enhance the ability of approaching motorists to detect moose

Strategy 4.5 *Continue with annual press releases to remind motorists of moose hazards and explore potential for including a warning message with helpful driving tips concerning deer and moose collisions in the Department of Motor Vehicle's Driver's Manual and in all new vehicle registrations or renewals.*

❖**Action:** The Department issued biannual press releases to newspapers and broadcast media each year to advise motorists during times of the year when movement of moose poses the greatest hazard to motorists. The Department also partnered with the Vermont Frost Heaves PBA basketball team to raise driver awareness concerning the hazard of moose on highways.



TOM MERRIFIELD

II. 2010-2020 Moose Management Issues, Goals, and Strategies

The overall goal of moose management in Vermont is to manage Vermont's moose to sustain healthy, viable populations consistent with biological, social, and economic considerations, and provide maximum hunting opportunities.

ISSUE 1. Regional Population Goals

GOAL: To maintain regional populations of healthy moose at or below cultural carrying capacity.

The Department uses several approaches in estimating moose populations — surveys, mortality data, and aerial censuses. Two annual hunter surveys (one for deer hunters and one for moose hunters), annual moose hunter success rates, and nonhunting mortality records provide the basis for the Department's moose permit allocation recommendations. Observations and knowledge provided by state game wardens, foresters, biologists, and landowners are also considered when making decisions and recommendations.

Since 1999, Vermont has conducted deer and moose hunter surveys that provide a measure of relative moose density trends by WMU across the entire state. The deer hunter survey asks hunters to identify and record the number of bulls, cows, calves, or moose of unknown sex or age that are observed. The moose hunter survey requests hunters to report any preseason scouting activities. Hunters are asked to record the number of scouting trips they took; the number of hours they spent scouting; and the number of moose they saw during these trips. The numbers are standardized to determine the average number of moose sighted per hundred hours scouting.

Moose hunter success rate is calculated as the percentage of all permit holders that harvested and registered a moose. Success rates are calculated annually for each WMU that is open to hunting. The current year hunter success rate is compared to the previous year to assess changes at the WMU level, considering number and type of permits issued. Hunter success can be affected by individual hunters' effort (time spent afield), weather conditions during the hunt, moose behavior, population levels, and the accessibility of moose to hunters (for example, the distribution of roads and trails in moose habitat).

The moose sighting rate from deer hunter surveys in WMU E has declined during the past four years, thus, the estimated moose density has also declined. The population density estimate for November 2008 was 2.59 moose per square mile, an estimated 1,526 moose. With the current permit quota, the target density for WMU E should be achieved following the 2010 hunting season. Moose sighting rates for D2, after remaining fairly stable for several years, finally decreased in November 2008. Using a rolling three-year average for deer hunter survey moose sighting rate data, the moose density in D2 is currently estimated to be 1.16 moose per square mile. It is possible that by maintaining the current permit quota of 340 for one more year that the D2 population may closely approach the target density of one moose per square mile. Permit numbers have been steadily increased in these units from 30 in 1998 to 110 in 2009. The combined population estimate for these units has remained relatively stable since 2001 at about 700 moose.

The Department maintains a statewide database of all reported nonhunting moose deaths. Nonhunting mortality data is collected and reported on a biological year basis that begins on June 1, after most of the moose calves have been born, and ends on May 31. Summaries of nonhunting moose mortalities are prepared each year and assessed prior to development of season recommendations. This information also helps us assess changes in moose numbers through time.

New Hampshire conducts aerial censuses using forward-looking infrared (FLIR) cameras that enhance the ability to observe moose on the ground and has developed a model that provides more accurate estimates of moose populations. Although potential differences in topography, road access, hunter behavior, and other factors could influence moose sighting rates between northern New Hampshire and northeastern Vermont which could affect the applicability of this model in Vermont, the Department has found the model to be useful in estimating moose densities in the state. The Department is seeking to conduct its own aerial FLIR count of moose in Vermont to verify that the New Hampshire model provides accurate estimates in Vermont. Flights are scheduled for December 2009.

Moose hunting has expanded into several additional WMUs since 1999 as populations have grown large enough to sustain hunting (see Table 3.1, page 41) As moose have become more abundant, public attitudes toward the moose herd have changed over the nine-year period (1996-2007) as well. Results from the 2007 statewide telephone survey indicated, with some regional variations, that overall Vermonters (54%) want to see the moose population remain the same, 19% want to see it increased, and 10% want to see it decreased. Analyses of the data, with the 17% "don't know/ no opinion" responses removed, is shown in Table 3.2.

Table 3.2 Public opinion on desired regional moose population size by region of residence, in percent (sample size in parenthesis).

Region*		Decrease	Remain the Same	Increase
Northeast Kingdom	(99)	31 (31)	54 (53)	15 (15)
Greater Chittenden	(268)	9 (24)	69 (184)	22 (60)
Central Vermont	(243)	11 (26)	64 (156)	25 (61)
Southern Vermont	(246)	10 (25)	66 (161)	24 (60)

*Northeast Kingdom: Caledonia, Essex and Orleans Counties
Greater Chittenden: Franklin, Chittenden and Grand Isle Counties
Central Vermont: Addison, Lamoille, Washington and Orange Counties
Southern Vermont: Rutland, Bennington, Windsor and Windham Counties

With this public feedback in mind, the Department proposes to maintain regional moose numbers at their current levels in most areas of the state, with the exception of the Northeast Kingdom region, where moose numbers need to be reduced to a level below biological carrying capacity, and in a few WMUs where an increase in moose populations may be acceptable (WMUs I, L, P, and Q, and perhaps others). The Department will solicit more public input on this issue prior to setting final objectives on moose herd numbers for WMUs. Web-based questionnaires will be used early in this management plan cycle to solicit public input.

Based on November 2008 population estimates for each WMU (Fig. 3.5.), the Department will make adjustments in two units. The Department proposes continuing with a population target of 1,000 moose in WMU E (1.75 moose per square mile), but to readjust the target for WMU D2 from 400 to 600 moose. This new objective for WMU D2 equates to one moose per square mile, which should be well below biological carrying capacity. This change is proposed because areas of current overbrowsing in D2 are limited, whereas historically higher moose densities (1.4 moose per square mile, 800 total) created overbrowsing. With the growing importance of moose hunting in this region, 600 moose may be an acceptable population level to area residents.

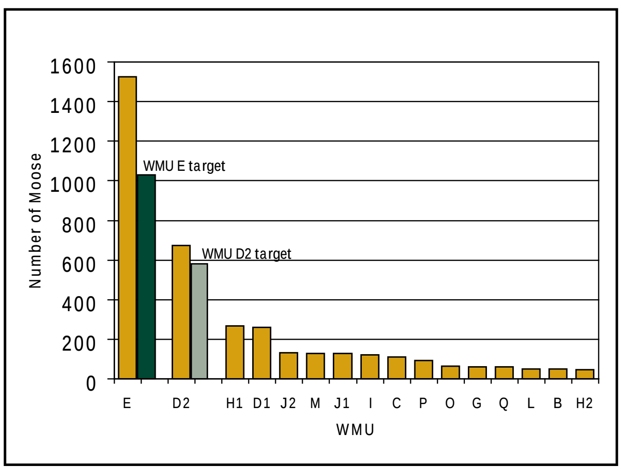


Fig. 3.5 Estimated moose population by WMU from sighting rates of 2006 -2008 November deer seasons.

Management Strategies

1.1 Maintain a statewide fall post-hunt population of between 3,000 and 5,000 moose.

1.2 Maintain a sex ratio of between 40 to 50 bulls per 100 adults (moose of at least age-class one).

1.3 Maintain an adult age-class distribution of at least 25% of at least age-class four.

1.4 Maintain an average ovulation rate of more than 1.15 for cows age class of at least three.

1.5 Assess relative moose habitat condition of individual WMUs or regions of the state using forest inventory data and a GIS-based Habitat Suitability Index Model.

1.6 Reduce and maintain WMU E moose densities to 1.75 moose per square mile (approximately 1,000 moose post-hunt).

1.7 Reduce and maintain WMU D2 moose densities to 1.0 moose per square mile (approximately 600 moose post-hunt).

1.8 Allow slow population growth in WMUs I, L, P and Q while not exceeding one moose per square mile.

1.9 Stabilize moose population in other WMUs at current levels.

ISSUE 2. Moose / Human Conflicts

GOAL: To minimize motor vehicle/moose collisions and other forms of damage caused by moose.

As the moose population has expanded, so have the negative interactions with humans. Damage to fences and maple sugaring equipment are common problems. More and more moose are finding their way into developed neighborhoods or becoming habituated to humans. Both situations are rarely resolved without significant public disturbance and usually result with the moose's demise.

Vehicle collisions are the most serious human/moose encounters. Although deer collisions are far more common and often result in costly damage to vehicles, they rarely result in serious human injury. Moose collisions, on the other hand, often result in serious human injury or even death. The Department is continually looking for ways to reduce the number of motor vehicle collisions with moose. Currently, there are approximately 77 signed crossing areas statewide. Many of these signs carry a 40 mph speed advisory per the Department's recommendation.

The number of nonhunting moose mortalities steadily increased through the early part of this decade. Nonhunting moose mortalities during the last several years have decreased slightly (Fig. 3.6) with increased numbers of permits. Many of these mortalities (41%) occurred in the Northeast Kingdom units of D2, E1, and E2.

The Department began drafting a protocol for dealing with moose that are not sick but pose a threat to public safety. When finalized, this protocol will conform to the Department's umbrella policy governing how it handles "nuisance" or "hazardous" wildlife in general (Regan 1998). Under the umbrella policy, humane treatment of animals is an important consideration. Euthanasia is recognized as sometimes being the only cost-effective and practical response.

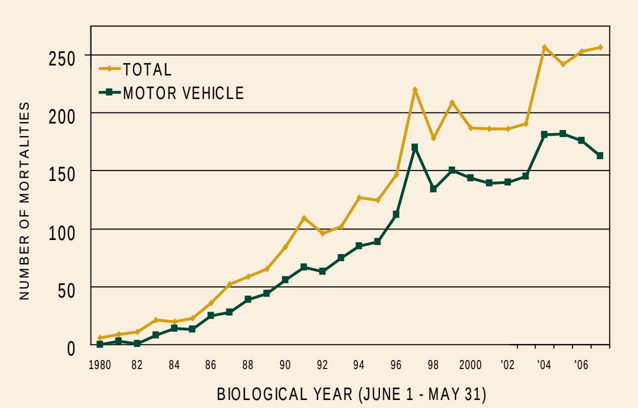


Fig. 3.6 VT non-hunting moose mortalities for biological years 1980 – 2007.

Management Strategies

2.1 Develop and implement a policy for Department response to "nuisance" moose.

2.2 Continue to cooperate with the Vermont Agency of Transportation (VTRANS) to erect warning signs at traditional moose highway crossings.

2.3 Cooperate with VTRANS in implementing roadside brush-clearing projects to improve visibility at the most dangerous moose crossings, when feasible.

2.4 Cooperate with VTRANS to investigate the use of new technology that may help reduce moose/vehicle collisions.

2.5 Continue with annual press releases to remind motorists of moose hazards during seasons of increased moose movements.

ISSUE 3. Moose Hunting Opportunities

GOAL: To maximize quality moose hunting opportunity.

Hunting Satisfaction

Feedback the Department receives from various sources indicates a favorable satisfaction rate from moose hunters on the present structure and timing of hunting seasons. No major changes are being proposed in the current new plan.

Management Strategies

3.1 Provide quality moose hunting opportunity in all WMUs where feasible.

3.2 Coordinate with large property owners to enhance moose hunter access.

3.3 Provide information to hunters on how they can share moose meat with needy households throughout Vermont.

3.4 Conduct outreach efforts prior to any significant reduction in total permit numbers made in response to moose population changes.

3.5 Provide public opportunity to harvest moose for food and other utilitarian purposes.

Moose Permit Lottery

An average of 10,448 Vermonters have applied for a moose permit each year for the last five years. Beginning with the 2007 permit lottery, hunters who had applied the previous year but had not won a permit were awarded an extra chance, or "bonus point." Unsuccessful applicants now accumulate a bonus point for each year they apply and fail to draw a permit. Each "point" adds another occurrence of their name into the lottery pool of applicant names increasing their odds of winning a permit. This recent change has helped satisfy those who have applied for many years without success and seems to have been favorably received by moose hunters. No further changes to the permitting process are currently being contemplated.

Vermont has issued a relatively high number of permits in recent years to reduce the moose population in the Northeast Kingdom. For the 2009 season, 1,230 permits were proposed statewide with 940 allocated to WMUs D2, E1, and E2 alone. Once population goals are reached in the Northeast Kingdom, the number of permits issued may be reduced.

Management Strategies

3.6 Maintain and improve hunter satisfaction by managing a preference point lottery system.

Special Archery Season

Bow-hunting enthusiasts have encouraged the Department and the Fish and Wildlife Board to consider a special archery-only season for moose. Although bows can be used in the current moose season, some archers feel they might have more success in calling moose into close range if they were able to hunt during the peak of the rut and without competition from more mobile firearm hunters. Because of this interest, the Department included the following question in the 2007 telephone survey: "Currently, moose may be harvested during the season with rifles, handguns, muzzleloaders, bows, or shotguns. Do you support or oppose establishing an archery-only season for moose in Vermont in addition to the regular moose hunting season?"

This question was asked only of survey participants who were hunters. Of 252 respondents, 50% were opposed (39% strongly opposed and 11%

moderately opposed) and 39% were supportive (23% strongly and 16% moderately). Four percent neither supported nor opposed the idea while 7% answered "Don't know." The 39% of responding hunters corresponds closely with the proportion of Vermont hunters who bow hunt for deer, so it seems likely that most opponents are not archery hunters. Most of the respondents opposing an archery moose season were probably concerned that their chances of winning a moose permit in the regular season lottery would diminish. A similar opposition was expressed prior to the initial deer archery season in Vermont. Subsequently, many rifle hunters took up archery hunting, and the deer archery season became widely accepted. Archery deer season has subsequently added a significant recreational opportunity for Vermont's deer hunters.

In reality, a limited archery season would have minimal impact on chances for a regular moose season hunter to win a lottery permit because permit numbers are based upon harvest objectives and the success rate of hunters. Archers are expected to have a lower success rate and would be expected to take a small portion of the target moose harvest.

The Fish and Wildlife Board received several petitions in the spring of 2008 for the establishment of a special archery season for moose. Consequently, the Department will propose a Board regulation to establish a short moose archery season, potentially beginning the first Saturday in October. The season might run for nine days with perhaps 50 permits issued via a lottery. Success rates will likely be less than 30%, so the archery moose harvest would be expected to take less than 20 moose statewide. This small harvest would have minimal biological impact on the moose population even if it was in addition to the regular permits set by harvest objective.

Management Strategies

3.7 Propose to implement a limited special archery-only moose hunting opportunity.

ISSUE 4. Moose Viewing

GOAL: Provide safe and quality moose viewing opportunity.

A public opinion survey found that nearly 57% of Vermont residents participated in viewing or photographing wildlife (Duda and Young 1996). White-tailed deer are the most viewed and photographed (89% of respondents). Due to their large size, interesting features, and historical scarcity, viewing moose remains a special thrill for most Vermonters. Moose can often be easily observed and photographed from vehicles while feeding along roadside salt licks or shallow wetlands. People frequently make special trips to the Northeast Kingdom and other areas to observe moose thereby contributing to the economy in rural areas of the state.

The Department answers many inquiries each year concerning when and where to observe moose. Efforts are underway to place a moose viewing tower at a favorite viewing spot east of Island Pond. This project should continue to move forward with completion expected by 2010.

Management Strategies

4.1 Construct at least one moose observation tower with a parking area near a state highway in the Northeast Kingdom region and investigate other locations in other regions.

4.2 Include moose in a guide to wildlife viewing sites on the Department's website.

ISSUE 5. Moose Habitat

GOAL: Maintain necessary habitat to support 3,000 to 5,000 moose on a sustained basis.

The moose is a northern forest species and uses different habitats during various seasons of the year. In general, moose prefer thick, brushy habitat for concealment and as sources of abundant food. Lowland softwood forests, beaver ponds, and other shallow bodies of water are favorite spring and summer habitats for moose. During the hot summer months, moose can suffer from overheating and must have access to dense shade or water for cooling. Moose also use ponds to escape biting insects and predators. Moose frequent upland hardwood or mixed forests during the fall and winter. Younger age classes of these forest types provide abundant browse, especially in recently cutover areas. Managing habitats specifically for moose is difficult because this species has a large home range (4 to 10 square miles).

Moose are not as social as deer. Although it is not uncommon to encounter several moose together during the post-rut period, by late winter moose are usually either solitary or found in groups of two or three animals. These small individual groups of moose may each seek out middle-aged to mature softwood stands where they can escape deep snows and severe winter weather.

Moose habitat management is typically a by-product of areas where commercial logging has occurred and produced abundant browse. Forested landscapes that are actively managed therefore contribute to productive moose range. Clearcutting more than 50% of a moose home range within a few years, however, can result in an unfavorable balance of forest age classes which may cause moose populations to decline (Girard and Joyal 1984).

While clearcuts may provide plenty of food, moose prefer to remain close to cover. Thus, there is relatively less browsing within the interior of larger clearcuts, particularly during the winter, than within areas closer to forest shelter. The browse within clearcuts of ten acres or less in size maximizes browse availability to moose. Special habitats that may be critical to moose survival or productivity include late-winter concentration areas, aquatic feeding areas, and salt licks.

Logging practices in Vermont over the past few decades have generally had a favorable impact on moose, especially in the Northeast Kingdom. Timber harvesting in this region increased significantly during the 1980s. Hardwood browse became abundant even in many of the former softwood stands (Moulton et al. 1984).

Many large private forestlands throughout the state are currently enrolled in Vermont's Use Value Appraisal program and/or are under working forest easements. These legal instruments mandate sustained timber harvesting, which benefit moose. Most of the larger state forests and wildlife management areas also have active timber harvesting and habitat management plans designed to sustain a diversity of habitat conditions. Thus, the quality of forested moose habitats in Vermont should remain good for many years. Exceptions may occur on the "wilderness" designated areas of federal lands, such as the Green Mountain National Forest, which tend to minimize the early successional forests favored as forage for moose. When possible, the Department will advocate for active management to provide for all seral stages of forest vegetation and adequate amounts of early successional habitat to provide for moose and other wildlife species that favor younger forests. In isolated cases, loss of small areas of older softwood trees might be detrimental to wintering moose. In the past, the Department has been able to obtain cooperation from industrial forestland owners in reserving some of these important winter moose habitats from timber harvest.

Vermont also has a wetlands protection law that often affords protection of these important habitats. Thus, natural and roadside salt licks are not likely to disappear in the foreseeable future. Increasing human development, however, is likely to continue to slowly erode moose habitat in Vermont. More important than actual loss of acres of moose habitat will be increases in human/moose conflicts expected as residential development and road systems extend into moose habitat.

Private landowners who wish to consider moose habitat in their land management plans can receive habitat management recommendations from the Department of Fish and Wildlife. A booklet entitled "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" is scheduled to be updated and reprinted in 2010.

Management Strategies

5.1 Implement field studies to investigate, measure, and monitor the degree of moose and deer browsing within selected WMUs.

5.2 Provide natural resource professionals and landowners with moose habitat management guidelines.

ISSUE 6. Deer-Moose Competition and Forest Impacts

GOAL: Balance the nutritional needs of regional moose and deer populations with the need for adequate forest regeneration.

White-tailed deer and moose play a significant role in the ecology of Vermont's forests. As herbivores (plant eaters), seed dispersers, and prey, they can have a large impact on other plants and animals in forest systems. The presence of these animals has profound implications for the structure and function of forested ecosystems. If deer and moose were to disappear from the forest system, a wide variety of changes would ripple through the forest.

Deer and moose feeding habits are a significant influence on the ecology of the forest. Deer have been estimated to eat between four and ten pounds of plant matter each day while moose may eat more than 40 pounds per day. In winter, both species prefer the twigs of many hardwood and softwood trees. In summer, deer focus their feeding on a variety of green herbaceous plants while in the fall, fruits, nuts, and seeds make up an important part of their diet. In summer, moose continue feeding on hardwood and softwood trees but also eat succulent, sodium rich, aquatic vegetation in or near swamps, bogs, and wet forest edges. Browsing by deer and moose is a natural and desirable aspect of Vermont's forest ecology, but too many deer and/or moose in a given area can cause problems for forests and people.

As the moose population has increased, the question of how to determine carrying capacity for both species separately and in combination has become a challenge. The Department needs to develop new ways to assess forest habitat and its capacity to support both moose and deer while maintaining a healthy native forest. There is also a need to monitor changes in the forest at various scales across the state and through time.

Management Strategies

6.1 Develop a study to assess the carrying capacity for moose and deer on Vermont's forestland.

6.2 Develop a decision making process that assists managers in determining the appropriate mix of moose and deer densities for a given WMU based on cultural and ecological factors.

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JOHN HALL

BLACK BEAR

I. Management History


VICKI COMBS

The black bear is a native species in Vermont. It is the smallest of the three North American bear species, grizzly and polar bear comprising the other two, and the only one of the three found in the eastern United States.

To survive in Vermont, black bears require large tracts of forestland. As a result, historical accounts suggest that the state had a fairly abundant bear population when the first settlers arrived. The influx of settlers into Vermont significantly changed habitat conditions for bears. With their axes, the settlers literally cut their farms out of the forests and progressively whittled away the black bear's habitat – confining bears to those mountainous areas too steep or rocky to farm. It was then that Vermont's bear population reached its lowest point.

Loss of habitat was not the only reason for the decline of the bear population. The rapidly expanding human population used their fat, flesh, and hide to sustain themselves. Not being held in high esteem, bears were treated as vermin, readily associated with crop loss and livestock depredation. In 1831 the Vermont Legislature imposed a bounty on bears. Over the next 110 years, 1,295 bounty claims were paid out.

It was habitat change, however, not changes in the bounty laws that saved the Vermont black bear from extinction. Decades of farmers leaving the land following the Civil War led to a pattern of reforestation that provided great benefit to the bear population. Sentiment towards black bears began to change as well. Perhaps echoing the conservation views championed by President Teddy Roosevelt, Vermonters began to view bears and other wildlife as an important natural resource. In 1941 not only was the bounty on bears repealed, but they could only be hunted between June 1 and December 31 each year. Not insensitive to the potential bear damage farmers could incur, Vermont's Legislature obligated the Department, then known as the "Fish and Game Service," to reimburse persons for damages to "livestock." This is still the law.

Laws and regulations affecting the management of black bears during the twentieth century became more frequent as Vermont's human population continued to grow. Beginning in 1955 the reporting of harvested bears was required. In 1961, the season was shortened to the 91 days between September 1 and November 30. Other changes regulating the harvest of bears occurred over the next three decades, including prohibiting trapping (1967), limiting the harvest to one bear per season (1968), a prohibition on baiting and requiring bear houndsmen to hold a special permit (1972), and reducing the season length twice (1974 and again in 1990).

During this time of changing management and reforestation, the bear population has grown from an estimated 2,000 bears in 1975 to approximately 5,000 in 2008. Today bears are found in approximately 80% of Vermont from the Massachusetts border to Canada. Compared with their status 100 years ago, black bears are in a secure position. The greatest threat to the survival of black bears is in the form of fragmentation of their habitat (for example, roads and mountainside homes). This situation presents new management challenges for the twenty-first century. Vermonters have indicated they are satisfied with current population levels and wish to see them maintained during the next ten-year management period.

Ensuring the existence of a viable bear population and meeting public expectations for an abundant bear population while, at the same time, not having so many bears that they become a nuisance to agriculture and home owners will be the focus of the management actions contained in this plan.

1997-2006 Plan Accomplishments

➢ **Recommendation 1.** ***Revise black bear population objectives to reflect public interest in slightly increasing bear populations and repopulate suitable areas currently unoccupied by a breeding bear population.***

➢ **Strategy 1.1** *Analyze population data to determine current population levels and establish revised population objectives.*

❖ **Action:** The Department monitored growth of the state's black bear population. Population models indicated that Vermont's black bear population was relatively stable between 1985 and 1990 with about 3,000-3,400 bears existing in the state. Estimates indicate that the steady growth in the bear population occurred over the next ten years with about 4,800-5,200 bears existing by 2000.

➢ **Strategy 1.2** *Reduce black bear harvests by establishing a bear license or regional management zone.*

❖ **Action:** Reduced Vermont bear harvests from 1996 through 1998 resulted from a combination of widely distributed food supplies and the shortening of the length of the bear season beginning in 1990 that contributed to an increase in the statewide bear population. The plan's population goals were met without establishing a bear license or regional bear management zones. Another reason, however, that these actions were not taken was an increasing level of nuisance bear activity. As nuisance bear complaints increased, Department staff became concerned that a black bear license might reduce hunter participation to the point where harvests would no longer be an effective bear management "tool." When a bear license was proposed, initial legislative language proposed a fee that the Department felt would discourage hunter participation. For these reasons, the Department abandoned efforts to establish a black bear license.

➢ **Recommendation 2.** ***Continue bear habitat conservation strategies such as Act 250, land acquisition, review of wood-to-energy harvest operations, and town and regional planning. The Department should pursue regulated logging and explore instituting a habitat stamp.***

➢ **Strategy 2.1** *Continue Department efforts on Act 250, land acquisition, review of wood-to-energy harvest operations, and town and regional planning.*

❖ **Action:** Between 1997 and 2006, Department staff reviewed 283 Act 250 projects that could potentially affect an estimated 1,000 acres of critical black bear habitat. As a result of subsequent revisions in these projects, a total of 12,621 acres of black bear habitat were protected during this ten-year period. The Department also published Conserving Vermont's Natural Heritage, a book to guide town planning for wildlife habitat, including black bear habitat. A new Department employee was assigned to work with town and regional planning agencies to guide conservation of wildlife habitat.

➢ **Strategy 2.2** *Pursue regulations on logging in critical bear habitat.*

❖ **Action:** The Department participated on the Heavy Cutting Committee that directed legislation on heavy cutting in Vermont. Department recommendations to include critical bear habitat in this legislation were not incorporated into the law.

➢ **Strategy 2.3** *Investigate establishing a habitat stamp.*

❖ **Action:** Various funding "stamps" were discussed with a legislative committee but no action on a habitat stamp occurred.

➢ **Recommendation 3.** ***The Department will propose establishing a black bear license.***

❖ **Action:** As described in Recommendation 1, efforts to establish a black bear license were abandoned due to concerns over an increasing bear harvest, increased nuisance bear complaints, and potential for decrease in bear hunter participation. The concern was that this action might result in an increase in the bear population to a point where it exceeded the target population objective established by the plan.

➢ **Recommendation 4.** ***Regional management zones may be used to adjust bear harvests to meet higher population objectives.***

❖ **Action:** Regional management zones were also considered as a management tool to increase bear numbers in areas where suitable habitat remained unoccupied. Expansion of the bear population during the previous planning period eliminated the need to adopt management zones.

➢ **Recommendation 5.** ***No changes to season length or structure will be initiated until after it is determined if a black bear license will be established.***

❖ **Action:** Bear population goals were achieved without the implementation of a bear license, regional management

1997-2006 Plan Accomplishments

zones, or changes in the season structure. Changes in length of the season could be needed in the future to meet bear population objectives.

➤ **Recommendation 6. *The Department will propose hunting hours for bears be changed to correspond to those for deer.***

❖**Action:** These changes were established in state statute.

➤ **Recommendation 7. *Work closely with the Vermont Bear Hound Association to discuss issues of concern.***

❖**Action:** Department staff participated in many meetings with the Bear Hound Association to discuss bear issues, such as length of training season, nonresident dogs, procedures for addressing public perception/ landowner conflicts, and public education. This cooperative effort has resulted in regulatory changes in bear hound permits related to the ownership and residency requirements of dogs listed on permits. It has also led to successful dealings with negative human-bear interactions. The Department worked to modify state statutes related to black bear causing property damage.

➤ **Recommendation 8. *The Department will establish a monitoring program on the sale of all bear parts through a mandatory tagging program.***

➤ **Strategy 8.1** *Evaluate level and nature of sale of bear parts.*

❖**Action:** The Department conducted a survey of successful bear hunters to determine the nature of using harvested bears and bear parts, including whether parts were being sold. Survey results indicated that bear hunters fully utilized harvested bears. The sale of gall bladders and other parts was found to be insignificant and no threat to the sustainability of Vermont's bear population.

➤ **Strategy 8.2** *Department will establish a monitoring program through mandatory tagging for the sale of bear parts.*

❖**Action:** Results from the Vermont hunter survey indicated that a mandatory tagging program was not necessary to protect Vermont's bear population. It was determined that costs associated with mandatory tagging would not provide a cost-effective benefit in management of the already growing bear population. Department staff continued to monitor the global and national markets for bear parts.

II. 2010-2020 Black Bear Management Issues, Goals, and Strategies

ISSUE 1. Bear Population Size and Distribution

GOAL: Identify an appropriate bear population objective that ensures the viability of a wild, free-ranging bear population, provides for hunting opportunities, and satisfies human social expectations and tolerances for nuisance bear occurrences.

Black bears can be found throughout Vermont where preferred food and cover is located (Fig. 4.1). They are secretive animals that prefer to travel among forest and shrub habitat, usually only using fields and large forest openings at night or in low light. Normal bear behavior includes a strong avoidance of humans. Given these bear characteristics, the greatest bear population densities are found along the spine of the Green Mountains and in the Northeast Kingdom counties of Orleans, Caledonia, and Essex. Because male and female bears lead separate lives, it is important to recognize the differences in the territorial ranges that each sex selects. Males are more solitary and tend to roam further in search of food and shelter. During the breeding season (June) older, more dominant males will search wider areas for receptive females. Females, on the other hand, tend to use smaller home ranges having high quality food sources and security for raising cubs.

Central to the management of a species is the need to accurately estimate the size of its population, the factors that influence growth and decline of the population, and the distribution of the population across the landscape. Based on this information, management goals can be met that satisfy the species' biological needs and human expectations.

Unlike other big game species, estimates of the bear population must be made using five-year averages. There are several reasons for this: bears live longer, they have a low reproductive rate, and harvests vary, depending on food supplies. Although the five-year averages do not pinpoint current bear populations, they do reflect population trends very well up to the previous year. The data for making population estimates include all known bear mortalities (nonhunting and hunting) and include such factors as age, sex, and location of harvest.

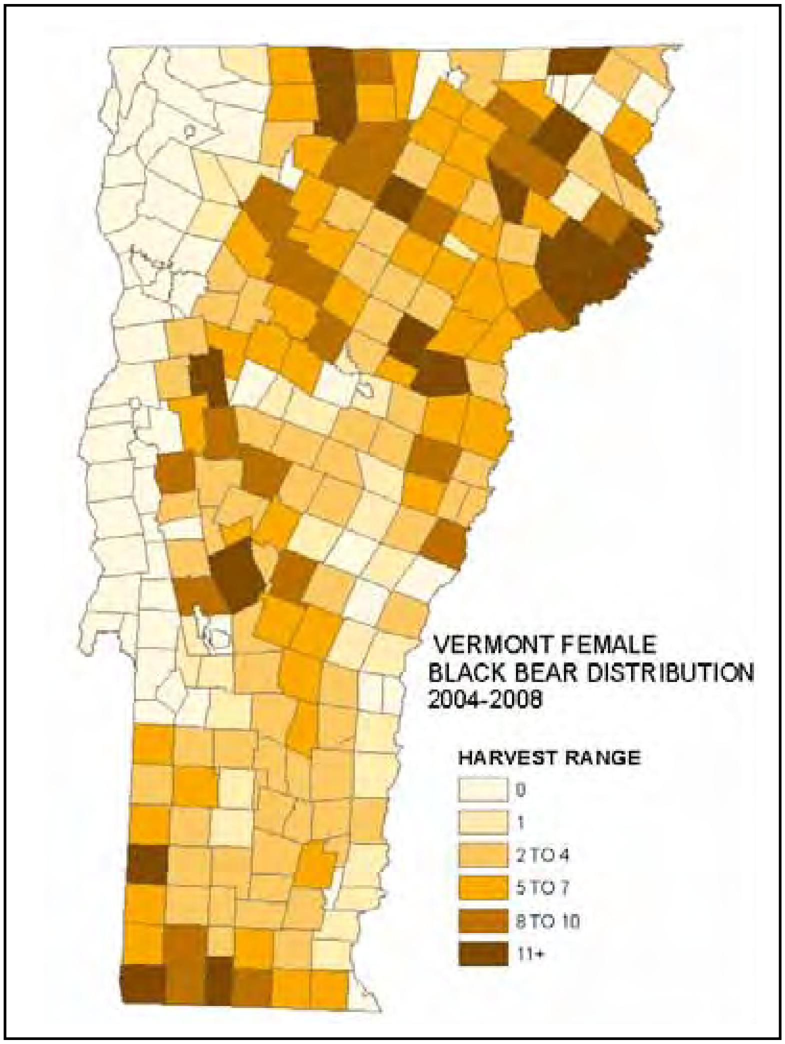

Figure 4.1 Distribution of female bears from harvest data, 2004-2008.

Figure 4.2 illustrates the estimated average Vermont black bear population beginning with the five-year period 1983-1987. The graph shows two periods of population increases – the early 1990s and the late 1990s/early 2000s. The 2003 – 2007 estimated population was between 4,600 and 6,100 bears in 2007. This represents an estimated 27% increase over the 1997 population estimate. These increases in the black bear population are consistent with management goals laid out in the previous plan.

In developing the current management plan, the Department sought Vermonters' opinions on whether bear populations in their county should increase, stay the same, or decrease. The majority of Vermonters surveyed (57%) wanted to see bear populations in their county remain the same, 16% wanted the population to increase, 7% wanted it to become lower, and 20% either didn't have an opinion or didn't know (Fig. 4.3)

In general, Vermonters' opinions on bear populations were consistent across regions of the state. There were two exceptions: in Central Vermont 22% of the respondents supported an increase in the population and in Chittenden County 28% of respondents either had 'No Opinion' or 'Didn't Know' (Table 4.1). Of those Vermonters favoring to increase bear populations, wanting to see more bears and the value of bears to

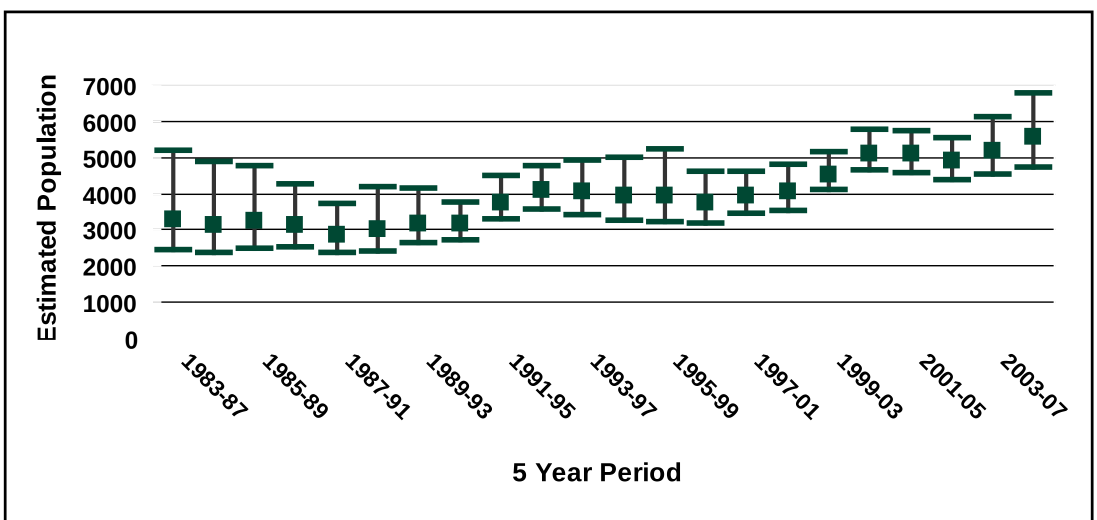

Figure 4.2 Estimated Black Bear populations by 5-year blocks, with 80% confidence limits, 1987-2008.

the ecosystem were given as the primary reasons. Residents of the Central and Southern Vermont regions who wanted bear population increases were particularly interested in seeing more bears. Statewide, reducing bear-human conflicts was the primary reason given for wanting decreases in local bear populations.

In contrast to Vermonters' general satisfaction with bear populations in their county, bear hunters satisfaction declined significantly from 75% to 54% since the previous survey was conducted in 1996. Dissatisfaction increased from 20% to 32% during the same survey interval. The survey was not able to query the rationale for the decline, but factors other than bear population levels, such as access to unposted land or a low bear harvest the previous year may have influenced respondents' opinions.

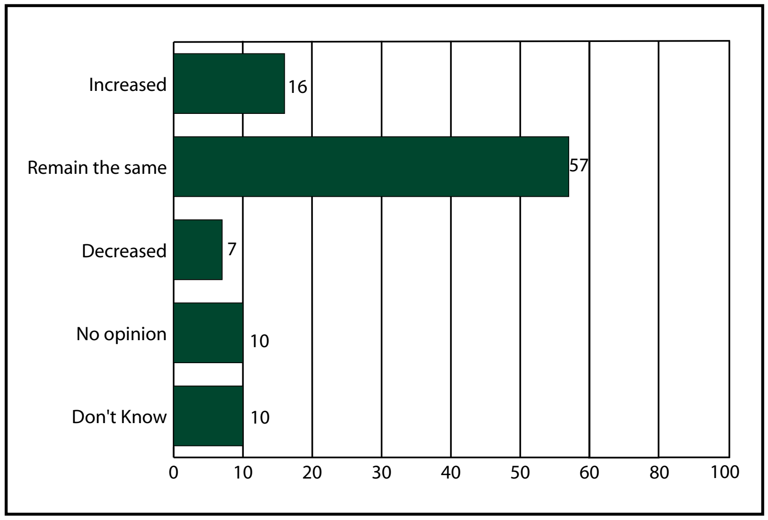

Figure 4.3 .Vermont residents' opinion regarding future bear population change

Table 4.1 Vermont Residents' Opinions on Desired Bear Populations by Region.

Region	Increase	Same	Decrease	No Opinion	Don't Know
Chittenden	10 %	56 %	5 %	14 %	14 %
Northeast Kingdom	17 %	60 %	9 %	8 %	6 %
Central Vermont	22 %	54 %	7 %	7 %	10 %
Southern Vermont	18 %	60 %	7 %	7 %	9 %

Management Strategies

1.1 Update and re-evaluate Vermont's black bear population model to reflect the most current harvest and biological parameter data available.

1.2 Evaluate and develop hunting season structures that align population estimates with biological data, habitat limitations, and public satisfaction data to sustain a bear population between 4,500 and 6,000 animals.

ISSUE 2. Bear Habitat Conservation

GOAL: Maintain a no net loss of function and value of existing bear habitat.

Historically, black bear management programs concentrated on regulating the legal harvest of the species to ensure that the population was sustainable. Today, management objectives in Vermont revolve around maintaining wild, free-ranging, viable populations of black bear as well as the conservation of bear habitat. Wildlife managers are looking toward conservation of large blocks of interconnected forestland and protection of the most critical areas of black bear habitat as the best long-term strategy for sustaining Vermont's bear population.

In Vermont, black bears require large forested areas that have a variety of food resources, particularly hard mast such as acorns and beechnuts, and provide core habitat for successful reproduction and allow them to avoid humans (Hugie 1982; Hammond 2002). Black bears rely on concentrated stands of American beech trees located at least one kilometer from roads and houses as an essential fall source of high nutrition food needed to build fat reserves prior to denning for the winter (Hammond 2002; McLaughlin 1998; McLaughlin et al. 1994; Wolfson 1992; Hugie 1982; Beeman et al. 1977). Researchers have found during years that beechnuts are in short supply, bears travel great distances to find alternative food sources and incur heavier mortality rates (McLaughlin et al. 1994). The availability of hard mast in the fall affects the minimum reproductive age and rate and cub survival. Simply put, concentrated stands of beech trees used by black bears are critical to the survival and reproduction of bears in Vermont.

Other important hard and soft mast food resources in Vermont include acorns, cherries, berries, apples, and mountain ash.

Vermont's bear population has increased in recent decades as forests have increased over the landscape and recent bear management strategies have encouraged population growth. Bears are now found throughout much of the state, yet the greatest concentrations of Vermont bears are found in "core" habitats that tend to be remote from roads, human developments, and human activity. Vermont black bears need large forested blocks of sufficient size to meet the home range and food requirements of female bears and cubs. The existing range, although becoming increasingly more fragmented in some parts of the state, has been sufficient to support an increasing bear population. Large public and private forest land holdings play an important habitat conservation role in this regard.

A recent study at the University of Vermont, however, indicates that increases in human development will diminish bear habitat (Donovan et al. 2007). The study projects that between the years 2000 and 2020, the number of housing units in Vermont will increase by at least 12,107 and that most of these units will occur in what are now relatively undeveloped locations. Under this scenario, the occurrence of black bear would likely decline in some areas of the state in the next 12 years (Fig. 4.4).

In the mid-1980s, the Department recognized the negative impact that housing developments were having on key black bear feeding and travel areas and began recommending through Act 250, the state's land use and development law, protection of critical bear habitat. For six years during the 1990s, Department biologists studied the movements and behavior of radio-collared bears in relation to roads, houses, ski trails, and various recreational activities. The findings from this study have helped the Department in its efforts to work with developers to include the habitat needs of bears into their long-term planning processes (Hammond 2002).

Today, the Vermont Fish & Wildlife Department provides advice and technical assistance for the protection of critical bear habitat, such as beech and oak stands, wetlands, and travel corridors. For example, the Department has been working with the Vermont Agency of Transportation to address the issue of habitat connectivity by developing wildlife suitability maps identifying areas that support animals that require large areas, such as black bear and moose. These maps help identify areas that should be conserved and managed so that animals can safely cross roads that bisect their habitat. The map also provides towns and regional planning commissions with a focus for land use planning (Fig. 4.5).

Public opinion surveys suggest that Vermonters continue to strongly support many forms of habitat conservation. Surveys also found that the public supports land conservation efforts in order to maintain the existing habitat base. In addition, 89% of the respondents said it was important to them to know that species like the black bear exist in Vermont, even though they are seldom seen. Eighty percent of Vermonters support using Act 250 as an important habitat protection tool (Duda et al. 2007). Although Act 250 is unique and effective legislation, it does not apply to development involving all critical bear habitat. A survey conducted by Responsive Management (Duda et al. 2007) found that 92% of the general public supported the Department working with town or regional planning commissions to design town plans that address and preserve important wildlife habitat. As a result, the Department has increased its efforts to work with towns and regional planners by providing technical assistance and on the ground assistance for related issues involving conservation of wildlife habitat.

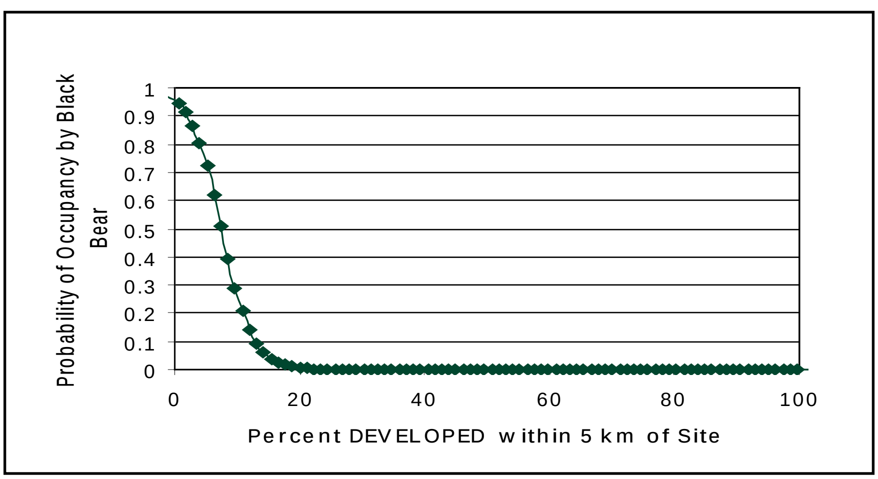

Figure 4.4. Probability of occupancy of a site by black bear in Vermont in relation to the percent of development.

Management Strategies

2.1 Maintain and enhance habitat protection efforts through Act 250, wood-to-energy harvest review, work with town and regional planning commissions, land acquisition, and other conservation methods.

2.2 Provide technical assistance in managing for critical bear habitat in the Use Value Appraisal program.

2.3 Revise and update "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" to include habitat management recommendations for black bears.

ISSUE 3. Human/Bear Conflicts

GOAL: Minimize the overall number of negative interactions occurring between bears and humans to achieve acceptable levels of human safety and social acceptance.

Bear populations, like all wildlife populations, are normally restricted by two factors — biological carrying capacity and cultural carrying capacity. As described previously, biological carrying capacity is the maximum number of animals an environment will support on a sustained basis. Population density and distribution depends on availability of food, cover, and space. Cultural carrying capacity is the maximum number of bears that can coexist compatibly with local human populations. Bear habitat can often support more animals than the public is willing to tolerate. Bears are large animals capable of causing extensive property damage and even human injury.

Department personnel have documented an increase in the number of people reporting conflicts with bears since the last management plan (1997-2008). This is also reflected in survey data from 2007 that found 14% of wildlife damage incidents were related to nuisance bears. This represents a seven-fold increase from 1996 when only 2% of incidents were related to nuisance bears. In spite of this increase in bear/human conflicts, a large majority of Vermonters (70%) are tolerant of bears on their property while only 18% are not (Duda et al. 2007). Had Vermont residents not had this tolerance for bears, the Department expects that many more might have registered reports of conflict given the increase in both bear numbers and the human population in the past ten years.

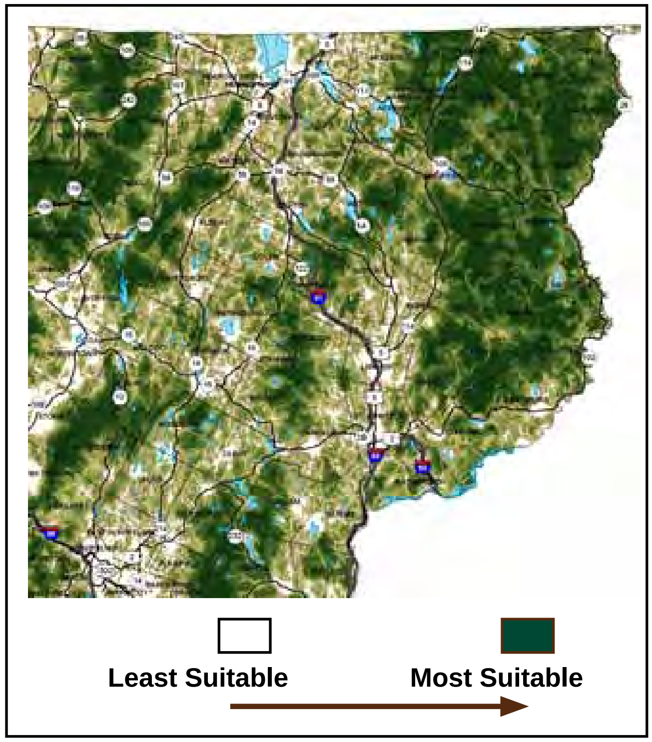

Figure 4.5 Wildlife Suitability Map example for black bear and other wide-ranging species.

Hunting plays a significant role in shaping Vermont's cultural carrying capacity for bears. The Vermont Fish & Wildlife Department uses regulated hunting both to provide harvest and utilization of bears and as a tool to maintain bear numbers at target population levels throughout the state. Hunting also teaches bears to be wary of humans. This reduces the number of bears that might become "nuisance animals" causing damage to livestock or farmers' crops, raiding dumpsters, or entering buildings in search of food.

The history of hunting and utilizing bears for food in Vermont is a long one. The Department believes that regulated hunting and the training of hunting dogs helps keep Vermont's bears wild, which in turn has encouraged a higher cultural carrying capacity. The extreme wariness of the Vermont black bear may be related to the bounty system that was in place for 110 years ending half way through the twentieth century. Following the end of the bounty system, liberal hunting seasons and the chasing of bears with hounds has continued to make bears wary of humans. Currently, nuisance bear situations are more likely to occur when there is a shortage of natural food sources that cause them to become bolder in their search for food.

Generally, the wariness of black bears limit their exposure to human-occupied landscapes. A shortening of the bear hunting season in 1990 resulted in a planned increase in the bear population, resulting in more bears attempting to establish home ranges in less secluded areas that had previously been unoccupied. Vermont now has more bears living in closer proximity to human residences. This situation has increased the likelihood of undesirable human interactions. These situations include, but are not limited to, the destruction of farmers' crops, commercial beehives, and fruit orchards; the killing of livestock; the raiding of garbage barrels and bird feeders; and an increase in the number of bear-motor vehicle collisions.

The Department has developed posters, brochures, and public service announcements designed to increase awareness and to help the general public understand black bear behavior and to live better with black bears (Fig. 4.6). These public outreach efforts advise citizens to remove bird feeders from their yards when bears are not in hibernation and discourage feeding bears through the slogan, "A fed bear is a dead bear." Game wardens also advise and help landowners who report damage from bears.

Management Strategies

3.1 Update statewide policy for handling black bear/human conflicts.

3.2 Improve and disseminate outreach/education materials and messages for minimizing human/bear conflicts.

3.3 Monitor bear/human conflicts and explore new strategies for reducing the number of complaints from the public.

3.4 Use permitted houndsmen with trained bear hounds to haze bears and keep them wary of humans.

ISSUE 4. Bear Management Strategies and Season Structure

GOAL: Optimize public hunting opportunity for the utilization of bears for food and other appropriate purposes and ensure hunter satisfaction within biologically sustainable regulations.

People hunt for many different reasons, but over 90% of hunters who were surveyed listed the reason they hunt black bear was "for food." Most hunters also have a deep appreciation of the out-of-doors and love and respect the species they pursue during hunting season and watch during the rest of the year. This appreciation often results in hunters leading efforts for increased harvest regulation, habitat protection, and other conservation initiatives.

There are currently 25 laws and regulations that regulate the harvest, utilization, and sale of bears in Vermont. Black bear season is currently set on a statewide basis with no regulatory differences among wildlife management units. The season length is one of the longest in the nation, running from September 1 to the Wednesday following the opening day of the November deer rifle season. Use of trained hunting dogs to hunt bears is allowed in Vermont by permit only. Baiting for the purpose of taking bears is prohibited. The bag limit is currently set at one bear per licensed hunter per season.

The management of Vermont's black bear population through regulated hunting offers several challenges.

Figure 4.6 Two-foot by three-foot black bear poster developed by the Department for distribution to the public.

Annual black bear harvests are sometimes more reflective of food availability, weather events influencing the timing of denning, and other factors affecting bear movements instead of simply increases or decreases in the population (Fig. 4.7). For this reason, managing a bear population requires reviewing several years of harvest information before proposing regulatory changes to the hunting season. The low reproductive rate and longevity of black bears further complicate management by delaying bear population responses to harvest adjustments (Fig. 4.8).

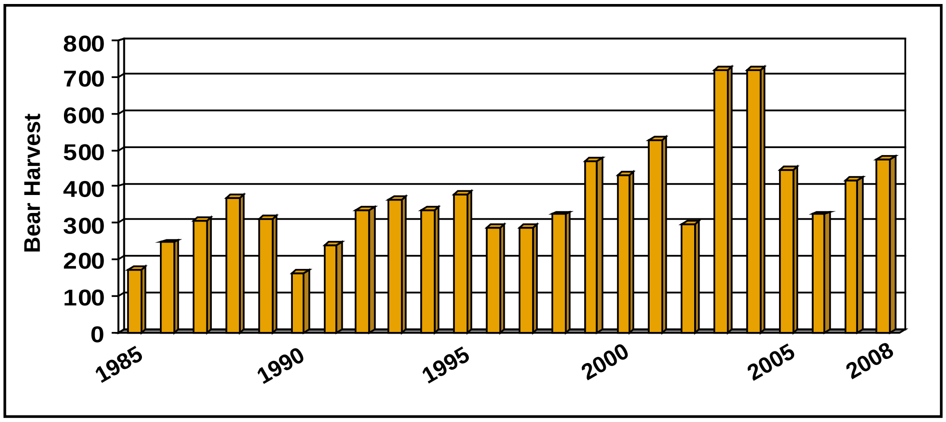

Figure 4.7. Annual Vermont black bear harvest, 1985-2008.

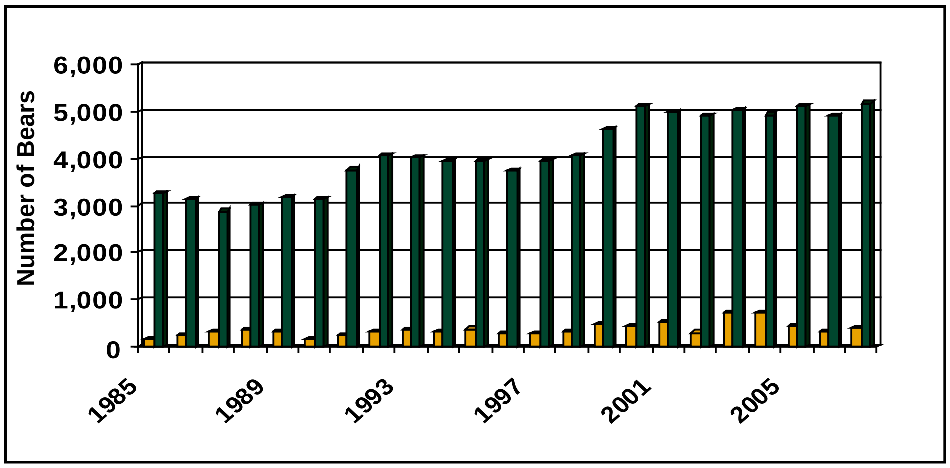

Figure 4.8 Vermont bear harvest as a proportion of population estimate.

Black bear hunting participation rates in Vermont are relatively low, remaining significantly below that of white-tailed deer and wild turkey. They have decreased from an estimated 28% of hunters in 1996 to 17% in 2007 probably as a result of shortening the length of the bear season that overlaps with the November rifle deer season. Prior to shortening the season in 1990, bear harvest levels were greatly affected by deer hunters that opportunistically harvested black bear while pursuing deer. Given these facts, it may come as no surprise that bear hunting satisfaction decreased from 75% to 54% between 1996 and 2007.

There are a variety of management strategies available for stabilizing and maintaining existing bear populations in Vermont while providing hunting opportunities. Listed below are management tools that can, individually or in combination, aid in regulating the bear harvest to meet the statewide population goals of 4,500 to 6,000 bears. It must be emphasized that bear season length and structure have historically been adjusted to increase or reduce the statewide bear population.

Bear License

A key component to an accurate population measure based on harvest is the parameter of hunter effort. Simply examining harvest differences each year cannot provide a reliable correlation between harvest and total numbers of bears. Bear hunters in Vermont are not required to purchase a separate bear license. A bear tag is included as part of the big game hunting license. This license has a long history (at least 45 years) and has resulted in the expectation that a bear tag is part of the value purchased with the big game license.

A separate black bear license would be one way to determine the number of hunters intending to pursue bears each year. However, the sale of separate bear licenses would not provide other important information such as hunting hours expended in pursuit of bears, the number of bear sightings, or WMU preferences. Collection of all of these data could be accomplished without requiring a separate bear license. Since 2000, surveys indicate that 46% of all bears harvested were taken incidentally by hunters while hunting another game species. Deer hunters took the largest percent of bears, 29% (Table 4.2).

Table 4.2 Percent of Vermont bears harvested while hunting for a specific species 2001 – 2008.

SPECIES HUNTED	SEPTEMBER	OCTOBER	NOVEMBER	TOTAL	PERCENT
Bear	1,233	883	264	2,380	54%
Deer	0	473	797	1,270	29%
Birds	4	16	3	23	<1%
Other	15	55	14	84	2%
Unknown	270	230	132	632	14%
Total	**1,522**	**1,657**	**1,210**	**4,389**	**100%**

Survey results from 2007 indicate opposition to the establishment of a separate black bear license has remained at 61%. The percent of hunters supporting a separate bear license had declined to 29% in 2007 from 31% in 1995. These results suggest implementation of a separate license would be difficult. Given that Vermont's bear population has been increasing, it is possible that it will be necessary to extend bear season further into the November deer rifle season in the future. Reducing the number of hunters that may take a bear by requiring a new and separate bear license could jeopardize the Department's future ability to control total bear numbers.

Bag Limit

Vermont's statewide bear season bag limit of one bear was first established in 1968. Bag limits may be effective means of adjusting harvest levels to meet particular population goals. The single bear season bag limit has served Vermont well in initially reducing bear harvests and allowing for population growth. New population goals that require stabilizing or potentially reducing the number of bears could involve re-examining the current bear season bag limit. However, increasing the annual bag limit for bears might call for reducing the length of the bear hunting season, a move that could require eliminating the current overlap of bear season with the first five days of the deer rifle season. Increasing opportunity for one segment of the hunting population will likely decrease opportunity for another.

To date, only Oregon, Washington, and Alaska have fall season bag limits greater than one. Several states and Canadian provinces hold a spring bear season that includes its own bag limit. Although increased fall bag limits are a relatively untested management tool, they may be important in stabilizing bear populations if they can be implemented cautiously and other management tools prove to be ineffective.

It would be critical to monitor any increased harvest from expanded bag limits to evaluate its effects on regional bear populations and the sex and age of the animals harvested.

The Department believes that revising the bear season bag limit is one possible way to stabilize and control the bear population. Since this method would reallocate the bear resource, any proposal to change bag limits, however, will need to follow a rigorous public outreach effort and significant buy-in from the hunting public.

Regional Management Zones

Management of black bear is currently conducted on a statewide basis because data in measuring hunter effort and distribution are inadequate to inform fine scale regulation of harvest. Although simple to administer, comply with, and enforce, a statewide bear season does limit the flexibility of the Department to adjust the harvest in response to regional issues or variables. In spite of its small size, Vermont does have significant regional differences in bear density, bear habitat use, food supplies, weather patterns, road access, habitat fragmentation, hunting pressure, number of nuisance complaints, and development pressure. As a better understanding of bear population distribution develops, the flexibility to tailor hunting seasons to regional differences may be necessary.

Season Length and Structure

Vermont has regulated the annual bear harvest for the past 40 years by simply adjusting the length of the hunting season. In particular, the number of days that bear season is open during the November deer rifle season has the greatest effect on the total bear harvest especially during years when food supplies are abundant and bears continue to feed instead of going to their dens for the winter.

In 1990, Vermont's bear season was shortened by four days in November (from the second Sunday of deer season to the first Wednesday) in order to reduce bear harvests and increase the population. As previously discussed, this management action was very effective and resulted in a significant increase in Vermont's bear population.

The Department has demonstrated that incremental changes in the number of days that bear season extends into the November rifle deer season is an effective means to regulate the harvest of bears and to adjust the bear population. However, creative ways to achieve population goals on a local or regional basis may be needed in the future. As human and/or bear populations grow, greater flexibility may be needed to address the specific issues to best respond to the needs of bears and people.

Hunting Bears with Hounds

Bear hunting with hounds can be a controversial method to locate and pursue a bear. The Department recognizes and acknowledges that there are issues of public concern such as hounds on private property, the use of telemetry, and the length of the training season. Nevertheless, the Department continues to support bear hunting with hounds as a legitimate and biologically sound hunting method that has advantages in that chasing bears keeps bears wild and minimizes nuisance and other conflicts with humans. Vermont game wardens routinely recommend bear houndsmen to property owners who are dealing with nuisance bears. Houndsmen have come to the rescue of many a farmer who has had problems with bears in their corn, apple orchard, or beehives. Many times, chasing a bear away will prevent its death at the hands of the property owner.

Bear houndsmen are required to have a permit to train and hunt bear with dogs in Vermont. The number of nonresident bear houndsmen permitted to hunt in Vermont is limited to 10% of the resident permit numbers. Recent law changes have placed greater restrictions on the ownership and residency of the dogs permitted to run on the permits of Vermont resident houndsmen. Because the number of bears taken with the aid of hounds is only about 10-15% of the total bear season harvest, bear hunting with dogs is not the most important method for controlling the bear population. The benefits of hunting bears with dogs are significant, however, and the Department will continue to address issues of public concern that would restrict hound hunting in Vermont. The Department will also continue to work closely with the Vermont Bear Hound Association to discuss and understand the issues of concern and identify actions that can be taken to address them.

Sale of Bear Parts

The Department continues to participate in and monitor national and international assessments of the effect of trade in bear parts on wild bear populations. Recent changes in the market for bear parts along with increasing black bear populations in North America have reduced concerns over this activity in recent years. The 1992 listing of the American black bear as a CITES Appendix I species now also provides significant monitoring of international trade.

The Department will continue to monitor the sale of black bear parts. If trends and activity in the sale of bear parts, particularly gallbladders, is found to be detrimental to Vermont's bear population or pose a threat to bear populations in other parts of the world, it may propose further regulation or prohibition of such sales.

Guided Commercial Bear Hunts

Bear hunters have expressed their concern that commercial guides have been securing exclusive hunting rights to key bear feeding areas such as cornfields near traditional bear travel routes. This allows guides to offer clients a "guarantee" of sorts that they will take a bear because of the high concentration of bears in these areas. Because cornfields may attract bears from several miles, it has been suggested that the cumulative harvest of bears at these sites could have a disproportionate impact on bear populations in several nearby towns. On face value, this seems to be a plausible argument, but it has not been borne out by statistics.

Guiding, when properly administered, can be a quality introduction to hunting and a form of hunter mentoring. These are important components of hunting recruitment and retention. Poorly administered guide services that are purely profit-driven can be very damaging to hunting. Developing some standard for commercial guiding may be a way to assess the effect on the bear population from the guiding industry through analysis of hunter effort and harvest data. A standard might also serve as a marketing tool for guides. Guide programs administered by fish and wildlife departments in other states are not self-supporting and are costly to administer.

Management Strategies

4.1 Hunting season management strategies and season structure will be evaluated and adjusted to maintain the population goal of 4,500 to 6,000 bears. Changes in hunting season structure will consider, when necessary, the use of season length, regionalization, or incremental changes to season bag limits to achieve population goals.

4.2 Work with partner organizations on issues related to bear management as they are raised throughout the management plan period and develop specific strategies to address them. Such strategies may range from legislative changes to educational efforts.

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I. Management History

Records from the late 1700s and early 1800s indicate wild turkeys were present in southern Vermont. Most turkeys in the state seem to have existed along the Taconic Mountain Range in the southwest and along the Connecticut River Valley in the southeast. Massive loss of forestland and unregulated market hunting in the early nineteenth century led to the disappearance of Vermont's wild turkeys by the mid-1800s.

A number of private fish and game clubs attempted to re-establish the birds during the late 1950s at various locations around the state by releasing turkeys raised on game farms. This effort failed, however, because these birds lacked the inherent hardiness and survival skills of wild turkeys. These stocking attempts convinced the Department that successful reintroduction of turkeys into Vermont would require live-trapping of the hardier wild birds from another state.

In the late 1960s, the Department made arrangements with the New York Department of Environmental Conservation to permit Vermont biologists to live-trap wild turkeys and relocate them. Vermont first released 17 wild New York birds in Pawlet, Vermont, in 1969. A second release of 14 wild birds was made in Hubbardton in 1970. Today's wild turkey population of more than 50,000 birds directly descends from this original stock of 31 New York wild turkeys. The Department initially expected the expansion of the wild turkey population to be limited to the part of the state reported to be historical wild turkey range, south of US Route 4. Only 30 years after introduction, turkeys ranged across the entire state. These hardy birds have far exceeded expectations and have successfully exploited Vermont's mosaic of forestland and dairy farms.

The Department began efforts to expand wild turkey range within the state soon after their initial introduction. Over a ten-year period ending in mid-1980s, live-trap and transfer techniques were employed to capture and move wild birds from the original release area in Rutland County to other parts of the state. Birds were released in Bennington, Brattleboro, Bristol, Dummerston, Grand Isle, Halifax, Jericho, Milton, Norwich, Pownal,


WAYNE LAROCHE

Rockingham, Shaftsbury, Springfield, Strafford, and Weybridge. Birds were also restocked in Alburg, Fairfax, Georgia, Grand Isle, and Swanton in the mid-1990s to augment a struggling local population perhaps limited by overharvesting in the fall.

Vermont's first, modern wild turkey hunting season was held in parts of Addison, Bennington, and Rutland Counties in the spring of 1973. A season was held for 12 days (May 9-20) with a limit of one bearded turkey. Twenty-three turkeys were harvested by 579 permitted hunters. The first fall hunt, held in 1975, occurred in a limited area of southwestern Vermont.

Over the past 30 years, wild turkeys have thrived in Vermont and public participation in turkey hunting has continued to increase. Reduction in fall harvest opportunities imposed following the disastrous and extremely severe winter of 1993-94 helped stimulate rapid turkey population growth and expansion. The population is estimated to have increased from approximately 12,000 to 45,000 birds in the period from 1995 through 2001. The increase in spring turkey harvest mirrors the species' population growth (Fig. 5.1).

Turkey hunting opportunities have been expanded to new areas of the state as the population has grown. The entire state of Vermont was opened for the first time to spring turkey hunting in 2004. In addition, relatively liberal fall turkey hunting opportunities, compared to those in other states, are now offered in most areas of the state. Average annual combined spring and fall harvest of turkeys now totals about 5,800 birds per year. Viewing opportunities have also expanded tremendously for thousands of Vermonters who delight in simply viewing wild turkeys in their natural setting. As a result of the Department's turkey management initiatives, the wild turkey population has risen to the highest level in Vermont history. The wild turkey population is currently estimated to exceed 50,000 birds statewide.

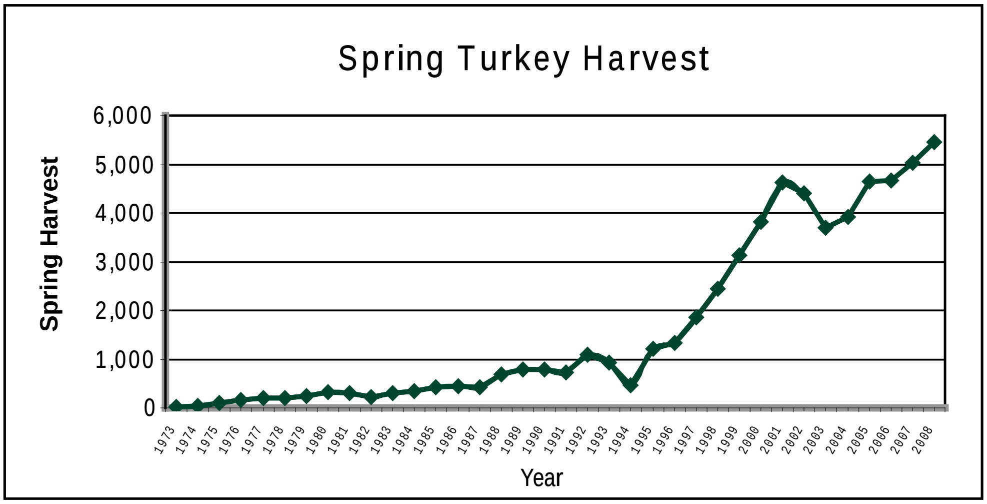

Figure 5.1. Spring Turkey Harvests 1972 - 2008

Wild turkey research has found that short-term turkey population fluctuations result from combinations of random environmental conditions such as rainfall and temperature events that affect nesting hatching success, survival of poults and winter survival. Long-term population trends, however, are primarily influenced by changes in the quantity and quality of suitable habitat across the landscape.

Forests now dominate close to 75% of Vermont's land area with only about 15% in an open, nonforested condition. Although the eastern wild turkey is primarily regarded as a forest-dwelling bird, ideal turkey habitat includes a diverse mix of habitat types, forest succession stages and open land, which provides the greatest opportunity for feeding, nesting, and brood rearing. Research shows that turkey nesting rates are consistently higher and turkey populations more stable in habitats consisting of a mosaic of forests and fields than in those areas composed mainly of either mostly forest or mostly open land. The highest densities of turkeys in Vermont follow this pattern, occurring in areas where the available habitat is closer to the ideal mosaic mix of conditions.

Forests are an important habitat component for turkeys especially when forests consist of oak, beech, and pine stands that produce abundant hard mast crops (acorns, beechnuts, and other seeds) that are consumed by the birds in the fall and winter months. Forests also provide the large, dominant trees used by turkeys for roosting. These types of forests are relatively common in Vermont, especially in the Champlain Valley, Connecticut River Valley, and the foothills of the Green Mountains and Taconic Mountains. Forest management practices can be used to insure availability of adequate mast crops and roost trees through time.

Clearings and openings in the forest are also a vital habitat component for Vermont's wild turkey population. Whether created as farm pastures, hay fields, or openings within the forest, herbaceous plants such as grasses and clover provide critical habitat for turkey broods. These open areas have abundant insect populations on which young turkeys rely during early growth. The most beneficial clearings are old pastures, dominated by a mix of forbs, weeds, and fruit-bearing shrubs, as opposed to monocultures of grasses. Management can be used to enhance openings through periodic, selective mowing, liming, and fertilizing to favor desirable plant species.

Turkey brood range is a very important habitat consideration. Hen turkeys nest on the ground and prefer nesting in locations having lateral cover of herbaceous plants and shrubs. Recent clear cuts, thinned timber stands, fields, and croplands provide cover suitable for nesting and brooding turkeys. The best management practices for enhancing forest nesting habitat are conventional forest regeneration practices, especially even-aged timber management and group selection methods.

Trends in agriculture may affect the future distribution and abundance of turkeys statewide. As the number of Vermont farms continues to decline and the trend toward increasing forestation and forest age progresses, availability of open land may limit wild turkey production in Vermont.

II. 2010-2020 Turkey Management Issues, Goals, and Strategies

The overall goal of wild turkey management in Vermont is to manage the state's wild turkeys to sustain healthy, abundant populations that will provide hunting and viewing opportunities and will satisfy social expectations and tolerances for turkeys. This management goal aims to sustain an abundant wild turkey population that is truly wild and that is below both the biological carrying capacity of its habitat and the cultural carrying capacity.

ISSUE 1. Turkey Population

GOAL: To adequately assess Vermont's wild turkey populations and trends.

Sustaining healthy wild turkey populations in each wildlife management unit (WMU) that is consistent with Department goals requires an ability to accurately estimate abundance of turkeys or at least trends in relative abundance. Harvest data, nesting success indices as provided by brood surveys, and hunter pressure through license sales are critical elements of the Department's ability to monitor turkey population trends.

Management Strategies

1.1 Annually collect and assess turkey harvest data to determine trends as well as summer/fall turkey sighting survey data in order to direct future management decisions.

1.2 Conduct the public annual Internet turkey brood survey

1999-2008 Plan Accomplishments

Vermont's wild turkey population was estimated to be approximately 23,000 to 25,000 birds in 1998 at the time the previous turkey management plan was written. The population had risen to 50,000 to 55,000 birds by 2008, a doubling of the population during the ten-year management period. New spring turkey harvest records have been set in eight of the past 11 years. Wild turkey enthusiasts throughout our state have enjoyed countless hours of harvest and viewing opportunities of this highly regarded native wildlife resource.

The following is a list of specific issues and recommendations that were originally proposed in the 1999 plan with the resulting action taken to address them during the past ten-year planning cycle.

➤ **Recommendation 1. *Adjust spring hunting hours to begin one-half hour before sunrise to noon (previous hours were 5:00 a.m. to 11:00 a.m.).***

➤ **Recommendation 2. *Adopt turkey hunting season zones based on existing wildlife management units (WMUs).***

❖ **Action:** Both of these recommendations were adopted by regulation in 2000.

➤ **Recommendation 3. *Change (expand) existing spring turkey hunting zones.***

❖ **Action:** The expansion of spring turkey hunting was adopted by numerous regulation changes throughout the planning period.

2000 – Expanded spring hunting to include all of WMUs H1, H2, and G

2001 – Expanded spring hunting to include Zones B, D1, and D2; WMU A opened to spring hunting by permit, 75 permits issued

2002 – Held the first spring youth season first weekend prior to start of May season; 80 permits issued in WMU A

2003 – Opened WMU A to all licensed hunters, no WMU A permits required

2004 – Expanded spring season to include all of Zone C and E, resulting in entire state of Vermont open to spring hunting for all licensed hunters

➤ **Recommendation 4. *Change fall hunting zones and season length, and establish threshold guidelines for initiating, liberalizing, or curtailing fall hunting seasons.***

❖ **Action:** Changes to the fall wild turkey season were adopted by regulations established in 2000 and 2003.

2000 – Expanded the fall season in J1 to include the entire zone with seven-day shotgun season

– Expanded fall hunting in Zones H2 and J2 to include the regular bow and arrow season and a new archery-only season during the current seven-day shotgun season in adjacent zones

– Reduced fall shotgun season in WMUs G, I, L, M1, M2, O1, O2, P, Q from 16 days to 7 days in length

2003 – Expanded fall bow hunting season length in H1 to include regular bow and arrow season and through regular seven-day shotgun season

– Expanded fall seven-day shotgun hunting in J2 and H2 along with the Department staff summer turkey survey.

1.3 Continue the turkey project's investigation into the genetic variability and structure of the statewide population.

1.4 Evaluate new wild turkey population estimation methods and models for use in Vermont.

1.5 Evaluate the use of a public Internet survey to assess winter flock sightings.

ISSUE 2. Public Satisfaction with Current Population Levels

GOAL: Assess public and hunter satisfaction with current turkey population levels and management program.

Respondents to a 2007 public opinion survey were asked their opinion about wild turkey population levels around the state. The majority of Vermonters (60%) were satisfied with the turkey population in their county; 15% wanted more turkeys, 10% wanted fewer turkeys, and 15% had no opinion. In an effort to gauge the current level of satisfaction among Vermont's turkey hunters, the Department asked survey participants: "How satisfied are you with your wild turkey hunting experience in Vermont over the past five years?" Ninety-two percent (92%) of the respondents indicated that they were either "Very Satisfied" or "Somewhat Satisfied" with their hunting experience in Vermont. This level of satisfaction for turkey hunting was higher than any other big game species and 16% higher than the opinion survey taken in 1998. The complete results of this question are reported in Table 5.1.

Management Strategies

2.1 Provide statewide spring bearded-bird-only seasons (including the Youth and regular May season) and limited fall either-sex hunting seasons in WMUs that can sustain a fall harvest so as to provide for population stability.

2.2 Prioritize high quality spring hunting over additional fall harvest opportunity.

2.3 Manage fall turkey harvests through changes in fall hunting season length within WMUs depending upon stability or growth of three-year average spring harvest densities, except in WMU A Champlain Islands where inadequate forest cover exists to sustain a fall firearm harvest.

ISSUE 3. Fall Turkey Hunting

GOAL: To provide appropriate opportunity for sustainable fall hunting while maintaining current levels of high quality spring turkey hunting.

The topic of fall turkey hunting is perhaps one of the most misunderstood facets of turkey management in Vermont and generates the most comments from the hunting community. While there is inherent variation in both annual production and survival of wild turkeys, fall either-sex hunting can play a pivotal role in regulating population size. Research on wild turkeys and population modeling in several other states indicates that significant fall hunting pressure can suppress turkey population growth and reduce spring population densities. Although the effects of spring turkey hunting may not be entirely benign due to potential nest disturbance, illegal harvesting of hens, and effects on age structure of male turkeys, fall turkey hunting can have a much more profound impact on turkey populations. Vermont's experience with fall turkey hunting in Grand Isle and Franklin counties in the mid-1980s demonstrated how quickly heavy fall harvests can reduce turkey populations. This is the principal reason that the current fall season bag limit and season length is less in zones with lower turkey densities. In some cases these limits are more conservative than some hunters would prefer.

The Department supports the management practice of using fall hunting zones to regulate turkey populations in areas having the best turkey habitat and highest densities for the following reasons:

- ***Fall wild turkey seasons impact turkey populations by primarily removing female turkeys.*** Sixty-five to 70% of Vermont's fall harvest consists of female turkeys. This large

Table 5.1 2007 Hunter Satisfaction Survey Results

Satisfaction level	Percent of respondents
Very satisfied	57%
Somewhat satisfied	35%
Neither satisfied nor dissatisfied	0%
Somewhat dissatisfied	7%
Very dissatisfied	1%

female fall harvest reduces the number of hens nesting the following spring. Fall harvests of hens followed by a severe winter and/or poor reproduction the following spring can quickly change the abundance of turkeys — thus fall hunting in this situation can only add to the mortality rate.

- ***The illegal harvest of female turkeys may be more of a factor in the fall season when entire broods are vulnerable to harvest.*** Several states have documented higher illegal take during the fall season.

- ***Turkeys in Vermont are living at the northern fringe of their continental range and are more vulnerable to natural mortality from severe winters and cold, wet springs.*** Severe winters can result in substantial population losses and depress spring reproductive success. While Vermont can experience severe winter conditions throughout the state, this factor is especially significant in the more northerly and higher elevation wildlife management units. The harvest of female turkeys can be additive to these natural mortalities.

- ***The regulatory process does not allow for timely changes to the fall hunting season in response to annual fluctuations in turkey productivity.*** Changing harvest regulations via the mandatory, Administrative Procedures Act is a very deliberative, lengthy process. The time frame for developing a change in turkey regulations, from preparing a proposed rule until final adoption of the rule, requires approximately 18 to 22 weeks. This severely limits the Department's ability to respond quickly to significant increases or decreases in poult production or survival. This also requires the Department to be conservative when proposing harvest regulations.

When asked in the 2007 opinion survey, the majority of turkey hunters (68%) support the current management strategy to limit fall turkey hunting for the purpose of maximizing spring turkey harvests. Although this indicates strong support for the current approach, there may be opportunities to systematically enhance/expand fall turkey hunting without compromising the goal of providing quality spring turkey hunting in Vermont.

Management Strategies

3.1 Provide public opportunity to harvest wild turkey for food and other utilitarian purposes.

3.2 Facilitate healthy, abundant spring turkey populations that are stable using modest, fall hunting seasons/bag limits to control the population. When the three-year spring average harvest density reaches the specific threshold value, liberalization of fall hunting in a WMU may be called for (initiate shotgun seasons, extend gun seasons). See Table 5.2.

3.3 Consider reducing the current guideline for the threshold as to when fall gun hunting opportunities could be initiated in a new WMU, from the three-year average spring harvest density of one bird per square mile, to an average harvest density of .75 bird per square mile.

3.4 Lengthen the current fall seven-day shotgun season to a nine-day season.

3.5 Expand the fall shotgun season to include WMUs H1, D1, and B with a nine-day shotgun season.

3.6 Expand the fall archery turkey season, coinciding with the opening of the deer archery season, to allow archery hunting statewide.

3.7 Investigate establishing a new separate "Fall Gun Season Only" tag.

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Table 5.2 Spring Wild Turkey Harvest 1998-2008

	Spring Harvest per Square Mile											3-year Average
WMU	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2006-08**
A	1.10	1.57	1.86	1.90	1.62	3.33	2.76	2.38	2.86	3.19	3.10	**3.05**
B				0.28	0.37	0.25	0.43	0.59	0.83	0.84	1.32	**1.00**
C							0.20	0.25	0.39	0.29	0.49	**0.39**
D-1				0.34	0.37	0.23	0.39	0.56	0.70	0.54	0.99	**0.74**
D-2				0.36	0.44	0.25	0.35	0.53	0.60	0.53	0.65	**0.59**
E	0.01	0.03	0.02	0.04	0.08	0.05	0.17	0.25	0.27	0.20	0.28	**0.25**
F-1	2.14	2.90	3.59	3.92	4.14	3.50	3.40	3.36	3.14	3.78	2.61	**3.18**
F-2	1.73	1.55	2.76	2.64	2.34	2.02	2.12	2.04	1.99	1.80	1.57	**1.79**
G	0.10	0.18	0.26	0.21	0.25	0.16	0.32	0.29	0.35	0.37	0.40	**0.37**
H-1	0.11	0.41	0.60	0.63	0.80	0.52	0.60	0.79	0.77	0.68	0.85	**0.77**
H-2	0.58	0.78	1.24	1.03	1.64	1.37	1.37	1.56	1.16	1.40	1.78	**1.45**
I	0.17	0.19	0.24	0.24	0.30	0.20	0.23	0.25	0.24	0.24	0.20	**0.23**
J-1	0.49	0.46	0.74	0.85	0.84	0.64	0.78	0.81	0.60	0.90	0.86	**0.79**
J-2	0.41	0.67	0.63	0.83	0.78	0.54	0.74	0.78	0.67	0.83	0.66	**0.72**
K-1	1.29	1.96	1.95	2.00	1.85	1.70	1.09	1.08	1.42	1.34	1.28	**1.35**
K-2	1.43	1.66	1.74	2.02	1.35	1.50	1.33	1.49	1.34	1.50	1.30	**1.38**
L	0.11	0.21	0.25	0.33	0.25	0.21	0.15	0.28	0.26	0.28	0.30	**0.28**
M-1	0.23	0.31	0.41	0.34	0.23	0.26	0.17	0.36	0.27	0.47	0.42	**0.39**
M-2	0.53	0.62	0.87	0.86	0.65	0.65	0.51	0.77	0.75	0.88	1.08	**0.90**
N	0.92	1.01	1.24	1.47	0.92	0.91	0.67	0.79	0.91	0.97	1.09	**0.99**
O-1	0.21	0.19	0.34	0.44	0.27	0.33	0.21	0.41	0.31	0.44	0.45	**0.40**
O-2	0.58	0.77	0.61	0.91	0.75	0.75	0.49	0.72	0.75	0.84	0.93	**0.84**
P	0.12	0.14	0.15	0.16	0.17	0.13	0.10	0.17	0.15	0.21	0.25	**0.20**
Q	0.40	0.53	0.34	0.40	0.44	0.44	0.43	0.50	0.50	0.59	0.50	**0.53**

ISSUE 4. Wild Turkey/Human Conflicts

GOAL: To minimize and manage agricultural damage and nuisance turkey incidents.

Some wild turkey nuisance complaints and/or negative interactions with the public are unavoidable. While complaints have increased in recent years as the turkey population has grown, the annual number of complaints is relatively low compared with those for black bear and white-tailed deer.

The majority of the nuisance wild turkey complaints stem from turkeys' consumption or spoilage of silage or other stored crops. This situation often occurs when deep snow limits turkey mobility and restricts the birds' access to natural foods. Extreme weather creates intense stress on wild turkey populations whose fall food supplies become buried under snow at the same time that cold temperatures cause fat reserves to dwindle. Wild turkeys have a strong survival instinct that leads large winter flocks to exploit a convenient high calorie agricultural crop. Given this natural survival instinct, it is difficult to discourage them, especially once birds have established a pattern of regular feeding around a farm. While fall hunting may reduce the numbers of offending birds to some degree, it will not solve this problem.

Farmers can protect silage in exposed bunkers by periodically placing waste silage close to the forest where turkeys are taking shelter. By starting this early before turkeys become accustomed to going to the bunker, the birds may be diverted to a food source that has little value to the farmer.

Dairy farmers have expressed concerns regarding potential transmission of diseases to their livestock from turkey feeding/defecation in feed bunkers. Vermont, New Hampshire, and Minnesota have conducted numerous investigations involving disease testing of local wild turkey flocks and, to date, have found no evidence of the presence of Salmonella DT 104 bacteria in these birds. Thus, farmers' concerns for disease transmission between wild turkeys and dairy cows appear to be unwarranted.

A turkey damage control regulation has been promulgated as another method to help address the nuisance issue. Under the "turkey damage rule," a landowner under game warden supervision may take a pre-approved number of offending turkeys that have been determined to have caused repeated or substantial damage to cultivated crops. The use of lethal control by shooting is normally considered to be the last option. With the assistance of a game warden, Department biologists, and U.S. Department of Agriculture's Wildlife Services personnel, other control methods such as hazing and/or fencing are attempted first. Frequently, complaints can be handled simply by providing technical or management assistance over the phone to educate landowners regarding turkey behavior and methods to change problem behavior.

Local National Wild Turkey Federation (NWTF) members can assist in quelling wild turkey/human conflicts. It is possible, given the demographic shift from farming to increased rural development, that nonagricultural nuisance complaints may increase in the near future. With this in mind, the Department will continue to adapt its approach to fit the issue.

Management Strategies

4.1 Provide property owners with access to coordinated services of personnel trained to deal with nuisance turkey issues including wildlife biologists, game wardens, and USDA Wildlife Services staff to assist with nuisance complaints via technical guidance/assistance on techniques to minimize/discourage damage.

4.2 Conduct follow-up site visits to nuisance complaint sites when necessary and provide hazing equipment to help ameliorate persistent nuisance situations.

4.3 Solicit assistance from local volunteers through the Vermont Chapter of the National Wildlife Turkey Federation (NWTF) to help provide on-the-ground assistance to landowners via hazing and behavior modification efforts.

4.4 Assist USDA Wildlife Services staff with development of educational materials to inform and educate farmers about techniques for minimizing conflicts.

4.5 Compile and evaluate wild turkey damage complaint reports from farmers, state game wardens, biologists and wildlife service personnel to document problems, management approaches and results.

4.6 Develop/modify a standard set of protocols/guidelines/solutions to perceived and actual conflicts caused by wild turkeys (nuisance animals, agricultural damage).

ISSUE 5. Turkey Habitat Management and Conservation

GOAL: To encourage conservation and appropriate habitat management practices to support and sustain Vermont's wild turkey population.

Habitat quality and quantity are necessary to achieve wild turkey management goals. Land use changes that convert habitat to a lower quality or result in permanent habitat loss diminish its ability to sustain healthy, abundant turkey populations.

Management Strategies

5.1 Continue efforts on wildlife management areas and other public lands to provide habitat demonstration areas to promote appropriate commercial and noncommercial vegetation management practices beneficial to turkeys and other wildlife. This includes the use of prescribed fire and other management practices to establish and maintain long-term mast production areas.

5.2 Provide technical information and assistance regarding turkey habitat management to private

landowners and other land managers, town planning commissions via staff biologists, habitat demonstration projects, LIP and WHIP program lands, etc.

5.3 Update the "A Landowner's Guide, Wildlife Habitat Management for Vermont Woodlands" and make it available on the Department's website and in published form.

5.4 Work with the NWTF regional biologists and chapter volunteers on development of the North American Wild Turkey Management Plan.

5.5 Work with partnering organizations on high priority projects and issues.

ISSUE 6. Perception Regarding the Interaction Between Deer and Wild Turkeys, Ruffed Grouse and Wild Turkeys, and Various Predators and Wild Turkeys

GOAL: To improve the public's knowledge, awareness, and understanding of the role of the wild turkey and its interactions within the ecosystem.

While the number of wild turkeys has increased dramatically throughout Vermont over the last decade, ruffed grouse and deer have at times declined in abundance. This leads some hunters to assume that turkeys could somehow be having a negative impact upon these other popular species. Some hunters believe that turkeys are eating more and more of the available food. However, biologists throughout the range where these species overlap believe that changes in deer or grouse numbers have nothing to do with the size of the turkey population. The factors limiting survival and populations of deer and grouse are different than those limiting turkeys. Although the effects of winter severity can limit all three species, their effects vary by species. In winter, deer require softwood cover and woody browse. Turkeys don't eat woody browse. While the formation of crusts on the snow surface can trap or prevent grouse from burrowing below the snow's surface, crusts make it easy for turkeys to get around in search of food.

Through all the restoration efforts and the tremendous population growth there have been no documented reports of wild turkeys having any negative impact on other wildlife or threatened or endangered species. Because of their general and opportunistic feeding habits and adaptability, the wild turkey seems to be able to find a noncompetitive niche in which to survive regardless of the other species found in the area. One researcher noted that turkeys "usually have filled a vacant environmental niche wherever they have been introduced and no significant environmental problem has been attributed to them." (Wunz 1992, National Wild Turkey Federation 2001).

Deer and Wild Turkeys

The most common concern expressed regarding turkeys competing with deer is that they out-compete deer for hard mast such as acorns or beech nuts. While it's true that both deer and turkeys feed more on mast during years of mast abundance, but so do bears, squirrels, grouse, blue jays, and numerous small mammal species. Of these, turkeys may leave the most obvious evidence of feeding due to their scratching, but it's highly unlikely that the birds consume mast to the detriment of deer. Autumn is the period of greatest wild food abundance. Wild apples, corn and other agricultural crops, grasses and forbs, berries and seeds of all kinds are used by both turkeys and deer and many other animals. In fact, a Pennsylvanian researcher used fencing to determine that of all species feeding on red oak acorns, deer actually obtain the greatest proportion of mast. Regarding beech mast, a Michigan researcher (Rosemier et al. 2005) found that in non-mast years, rodents actually consume most of the beechnuts. Considering the fact that only two 150 pound deer (300 lbs) equal the biomass of a flock of about 30 juvenile turkeys (or 15 large adults), it is easy to see how a few deer could easily consume considerably most of the mast crop.

While high turkey densities are believed to have no significant negative impact upon deer populations, high deer densities do have a harmful impact upon turkeys, ruffed grouse, and other forest birds because excessive browsing of shrubs reduces protective cover, food sources, and nesting sites (Witmer and DeCalesta 1991).

Ruffed Grouse and Wild Turkeys

Dan Dessecker, a forest biologist with the Ruffed Grouse Society, points out that "In order for increasing wild turkey populations to be able to exert a direct negative influence on local ruffed grouse, there would have to be some form of competition" (Dessecker 1996). This competition would be expected to focus on some limited resource, such as space, food, breeding areas, nesting sites, or some other resource. Dessecker notes that it's highly doubtful that these two species compete for any limited resource. Ruffed grouse thrive in dense young forest stands. Turkeys prefer relatively open mature forests.

Regarding breeding areas, grouse drum on logs surrounded by dense shrubs, and turkey gobblers display in fields or forest openings. Although hens of both species nest in middle-aged or mature forest, their nest site requirements are quite general with both species using a wide range of sites that are found throughout forests. Again, it is very unlikely that there is limited space and competition for nest sites.

Research has shown that wild turkeys do not affect other bird species by eating young birds or destroying nests. Dr. Bill Palmer, a game bird biologist in Florida, used micro-video cameras and radio-tagged hens to monitor more than 400 quail nests and broods in an area with very high turkey populations (30-60 turkeys per square mile). The research did not record a single turkey destroying a nest or eating or killing a quail chick (Zimmer 2002). Gary Zimmer, another Ruffed Grouse Society forest biologist, points out that young grouse can fly well at only three weeks of age. When threatened the brood flushes in all directions to find cover and hide. That would make it nearly impossible for a turkey, with its poor sense of smell, to locate and harm grouse chicks (Zimmer 2002).

Competition for food is also not likely to be significant between turkeys and ruffed grouse. Both birds are generalists, in that they feed on an extremely wide variety of foods throughout the year. During winter, the most stressful period when food resources are most scarce, turkeys and grouse typically use different food sources (Whitaker 1998).

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Ruffed grouse feed on the buds of trees and shrubs. Dessecker notes that turkeys are heavy birds that can only stand on stout tree limbs, so they prefer to feed on the ground on waste grains, acorns and beechnuts, and residual fruits and seeds, such as highbush cranberry, burdock, and ash seeds.

Dave Neu, a regional biologist for the National Wild Turkey Federation, states, "Ruffed grouse and wild turkey are two species that have evolved together for thousands of years and their habitats slightly overlap. There is no documented evidence that either species directly impacts populations of the other" (Zimmer 2002). Although turkey populations have increased while grouse have decreased in some portions of Vermont, the population changes are mainly due to changes in agriculture and forest habitat. As young forests mature, the habitat becomes more suitable for turkeys and less attractive to grouse. Thus, populations of both species birds respond to changing habitat conditions rather than turkeys displacing grouse. Gary Zimmer stated it best when he said that "Any impact caused to ruffed grouse populations by turkeys is insignificant compared to declines in young-forest habitats…" (Zimmer 2002).

Predators and Wild Turkeys

Department personnel are often asked why they don't promote a bounty on coyotes or some other form of predator control to "protect" wild turkeys or other game species. It is well established that predator "control" will not protect wild turkeys. Predator/prey relationships are extremely dynamic and complex. These relationships involve a variety of factors that defy a simple, quick fix. Wild turkeys are prey to a long list of predators including coyotes, bobcats, foxes, fisher, weasels, skunks, opossum, raccoons, snakes, hawks, owls, domestic dogs, and humans. In the case of implementing "coyote control," for example, assuming that this could be effective, removal of coyotes would only reduce competition among the remaining host of predators that would continue to prey on turkeys. Coyotes, in fact, prey upon weasels, opossums, raccoons, foxes, and rarely skunks. All of these species are effective predators of nests, chicks, and nesting turkey hens. For this reason, it is possible that removal of coyotes could allow the populations of these other predators to increase resulting in more, not less, turkey predation and an overall decrease in a turkey population. Complex species relationships are common in nature. In fact, the rapid growth in Vermont's turkey population has occurred during a time when the coyote population has been abundant.

Many of the qualities that hunters admire so much about these birds, such as their incredible eyesight, ability to detect movement and wariness, are products of the turkey's long evolutionary history that they share with their predators. As wild turkey populations increase, the potential role of this species as a significant source of prey for other Vermont animals may now be greater than ever before.

Management Strategies

6.1 Promote sound scientific principles regarding inter-species competition and predator-prey relationships through a variety of outreach methods including public speaking events, web-based information and links, and print and broadcast media.

ISSUE 7. Developing and Maintaining an Informed Public is Crucial to the Management Success of the Wild Turkey Project.

GOAL: To ensure continued information exchange and program acceptance by keeping the general public, state and federal agencies informed on the status of the wild turkey resource in Vermont.

Habitat conservation and public use of the turkey resource are best accomplished when citizens are well-informed. Understanding the public's opinion regarding turkey biology, habitat, and management issues is important in making acceptable management decisions.

Management Strategies

7.1 Disseminate wild turkey project information to the public/media professionals via biological reporting stations, teacher workshops, private and public landowner visits/conferences, slide/video presentations, mail correspondence, popular and technical reports, etc.

7.2 Use the Department's library to fill all public requests for its video production "The Wild Turkey in Vermont" as well as its wildlife study guide "The Wild Turkey Education Kit."

7.3 Continue involvement with standing professional committees, regulatory bodies and cooperative agreements with nongovernmental organizations to assist the Department with meeting the goals and objectives of this plan.

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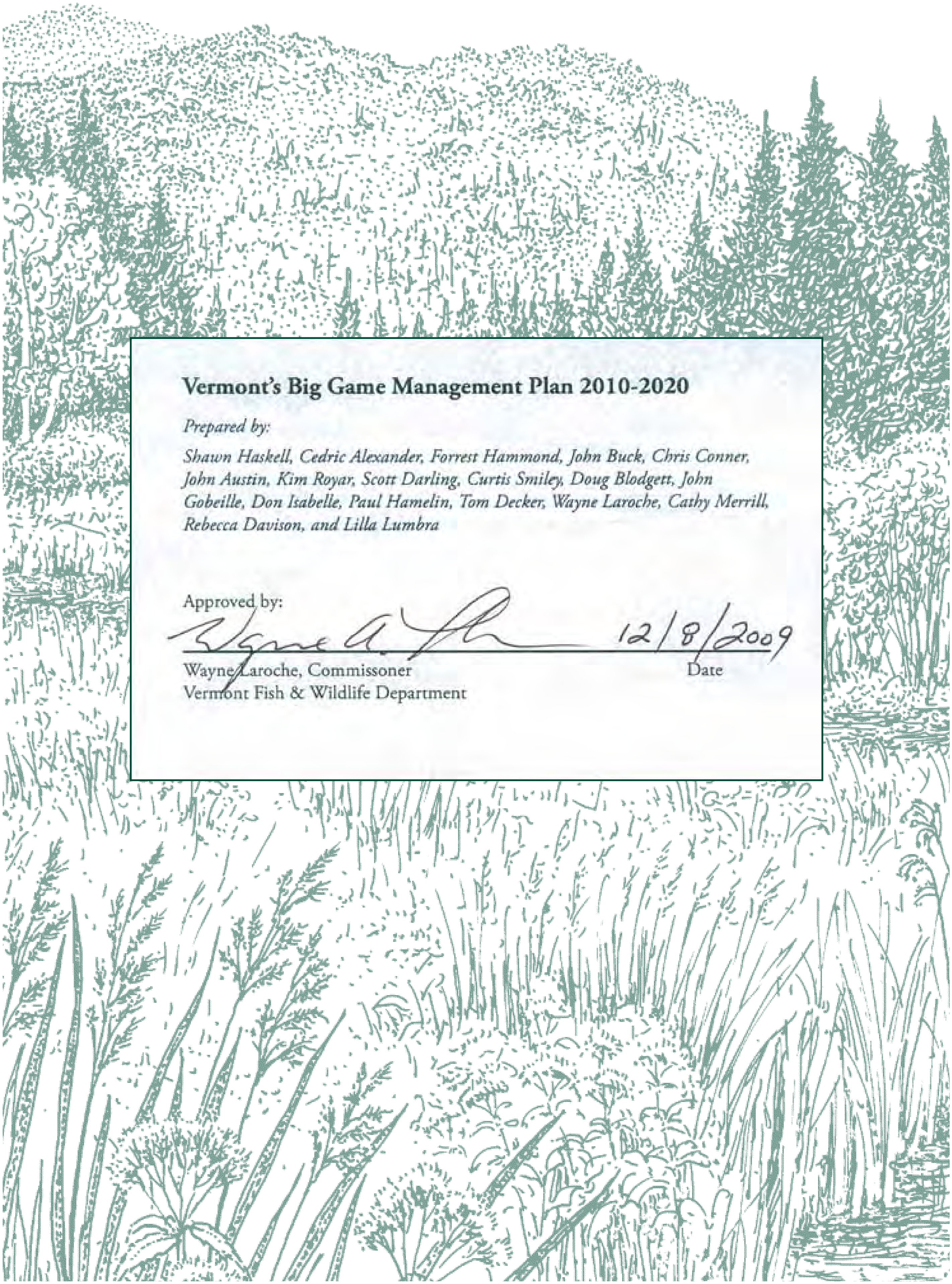

Vermont's Big Game Management Plan 2010-2020

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12/8/2009

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Vermont Fish & Wildlife Department

Appendix I

Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Vermont's Wildlife Action Plan 2015

Appendix I: Plant Species of Greatest Conservation Need -Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Acalypha gracilens	Slender Copperleaf	G5	S1		M	Old Field Shrub, Powerlines RR Tracks, Sandy Openings, Disturbed natural communities
V	Adiantum aleuticum	Aleutian Maidenhair-fern	G5?	S1		H	Serpentine outcrop*
V	Adiantum viridimontanum	Green Mountain Maidenhair-fern	G2	S2	T	H	Serpentine outcrop*
V	Agastache nepetoides	Yellow Giant Hyssop	G5	S1	T	H	Oak-Pine-Northern Hardwood Forest, Forest Edges Logging Rds
V	Agastache scrophulariifolia	Purple Giant Hyssop	G4	SH	T	H	River cobble shore, Rivershore grassland, Floodplain Forests, Acidic Riverside Outcrop
V	Agrostis mertensii	Boreal Bentgrass	G5	S1		M	Alpine meadow*, Boreal outcrop
V	Allium canadense var. canadense	Wild Garlic	G5	S1	T	M	Alluvial shrub swamp, Floodplain Forests, Silver maple-ostrich fern riverine floodplain forest, Silver maple-sensitive fern riverine floodplain forest, Sugar maple-ostrich fern riverine floodplain forest
V	Allium schoenoprasum	Siberian Chives	G5T5	S1		M	Riverside sand or gravel shore, Rivershore grassland, Acidic Riverside Outcrop, Calcareous Riverside Outcrop
V	Allium tricoccum var. burdickii	Burdick's Wild Leek	GNR	SH		H	Rich northern hardwood forest
V	Amaranthus tuberculatus	Water Hemp	G4G5	S2		H	Lakeshore grassland, Lake sand beach, Lake shale or cobble beach, Wet Swales Ditches, Lake Mud Shores
V	Amerorchis rotundifolia	Small Round-leaved Orchis	G5	SH		H	Red maple-northern white cedar swamp, Northern white cedar swamp
V	Ammophila breviligulata ssp. champlainensis	Champlain Beach Grass	G1Q	S1	E	H	Lake sand beach*, Sand dune*
V	Anemone cylindrica	Long-headed Thimbleweed	G5	S1S2		M	Temperate calcareous outcrop, Old Field Shrub, Powerlines RR Tracks
V	Anemone multifida var. multifida	Early Thimbleweed	G5	S1	E	H	Calcareous Riverside Outcrop*
V	Anthoxanthum monticola ssp. monticola	Alpine Sweet-grass	G5	S1	T	H	Alpine meadow*
V	Anticlea glauca	White Camas	G5	S1	E	H	Temperate calcareous cliff, Limestone bluff cedar-pine forest
V	Aplectrum hyemale	Putty-root	G5	SH	T	H	Rich northern hardwood forest, Mesic maple-ash-hickory-oak forest
V	Arabidopsis lyrata	Lyre-leaved Rock-cress	G5	S2	T	M	Temperate calcareous outcrop*, Temperate calcareous cliff*
V	Arceuthobium pusillum	Dwarf Mistletoe	G5	S2		M	Black spruce woodland bog*, Black spruce swamp
V	Arethusa bulbosa	Arethusa	G4	S1	T	H	Poor fen*, Rich fen, Intermediate fen*
V	Arisaema dracontium	Green Dragon	G5	S2	T	M	Lakeside floodplain forest*, Silver maple-ostrich fern riverine floodplain forest, Silver maple-sensitive fern riverine floodplain forest*
V	Aristida longespica var. geniculata	Spiked Grass	G5	S1		M	Pine-oak-heath sandplain forest, Old Field Shrub
V	Artemisia campestris ssp. canadensis	Boreal Wormwood	G5T5	S2		H	Boreal outcrop, Boreal calcareous cliff*
V	Artemisia campestris ssp. caudata	Beach Wormwort	G5T5	S1		H	Lakeshore grassland, Lake sand beach*
V	Asclepias amplexicaulis	Blunt-leaved Milkweed	G5	S1	T	M	Pine-oak-heath sandplain forest*, Sandy Opening
V	Asclepias tuberosa	Butterfly-weed	G5?	SH	T	M	Old Field Shrub
V	Asclepias verticillata	Whorled Milkweed	G5	S1	PE	M	Temperate calcareous outcrop*
V	Asplenium montanum	Mountain Spleenwort	G5	S1	T	H	Temperate acidic cliff*
V	Asplenium viride	Green Spleenwort	G4	S1	T	H	Boreal calcareous cliff*

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Astragalus canadensis var. canadensis	Canadian Milk-vetch	G5	S2	T	H	Lake shale or cobble beach*
V	Astragalus robbinsii var. jesupii	Jesup's Milk-vetch	G5T1	S1	E	H	Calcareous Riverside Outcrop*
V	Astragalus robbinsii var. minor	Blake's Milk-vetch	G5T5	S2		H	Boreal outcrop, Boreal calcareous cliff*
V	Aureolaria flava var. flava	Smooth False-foxglove	G5	S2		M	Temperate calcareous outcrop, Dry oak forest, Dry Red Oak-White Pine Forest, Dry oak-hickory-hophornbeam forest, Powerlines RR Tracks
V	Aureolaria pedicularia	Feverweed	G5	S1		M	Temperate acidic outcrop, Dry oak forest, Powerlines RR Tracks
V	Aureolaria virginica	Downy False-foxglove	G5	S1		M	Temperate calcareous outcrop, Dry oak forest*
V	Bartonia virginica	Yellow Bartonia	G5	S2		M	Red or silver maple-green ash swamp, Red maple-Sphagnum Acidic Basin, Red maple-black gum swamp, Wet Sand-Over-Clay Forest, Red maple-white pine-huckleberry swamp
V	Betula minor	Dwarf Birch	G4	S1	PE	H	Subalpine krummholz*
V	Bidens discoidea	Small Bidens	G5	S2		M	Lakeside floodplain forest*, Red or silver maple-green ash swamp
V	Blephilia ciliata	Downy Wood-mint	G5	SH		H	Old Field Shrub
V	Blephilia hirsuta var. glabrata	Hairy Wood-mint	G5?	S1	T	H	Rich northern hardwood forest*, Old Field Shrub
V	Blephilia hirsuta var. hirsuta	Hairy Wood-mint	G5?T5?	S2	T	H	Rich northern hardwood forest
V	Blitum capitatum	Strawberry Blite	G5	S1		M	Transition hardwood talus woodland, Cultivated Land/ Hayfield, Disturbed natural communities
V	Boechera stricta	Drummond's Rock-cress	G5	S1S2	E	M	Temperate acidic outcrop, Temperate calcareous outcrop, Temperate calcareous cliff, Northern hardwood talus woodland
V	Borodinia missouriensis	Green Rock-cress	G4G5Q	S1		H	Temperate calcareous outcrop, Temperate calcareous cliff
V	Botrychium ascendens	Upswept Moonwort	G3	S1		H	Temperate calcareous outcrop*
V	Botrychium campestre	Prairie Moonwort	G3G4	S1		H	Temperate calcareous outcrop*
V	Botrychium lunaria	Common Moonwort	G5	SH		H	Old Field Shrub
V	Botrychium minganense	Mingan Moonwort	G4G5	SH	E	H	Rich northern hardwood forest
V	Botrychium oneidense	Blunt-lobed Grapefern	G4	S1		H	Northern hardwood forest, Rich northern hardwood forest, Forest Edges Logging Rds
V	Botrychium rugulosum	Rugulose Grape-fern	G3	S1		H	Pine-oak-heath sandplain forest, Old Field Shrub, Sandy Opening
V	Botrychium spathulatum	Spatulate Moonwort	GNF	S1		M	Temperate calcareous outcrop*
V	Botrychium tenebrosum	Shade Moonwort	G5T4	S1		H	Northern white cedar swamp*
V	Braya humilis	Northern Rock-cress	G5	S1	T	H	Boreal calcareous cliff*
V	Bromus kalmii	Wild Chess	G5	S2		M	Temperate calcareous outcrop*, Transition Hardwood Limestone Forest*
V	Calamagrostis canadensis var. langsdorfii	Langsdorf's Bluejoint	G5T5	S1		H	Boreal calcareous cliff
V	Calamagrostis canadensis var. macouniana	Short-flower Bluejoint	G5T5?	SH		H	Marshes & Sedge Meadows
V	Calamagrostis pickeringii	Pickering's Reed Bent-grass	G4	S1		M	Alpine peatland, Shallow emergent marsh
V	Calamagrostis stricta ssp. inexpansa	Bentgrass	G5T5	S1	E	H	Boreal calcareous cliff*, Temperate calcareous cliff

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Callitriche hermaphroditica	Northern Water-starwort	G5	SH		H	Lacustrine
V	Callitriche heterophylla	Large Water-starwort	G5	S2		M	Oligotrophic, High Elevation Acidic
V	Calypso bulbosa var. americana	Fairy Slipper	G5	S1	T	H	Northern white cedar swamp*
V	Calystegia silvatica ssp. fraterniflora	Twin-flower Hedge Bindweed	G4G5	S2		H	Old Field Shrub
V	Calystegia spithamaea ssp. spithamaea	Low Bindweed	G4G5	S2	T	H	Temperate acidic outcrop, Temperate calcareous outcrop, Pine-oak-heath sandplain forest*, Powerlines RR Tracks, Sandy Opening
V	Cardamine bulbosa	Spring Cress	G5	S1		M	Red maple-northern white cedar swamp, Red maple-black ash seepage swamp, Cultivated Land/ Hayfield
V	Cardamine dentata	Cuckoo Flower	GNR	S2		H	Floodplain Forests
V	Cardamine parviflora var. arenicola	Small-flower Bittercress	G5	S2		M	Temperate acidic outcrop, Temperate calcareous outcrop, Open talus, Transition Hardwood Limestone Forest, Dry oak forest, Dry oak-hickory-hophornbeam forest, Transition hardwood talus woodland
V	Carex albicans var. emmonsii	Emmon's Sedge	G5	S1		M	Temperate calcareous outcrop
V	Carex alopecoidea	Foxtail Sedge	G5	S1		H	Rivershore grassland, Lakeside floodplain forest*
V	Carex arcta	Contracted Sedge	G5	S1	E	M	Alluvial shrub swamp, Red maple-northern white cedar swamp
V	Carex atherodes	Awned Sedge	G5	S1		H	Grassland/ Pasture
V	Carex atlantica var. atlantica	Eastern Sedge	G5	S1		M	Poor fen, Rich fen, Alder swamp
V	Carex atlantica var. capillacea	Howe's Sedge	G5T5?	S1		M	Poor fen, Wet Sand-Over-Clay Forest, Powerlines RR Tracks
V	Carex atratiformis	Blackish Sedge	G5	S1	T	H	Alpine meadow*, Boreal calcareous cliff
V	Carex bicknellii	Bicknell's Sedge	G5	SH		H	Old Field Shrub
V	Carex bigelowii ssp. bigelowii	Bigelow's Sedge	G5	S1		H	Alpine peatland, Alpine meadow*, Boreal outcrop
V	Carex bushii	Bush's Sedge	G4	S1		H	Grassland/ Pasture, Old Field Shrub
V	Carex buxbaumii	Buxbaum's Sedge	G5	S1	E	M	Boreal calcareous cliff, Mesic Clayplain forest, Old Field Shrub
V	Carex capillaris ssp. capillaris	Capillary Sedge	G5	S1	T	H	Rich fen
V	Carex chordorrhiza	Creeping Sedge	G5	S1	E	H	Poor fen, Rich fen, Intermediate fen, Red maple-northern white cedar swamp
V	Carex cumulata	Clustered Sedge	G4?	S1		M	Temperate acidic cliff, Pitch pine-oak-heath rocky summit, Sandy Opening
V	Carex davisii	Davis' Sedge	G4	S1		H	Mesic red oak-northern hardwood forest, Forest Edges Logging Rds
V	Carex echinodes	Urchin Sedge	GNR	S1		M	Lakeshore grassland, Lakeside floodplain forest
V	Carex exilis	Bog Sedge	G5	S2		M	Dwarf shrub bog*, Black spruce woodland bog, Poor fen
V	Carex foenea	Bronze Sedge	G5	S2	E	M	Temperate acidic outcrop*, White pine-red oak-black oak forest
V	Carex garberi	Garber's Sedge	G4	S1	T	H	Calcareous riverside seep*
V	Carex glaucodea	Flaccid Sedge	G5T5	SH		H	Outcrops & Upland Meadows, Mesic maple-ash-hickory-oak forest
V	Carex gracilescens	Slender Sedge	G5?	S1		H	Mesic maple-ash-hickory-oak forest
V	Carex livida	Pale Sedge	G5	S1	T	H	Intermediate fen*
V	Carex lupuliformis	False Hop Sedge	G4	S2		M	Deep broadleaf marsh, Lakeside floodplain forest*, Red or silver maple-green ash swamp

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Carex merritt-fernaldii	Fernald's Sedge	G5	S1		M	Pine-oak-heath sandplain forest, Sandy Opening
V	Carex michauxiana	Michaux Sedge	G5	S2		M	Dwarf shrub bog, Poor fen*
V	Carex molesta	Troublesome Sedge	G4	S1		H	Erosional river bluff, Temperate acidic outcrop
V	Carex muehlenbergii var. enervis	NervelessMuehlenberg's Sedge	G5	S1	T	H	Sandy Opening
V	Carex muehlenbergii var. muehlenbergii	Muehlenberg's Sedge	G5	S2		M	Pine-oak-heath sandplain forest*, Powerlines RR Tracks, Sandy Opening
V	Carex oligocarpa	Few-fruited Sedge	G4	S1	E	H	Temperate calcareous outcrop*
V	Carex richardsonii	Richardson's Sedge	G4	S1	E	H	Temperate calcareous outcrop*
V	Carex schweinitzii	Schweinitz's Sedge	G3	S2		H	Rich fen*
V	Carex scirpoidea ssp. scirpoidea	Scirpus-like Sedge	G5	S2		H	Boreal acidic cliff, Boreal calcareous cliff*
V	Carex siccata	Hay Sedge	G5T5	S1	E	M	Lake sand beach, Dry oak forest, Pine-oak-heath sandplain forest
V	Carex sterilis	Dioecious Sedge	G4	S1		H	Rich fen
V	Carex tenuiflora	Thin-flowered Sedge	G5	S1		H	Red maple-northern white cedar swamp, Northern white cedar swamp*
V	Carex vaginata	Sheathed Sedge	G5	S1	E	H	Northern white cedar swamp*
V	Carex wiegandii	Wiegand's Sedge	G3	S1		M	Dwarf shrub bog*
V	Carex willdenowii	Willdenow's Sedge	G5	SH		H	Temperate calcareous cliff, Transition Hardwood Limestone Forest, Transition hardwood talus woodland
V	Carya glabra	Pignut Hickory	G5	S2		M	Mesic maple-ash-hickory-oak forest, Dry oak forest
V	Castilleja septentrionalis	Pale Painted-cup	G5	S1	T	H	Boreal calcareous cliff*
V	Ceanothus herbaceus	Prairie Redroot	G5	S1	E	H	Powerlines RR Tracks
V	Cerastium nutans ssp. nutans	Nodding Chickweed	G5	S1		H	Temperate calcareous outcrop
V	Chamaecrista nictitans var. nictitans	Wild Sensitive Plant	G5	S2		M	Roadsides, Powerlines RR Tracks, Sandy Opening
V	Chenopodium berlandieri var. bushianum	Bush's Goosefoot	G5T4	S1		H	Lake sand beach, Lake shale or cobble beach, Powerlines RR Tracks
V	Chenopodium foggii	Fogg's Goosefoot	G2G3	S1		H	Temperate calcareous outcrop, Open talus
V	Cirsium discolor	Field Thistle	G5	S2		M	Old Field Shrub
V	Claytonia virginica	Virginia Spring Beauty	G5	S2		H	Rich northern hardwood forest, Mesic red oak-northern hardwood forest
V	Collinsia parviflora	Small-flowered Collinsia	G5	SH		H	Transition hardwood talus woodland
V	Collinsonia canadensis	Canada Horse-balm	G5	S2		M	Rich northern hardwood forest, Mesic maple-ash-hickory-oak forest*, Forest Edges Logging Rds
V	Corallorhiza odontorhiza var. odontorhiza	Autumn Coral-root	G5	S2	T	M	Oak-Pine-Northern Hardwood Forest*
V	Cornus florida	Flowering Dogwood	G5	S1	T	M	Mesic red oak-northern hardwood forest, Mesic maple-ash-hickory-oak forest
V	Corydalis aurea	Golden Corydalis	G5	S2	T	H	Temperate calcareous cliff*, Limestone bluff cedar-pine forest
V	Crassula aquatica	Pygmyweed	G5	S1		M	medium size, mid-reach, low gradient streams
V	Crataegus biltmoreana	Biltmore Hawthorn	G5	S1		M	Temperate calcareous outcrop*
V	Crataegus boyntonii	Stinking Hawthorn	GNR	SH		H	Outcrops & Upland Meadows, Old Field Shrub, Forest Edges Logging Rds, Disturbed natural communities
V	Crataegus brainerdii	Brainerd's Hawthorn	G5	SU		H	Forest Edges Logging Rds
V	Crataegus chrysocarpa var. praecox	Precocious Hawthorn	GNR	SH		H	Transition hardwood talus woodland, Old Field Shrub
V	Crataegus dodgei	Dodge's Hawthorn	G4	S1		H	Disturbed natural communities
V	Crataegus faxonii	Faxon's Hawthorn	G5	SU		H	Forest Edges Logging Rds

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Crataegus irrasa var. blanchardii	Zigzag Hawthorn	GNR	S1		H	Forest Edges Logging Rds, Roadsides
V	Crataegus irrasa var. irrasa	Zigzag Hawthorn	GNR	S1		M	
V	Crataegus kennedyi	Kennedy's Hawthorn	GNA	SH		H	Boreal outcrop
V	Crataegus lucorum	Grove Hawthorn	G4?	SU		H	Outcrops & Upland Meadows, Old Field Shrub, Forest Edges Logging Rds
V	Crataegus macracantha var. occidentalis	Western Long-spine Hawthorn	GNR	SU		H	Cliffs & Talus
V	Crataegus oakesiana	Oake's Hawthorn	GNR	S1S2		H	Roadsides, Powerlines RR Tracks
V	Crataegus pisifera	Pea Hawthorn	GNR	SH		H	Forest Edges Logging Rds
V	Crataegus populnea	Poplar Hawthorn	GNR	S1		H	River cobble shore, Rivershore grassland
V	Crataegus scabrida	Harsh Hawthorn	G5?	SU		H	Old Field Shrub
V	Crataegus succulenta var. succulenta	Fleshy Hawthorn	G4G5	S1		H	Old Field Shrub, Roadsides
V	Crepidomanes intricatum	Weft Fern	G4G5	S1		H	Temperate acidic cliff*
V	Crocanthemum bicknellii	Plains Frostweed	G5	S2		M	White pine-red oak-black oak forest, Pine-oak-heath sandplain forest*, Sandy Opening
V	Crotalaria sagittalis	Rattlebox	G5	S1	T	M	Grassland/ Pasture, Powerlines RR Tracks
V	Cuscuta cephalanthi	Buttonbush Dodder	G5	S1		M	Powerlines RR Tracks
V	Cuscuta gronovii var. latiflora	Broad-flower Dodder	GNR	SU		H	Upland shores, Outcrops & Upland Meadows, Old Field Shrub
V	Cynoglossum virginianum var. boreale	Northern Wild Comfrey	G5T4	S1	T	H	Dry oak-hickory-hophornbeam forest*
V	Cyperus diandrus	Low Cyperus	G5	S1	E	M	Lake sand beach*
V	Cyperus houghtonii	Houghton's Cyperus	G4?	S2	T	H	Pine-oak-heath sandplain forest*, Sandy Opening
V	Cypripedium arietinum	Ram's Head Lady's-slipper	G3	S2	T	H	Red maple-northern white cedar swamp*, Northern white cedar swamp, Limestone bluff cedar-pine forest*
V	Cypripedium parviflorum var. makasin	Makasin's Yellow Lady-slipper	G5	S2S3		H	Red maple-northern white cedar swamp*, Northern white cedar swamp
V	Cystopteris laurentiana	Laurentian Bladder fern	G3	S1		H	Boreal calcareous cliff*
V	Descurainia pinnata var. brachycarpa	Tansy-mustard	G5	S1		H	Temperate calcareous outcrop
V	Desmodium cuspidatum	Large-bracted Tick-trefoil	G5	S1	E	H	Mesic maple-ash-hickory-oak forest, Powerlines RR Tracks
V	Desmodium perplexum	Perplexed Tick-trefoil	G5	S2		M	Temperate calcareous outcrop, Powerlines RR Tracks
V	Desmodium rotundifolium	Prostrate Tick-trefoil	G5	S1	T	M	Mesic maple-ash-hickory-oak forest, Dry oak forest
V	Diapensia lapponica ssp. lapponica	Diapensia	G5	S1	E	H	Alpine meadow*
V	Dichanthelium oligosanthes	Few-flowered Panic-grass	G5	S2		M	Pine-oak-heath sandplain forest, Old Field Shrub, Powerlines RR Tracks
V	Dichanthelium oligosanthes ssp. scribnerianum	Few-flowered Panic-grass	G5	S2		M	Temperate acidic outcrop, Powerlines RR Tracks
V	Dichanthelium sphaerocarpon	Spherical Panic-grass	G5	S1		M	Temperate acidic outcrop, Temperate calcareous outcrop
V	Diphasiastrum complanatum	Northern Ground-cedar	G5	S1S2		M	Spruce-Fir Northern Hardwood Forest, Old Field Shrub
V	Diphasiastrum sabinifolium	Ground-fir	G4	S2		M	Old Field Shrub, Powerlines RR Tracks
V	Draba cana	Lanceolate Cress	G5	S1	T	H	Boreal calcareous cliff*
V	Draba glabella	Smooth Draba	G4G5	S1	T	H	Temperate calcareous cliff, Limestone bluff cedar-pine forest
V	Dracocephalum parviflorum	American Dragonhead	G5	SH	T	H	Temperate calcareous outcrop

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Dryopteris filix-mas	Male Fern	G5	S2	T	H	Northern hardwood forest, Rich northern hardwood forest*
V	Dryopteris fragrans	Fragrant Fern	G5	S2		M	Boreal acidic cliff, Boreal calcareous cliff*
V	Elatine americana	American Waterwort	G4	SH		H	Lake Mud Shores, River Stream mud shore
V	Elatine minima	Small Water-wort	G5	S1		M	Meso-eutrophic
V	Eleocharis aestuum	Tidal Spikerush	G3	S1		H	Lake Mud Shores
V	Eleocharis compressa var. compressa	Flat-stem Spikerush	GNR	SH		H	Lake Mud Shores
V	Eleocharis diandra	Wright's Spikerush	G2	S1		H	Riverside sand or gravel shore, River mud shore, Lake sand beach*
V	Eleocharis flavescens var. olivacea	Olive Spikerush	G5	S1		M	Outwash plain pondshore
V	Eleocharis nitida	Slender Spikerush	G4	SH		H	Wet Shores, Lake Mud Shores
V	Eleocharis quinqueflora	Few-flowered Spikerush	G5	S2	T	M	Rich fen, Intermediate fen, Calcareous riverside seep, Boreal calcareous cliff
V	Eleocharis robbinsii	Robbins Spikerush	G4G5	S1		M	Oligotrophic*
V	Elymus macgregorii	MacGregor's Wild Rye	GNR	SH		H	Rivershore grassland
V	Elymus villosus var. arkansanus	Hairy Wild-rye	G5	S1		H	Silver maple-ostrich fern riverine floodplain forest, Rich northern hardwood forest, Transition hardwood talus woodland
V	Elymus villosus var. villosus	Hairy Wild-rye	GNR	S1		M	Calcareous Riverside Outcrop, Temperate calcareous cliff, Open talus
V	Empetrum nigrum	Black Crowberry	G5	S1		H	Alpine peatland, Alpine meadow*, Serpentine outcrop
V	Epilobium palustre	Marsh Willow-herb	G5	S1S2		M	Dwarf shrub bog, Poor fen*
V	Equisetum palustre	Marsh Horsetail	G5	S2	T	M	Lake sand beach, Lake shale or cobble beach, Cultivated Land/ Hayfield, Roadsides, Wet Swales Ditches
V	Erigeron hyssopifolius	Hyssop-leaved Fleabane	G5	S2		H	Calcareous Riverside Outcrop, Boreal calcareous cliff*
V	Erigeron philadelphicus var. provancheri	Provancher's Dwarf Fleabane	G5T2	S1		H	Temperate calcareous outcrop*
V	Eriophorum gracile	Slender Cotton-grass	G5	S1		M	Rich fen, Intermediate fen*
V	Eriophorum tenellum	Rough Cotton-grass	G5	S1S2		M	Poor fen*
V	Eupatorium sessilifolium	Sessile-leaved Boneset	G5	S1	E	M	Mesic maple-ash-hickory-oak forest, Transition hardwood talus woodland
V	Euphorbia nutans	Nodding Spurge	G5	S1		H	Grassland/ Pasture, Old Field Shrub
V	Eurybia radula	Rough-leaved Aster	G5	S2		M	Dwarf shrub bog*
V	Festuca brachyphylla ssp. brachyphylla	Shortleaf Fescue	G5	S1		H	Boreal outcrop*
V	Fimbristylis autumnalis	Autumn Fimbristylis	G5	S1	E	M	Outwash plain pondshore
V	Floerkea proserpinacoides	False Mermaid-weed	G5	SH		H	Floodplain Forests
V	Galium brevipes	Limestone Swamp Bedstraw	G4?	SH		H	Rich fen, Intermediate fen, Calcareous red maple-tamarack swamp
V	Galium labradoricum	Bog Bedstraw	G5	S1	T	H	Poor fen
V	Galium pilosum	Hairy Bedstraw	G5	S1		M	Oak-Pine-Northern Hardwood Forest
V	Gentiana andrewsii	Fringe-top Closed Gentian	G5?	S2	T	H	Sedge meadow, Lakeshore grassland, Lake shale or cobble beach
V	Gentianella amarella	Felwort	G5	SH	T	H	Boreal calcareous cliff
V	Gentianella quinquefolia	Stiff Gentian	G5	S1	T	M	Temperate calcareous outcrop
V	Geum vernum	Spring Avens	G5	S1		H	Old Field Shrub
V	Glyceria acutiflora	Sharp Manna-grass	G5	S1	E	M	Red maple-Sphagnum Acidic Basin*, Vernal pool
V	Glyceria septentrionalis	Eastern Manna-grass	G5	S2		M	Buttonbush swamp*, Red maple-Sphagnum Acidic Basin, Vernal pool
V	Goodyera oblongifolia	Giant Rattlesnake-plantain	G5?	SH		H	Northern White Cedar Sloping Seepage Forest, Spruce-Fir Northern

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
							Hardwood Forest, Lowland spruce-fir forest
V	Gymnocarpium jessoense ssp. parvulum	Northern Oak Fern	G5T4	SU		H	Temperate acidic outcrop, Temperate calcareous outcrop
V	Hackelia deflexa ssp. americana	Nodding Stickseed	G5T5	S2	T	H	Temperate calcareous cliff, Northern hardwood talus woodland, Transition hardwood talus woodland*
V	Halenia deflexa	Spurred Gentian	G5	S1		M	Forest Edges Logging Rds
V	Hedysarum alpinum	Apline Sweet-broom	G5	S1		M	Boreal calcareous cliff*
V	Helenium autumnale	Sneezeweed	G5	S1		M	Lake shale or cobble beach*
V	Helianthus strumosus	Harsh Sunflower	G5	S2S3	T	M	Erosional river bluff, Temperate calcareous outcrop, Mesic Clayplain forest, Pine-oak-heath sandplain forest*, Roadsides, Powerlines RR Tracks, Sandy Opening
V	Hieracium umbellatum	Umbellate Hawkweed	G5	SU		H	Old Field Shrub
V	Hippuris vulgaris	Mare's-tail	G5	S1	E	M	medium size, mid-reach, low gradient streams*
V	Houstonia longifolia	Longleaf Bluet	G4G5	S2		M	Temperate acidic outcrop, Temperate calcareous outcrop*
V	Hudsonia tomentosa	Beach Heather	G5	S1	E	H	Sand dune*
V	Huperzia appressa	Mountain Fir Clubmoss	G4G5	S2		H	Alpine meadow*, Boreal outcrop, Boreal acidic cliff*, Subalpine krummholz*
V	Huperzia selago	Northern Fir Clubmoss	G5	S1		H	Sandy Opening
V	Hybanthus concolor	Green Violet	G5	S1		H	Transition hardwood talus woodland*
V	Hydrastis canadensis	Golden-seal	G4	S1	E	H	Rich northern hardwood forest*
V	Hydrophyllum canadense	Broad-leaved Waterleaf	G5	S1	T	H	Sugar maple-ostrich fern riverine floodplain forest*
V	Hypericum ascyron	Great St. John's-wort	G4	S2	T	M	River cobble shore, Riverside sand or gravel shore, Rivershore grassland, Acidic Riverside Outcrop
V	Hypericum gentianoides	Orange Grass	G5	S2		M	Powerlines RR Tracks, Sandy Opening
V	Hypopitys lanuginosa	Red Pine-sap	GNR	SU		H	Dry Red Oak-White Pine Forest
V	Ilex laevigata	Smooth Holly	G5	S1		M	Red maple-black gum swamp*
V	Isoetes engelmannii	Engelmann's Quillwort	G4	S1	T	M	Lake sand beach
V	Isoetes lacustris	Lake Quillwort	G5	S1		M	Meso-eutrophic
V	Isoetes riparia	River-bank Quillwort	G5?	S2		M	River mud shore
V	Isoetes tuckermanii	Tuckerman's Quillwort	G4?	S1		M	Oligotrophic
V	Isoetes viridimontana	Green mountain Quillwort	G1	S1	PE	M	Oligotrophic*
V	Isotria verticillata	Large Whorled Pogonia	G5	S2	T	M	Mesic red oak-northern hardwood forest*, Dry oak forest, Pine-oak-heath sandplain forest
V	Juncus acuminatus	Tapering Rush	G5	S1		M	Deep bulrush marsh, Shallow emergent marsh, Riverside sand or gravel shore
V	Juncus alpinoarticulatus	Alpine Rush	G5	S2		M	River cobble shore, Riverside sand or gravel shore, Wet Swales Ditches
V	Juncus anthelatus	Greater Poverty Rush	GNR	S1?		M	Wet Swales Ditches, Lake Mud Shores
V	Juncus greenei	Greene's Rush	G5	S2	E	M	Powerlines RR Tracks, Sandy Opening
V	Juncus militaris	Soldier Rush	G4	S1	E	M	Lacustrine
V	Juncus secundus	Secund Rush	G5?	S1	E	M	Temperate acidic cliff*
V	Juncus subcaudatus	Woodland Rush	G5	S1		M	Riverside sand or gravel shore
V	Juncus torreyi	Torrey's Rush	G5	S2	E	H	Cultivated Land/ Hayfield, Powerlines RR Tracks, Wet Swales Ditches
V	Juncus trifidus	Highland Rush	G5	S1S2		H	Alpine meadow*
V	Juncus vaseyi	Vasey Rush	G5?	S1		H	Sedge meadow, Wet Swales Ditches
V	Juniperus horizontalis	Creeping Juniper	G5	S1	T	H	Temperate calcareous outcrop*

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Lactuca hirsuta	Hairy Lettuce	G5?	S1S2	T	H	Pine-oak-heath sandplain forest*, Powerlines RR Tracks, Sandy Opening
V	Lathyrus japonicus var. maritimus	Beach Pea	G5T4T5	S2	T	M	Lake sand beach*, Sand dune
V	Lathyrus ochroleucus	Pale Vetchling	G4G5	S2		H	Limestone bluff cedar-pine forest
V	Lathyrus palustris	Marsh Vetchling	G5	S2	T	M	Riverside sand or gravel shore, Lake shale or cobble beach*
V	Lechea minor	Lesser Pinweed	G5	SH		H	Pine-oak-heath sandplain forest, Forest Edges Logging Rds, Sandy Opening
V	Lechea mucronata	Hairy Pinweed	G5	S1	E	M	Old Field Shrub, Powerlines RR Tracks, Sandy Opening
V	Lemna perpusilla	Minute Duckweed	G5	SH		H	Rivershore grassland, Lacustrine
V	Lemna turionifera	Turion Duckweed	G5	SH		H	Lacustrine
V	Lespedeza frutescens	Violet Bush-clover	G5	S1	T	M	Transition Hardwood Limestone Forest, Dry oak-hickory-hophornbeam forest
V	Lespedeza hirta ssp. hirta	Hairy Bush-clover	G5	S1	T	M	Dry oak forest, Sandy Opening
V	Lespedeza procumbens	Trailing Bush-clover	G5	S1		M	Powerlines RR Tracks
V	Leucophysalis grandiflora	Large White-flowered Ground-cherry	G4?	SH		H	Old Field Shrub
V	Linum medium	Stiff Yellow Flax	G5	S1		H	Powerlines RR Tracks
V	Linum sulcatum var. sulcatum	Grooved Yellowflax	G5T5	SH		H	Outcrops & Upland Meadows, Sandy Opening
V	Liparis liliifolia	Lily-leaved Twayblade	G5	S1	T	H	Red maple-northern white cedar swamp*
V	Liriodendron tulipifera	Tulip Tree	G5	S1	PE	M	Mesic red oak-northern hardwood forest
V	Littorella americana	American Shore-grass	G5	S2		M	Oligotrophic
V	Lobelia siphilitica var. siphilitica	Great Blue Lobelia	G5	S1		H	Sedge meadow, Rivershore grassland
V	Lobelia spicata var. hirtella	Hairy Spike Lobelia	G5T4T5	SH		H	Temperate calcareous cliff, Temperate Hemlock-Hardwood Forest
V	Lonicera hirsuta	Hairy Honeysuckle	G4G5	S2		H	Temperate calcareous outcrop, Mesic maple-ash-hickory-oak forest, Dry oak-hickory-hophornbeam forest
V	Lonicera oblongifolia	Swamp Fly-honeysuckle	G4	S2		M	Red maple-northern white cedar swamp, Red maple-black ash seepage swamp, Northern white cedar swamp
V	Ludwigia polycarpa	Many-fruited False-loosestrife	G4	S1	E	H	Deep broadleaf marsh, Outwash plain pondshore, River mud shore
V	Lupinus perennis	Wild Lupine	G5	S1	E	H	Pine-oak-heath sandplain forest, Sandy Opening
V	Luzula spicata	Spiked Wood-rush	G5	S1		H	Boreal outcrop*
V	Lycopus virginicus	Virginia Bugleweed	G5	S2		M	Red maple-Sphagnum Acidic Basin, Red maple-black ash seepage swamp, Seep
V	Lysimachia hybrida	Lance-leaved Loosestrife	G5	S1		M	Lakeside floodplain forest
V	Lythrum alatum ssp. alatum	Winged-loosestrife	G5T5	SH		H	Marshes & Sedge Meadows
V	Malaxis monophyllos var. brachypoda	White Adder's Mouth	G4Q	S2S3	T	H	Red or silver maple-green ash swamp, Red maple-northern white cedar swamp, Red maple-black ash seepage swamp, Northern white cedar swamp
V	Malaxis unifolia	Green Adder's Mouth	G5	S2		M	Red maple-Sphagnum Acidic Basin, Red maple-northern white cedar swamp, Calcareous red maple-tamarack swamp, Red maple-black ash seepage swamp, Temperate acidic cliff
V	Minuartia groenlandica	Mountain Sandwort	G5	S1		H	Alpine meadow

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Minuartia marcescens	Marcescent Sandwort	G2	S1	T	H	Serpentine outcrop
V	Minuartia rubella	Marble Sandwort	G5	S1	T	H	Boreal calcareous cliff
V	Moehringia macrophylla	Large-leaved Sandwort	G4	S2		H	Serpentine outcrop
V	Monarda punctata	Dotted Horsemint	G5	S1		H	Sandy Opening
V	Morus rubra	Red Mulberry	G5	S1	T	H	Dry oak-hickory-hophornbeam forest
V	Muhlenbergia schreberi	Schreber's Muhly	G5	S2		M	Powerlines RR Tracks
V	Muhlenbergia sobolifera	Sprout Muhly	G5	S2		M	Temperate calcareous outcrop, Transition Hardwood Limestone Forest, Dry oak-hickory-hophornbeam forest, Powerlines RR Tracks
V	Muhlenbergia sylvatica	Woodland Muhly	G5	S1		M	Oak-Pine-Northern Hardwood Forest
V	Myosotis laxa	Smaller Forget-me-not	G5	S2		M	Red maple-northern white cedar swamp, Seep
V	Myosotis verna	Spring Forget-me-not	G5	S1S2		M	Temperate calcareous outcrop, Grassland/ Pasture
V	Myriophyllum humile	Low Water-milfoil	G5	S1S2		M	Dystrophic
V	Nabalus boottii	Boott's Rattlesnake-root	G2	S1	E	H	Alpine meadow, Boreal acidic cliff
V	Najas gracillima	Slender Naiad	G5?	S2		M	Meso-eutrophic
V	Najas guadalupensis	Guadalupe Naiad	G5	S2		M	Meso-eutrophic
V	Neottia auriculata	Auricled Twayblade	G3G4	S1	E	H	Alder swamp, Alluvial shrub swamp
V	Neottia bifolia	Southern Twayblade	G4	S1	E	H	Dwarf shrub bog, Black spruce woodland bog
V	Nymphaea leibergii	Dwarf Water-lily	G5	S1	E	H	medium size, mid-reach, low gradient streams
V	Oclemena nemoralis	Bog Aster	G5	S2		M	Dwarf shrub bog, Black spruce woodland bog
V	Oenothera nutans	Nodding Evening-primrose	G4	SH		H	Old Field Shrub
V	Omalotheca sylvatica	Woodland Cudweed	G5	S1	E	M	Forest Edges Logging Rds
V	Ophioglossum pusillum	Northern Adder's-tongue	G5	S1		H	Open Peatlands, Grassland/ Pasture
V	Osmorhiza depauperata	Blunt-fruited Sweet-cicely	G5	SH		H	Rich northern hardwood forest
V	Oxalis violacea	Violet Wood-sorrel	G5	SH		H	Northern hardwood talus woodland
V	Panax quinquefolius	American Ginseng	G3G4	S3		H	Rich northern hardwood forest, Mesic red oak-northern hardwood forest
V	Panicum flexile	Stiff Witch-grass	G5	S1	E	H	Temperate calcareous cliff
V	Panicum philadelphicum var. philadelphicum	Philadelphia Panic-grass	G5	S1		M	Temperate calcareous outcrop
V	Parathelypteris simulata	Massachusetts Fern	G4G5	S2		M	Red maple-Sphagnum Acidic Basin, Red maple-black gum swamp, Hemlock-Sphagnum Acidic Basin Swamp
V	Paronychia canadensis	Smooth Forked Chickweed	G5	S1		H	Temperate calcareous outcrop, Dry oak-hickory-hophornbeam forest, Dry oak woodland
V	Paronychia fastigiata	Hairy Forked Chickweed	GNR	SU		H	Dry oak-hickory-hophornbeam forest
V	Paspalum setaceum var. muhlenbergii	Slender Paspalum	G3G5	S2		M	Erosional river bluff, Old Field Shrub, Powerlines RR Tracks, Sandy Opening
V	Penstemon pallidus	Pale Beardtongue	G5	S1		M	Roadsides
V	Persicaria careyi	Carey's Smartweed	G4	S1		M	Grassland/ Pasture, Roadsides
V	Petasites frigidus var. palmatus	Sweet Coltsfoot	G5T5	S2	T	M	Northern white cedar swamp, Hemlock-Balsam Fir-Black Ash Seepage Swamp
V	Phragmites australis ssp. americanus	American Reedgrass	G5	S1S2		H	Deep bulrush marsh, Cattail marsh
V	Physalis grisea	Strawberry-tomato	G5?	S1		M	Grassland/ Pasture, Cultivated Land/ Hayfield
V	Physostegia virginiana	Obedience	G5	S2	T	M	Lakeshore grassland, Lake shale or cobble beach

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Pilea fontana	Black-seeded Clearweed	G5	SH		H	River mud shore, River Stream mud shore
V	Pinguicula vulgaris	Butterwort	G5	S1		H	Boreal calcareous cliff
V	Pinus banksiana	Jack Pine	G5	SH	T	M	Dry Red Oak-White Pine Forest
V	Piptatheropsis pungens	Slender Mountain-rice	G5	S2	T	M	Temperate acidic outcrop, White pine-red oak-black oak forest, Pine-oak-heath sandplain forest
V	Platanthera blephariglottis var. blephariglottis	White-fringed Orchis	G4G5	S2		M	Dwarf shrub bog, Black spruce woodland bog
V	Platanthera flava var. herbiola	Tubercled Orchis	G4	S2	T	M	Sedge meadow, River cobble shore, Rivershore grassland, Alluvial shrub swamp
V	Platanthera hookeri	Hooker's Orchis	G5	S2	T	M	Rich northern hardwood forest, Mesic red oak-northern hardwood forest, Mesic maple-ash-hickory-oak forest
V	Platanthera macrophylla	Large Roundleaf Orchid	G4	S1		M	Spruce-Fir Northern Hardwood Forest, Northern Hardwood Forest
V	Platanthera orbiculata	Roundleaf Orchid	G5	S2		M	Mesic red oak-northern hardwood forest, Oak-Pine-Northern Hardwood Forest
V	Poa glauca ssp. glauca	Glaucous Bluegrass	G5T5	SH		H	Temperate calcareous outcrop, Limestone bluff cedar-pine forest
V	Poa interior	Inland Bluegrass	G4G5	S1		H	Boreal calcareous cliff, Limestone bluff cedar-pine forest
V	Poa laxa ssp.fernaldiana	Wavy Bluegrass	G5?T3	S1		H	Boreal outcrop
V	Poa pratensis ssp. agassizensis	Agassiz Kentucky Bluegrass	GNR	SU		H	Boreal outcrop
V	Poa saltuensis ssp. languida	Drooping Bluegrass	G5	S1S2		H	Rich northern hardwood forest, Mesic maple-ash-hickory-oak forest
V	Podophyllum peltatum	May-apple	G5	S1		H	Mesic maple-ash-hickory-oak forest
V	Podostemum ceratophyllum	Riverweed	G5	S1		M	moderate to large rivers directly entering Lake Champlain
V	Polemonium vanbruntiae	Eastern Jacob's Ladder	G3	S2	T	H	Shallow emergent marsh, Red maple-northern white cedar swamp, Seep, Wet Swales Ditches
V	Polygala polygama	Racemed Milkwort	G5	S2		M	Temperate acidic outcrop, Pine-oak-heath sandplain forest, Powerlines RR Tracks, Sandy Opening
V	Polygala verticillata var. ambigua	Ambiguous Milkwort	G5?	S1S2		H	Temperate calcareous outcrop, Old Field Shrub, Powerlines RR Tracks
V	Polygonatum biflorum	Giant Solomon's Seal	G5T5	S1		M	Mesic maple-ash-hickory-oak forest, Transition hardwood talus woodland
V	Polygonum douglasii	Douglas Knotweed	G5	S2	E	M	Temperate acidic outcrop, Temperate calcareous outcrop, Dry oak woodland
V	Polygonum erectum	Erect Knotweed	G5	SH		H	Old Field Shrub, Powerlines RR Tracks
V	Polygonum tenue	Slender Knotweed	G5	S1?		M	Pine-oak-heath sandplain forest, Sandy Opening
V	Polymnia canadensis	White-flowered Leafcup	G5	S1	E	H	Temperate calcareous outcrop, Transition hardwood talus woodland
V	Potamogeton bicupulatus	Snail-seed Pondweed	G4?	S2		M	Dystrophic
V	Potamogeton confervoides	Tuckerman's Pondweed	G4	S2		M	Dystrophic, High Elevation Acidic
V	Potamogeton hillii	Hill's Pondweed	G3	S3		H	Meso-eutrophic
V	Potamogeton vaseyi	Vasey's Pondweed	G4	S2		M	Meso-eutrophic
V	Potamogeton x ogdenii	Ogden's Pondweed	G1	S1		H	Meso-eutrophic
V	Primula mistassinica	Bird's-eye Primrose	G5	S1	T	H	Boreal calcareous cliff
V	Proserpinaca palustris	Marsh Mermaid-weed	G5	S1		M	Poor fen, Outwash plain pondshore, Sweet gale shoreline swamp, Buttonbush swamp, medium size, mid-reach, low gradient streams
V	Prunus americana	Wild Plum	G5	S1	T	M	Transition hardwood talus woodland, Old Field Shrub
V	Prunus pumila var. depressa	Low Sand Cherry	G5T5	S2		M	River cobble shore, Rivershore grassland, Acidic Riverside Outcrop

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Prunus susquehanae	Sand Cherry	G5T4	S1		M	Roadsides, Sandy Opening
V	Pterospora andromedea	Pinedrops	G5	S1	E	H	Oak-Pine-Northern Hardwood Forest, Temperate Hemlock-Hardwood Forest
V	Pycnanthemum incanum	Hoary Mountain Mint	G5	S1	E	M	Temperate calcareous outcrop
V	Pycnanthemum muticum	Blunt Mountainmint	G5	S1		M	Temperate calcareous outcrop, Powerlines RR Tracks
V	Pyrola asarifolia ssp. asarifolia	Bog Wintergreen	G5	S2	T	M	Rich fen, Intermediate fen, Sugar maple-ostrich fern riverine floodplain forest, Calcareous red maple-tamarack swamp, Northern white cedar swamp
V	Pyrola minor	Lesser Pyrola	G5	S1	E	H	Subalpine krummholz, Montane spruce-fir forest, Montane yellow birch-red spruce forest
V	Quercus coccinea	Scarlet Oak	G5	S1		M	White pine-red oak-black oak forest, Dry oak forest*
V	Quercus ilicifolia	Scrub Oak	G5	S1	E	M	Dry oak forest, Dry oak woodland*, Powerlines RR Tracks
V	Quercus prinoides	Dwarf Chinquapin Oak	G5	S1	PE	M	Temperate acidic outcrop*, Dry oak forest
V	Ranunculus allegheniensis	Allegheny Crowfoot	G4G5	S2	T	M	Mesic maple-ash-hickory-oak forest, Dry oak-hickory-hophornbeam forest
V	Ranunculus hispidus var. hispidus	Bristly Buttercup	G5T5	S1		H	Dry oak-hickory-hophornbeam forest
V	Rhexia virginica	Virginia Meadow-beauty	G5	S1	T	M	Outwash plain pondshore*
V	Rhodiola rosea	Roseroot	G5	S1	T	H	Boreal calcareous cliff
V	Rhododendron maximum	Great Laurel	G5	S2	T	H	Hemlock-northern hardwood forest
V	Rhododendron periclymenoides	Pinxter Flower	G5	S1?		M	Wet Sand-Over-Clay Forest, Red maple-white pine-huckleberry swamp, Lowland spruce-fir forest
V	Rhynchospora capillacea	Capillary Beak-rush	G4G5	S1	T	H	Calcareous riverside seep, Boreal calcareous cliff
V	Rorippa aquatica	Lake-cress	G4?	S1	T	H	Deep bulrush marsh, Deep broadleaf marsh, Lakeside floodplain forest
V	Rosa acicularis ssp. sayi	Needle-spine Rose	G5	S1	E	H	Temperate acidic outcrop, Temperate calcareous cliff, Dry oak-hickory-hophornbeam forest
V	Rosa nitida	Shining Rose	G5	S2		M	Poor fen, Sweet gale shoreline swamp
V	Rudbeckia hirta var. hirta	Black-eyed Susan	G5T4T5	SH		H	Old Field Shrub, Forest Edges Logging Rds
V	Rumex occidentalis	Western Dock	G5T5	SH		H	Marshes & Sedge Meadows, Hardwood Swamps, Lake Mud Shores, River Stream mud shore
V	Sagina decumbens	Small Pearlwort	G5	SH		H	Disturbed natural communities
V	Salix amygdaloides	Peach-leaf Willow	G5	S1		H	Floodplain Forests
V	Salix pedicellaris	Bog Willow	G5	S2		M	Poor fen, Rich fen, Intermediate fen, Northern white cedar swamp
V	Salix pellita	Satiny Willow	G5	S1		M	Intermediate fen, Riverside sand or gravel shore
V	Salix planifolia	Tea-leaved Willow	G5	S1	T	H	Alpine peatland
V	Salix uva-ursi	Bearberry Willow	G5	S1	E	H	Alpine meadow
V	Samolus parviflorus	Water Pimpernel	G5	S1		M	Sweet gale shoreline swamp
V	Sanguisorba canadensis	Canada Burnet	G5	S2		M	River cobble shore, Riverside sand or gravel shore, Rivershore grassland
V	Sanicula canadensis var. canadensis	Short-styled Snakeroot	G5	S2S3	T	H	Mesic maple-ash-hickory-oak forest, Mesic Clayplain forest, Dry oak-hickory-hophornbeam forest, Forest Edges Logging Rds
V	Sanicula canadensis var. grandis	Long-styled Snakeroot	G5T3T5	SH	T	H	Mesic maple-ash-hickory-oak forest, Transition Hardwood Limestone Forest
V	Saxifraga aizoides	Yellow Mountain Saxifrage	G5	S1		H	Boreal calcareous cliff

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Saxifraga oppositifolia ssp. oppositifolia	Purple Mountain Saxifrage	G4G5	S1		H	Boreal calcareous cliff
V	Saxifraga paniculata	White Mountain-saxifrage	G5	S1		H	Boreal calcareous cliff
V	Scheuchzeria palustris	Pod-grass	G5T5	S2	T	M	Dwarf shrub bog, Poor fen
V	Schoenoplectiella smithii var. smithii	Smith's Bulrush	G5?	S1		M	Shallow emergent marsh, Sedge meadow
V	Schoenoplectus heterochaetus	Slender Bulrush	G5	S1S2		H	Deep bulrush marsh, Shallow emergent marsh
V	Schoenoplectus torreyi	Torrey's Bulrush	G5?	S1S2		M	Shallow emergent marsh
V	Scirpus ancistrochaetus	Barbed-bristle Bulrush	G3	S2S3	E	H	Shallow emergent marsh, Buttonbush Basin Swamp, Red maple-Sphagnum Acidic Basin, Beaver wetlands
V	Scirpus georgianus	Georgia Bulrush	G5	SH		H	Marshes & Sedge Meadows
V	Scleria triglomerata	Whip Nutsedge	G5	SU		H	Dry Red Oak-White Pine Forest, Sandy Opening
V	Scutellaria parvula var. missouriensis	Shale Barren Skullcap	G4T4	S1		H	Sandy Opening
V	Scutellaria parvula var. parvula	Small Skullcap	G4T4	S2		H	Lakeshore grassland, Lake shale or cobble beach, Temperate calcareous outcrop, Limestone bluff cedar-pine forest
V	Senna hebecarpa	Wild Senna	G5	S1		H	River Stream mud shore
V	Silene stellata	Starry Catchfly	G5	SH		H	Floodplain Forests
V	Sisyrinchium atlanticum	Eastern Blue-eyed-grass	G5	S1		M	Old Field Shrub
V	Solidago leiocarpa	Cutler's Goldenrod	G5T4	S1		H	Alpine meadow
V	Solidago odora ssp. odora	Sweet Goldenrod	G5T5	SH	T	M	Old Field Shrub
V	Solidago ptarmicoides	Snowy Aster	G5	S2		H	Calcareous Riverside Outcrop, Temperate calcareous outcrop
V	Solidago racemosa	River-ledge Goldenrod	G5T3?Q	S1		H	Calcareous Riverside Outcrop
V	Solidago squarrosa	Squarrose Goldenrod	G5	S1		M	Mesic maple-ash-hickory-oak forest, Mesic Red oak Northern hdwd, Dry oak forest
V	Solidago ulmifolia	Elm-leaved Goldenrod	G5	S1	E	M	Temperate calcareous outcrop
V	Sparganium androcladum	Branching Bur-reed	G4G5	S1		H	Intermediate fen, Shallow emergent marsh, River mud shore
V	Sparganium natans	Lesser Bur-reed	G5	S2S3	T	M	Deep broadleaf marsh
V	Sphenopholis nitida	Shiny Wedgegrass	G5	S1	E	H	Temperate calcareous outcrop
V	Sphenopholis obtusata	Blunt Sphenopholis	G5	S1	E	H	Temperate calcareous outcrop, Cliffs & Talus
V	Spinulum canadense	Stiff Clubmoss	G5T4	S1		M	Boreal outcrop, Boreal acidic cliff, Boreal calcareous cliff
V	Spiranthes casei var. casei	Case's Ladies-tresses	G4T4	S2?		H	Old Field Shrub, Sandy Opening
V	Sporobolus compositus	Rough Dropseed	G5	S2	E	M	Temperate calcareous outcrop
V	Sporobolus neglectus	Small Dropseed	G5	S1		H	Temperate calcareous outcrop
V	Stachys hispida	Rough Hedge-nettle	GNR	SU		H	Floodplain Forests, Lakeside floodplain forest, Upland shores
V	Stachys pilosa var. pilosa	Marsh Woundwort	G5	S2?		M	Sedge meadow, Old Field Shrub
V	Stellaria alsine	Trailing Stitchwort	G5	S2		M	Northern white cedar swamp, Seep*
V	Stuckenia filiformis	Slender Pondweed	G5	S1		H	medium size, mid-reach, low gradient streams, Meso-eutrophic
V	Stuckenia x fennica	Hybrid Thread-leaved Pondweed	GNR	S1		M	Riverine
V	Symphyotrichum lanceolatum var. interior	Inland Lance-leaf Aster	G5T5	SU		H	Old Field Shrub
V	Symphyotrichum ontarionis	Ontario Aster	G5	S1S2		H	Lakeshore grassland, Lakeside floodplain forest
V	Symphyotrichum racemosum	Small White Aster	G4G5	S2		M	Old Field Shrub, Forest Edges Logging Rds

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Symphyotrichum tradescantii	Tradescant Aster	G4Q	S2		M	River cobble shore, Riverside sand or gravel shore
V	Symphyotrichum urophyllum	Arrow-leaved Aster	G4G5	S1		H	Dry Red Oak-White Pine Forest, Old Field Shrub, Forest Edges Logging Rds
V	Taenidia integerrima	Yellow Pimpernel	G5	S2	T	H	Temperate calcareous outcrop, Limestone bluff cedar-pine forest, Mesic maple-ash-hickory-oak forest
V	Thalictrum thalictroides	Rue-anemone	G5	S1		M	Mesic maple-ash-hickory-oak forest, Dry oak-hickory-hophornbeam forest
V	Thalictrum venulosum	Border Meadow-rue	G5	S2S3		H	Lakeshore grassland, Lake shale or cobble beach
V	Toxicodendron radicans ssp. negundo	Hairy Climbing Poison-ivy	G5T5	SH		H	Hardwood Swamps
V	Triantha glutinosa	Sticky False-asphodel	G5	S1	T	M	Calcareous riverside seep, Lakeshore grassland
V	Trichophorum cespitosum	Deer-hair Sedge	G5	S1		M	Alpine peatland, Serpentine outcrop, Boreal acidic cliff, Boreal calcareous cliff
V	Trichophorum planifolium	Bashful Bulrush	G4G5	S1	E	M	Temperate calcareous cliff, Dry oak-hickory-hophornbeam forest
V	Trichostema brachiatum	False Pennyroyal	G5	S1		H	Temperate calcareous outcrop, Roadsides
V	Triglochin maritima	Common Arrow-grass	G5	S1		H	Intermediate fen
V	Triphora trianthophora	Three-bird Orchid	G3G4	S1	T	M	Northern hardwood forest, Hemlock-northern hardwood forest
V	Trisetum spicatum var. pilosiglume	Spiked Bristle Grass	G5T3?Q	S1?		M	Boreal calcareous cliff
V	Ulmus thomasii	Cork Elm	G5	S1		H	Transition Hardwood Limestone Forest, Transition hardwood talus woodland
V	Utricularia radiata	Inflated Bladderwort	G4	S2		M	Dystrophic
V	Utricularia resupinata	Northeastern Bladderwort	G4	S1	T	M	Dystrophic, High Elevation Acidic
V	Uvularia perfoliata	Perfoliate Bellwort	G5	S2		M	Mesic maple-ash-hickory-oak forest, Dry oak-hickory-hophornbeam forest
V	Vaccinium boreale	Boreal Blueberry	G4	S1		M	Alpine meadow, Boreal acidic cliff, Subalpine krummholz
V	Vaccinium caespitosum	Dwarf Bilberry	G5	S2		M	Acidic Riverside Outcrop
V	Vaccinium stamineum	Deerberry	G5	S1	E	M	Dry oak-hickory-hophornbeam forest
V	Vaccinium uliginosum	Alpine Bilberry	G5	S2		H	Alpine peatland, Alpine meadow, Boreal acidic cliff, Subalpine krummholz
V	Vaccinium vitis-idaea	Mountain Cranberry	G5	S2		M	Black spruce woodland bog, Alpine meadow, Subalpine krummholz, Lowland spruce-fir forest
V	Valeriana uliginosa	Marsh Valerian	G4Q	S1	E	H	Northern white cedar swamp
V	Verbena simplex	Narrow-leaved Vervain	G5	SH		H	Outcrops & Upland Meadows, Cliffs & Talus, Old Field Shrub
V	Veronica catenata	Water-speedwell	G5	S1		H	Intermediate fen
V	Veronicastrum virginicum	Culver's-root	G4	S1	E	H	Roadsides
V	Viburnum edule	Squashberry	G5	S1	T	M	Subalpine krummholz, Montane spruce-fir forest
V	Viola lanceolata ssp. lanceolata	Lance-leaved Violet	G5	S1	T	M	Outwash plain pondshore, Powerlines RR Tracks
V	Viola palmata	Early Blue Violet	G5	S2		M	Transition Hardwood Limestone Forest, Dry oak-hickory-hophornbeam forest
V	Viola subsinuata	Lobed Violet	G3G5	S1		H	Transition Hardwood Limestone Forest, Dry oak-hickory-hophornbeam forest
V	Vulpia octoflora var. tenella	Eight-flowered Fescue	G5	S1	E	M	Temperate acidic outcrop, Sandy Opening
V	Woodsia alpina	Alpine Woodsia	G4	S1	E	H	Boreal calcareous cliff
V	Woodsia glabella	Smooth Woodsia	G5	S2		H	Temperate calcareous outcrop, Boreal calcareous cliff, Temperate calcareous cliff

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Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
V	Woodwardia virginica	Virginia Chain-fern	G5	S1	T	M	Pitch pine woodland bog, Red maple-Sphagnum Acidic Basin, Red maple-black gum swamp, Spruce-fir-tamarack swamp, Mesic Clayplain forest
V	Xyris montana	Northern Yellow-eyed Grass	G4	S1	T	M	Dwarf shrub bog, Poor fen
V	Zannichellia palustris	Horned Pondweed	G5	S1S2		M	Meso-eutrophic
M	Amphidium lapponicum (Hedw.) Schimp.	A Moss		S2		M	Boreal Acidic Cliff, Temperate Acidic Cliff
M	Anacamptodon splachnoides (Frol. ex Brid.) Brid.	A Moss		S2		M	Northern Hardwood Forests (formation)
M	Andreaea rothii Web. & Mohr.	A Moss		S2		M	Temperate Acidic Cliff
M	Arctoa fulvella (Dicks.) Bruch & Schimp. in B.S.G.	A Moss		S1		M	Alpine Meadow, Boreal Outcrop
M	Cinclidium stygium Sw. in Schrad.	A Moss		S1		M	Rich Fen
M	Cirriphyllum piliferum (Hedw.) Grout	A Moss		S2		M	Northern White Cedar Swamp
M	Cynodontium alpestre (Wahl.) Milde	A Moss		S1		M	Boreal Acidic Cliff
M	Cyrtomnium hymenophylloides (Hub.) Nyh. ex T. Kop.	A Moss		S1		M	Temperate Calcareous Cliff
M	Dichelyma capillaceum (With.) Myr.	A Moss		S1		M	Hardwood Swamps (formation)
M	Dichelyma pallescens Schimp. in B.S.G.	A Moss		S1		M	Hardwood Swamps (formation)
M	Dicranodontium denudatum (Brid.) Britt. in Williams	A Moss		S2		M	Temperate Acidic Cliff
M	Dicranoweisia crispula (Hedw.) Lindb. ex Milde	A Moss		SH		M	Temperate Acidic Cliff
M	Dicranum ontariense Peters.	A Moss		S2		M	Spruce-Fir Forests (formation)
M	Dicranum spurium Hedw.	A Moss		S1		M	Temperate Acidic Outcrop
M	Didymodon tophaceus (Brid.) Lisa	A Moss		S1		M	Temperate Calcareous Cliff
M	Distichium capillaceum (Hedw.) Bruch. & Schimp. in B.S.G.	A Moss		S2		M	Temperate Calcareous Cliff
M	Ditrichum flexicaule (Schwaegr.) Hampe	A Moss		S1		M	Temperate Calcareous Outcrop
M	Ditrichum rhynchostegium Kindb.	A Moss		SH		M	
M	Forsstroemia trichomitria (Hedw.) Lindb.	A Moss		S1		M	Temperate Calcareous Cliff
M	Grimmia donniana Sm.	A Moss		SH		M	Boreal Acidic Cliff
M	Grimmia hartmanii Schimp.	A Moss		S1		M	Temperate Acidic Cliffs and Outcrops
M	Grimmia laevigata (Brid.) Brid.	A Moss		SH		M	Temperate Acidic Cliffs and Outcrops
M	Grimmia longirostris Hooker	A Moss		S1		M	Temperate Acidic Cliffs and Outcrops
M	Grimmia torquata Hornsch. in Grev.	A Moss		SH		M	Boreal Acidic Cliff
M	Hamatocaulis vernicosus (Mitt.) Hedenas	A Moss		S2		M	Rich Fen
M	Hylocomiastrum pyrenaicum (Spruce) Fleisch. in Broth.	A Moss		S2		M	Northern White Cedar Swamp

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
M	Hyophila involuta (Hook.) Jaeg.	A Moss		S1		M	Temperate Calcareous Outcrop
M	Hypnum fauriei Card.	A Moss		S1S3		M	
M	Leskea obscura Hedw.	A Moss		S2		M	Floodplain Forests (formation)
M	Limprichtia cossonii (Schimp.) Anderson et al.	A Moss		S2		M	Intermediate Fen, Rich Fen
M	Limprichtia revolvens (Sw.) Loeske	A Moss		S1S3		M	Poor Fen, Intermediate Fen
M	Meesia triquetra (Richt.) Angstr.	A Moss		S2		M	Rich Fen
M	Meesia uliginosa Hedw.	A Moss		SH		M	Northern White Cedar Swamp, Temperate Calcareous Cliff
M	Myurella julacea (Schwaegr.) Schimp. in B.S.G.	A Moss		S2		M	Temperate Calcareous Cliff
M	Paludella squarrosa (Hedw.) Brid.	A Moss		S2		M	Rich Fen
M	Palustriella commutata (Brid.) Ochyra	A Moss		S1		M	Temperate Calcareous Cliff
M	Plagiobryum zieri (Hedw.) Lindb.	A Moss		S1		H	Boreal Acidic Cliff, Boreal Outcrop
M	Pogonatum dentatum (Brid.) Brid.	A Moss		S2		M	Boreal Outcrop
M	Pseudocalliergon trifarium (F. Weber & D. Mohr) Loeske	A Moss		S1		M	Rich Fen
M	Rhizomnium pseudopunctatum (Bruch. & Schimp.) T. Kop.	A Moss		S1		M	Northern White Cedar Swamp
M	Saelania glaucescens (Hedw.) Broth. in Bomanss. & Broth.	A Moss		S2		M	Temperate Calcareous Cliff
M	Scorpidium scorpioides (Hedw.) Limpr.	A Moss		S2		M	Rich Fen
M	Seligeria calcarea (Hedw.) Bruch. & Schimp. in B.S.G.	A Moss		SH		M	Temperate Calcareous Cliff
M	Seligeria tristichoides Kindb.	A Moss		SH		M	Temperate Calcareous Cliff
M	Sematophyllum marylandicum (C. Mull.) Britt.	A Moss		S1		M	Temperate Acidic Cliff
M	Sphagnum pulchrum (Lindb. ex Braithw.) Warnst.	A Moss		S1		M	Dwarf Shrub Bog, Black Spruce Woodland Bog
M	Sphagnum riparium Angstr.	A Moss		S1		M	Dwarf Shrub Bog, Black Spruce Woodland Bog
M	Syntrichia ruralis (Hedw.) Web. & Mohr	A Moss		S2		M	Temperate Calcareous Outcrop
M	Thelia asprella Sull. in Sull. & Lesq.	A Moss		S1		M	Mesic Maple-Ash-Hickory-Oak Forest
M	Tortella fragilis (Drumm.) Limpr.	A Moss		S1		M	Temperate Calcareous Outcrop, Temperate Calcareous Cliff
M	Tortella inclinata (Hedw. f.) Limpr. var. densa (Lorentz & Molendo) Limpricht	A Moss		S1T1		M	Temperate Calcareous Outcrop
M	Trichostomum crispulum Bruch in F. Muell.	A Moss		S1		M	Temperate Calcareous Cliff
L	Anastrophyllum michauxii (Web.) Buch ex Evans	A Liverwort		S2		M	Spruce-Fir-Northern Hardwood Forests (formation)
L	Anastrophyllum saxicola (Schrad.) Schust.	A Liverwort		S1		M	Temperate Acidic Cliff

Appendix I: Plant Species of Greatest Conservation Need-Habitat Type Crosswalk

Taxon	Scientific Name	Common Name	G-Rank	S-Rank	S-Prot	SGCN Priority[1]	Associated Habitats
L	Barbilophozia floerkei (Web. et Mohr) Loeske var. floerkei	A Liverwort		SHTH		M	Montane Spruce-Fir Forest
L	Cephalozia catenulata (Hub.) Lindb.	A Liverwort		SH		M	Spruce-Fir Forests (formation)
L	Chandonanthus setiformis (Ehrh.) Lindb.	A Liverwort		S1		M	Boreal Acidic Cliff, Boreal Outcrop
L	Frullania selwyniana Pears.	A Liverwort		S1		M	Northern White Cedar Swamp
L	Gymnocolea inflata (Huds.) Dum. s.l.	A Liverwort		S1		M	Alpine Peatland
L	Gymnomitrion concinnatum (Lightf.) Corda	A Liverwort		S1		M	Boreal Acidic Cliff, Boreal Outcrop
L	Kurzia pauciflora (Dicks.) Grolle	A Liverwort		S1		M	Poor Fen, Dwarf Shrub Bog
L	Lophocolea minor Nees	A Liverwort		S1		M	Northern White Cedar Swamp, Temperate Calcareous Outcrop
L	Lophozia laxa (Lindb.) Grolle	A Liverwort		S2		M	Dwarf Shrub Bog
L	Lophozia rutheana (Limpr.) M.A. Howe22	A Liverwort		SH		M	Rich Fen, Northern White Cedar Swamp
L	Lophozia wenzelii (Nees) Steph. var. wenzelii	A Liverwort		SHTH		M	Alpine Peatland
L	Mannia fragrans (Balbis) Frye et Clark	A Liverwort		SH		M	Temperate Acidic Outcrop, Temperate Acidic Cliff, Temperate Calcareous Outcrop, Temperate Calcareous Cliff
L	Mannia pilosa (Hornem.) Frye et Clark	A Liverwort		SH		M	Temperate Calcareous Outcrop, Temperate Calcareous Cliff
L	Mannia triandra (Scop.) Grolle	A Liverwort		SH		M	Temperate Calcareous Outcrop, Temperate Calcareous Cliff
L	Marsupella ustulata (Hub.) Spruce var. ustulata	A Liverwort		SHTH		M	Alpine Meadow, Boreal Outcrop
L	Scapania paludicola Loekse et K. Mull. var. paludicola	A Liverwort		S2T2		M	Dwarf Shrub Bog

Associated Habitats marked with an '*' indicates there is high confidence that protection of the habitat will also protect functioning populations of the plant species. For associated habitats not marked with an '*' there is moderate confidence that protection of the habitat will also protect functioning populations of the plant species.

Taxon: V=Vascular Plant, M=Moss, L=Liverwort

SGCN Priority: M=Medium Priority, H=High Priority. See Plant Conservation Summary in chapter 5 for details.

S-Prot: E=state endangered, T=State Threatened

A Landowner's Guide

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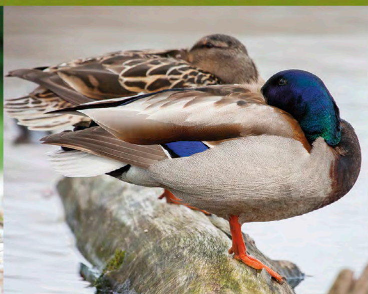

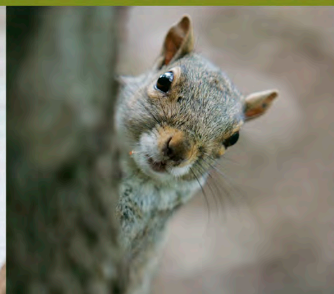

VERMONT FISH AND WILDLIFE DEPARTMENT

A Landowner's Guide

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Vermont Fish and Wildlife Department

in partnership with

Vermont Department of Forests, Parks and Recreation

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Wildlife Habitat Management for Lands in Vermont

Vermont Fish and Wildlife Department

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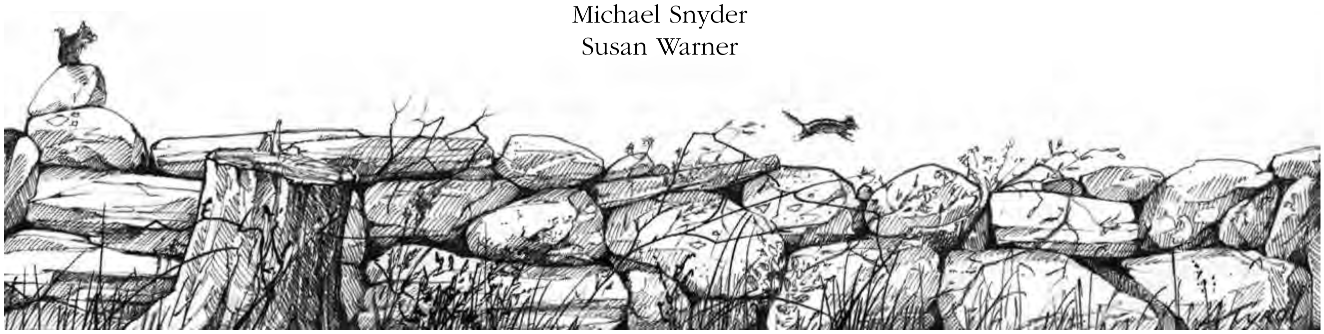

CONTENTS

FOREWORD

Vermont has a rich tradition of thoughtful land management, rural communities tied to working lands, and strong appreciation for fish and wildlife. Ultimately, fish and wildlife conservation begins with proper management and stewardship of land and habitat. As most land in Vermont is privately owned (approximately 85 percent), fish and wildlife conservation is inextricably tied to the decisions of private landowners and how they manage their lands. In fact, private landowners are among the most important partners we have to ensure a successful future of wildlife conservation and healthy habitats.

Therein lies the purpose behind the Vermont Fish and Wildlife Department's efforts to create guidelines for the effective management of wildlife habitat. We are excited to offer this manual to provide useful information and guidance to landowners, foresters, wildlife biologists, and others interested in managing land for the benefit of fish and wildlife. This represents an essential element to our ability to successfully realize our mission of conserving all species of plants and animals, their habitats, and the myriad benefits they provide to the public.

Our hope is that the information and ideas in this manual receive wide application, and our expectation is that they serve as a basis for the Department's efforts to work in partnership with Vermont landowners. From managing forests for ruffed grouse and wild turkey, and grasslands for bobolink and meadowlarks, to managing wetlands for herons and wood ducks, we believe that these guidelines provide useful information to ensure effective, long-lasting stewardship for these precious resources.

Louis Porter, *Commissioner*
Vermont Fish and Wildlife Department

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Vermont Department of Forests, Parks and Recreation

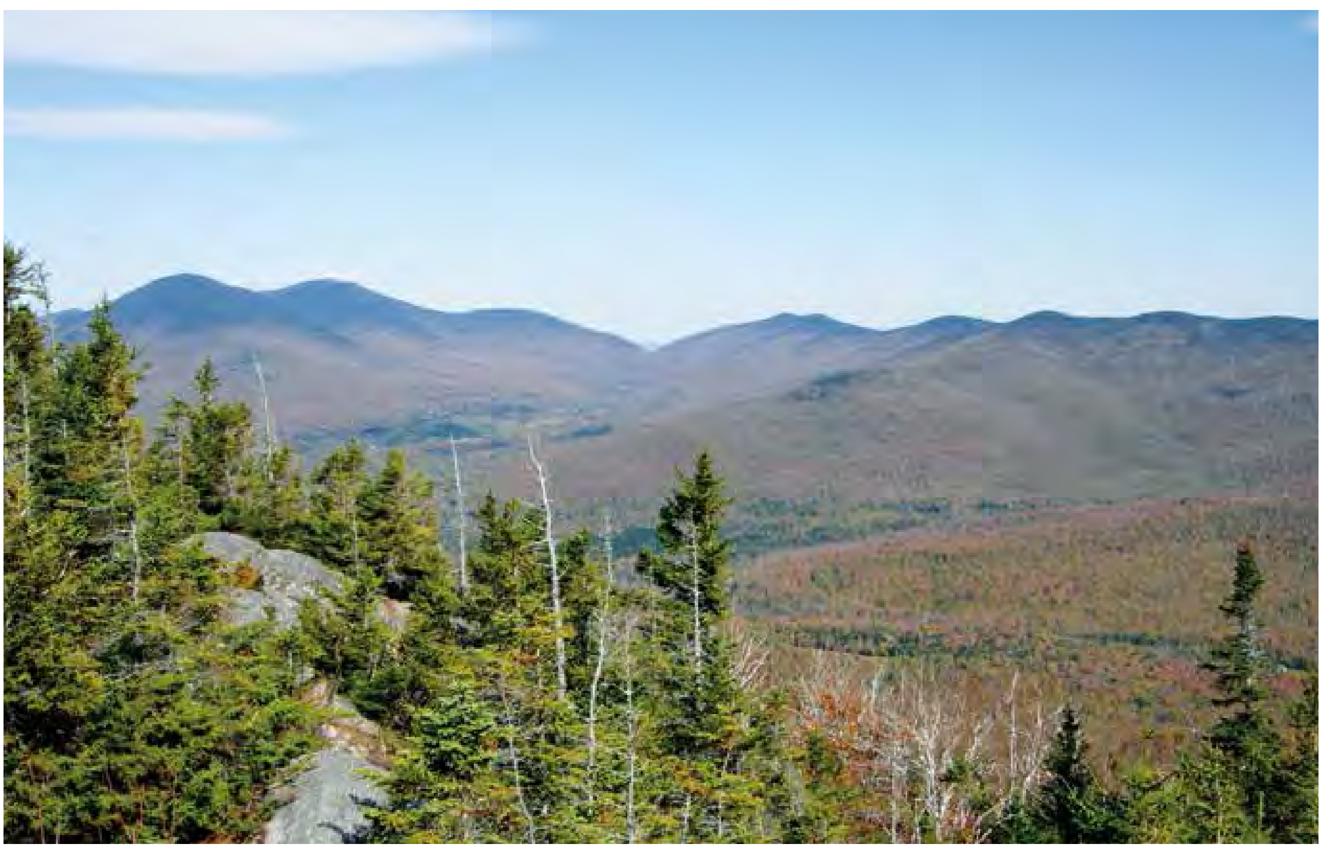
We are excited to offer this manual to provide useful information and guidance to landowners, foresters, wildlife biologists, and others interested in managing land for the benefit of fish and wildlife.

ACKNOWLEDGMENTS

We wish to thank the private landowners of Vermont who provide the inspiration to foster a strong sense of thoughtful land stewardship.

The Vermont Fish and Wildlife Department wishes to express its sincere appreciation to all the individuals and organizations that helped create this product. The Vermont Department of Forests, Parks and Recreation was instrumental in the development of these guidelines and offered outstanding and essential guidance and information. In particular, Commissioner Michael Snyder, Director of Forests Steve Sinclair, and Forest Management Chief Ginger Anderson provided strong, helpful support and guidance to make this a useful tool for Vermont landowners. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) played a similar partner role and also provided outstanding and essential guidance and information. In particular, Toby Alexander, NRCS state biologist and acting forester, provided thoughtful guidance, support, and information in the development of these guidelines. Vermont Audubon, Vermont Coverts, and Vermont Woodlands Association all provided guidance and support for the development of these guidelines.

We are particularly grateful to all the wildlife biologists and county foresters within the Vermont Agency of Natural Resources who contributed to this effort. They not only represent the driving force behind this product, but are the boots on the ground, day in and day out, who work with private landowners to improve wildlife habitat. And, of course, we wish to thank the private landowners of Vermont, who provide the inspiration to foster a strong sense of thoughtful land stewardship.



INTRODUCTION

These guidelines are intended to provide useful information and techniques for private landowners, wildlife biologists, foresters, and other land managers on how to effectively manage land to improve wildlife habitat. They have been developed for a wide audience to benefit wildlife habitat management on private lands throughout Vermont. Therefore, they represent a balance of technical information presented in an easy to use and understand format so that landowners as well as professional foresters can use them. These guidelines are voluntary and do not have any regulatory influence or application to private lands. In fact, they have been specifically designed to help landowners understand how to go above and beyond the normal course of land management to achieve the best possible outcome for wildlife habitat.

Vermonters place high value on the environment, rural working landscape, and wildlife. Time and again, these values are highlighted in surveys that illustrate strong public support for conservation of wildlife and land. As the Vermont landscape largely comprises private land, Vermont landowners play a critical role in ensuring the future health of our lands, waters, habitats, and wildlife. And, time and again, Vermont landowners provide outstanding examples of managing land in thoughtful ways to benefit the shared interests in wildlife.

The Vermont Fish and Wildlife Department is pleased to provide these guidelines to all those who are interested in managing their land to benefit and enhance wildlife habitat and the animals that use them. We look forward to realizing healthy habitats for many generations of Vermonters yet to come.

As the Vermont landscape largely comprises private land, Vermont landowners play a critical role in ensuring the future health of our lands, waters, habitats, and wildlife.

PART ONE:
Habitat Planning Process: An Overview

1. CONSIDERATIONS BEFORE YOU DEVELOP A PLAN

People own and value land for many reasons. Timber, firewood, bird watching, hiking, hunting, and many other values are realized from people owning land. To be sure, Vermont has a strong history and tradition associated with a rural working landscape that includes forest product economies, tourism and recreation, hunting, fishing, maple sugaring, farming, and more. This working landscape is what makes Vermont the special place it is.

This guide is intended to assist you as a landowner who is particularly interested in managing your land to benefit wildlife. That is not to say that by managing your land for wildlife you are deciding not to manage it for timber or hiking trails; indeed, many of these goals are compatible, if not complementary. Managing your land to enhance its value for wildlife requires careful attention to the species of plants and animals currently using the land as well as those desired from your management. This guide will help you, the landowner, forester, biologist, or other land manager, understand how to recognize various wildlife habitats and how to manage them for the future.

All good land management begins by creating a management plan to guide decisions and actions. Similar to developing a forest management plan, when managing your land for wildlife, the planning process should involve five steps: (1) evaluate the conditions and capabilities of the land; (2) set management goals based on your evaluation of the land and your desired outcomes; (3) consider management alternatives to be sure that your actions are the most effective to achieve your interests; (4) write a plan; and (5) implement the plan, monitor the results, and adjust your management strategies based on those results. Inherent in this process is the development of a map or maps that depict existing and desired conditions on your property.

This chapter introduces the overall habitat management planning process.

This guide is intended to assist you as a landowner who is particularly interested in managing your land to benefit wildlife.

Four habitat components are needed for wildlife to survive: food, water, cover, and space.

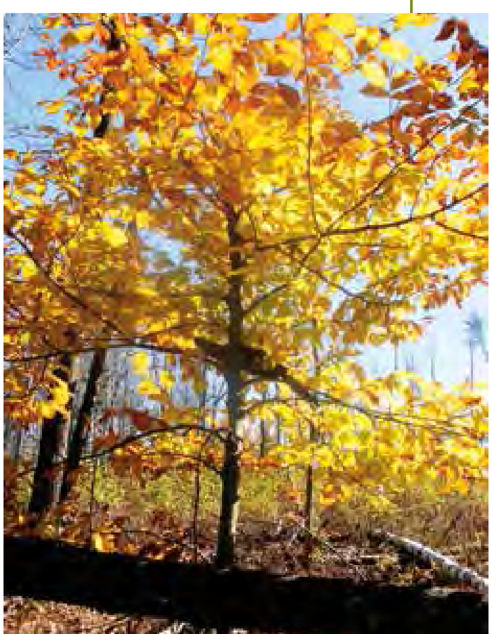
DEFINING WILDLIFE HABITAT

Before the planning process begins, you should be familiar with the concept of habitat in a broad sense. Four habitat components are needed for wildlife to survive: food, water, cover, and space. Even though all species need these habitat components, the amount and type of each required differs depending upon the species. Knowing the specific needs of each species (e.g., ruffed grouse), or group of species (e.g., grassland birds) will allow you to provide the correct habitat components to meet their needs and your interests. For more information on specific species, refer to **Part Seven: Habitat Management for Games Species** or **Part Eight: Habitat Management for Nongame Species**.

Relatedly, the term "carrying capacity" refers to the ability of a habitat to support a certain population (number of individuals) of a given species of wildlife. For instance, a limited supply of one type of habitat (e.g., habitat that provides an important source of food) will control how many of a given species of wildlife the habitat will support (e.g., hermit thrush and acres of interior forest habitat, or white-tailed deer and suitable softwood cover for winter habitat). Land managers can affect carrying capacity by providing or limiting important habitats, thus increasing or reducing wildlife populations.

PLANNING PROCESS

Evaluate the Land: Before you can effectively manage land for wildlife, you need to understand what wildlife live on the land and what habitat they require. In addition, a critical element to the planning process is to inventory and identify the habitat types and conditions on the land, and if possible, on surrounding lands owned by your neighbors. If you own forest land in Vermont, you can contact your local county forester with the Vermont Department of Forests, Parks and Recreation. That person will visit your land, free of charge, and help you evaluate the forested habitat conditions on your land. In addition, the Vermont Fish and Wildlife Department (VFWD) and the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) provide advice and planning services to Vermont landowners. You will see links to VFWD and NRCS in **Resources** sections throughout this guide.



By examining the land at different times of year, you can get a sense of the extent and diversity of habitat conditions (e.g., mast production by American beech or red oak trees in autumn). As explained in more detail in subsequent chapters, this includes identifying and assessing the number of snags (standing dead and dying trees) and the acreage and condition of a hemlock forest used as winter habitat by white-tailed deer, as two examples. Make a list of all the plants and animals you can easily identify on the land. Also, look for physical changes on the land that may vary by season. For example, look for how an opening in the forest gets shade during the growing season because this will influence how quickly it may regenerate to young forest, and look for areas that are seasonally wet and support standing water because they may be used by breeding amphibians for spawning and as sources of water for black bears and other wildlife. Examine what happens to the land and how the wildlife respond after a rain or snowstorm (e.g., deer may congregate in an area of softwood cover during winter, and mallard ducks may feed in seasonally flooded fields).

In addition, think about how your property fits into the local landscape. For example, how do your woods connect with your neighbors' lands? Do fencerows or stream corridors connect your land to other properties? What land use practices are occurring on the land around you, and what impact do they appear to have on local wildlife? Finding answers to these questions will help you to decide how to manage your property for wildlife, among other things, and whether or not your goals are realistic. In all of these larger landscape considerations an important overriding principle to keep in mind is, how are the habitats connected to one another, and how can those connections be maintained? Fragmenting those connections is one of the most significant impacts to many wildlife because it affects their ability to move, access important habitats, find mates to successfully reproduce, and disperse and maintain their populations.

Although it is possible to plan and implement some habitat management practices on your own, gaining assistance from professional foresters and wildlife biologists is invaluable for realizing success and achieving your goals. Contact a regional Vermont Agency of Natural Resources (ANR) office for assistance and lists of natural resource experts (see **Resources** for contact information). Experts can provide valuable information and advice on what habitats may be present and how to best manage and enhance them. Local county foresters are an excellent source of guidance and information for developing habitat management plans and, in many instances, can guide you through how to update an existing forest management plan to include wildlife habitat. Additional information that may help in managing your land is available from many sources, including chapters in this guide, local libraries, videos and television programs, adult education courses, and individual experts.

Set and Prioritize Goals: Setting management goals is an exciting part of the planning process; this is when you decide what measurable differences to implement that will benefit wildlife. For example, your goal might be to increase the number of woodpeckers, squirrels, cavity-nesting birds, and bats throughout the property. This goal might be achieved by increasing the number of snags (dead and dying trees) in a range of size classes in order to benefit those species that rely on such habitat. Another example might be to create young forest habitat to increase certain species of songbirds and ruffed grouse that rely on that habitat condition. It is important to be realistic when setting habitat management goals and base them on a thorough and thoughtful evaluation of the existing conditions of the landscape. For example, the desire to attract grassland birds is not realistic if the land you wish to manage is a 40-acre woodlot. You should become familiar with the habitat needs of the desired species, and be realistic in your appraisal of whether you can meet those needs. Think about the values you ascribe to your land as well as the health of the forest overall and how to ensure it remains healthy. Do you want it to produce income, provide hunting or other recreation, or are you more interested in aesthetic returns such as creating natural beauty, providing wildlife habitat for viewing pleasure, or protecting rare species? Through careful planning, many of these goals can be complementary and not mutually exclusive.

Once you have established habitat management goals for the property, the next step is to develop management objectives (measurable outcomes that help meet the larger goals). Following the development of habitat objectives, another step is to identify management strategies or actions that describe what actions or mechanisms will be used or employed to manipulate or otherwise manage the habitat. Actions are task-oriented and designed to be directly implemented by the landowner or resource professional to achieve a certain outcome (e.g., pruning apple trees,

Figure 1.1 Statewide contiguous habitat map

Maps are an essential part of an effective management plan and should be detailed enough to understand existing conditions and constraints, as well as goals and objectives (desired conditions) — a picture is worth a thousand words. The ANR Natural Resources Atlas (http://anrmaps.vermont.gov/websites/anra/) is an excellent GIS tool to develop useful forest and habitat management plans.

Prioritizing your goals is a way to view the "big picture" in small, organized parts. This will help you to plan accordingly and complete the most important goals first.

delineating a buffer zone to a stream, or controlling invasive plants through hand pulling or the use of herbicides). This framework of goals, objectives, and strategies is commonly used for developing forest and habitat management plans and is merely a progression of how to describe what you hope to achieve and how you plan to achieve it.

As an example, you may have a goal to attract bluebirds to your property. A review of your property suggests nesting structures and foraging habitat are lacking. One objective might be to install six nest structures to attract at least three nesting pairs within 3 years. The action needed to achieve that objective may include constructing and placing six nest boxes in suitable locations within the next 2 years. A second objective might be to provide 2 acres of high-quality foraging habitat within 3 years. Specific actions, such as mowing a portion of an old field, might be used to achieve the objective.

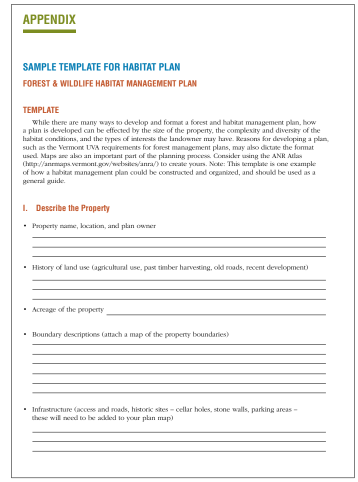
Once your goals are set, prioritize their importance and determine whether they can be realistically achieved. Prioritizing your goals is a way to view the "big picture" in small, organized parts. This will help you to plan accordingly and complete the most important goals first. Employing the services of a professional wildlife biologist or forester is a useful way to ensure that your goals, objectives, and actions are appropriate and realistic given the circumstances of the land and your interests and abilities.

Consider Alternatives to Meet the Goal: Usually, a goal can be achieved in more than one way, and foresters, wildlife managers, and landowners often have to sort through many options to find the best method. Every decision made will affect wildlife and wildlife habitat in some way, but some impacts may be beneficial to your goal while others may be harmful. The successful manager is one who tries to anticipate how each decision will make a difference and which decision is the best one to meet the goal.

There may be many alternatives to choose from. Once alternatives have been identified, you can select those goals, objectives, and strategies that are most appropriate to best meet your interests. Keep in mind that many goals can be achieved by using the same strategies. For instance, growing healthy trees for saw timber and firewood can be done in a way that is also compatible with developing healthy habitat for forest songbirds, small mammals, raptors, and deer, as just one example. Before choosing an alternative, be sure to consider cost, time involved, and impacts on other forms of wildlife as well as impacts to neighboring landowners. Choosing alternatives with the least amount of trade-offs is usually the best option. Some important consideration include: how much time and money are required, available options for technical and financial assistance (e.g., federal Farm Bill programs like the Environmental Quality Incentive Program), and what kind of equipment is needed. Equally important are the potential impacts of management decisions on neighboring landowners and the local landscape, and the costs and benefits to a wide array of wildlife. You should also remain mindful of the economic benefits of managing forested habitat. Harvesting timber produces income for the landowner and supports a state and regional forest products economy, which ultimately helps keep land in an undeveloped condition. Timber harvest activities can be designed to benefit wildlife, and the income generated from the timber harvest can offset the investment for habitat management.

Write a Management Plan: After you have established habitat management goals based on a careful assessment of existing habitat and land conditions as well as an assessment of alternative management options, it's time to write a management plan. It's important to note that an assessment of land conditions includes both the physical and ecological conditions of the land, as previously addressed. Any management plan will need to address issues of topography, stone walls, streams and wetlands as they relate to access for logging equipment, as just one example. Experts who can assist you with this task are noted in the sidebar below. The purpose of a management plan is to outline the steps needed to reach your goals. An essential first step includes developing a map that depicts the area to be managed, current physical conditions of the land (e.g., topography, roads, stone walls), ecological conditions (e.g., streams, seeps), habitat conditions (meadows, snags, forest openings, mature forest stands), the location of habitat management practices to be employed, the location of structures, access roads, and other relevant information.

There are many ways to create a map for purposes of planning habitat management projects. The Vermont Agency of Natural Resources offers a web-based GIS mapping tool known as the Vermont Natural Resources Atlas that is a valuable tool for this purpose. This tool provides access to important natural resource and wildlife data (e.g., deer wintering areas, rare and uncommon natural communities and species, wetlands, habitat connections, and more), aerial photography, and more. It is easy to access and use and can be found at the link in **Resources**. If you already have a forest management plan through the Use Value Appraisal (UVA) program, this can serve as an excellent opportunity to realize your wildlife habitat goals by working with your county forester and others to adjust them accordingly. In many cases, UVA plans already have been designed to meet wildlife habitat goals and serve as useful templates to neighboring landowners. Contact your county forester for more information. There are other tools and programs you can use to guide the development of a management plan such as the American Forest Foundation's "My Land Plan" program available at mylandplan.org.



APPENDIX

SAMPLE TEMPLATE FOR HABITAT PLAN

FOREST & WILDLIFE HABITAT MANAGEMENT PLAN

TEMPLATE

While there are many ways to develop and format a forest and habitat management plan, how a plan is developed can be effected by the size of the property, the complexity and diversity of the habitat conditions, and the types of interests the landowner may have. Reasons for developing a plan, such as the Vermont UVA requirements for forest management plans, may also dictate the format used. Maps are also an important part of the planning process. Consider using the ANR Atlas (http://anrmaps.vermont.gov/websites/anra/) to create yours. Note: This template is one example of how a habitat management plan could be constructed and organized, and should be used as a general guide.

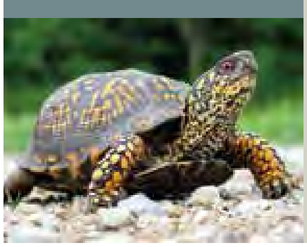
I. Describe the Property

- Property name, location, and plan owner
- History of land use (agricultural use, past timber harvesting, old roads, recent development)
- Acreage of the property
- Boundary descriptions (attach a map of the property boundaries)
- Infrastructure (access and roads, historic sites – cellar holes, stone walls, parking areas – these will need to be added to your plan map)

Figure 1.2 Sample habitat plan

Appendix provides a template for how to construct and organize a habitat management plan.

WHAT TO KNOW ABOUT CONSULTING FORESTERS AND WILDLIFE BIOLOGISTS



Consulting foresters and wildlife biologists can assist Vermont landowners in developing effective forest and wildlife habitat management plans. These guidelines can help landowners decide on management goals and strategies, while consulting natural resource professionals can articulate and implement successful wildlife habitat management activities. Consulting foresters and biologists can assist with plan and map preparation for your needs, design and implement resource inventories of your land, and help you apply for federal management practices programs and Use Value Appraisal (Current Use) enrollment. In addition, these professionals provide a wealth of knowledge that they will pass along to you — the landowner. There are many consulting foresters and wildlife biologists in Vermont and New England. The Vermont Fish and Wildlife Department maintains a list of practicing wildlife consultants that can be found at: http://www.anr.state.vt.us/FWD/Consultant.aspx

Your County Forester maintains a list of consulting foresters working in your area. The Vermont Woodlands Association maintains a list of consulting foresters at: http://www.vermontwoodlands.org/documents/CFMembershipDirectory2014-15.pdf

When selecting a consulting forester or biologist, consider their level of experience, and request examples of other plans they have written. Ask for references and in particular whether they have worked with any nearby landowners with whom you can speak. If you are enrolled in Vermont's UVA program, contact your county forester for guidance if you want to update your management plan to address wildlife habitat interests.

Implement the Decision, Monitor the Results: Once the habitat management plan is complete, you can begin to implement the various prescribed strategies in accordance with an implementation schedule.

While some habitat conditions respond quickly to management (e.g., aspen sprouting from patch cuts), other conditions require time and patience to be realized (e.g., development of riparian plantings). Monitoring the results of habitat management actions during the implementation of the plan is essential for determining to what extent the management goals are achieved and whether adjustments are required to better meet the goals. For instance, if your goal is to create young softwood habitat to encourage snowshoe hare and instead the site regenerates to mixed hardwood and softwood, it may be necessary to adjust your goal and focus on encouraging habitat for other species such as ruffed grouse, if your interest is small game hunting.

Remember that natural, economic, or other conditions may change during the life of the plan, and you may need to revise your goals, objectives, and strategies accordingly. For example, in the planning process, a landowner may decide to establish a 40-acre field of warm season grasses, beginning in 3 years. When it is time to begin the management action, seed prices may have gone up and the landowner can only afford to prepare and seed 20 acres. An appropriate and reasonable alternative response to this unforeseen change is to plant 20 acres of warm season grasses and allow the other 20 acres to revert to an old field providing valuable shrub habitat conditions. This decision allows the landowner to stay within budget, and still results in the creation of valuable habitat.

While some habitat conditions respond quickly to management (e.g., aspen sprouting from patch cuts), other conditions require time and patience to be realized (e.g., development of riparian plantings).

WORKING WITH NEIGHBORS

Working in partnership with other landowners is often an exciting management approach that can result in even greater benefits to wildlife given the larger area of influence. As wildlife habitat becomes more fragmented in Vermont due to the subdivision and sale of land, small property owners may find it difficult to understand and identify opportunities to manage their land for wildlife. The answer may lie in working with neighbors to create a more meaningful habitat plan. You may be able to provide one component of wildlife habitat (e.g., release oak trees to improve acorn production), and neighboring landowners may be able to provide other components (e.g., buffer to a nearby stream or wetland). For example, the wetland on one property and the old field with shrub habitat on an adjoining property can be managed together for the benefit of birds and mammals that rely on these habitats and the essential connections between them. Working together with neighboring landowners can turn a management operation that should involve harvest of timber into something that can become economically viable. By working with multiple landowners, there may be sufficient timber as an incentive for a commercial timber harvest designed to benefit wildlife habitat. Again, experts such as county foresters and state wildlife biologists as well as local and state land trusts can be helpful in making connections between landowners to discuss how best to manage your lands collectively.

VERMONT'S USE VALUE APPRAISAL PROGRAM

The Use Value Appraisal Program (UVA), also known informally as "Current Use," is a tax incentive program for Vermont property landowners. It assesses the value of agricultural or forest land based on the current use of the land, rather than the use of greatest financial value, which is often as developed with homes or commercial structures. This program allows owners of forest land the opportunity to pay lower property taxes as long as they do not develop their land and they commit to managing their land through a forest management plan approved by a county forester.

UVA is an outstanding program in terms of the opportunities it creates for landowners interested in managing their land for wildlife. The program allows landowners to develop management plans that focus on wildlife habitat enhancement while still allowing for the economic benefits of forest products through commercial timber sales. In addition, UVA allows landowners that own land with Ecologically Significant Treatment Areas (a.k.a., ESTAs) to protect and manage those features through noncommercial methods where necessary to protect the resource. In most cases, landowners enrolled in UVA rely on the services of professional consulting foresters, wildlife biologists, and ecologists. The plans must be reviewed and approved by county foresters in the Vermont Department of Forests, Parks and Recreation. This level of professional guidance and review ensures that the plans comply with statutory and program requirements and are appropriate, realistic, and of high quality.

County foresters are available for field visits to discuss forest stewardship goals and management options. They can advise on practices programs and technical assistance available through a variety of programs and partner organizations. These range from funding options for specific activities through the Natural Resources Conservation Service to peer-to-peer networks to assessment for songbird habitat through "Foresters for the Birds."

For landowners with 25 acres or more of land, this program is recommended as a means to develop a habitat management plan. (For more information about the UVA program and for other important website links, see **Resources.** Also, note the sample plan template provided in **Appendix**.)

The UVA program allows landowners to develop management plans that focus on wildlife habitat enhancement while still allowing for the economic benefits of forest products through commercial timber sales.

RESOURCES

Degraf, R.M., M. Yamaski, W.B. Leak, A.M. Lester. 2005. *Landowner's Guide to Wildlife Habitat – Forest Management for the New England Region*. Burlington, VT: University of Vermont

Long, S., V. Barlow, I. Post, M. Snyder, C. Thompson, C. Wooster. 2012. *More Than a Woodlot: Getting the Most from Your Family Forest*. Vermont: Northern Woodlands

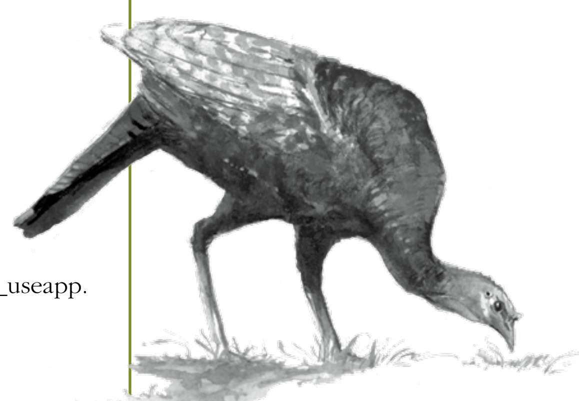
U.S. Department of Agriculture. Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/site/vt/home/

Vermont Department of Forest, Parks and Recreation. County Foresters. http://www.vtfpr.org/resource/for_forres_countfor.cfm

—. Use Value Appraisal Program. http://www.vtfpr.org/resource/for_forres_useapp.cfm

Vermont Fish and Wildlife Department. Wildlife Expertise. http://www.vtfishandwildlife.com/nnhp_expertise.cfm

Vermont Woodlands Association. Consulting Foresters of Vermont. http://www.vermontwoodlands.org/certified-foresters.asp



2. BIOPHYSICAL REGIONS AND A LANDSCAPE PERSPECTIVE FOR CONSERVATION AND MANAGEMENT

As a Vermont landowner, you will need to carefully consider the effects of your actions and plan for effective habitat management and conservation on at least three scales.

Vermont is rich with wildlife, largely because we have an abundance and diversity of habitat that supports the needs of many species. These habitats include extensive areas of interconnected forests of many types, swamps and lakeside marshes, fens and bogs, cliffs and caves, seeps and vernal pools, fields and grasslands, and streams, rivers, and ponds. An important conservation goal is to maintain this diverse array of habitats to continue to support Vermont's wildlife resources and all the values they provide.

Achieving this goal over the long term will be challenging, given the continued loss and degradation of habitat associated with development. As a Vermont landowner, you will need to carefully consider the effects of your actions and plan for effective habitat management and conservation on at least three scales. First, you need to consider the needs of individual species where they occur, especially those species that are particularly sensitive to changes in their surroundings. For example, American woodcock require shrub wetlands for feeding, adjacent to old fields for courtship.

Second, you need to consider the distribution and condition of all habitats and natural communities in your local area and across the state. This is the best insurance that you will provide the habitat requirements for a broad range of species.

And third, you need to consider large, landscape-scale features, such as large areas of contiguous forest and the habitat that connects them. Although you may make decisions on how to manage your own lands based primarily on its conditions, you should also consider these larger landscape issues in order to put the value of the habitat on the property you are managing into context.

One way to understand the complexity of landscapes in Vermont is to examine the state's biophysical regions. Vermont comprises eight distinct regions based on differences in elevation, climate, geology, topography, hydrology, land-use history, and vegetation. Although wildlife distribution was not used specifically to develop these eight biophysical regions, there are some clear patterns of wildlife species distribution across the

CV: CHAMPLAIN VALLEY
TM: TACONIC MOUNTAINS
VV: VERMONT VALLEY
NM: NORTHERN GREEN MOUNTAINS
SM: SOUTHERN GREEN MOUNTAINS
NP: NORTHERN VERMONT PIEDMONT
SP: SOUTHERN VERMONT PIEDMONT
NH: NORTHEASTERN HIGHLANDS

Figure 2.1 Biophysical regions of Vermont

eight regions (e.g., montane forest birds within the high-elevation habitats in the Northern Green Mountains and Northeastern Highlands regions). Following is a brief description of each biophysical region in Vermont.

CHAMPLAIN VALLEY (CV)

Extending from the southern end of Lake Champlain and northward into Canada and along the St. Lawrence River valley, the Champlain Valley is one of the warmest regions in Vermont. It is also dry, with less than half the annual precipitation that falls in the Green Mountains. Lake Champlain and the low-elevation level plains with clay and silt soils near the lake dominate this region. Low hills rise up to the east to meet the Green Mountains where northern hardwood forests are common. On the warm rocky hills of the valley bottom, diverse forests of oak and hickory occur amid an agricultural setting. The rare Mesic Clayplain Forest once dominated the clay soils of the region but has now mostly been converted to agricultural land. Large wetland complexes of marsh, swamp, and floodplain associated with Lake Champlain and the deltas of the larger rivers provide regionally significant waterfowl and marsh bird habitat. Chittenden County is the most populated region of the state and the abundance of high-quality agricultural soils means that there are few large blocks of forest in this region.

TACONIC MOUNTAINS (TM)

This primarily forested region has complex geology, including the band of world-famous slate south of Lake Bomoseen, acidic hills of schist and phyllite, and rich limestone and marble slopes to the east. The climate is as variable as are the elevations, with Mt. Equinox rising to 3,882 feet and the Hubbardton River flowing through Benson at an elevation of 200 feet. Northern hardwood forests are common at mid-elevations, and extensive rich northern hardwood forests occur on the eastern slopes. Spruce-fir forests grow on the highest elevations while oak-dominated forests grow on warm southern slopes and at lower elevations where hemlock and white pine are also common. Lakes and ponds are common to the northwestern part of the region (Bomoseen, St. Catherine, Hortonia, and Sunset), and river valleys provide productive agricultural land. The Taconic Mountains extend south into New York, Massachusetts, and Connecticut.

VERMONT VALLEY (VV)

This small, narrow region between the Taconic and Green Mountains is defined by its limestone and marble bedrock, the abundant wetlands along Otter Creek and Batten Kill River, and the low hills made up largely of well-drained, glacially derived soils. The underlying bedrock is rich in calcium, which has a strong influence on the wetlands of this region, resulting in many fens, seeps, and enriched swamps. Forests of oak, white pine, and hemlock are common on the coarse soils along the valley sides. The Vermont Valley has a long history of human use and now includes a major north-south road (Route 7) and train travel corridor. The valley wetlands provide important wildlife habitat, and maintaining adequate east-west wildlife corridors across the valley between the Green and Taconic Mountains will be an important challenge.

NORTHERN GREEN MOUNTAINS (NM)

The Green Mountains are part of the Appalachian Mountain chain that extends from Alabama north to Québec. The Northern Green Mountains include Vermont's highest mountain (Mount Mansfield at 4,393 feet), its coldest climate, and the greatest annual precipitation (72 inches). The bedrock is primarily acidic, composed of non-calcareous schists, phyllites, gneisses, and granofels. Northern hardwood forests blanket the region on the mountain slopes up to about 2,500 feet, above which yellow birch and red spruce are dominant. Spruce-fir forests occupy the higher slopes and summits, with alpine meadows above 3,500 feet. The extensive, unfragmented forests of this region provide habitat for many species of wildlife that thrive in remote, interior forest conditions. The high-elevation forests of this region and the Southern Green Mountains provide habitat for several species of birds, including Bicknell's thrush, Swainson's thrush, and blackpoll warbler. The heavy precipitation and deep snows in the mountains feed some of the state's largest rivers, including the Missisquoi, Lamoille, Winooski, and White. Floodplain forests were once common along these rivers, but they are now mostly converted to agriculture.

SOUTHERN GREEN MOUNTAINS (SM)

This region has many similarities with the Northern Green Mountains. It has high mountains (Killington Peak is 4,235 feet), acid bedrock composed of the same material as the Northern Green Mountains, cold temperatures, and heavy precipitation, and is dominated by the same forest types that are largely determined by elevation. One distinct feature of the Southern Green Mountains is the relatively level plateau on the southern and western sides of the region. Here, northern hardwood forest and spruce-fir forest intermix with spruce swamps, poor fens, and small ponds. Beavers are abundant and have had a significant influence on the wetlands of the plateau. Another distinct and dramatic feature of the Southern Green Mountains is the escarpment along the western boundary. The cliffs and steep slopes of the escarpment drop more than 1,000 feet in some areas to the valleys to the west. The escarpment's acidic rock and warm western slopes support northern hardwoods, hemlock, and in many locations, oak and pine.

NORTHERN VERMONT PIEDMONT (NP)

Moderate in both its climate and topography, the Northern Vermont Piedmont is a hilly region bisected by many rivers. With rich soils derived from the underlying calcium-rich bedrock and gentle topography, this landscape is dominated by a dense network of roads connecting farms and small villages. Consequently, it contains fewer large forest blocks and has more fragmented wildlife habitat than in the Green Mountains and Northeastern Highlands.

The calcium-rich bedrock is responsible for the abundance of rich northern hardwood forests, northern white cedar swamps, and rich fens — all characteristic communities of this region. In contrast, the acidic granite hills of Derby, Glover, and Groton State Forest support northern hardwoods with abundant spruce and fir. The granite quarried in Barre is world famous for its high quality. The Northern Vermont Piedmont has many lakes and ponds, including the larger Memphremagog, Seymour, and Caspian, as well as numerous smaller ponds in the vicinity of Woodbury and Groton State Forest. These lakes and ponds provide successful nesting habitat for the greatest concentration of common loons in Vermont.

SOUTHERN VERMONT PIEDMONT (SP)

The Southern Vermont Piedmont is a variable region, with a cool climate in the northern hills, and some of the warmest temperatures in Vermont recorded in Vernon. The topography comprises gentle, rolling hills that rise from the Connecticut River Valley to meet the Green Mountains. Northern hardwood forest dominates throughout, but oak and pine forests occupy warm southern and western slopes in the hills of the central and southern portions of the region. Hemlock forests are also common. The Connecticut River and its tributaries provide important aquatic habitat. These river valleys also have abundant deposits of sand and gravel resulting from the last glacial period in Vermont. Although many of these well-drained soils have been developed or processed for gravel, temperate climate oak and pine forests are common on those that remain. Floodplain forests are also common along many of the region's rivers. The dense network of roads in this region has resulted in smaller blocks of forest and more fragmented wildlife habitat than in the less-developed regions. Turkey, gray squirrel, and white-tailed deer are some of the species that benefit from the abundance of acorns.

NORTHEASTERN HIGHLANDS (NH)

One of the coldest regions in Vermont, the Northeastern Highlands has a short growing season that has limited the conversion of the land for agriculture and created conditions that favor growth of coniferous forests of spruce and fir. Northern hardwood forests, as well as extensive spruce and fir forests, dominate the landscape of this region. The geology of this region is similar to that found in the White Mountains of New Hampshire and areas of northern Maine. The higher mountains are formed of acidic, weather-resistant granite, and some good examples of this include East and Gore Mountains. In sharp contrast, the distinctive Nulhegan and Victory Basins are formed from very soft granite that has eroded over long geological time frames. These large basins collect cold air drainage and are dominated by spruce-fir forests, swamps, and bogs. This habitat is similar to areas found north of Vermont in Canada and supports several boreal forest species of wildlife including spruce grouse, gray jay, black-backed woodpecker, rusty blackbird, and mink frog. Moose are common in this region, and the spruce-fir forests are critical overwintering habitat for white-tailed deer. Canada lynx and American marten have recently returned to portions of this remote region.

RESOURCES

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3. HABITAT CONCEPTS AND FEATURES

By viewing single pieces of property in a landscape context, you will be able to manage your property in a way that benefits wildlife beyond your own property boundaries.

Wildlife habitat is defined as the places where animals live, find food, mate, and meet their life needs. Habitat occurs at several scales, and you will need to understand each of these to properly plan for successful habitat management and conservation. As noted in the previous chapter on biophysical regions of Vermont, habitat occurs at the landscape scale in the form of large areas of intact, contiguous forest and the connections between these large forest blocks. Habitat also occurs at the community scale where assemblages of plants and animals come together to create a wide array of natural communities and habitat conditions such as black spruce swamps, dry oak forests, and floodplain forests, to name only a few. And lastly, it occurs at the fine scale, where individual species utilize dead trees (snags) for nesting cavities, forested seeps for foraging habitat in spring, or an area of concentrated American beech trees as an important fall feeding area. You should consider all three scales when developing a plan for wildlife habitat management, even if the plan affects only habitat conditions at the fine scale.

Wildlife do not recognize property boundaries and may require habitat that extends across lands owned both publicly and privately. Habitat features such as stream corridors, ridge lines, and contiguous forests connect individual properties into the broader landscape. By viewing single pieces of property in a landscape context, you will be able to manage your property in a way that benefits wildlife beyond your own property boundaries.

This chapter will provide context and help you understand habitat concepts that are important for developing effective management plans. This will be useful when you inventory habitat conditions on your land and develop realistic management goals and objectives.

HABITAT CONCEPTS

The following information will help to define important habitat concepts:

Habitat is the natural area inhabited by an animal, plant, or other type of organism. The basic elements of habitat include food, water, and shelter. Habitat is also a function of the physical environment related to factors such as temperature, elevation, soil condition, and hydrology. Habitat occurs at several scales including the landscape scale (e.g., large areas of contiguous forest), the community scale (e.g., deep rush marshes), and the fine scale (e.g., snags and logs).

Natural communities are groups of plants and animals that recur across the landscape wherever similar environmental conditions occur, including climate, soils, bedrock type, slope, and water. Many natural communities are common in Vermont and are easily recognized, such as northern hardwood forest, spruce-fir forest, cattail marsh, and alder swamp. Others are uncommon or rare, such as clayplain forest, northern white cedar swamp, and rich fen. Natural communities are useful for understanding the ecological variations on the land and are an important tool for planning, land management, and conservation. Many natural communities are closely associated with the habitat needs of specific wildlife species. For more information on natural communities, see examples in **Chapter 5, "Managing with a Focus on Natural Communities,"** and in **Resources** at the end of this chapter for Thompson and Sorenson's *Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont*.

Here are a few examples of strong associations between natural communities and wildlife species in Vermont:

- Spruce grouse rely on lowland spruce-fir forests and interspersed black spruce swamps.
- Timber rattlesnakes use warm talus slopes for critical basking and hibernacula habitat.
- Bicknell's thrush and blackpoll warbler rely on Vermont's high-elevation montane spruce-fir forests.
- Several species of rare and common dragonflies and damselflies occur only in poor fens and dwarf shrub bogs with some open water.
- Hemlock forests are one of the most important forest types providing winter cover for white-tailed deer.

Species diversity is the number of species, subspecies, and genetic variants of animals, plants, and other organisms in a given area. Promoting **native species** is an important component of any management plan along with protecting those that are rare regionally and statewide.

Some nonnative **invasive species,** such as house sparrows and European starlings, are abundant near human habitation and compete with native birds for habitat. Invasive nonnative species are a serious threat to wildlife, habitats, and ecosystems in Vermont. Some invasive plants, such as honeysuckle, buckthorn, and purple loosestrife, can be introduced by poorly planned land management activities. You should make every effort to remove these and other nonnative species before they become established. For more information, see Vermont Agency of Natural Resources' "Saving Our Open Landscape: Effects of Sprawl on Wildlife" in **Resources**.

Structural complexity refers to the variation of size and age classes and spacing of trees (both living and dead, standing and down) and other plants. Increasing the structural complexity of forested habitats, for instance, can increase the diversity of wildlife that use an area because it creates more fine-scale habitats within the forest.

Even- and uneven-aged forest conditions are important factors to consider when planning for forest wildlife habitat management. Even-aged forest habitat refers to forest habitat where the majority of the trees within a stand, habitat, or area of interest are generally the same age. Even-age management is an important objective for developing habitat for species such as ruffed grouse, American woodcock, chestnut-sided warbler, and snowshoe hare, among many others. Uneven-aged management, on the other hand, refers to forest habitat where there is a wide distribution of ages among the trees in a stand, habitat, or area of forest. This condition is important for many forest-interior songbirds such as scarlet tanager, black-throated blue warbler, and ovenbird. Following clearing or other forest disturbance, a forested area will regenerate as an even-aged forest, with most trees within 10 years of age of each other. In an old forest,

Natural communities are useful for understanding the ecological variations on the land and are an important tool for planning, land management, and conservation.

individual trees die and create openings; in turn, they are replaced by new or suppressed trees that grow up in the opening, resulting in an uneven-aged forest. Silvicultural techniques can be used to produce either an even-aged or an uneven-aged forest. In the absence of natural events such as fire and blowdowns, silvicultural techniques such as patch cuts may be appropriate to increase the diversity of species and ages of trees within a larger forested area and create patches of early successional habitat to mimic natural gap formation and encourage species associated with early successional forest. Long's book *More Than a Woodlot* provides an excellent overview of these concepts and how to apply them to forest habitat management.

If you suspect that a rare, threatened, or endangered species may occur on your property, please contact the Vermont Fish and Wildlife Department. The department can provide specific management guidance to help you protect these important species on your property.

Forest fragmentation is a condition caused by breaking up large forested blocks into smaller, isolated forested areas, often surrounded by residential development, commercial development, or agricultural lands (e.g., row crops). Many wide-ranging species, such as black bear and moose, need large areas of unfragmented forest habitat and this should be considered in your management plan. Forest interior songbirds, such as the wood thrush are affected by fragmentation due to increased rates of nest predation and parasitism associated with the fragmentation. For more information, see the link Austin and colleagues' "Threats to Vermont's Natural Heritage" in **Resources**.

Rare, threatened, and endangered species are species of plants, animals, and fungi whose populations are low or are at risk of becoming extirpated or extinct. Species listed as "threatened" or "endangered" are legally protected under Vermont's Endangered Species Law or the Federal Endangered Species Act. In both cases, the laws prohibit harming or disturbing the listed species. Many of these species occur in specialized habitats or uncommon natural communities, or have experienced significant habitat loss over time. Rare species (those with low population levels) have less legal protection, but they still provide an important contribution to species diversity in Vermont. The Agency of Natural Resources (ANR) Natural Resources Atlas (see **Resources**) is a web-based GIS mapping tool that provides access to information on the approximate location of rare, threatened, and endangered species.

A buffer is a designated area surrounding an important habitat feature, such as a stream or wetland, in which the integrity of the plants and soils are protected. Buffers reduce the impacts of activities occurring outside the area. Buffer width and specific management practices within a buffer will vary with the habitat feature being protected. Buffers incorporated for forest management don't always assume a hands-off approach, and certain habitat benefits can be realized through careful management of trees within buffers (e.g., creating snags, providing downed woody material as habitat). Some buffers provide important habitat functions in and of themselves, such as riparian habitat along rivers and streams that provide nesting and feeding habitat for Baltimore orioles, yellow warblers, and wood ducks as well as travel corridors between larger areas of habitat for black bear, otter, and mink.

FINE-SCALE HABITAT FEATURES

The following information will help to define important habitat features.

Lakes, ponds, rivers, and streams are aquatic habitats that are essential for many species of fish and wildlife. To protect aquatic habitats from erosion, bank slumping, sedimentation, and loss of shade, buffers should be established along the edges of these aquatic habitats. Buffers should be largely undisturbed, naturally vegetated areas extending from the edge of the aquatic habitat feature. While buffers should always be treated with great care, there may be instances where active management is important such as when dealing with invasive species, pathogens, pests, and overall forest health concerns. Fisheries and wildlife biologists in the Vermont Fish and Wildlife Department can help you plan for the conservation of these important features. Buffers should be applied to both sides of stream channels and, in the case of wetlands, around the perimeter of the wetland.

In addition to protecting water quality and aquatic habitat, buffers also provide nesting and brooding cover for birds and travel corridors for bobcat, fisher, otter, and other wildlife that depend specifically on wetland and stream habitat. Although buffer widths and dimensions will vary depending on the conditions of the aquatic habitat or other features, in general, maintaining a relatively wide buffer will maximize those wildlife benefits as well as other ecological benefits such as stream bank and lakeshore stabilization. Most streams require a minimum of 50 feet for a buffer to protect the aquatic functions. However, to protect the wildlife functions along a stream corridor, it is often necessary to protect a buffer width of up to 660 feet. For more information on buffers and how to plan for appropriate widths, see **Chapter 14, "Riparian Habitat Management**."

If possible, the ideal buffer strip should extend 100 to 300 feet from water. It is important to be realistic when establishing buffers and understand that they can limit certain management activities. If you have an interest in timber production as part of your habitat management plan, it may be necessary to find room to accommodate those interests.

Wetlands include swamps, marshes, bogs, and seasonally flooded areas, which are extremely important to wildlife. The Vermont Wetland Rules regulate activity within wetlands and within a buffer zone around any wetland that provides significant functions and values (including wildlife habitat) as designated by the Wetlands Section of the Department of Environmental Conservation. Buffer zones are also recommended for any wetland that is determined to provide important wildlife habitat functions, including small forested wetlands. While the Vermont Wetland Rules typically require a 50-foot buffer around wetlands, many species will benefit from larger buffers. For instance, American bitterns require wetlands with buffers greater than 300 feet from development to avoid displacing those birds from suitable nesting and feeding habitat. Beavers may search out food supplies several hundred feet from a wetland.

In areas where agriculture is in close proximity to wetland habitats, fencing can restrict livestock from damaging plant stems and roots. Keeping livestock away from wetlands helps to prevent manure from contaminating water with nutrients that cause algal blooms that reduce the value of wetlands for a wide array of wetland-dependent wildlife.

Some buffers provide important habitat functions in and of themselves, such as riparian habitat along rivers and streams that provide nesting and feeding habitat for northern orioles, yellow warblers, and wood ducks as well as travel corridors between larger areas of habitat for black bear, otter, and mink.

In terms of the overall landscape in Vermont, open habitats are a smaller percentage of the landscape and merit attention when you are planning for habitat management.

Naturally occurring logs, branches, and stumps in and around wetlands provide important basking, feeding, and refuge sites for turtles, frogs, and snakes. Cedar, locust, and other rot-resistant wood are all excellent choices for constructing waterfowl nest structures, rather than using chemically treated wood. For more information on wetland management, refer to **Chapter 12, "Wetland Habitat Management,"** and **Chapter 25, "Waterfowl."**

Springs and seeps are small wetlands usually found within forested habitats. The shoots that emerge there in early spring provide an important source of food for many species of wildlife, as well as a reliable source of water and succulent plants during the summer. These features are also an important source of cold water for streams and rivers, and play an important role in maintaining aquatic habitat for species such as brook trout.

Vernal pools are temporary woodland pools that are especially important to breeding salamanders and frogs because, unlike in other wetlands, fish that eat eggs and larvae are absent in these pools. When standing water is absent, vernal pools can be detected by land depressions with matted, water-stained leaves. In general, a 100-foot buffer is recommended to protect these habitats from ground disturbance and to maintain shade. An additional limited buffer is recommended to 600 feet, in which timber is carefully harvested to minimize soil disturbance and at least 70 percent crown closure of the tree canopy is maintained. Avoid placing landings, roads, or slash or operating heavy machinery in the pool habitat in order to avoid destroying the conditions of the pool. Refer to **Chapter 12, "Wetland Habitat Management"** for more specific information on management recommendations.

Figure 3.1 Bobcats use a variety of habitats including wetlands, large forest blocks, and ledges.

Openings are both naturally occurring and man-made. These areas — such as old fields, meadows, and rocky outcrops — all provide important wildlife habitat. While not every species may use these openings, they are a valuable habitat for many species. Maintaining these areas where they already occur is a great habitat management technique. Avoid creating openings where they will fragment large areas of forest in order to minimize the effects of predation and nest parasitism to nesting forest interior songbirds, minimize the risk of wind damage to forest stands, and minimize the risk of weed and invasive plant invasion.

These open habitats are an important condition for many types of wildlife such as eastern towhee, golden-winged warbler, American woodcock, and bobcat. In terms of the overall landscape in Vermont, open habitats are a smaller percentage of the landscape and merit attention when you are planning for habitat management. Location is critical when planning for this type of habitat and must be considered in the broader context of landscape habitat conditions to ensure that the location is suitable and appropriate to manage for these habitat conditions. Keep in mind that if you're enrolled in UVA, the creation of large openings, generally 20 acres or more, will likely require amendments to your UVA plans.

Mast trees, such as oak, beech, hickory, and apple, provide many species with critical sources of nutritious food. Species that are attracted to mast crops include chipmunks, evening grosbeaks, turkeys, ruffed grouse, deer, squirrels, and bears. Because "hard" mast trees like oak and beech don't produce viable seeds until at least 25 years of age, preserving mature trees is important. Beech trees with bear claw marks are a clear indication that those trees have a reliable history of nut production. Cutting away shrubs and other trees that are crowding and shading apple trees is a good way to extend the productive life of these important "soft" mast trees. Other soft mast sources include cherries, mountain ash, blackberries, and raspberries. For more information on managing mast habitat, see **Part Three: Managing for Production of Wildlife Food Resources**, **Chapter 10, "Apple Tree and Soft Mast Shrub Management"** and **Chapter 20, "Black Bears."**

Heron rookeries are home to great blue herons, which often nest in colonies ranging in size from a few nests to hundreds. You can recognize these rookeries by the presence of large stick nests typically found in trees on islands, wetlands, or hillsides. Rookeries may be used for decades or even centuries; rookeries in dead trees flooded by beavers persist for shorter periods of time than rookeries in live trees. Intact trees and uncontaminated adjacent wetlands or shallow waters are important. If nests are disturbed, herons may desert their individual nests or the entire rookery, or young birds that are alarmed may fall from the nests to their death.

Different kinds of buffers are recommended for protecting heron rookeries:

- A *primary* buffer zone of 300 feet from the outermost nest trees in a rookery should exclude tree harvesting, roads, trails, and building construction year round and should exclude hiking, hunting, fishing, and camping outside the nesting period. Do not allow human intrusion to occur during the March 15 to August 1 nesting period.
- A *secondary* buffer zone from 300 to 650 feet from the rookery perimeter should exclude sand or gravel extraction, land clearing, and

Beech trees with bear claw marks are a clear indication that those trees have a reliable history of nut production.

Retain two or more large den trees per acre within 300 feet of lakes and ponds to accommodate cavity-nesting ducks and other larger cavity users.

construction of permanent structures or roads. Other activities to avoid between March 15 and August 1 are temporary road construction, timber harvesting, and ATV use. To be clear, this area does not preclude timber harvesting, but those activities should be timed appropriately and planned and implemented to avoid impacting the hydrology of the habitat. Existing farming operations, including maple sugaring and the use of existing paths by nonmotorized traffic, are unlikely to adversely impact the nesting season.

- You might also consider a *tertiary* buffer zone 650 to 1,300 feet from the rookery perimeter. Construction of small buildings, temporary roads, and timber harvesting may be feasible outside the nesting period.

Raptor nest trees are home to forest hawks and owls. To protect the large stick nests of these birds, provide buffers around the nest trees during timber harvests. Avoid harvesting timber within the buffer during the nesting season (typically April through June). The buffer should be equal to or greater than the height of the tallest tree within 20 feet of the nest. Be sure to drop all harvested trees away from the nest tree.

Avoid creating large openings or clear-cuts within 300 feet of a raptor nest to avoid isolating and exposing it to predators. An isolated raptor nest tree is more vulnerable to predators such as raccoons, which may force raptors to abandon these nests. When large areas are cut, leaving some large trees or clumps of trees for perches and future nest trees is important. You can do this by designating one or more trees 12 inches or greater in diameter at breast height per acre wildlife trees. These trees need not be high-quality timber, and culling trees with profuse branching may be appropriate.

Figure 3.2 Woodpeckers create cavities in dead and dying trees that are used by other wildlife.

Den trees and snags are living or dead upright trees with cavities or dead limbs that provide important habitat for a variety of birds and mammals. These trees are especially important to wildlife, especially when located near water. Among the many wildlife species that benefit from dead and dying trees are some of Vermont's now rare bats who use the loose bark and cavities to roost. Standing dead trees may also pose a risk to human safety, so you should consult with a professional forester or wildlife biologist who is familiar with the Vermont Occupational Safety and Health Administration's guidelines on logging before planning a harvest in or near unsound trees. To address safety issues, consider clustering cavity and snag trees in areas such as riparian zones and wetlands, and away from access roads and trails. If a den tree or snag must be felled for safety reasons, leave the material on the ground as important downed wood habitat.

To recognize trees that provide cavities used by wildlife for dens, look for broken-off tops and large branches, old scars, conks, and existing cavities. Hardwood trees with cavities closer to the top of the tree are ideal. When possible, leave a selection of different diameter den trees for cavity-using wildlife. Tree cavities near open water, including some wetlands, will also be used by wood ducks, common goldeneyes, hooded mergansers, and common mergansers. Retain two or more large den trees per acre within 300 feet of lakes and ponds to accommodate cavity-nesting ducks and other larger cavity users.

Snags, or standing dead trees, may also serve as den trees. They provide perches and feeding sites for insect-eating birds such as woodpeckers, nuthatches, and black-capped chickadees, and feeding as well as resting sites for some snakes. Retain as many of these trees as possible while observing human safety concerns. When snags are infrequent or absent in a forest, consider girdling trees or leaving unhealthy trees to eventually become snags.

Live trees showing signs of reduced vigor, broken limbs, or scars may be good candidates for replacement snags. This may be especially important in young stands. To maintain the maximum number of downy woodpeckers in the Northeast, the U.S. Forest Service reported that four snags of 6-inch diameter or greater should be maintained per acre. Guidelines in Maine use this same ratio as a "rule of thumb" for den trees and snags combined for all wildlife, but suggest maintaining one tree greater than 18-inch diameter, two trees 14- to 18-inch diameter, and three trees 6- to 14-inch diameter per acre when circumstances allow. As with many management prescriptions, your personal analysis of the on-site situation is very important in deciding what makes the most sense. Exceeding these recommendations will likely benefit wildlife, and providing fewer snags will likely reduce the wildlife habitat benefits.

Try to leave six or more snags with 15-inch or greater diameter within 300 feet of openings, ponds, and lakes. Snags near openings may be used as hunting perches by the eastern bluebird and red-tailed hawk. Snags near open water, even those with small diameters, may develop cavities used for nesting by tree swallows. All snags and den trees have wildlife value, but larger snags can provide for a wider range of wildlife species and may provide more wildlife value for longer periods of time.

The following are management recommendations for maintaining and managing den trees and snags:

- Manage for at least six cavity, snag, and/or decadent, living trees per acre on average, with one exceeding 18-inch diameter breast height (DBH) and three exceeding 16-inch DBH.
- Leave trees that have cavities of varying sizes and are located in the upper trunk of the tree. Also, give priority to hardwood trees with cavities, rather than softwood, as they remain intact longer.
- To address safety issues, consider clustering cavity and snag trees in areas such as riparian zones and wetlands and away from access roads and trails. Over time, these will become downed woody material and provide additional, long-term ecological benefits to fish, wildlife, and forest health.

Exposed perches are large exposed branches and isolated or tall trees that provide perch sites for raptors and other birds. However, brown-headed cowbirds, a grassland species that invades forests to lay their eggs in the nests of other birds, benefit from perches offering good vantage points to scan the area for nests. Avoid leaving exposed perches when forests are fragmented and there is nearby farmland that provides grassland habitat and livestock feed for cowbirds.

All snag and den trees have wildlife value, but larger snags can provide for a wider range of wildlife species and may provide more wildlife value for longer periods of time.

Figure 3.3 Large snags provide excellent habitat for a wide array of wildlife from birds to bats.

In most situations you should leave naturally downed trees where they fall.

Stumps provide feeding and den sites for small forest-floor animals such as mice, voles, shrews, chipmunks, squirrels, and even weasels, which will use the decaying root system as ready-made tunnels.

Coarse woody material, such as logs, provides display sites for ruffed grouse, travel lanes, and important microhabitats for small mammals, salamanders, frogs, fungi, and overall forest health (nurse logs for tree regeneration). Larger logs provide greater value to wildlife because they persist for many years. In particular, large hollow logs used as shelter or denning habitat come only from large, standing hollow trees, so the best way to create this habitat is to let large trees grow, decay, and fall naturally. Fallen trees, decomposing logs, bark slabs, and slash all serve as important habitat features for small mammals, salamanders, snakes, and nesting wild turkeys.

Trees that naturally fall into wetlands, lakes and ponds, and rivers and streams are beneficial to wildlife for shade and cover. In most situations you should leave naturally downed trees where they fall. In contrast, slash and other logging debris can create negative impacts to aquatic habitats. Leaving an unmanaged buffer zone along a waterbody will provide an appropriate amount of downed wood for the aquatic habitat.

Brush piles, including treetops and other slash, provide roost and nest sites for some birds, and cover for chipmunks and rabbits, and may provide a safe spot for a newborn fawn. Animals as large as bears use brush piles in remote forested areas for denning. In addition to providing habitat values, slash returns nutrients to the forest floor as it decomposes and can retard overbrowsing by "locally overabundant" deer and moose. However, slash in streams can disrupt water flow and cause sedimentation problems and should be removed during timber harvest operations.

Rock piles such as stone walls, old foundations, and other exposed rocks provide cover and microhabitats used by small, forest-floor mammals, reptiles, and amphibians. Some of these sites are valuable as cultural resources in addition to their wildlife habitat value.

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PART TWO: Forest Habitat Management

4. FOREST MANAGEMENT: AN OVERVIEW

In Vermont today, nearly 76 percent of the landscape consists of forest. This is in stark contrast to the Vermont landscape of the 1800s when vast areas were cleared for farming and agriculture. Over time, the Vermont landscape has returned to a largely forested condition with a wide variety of forest community types. This matrix of forest habitats, which comprises large and small patches connected by streams, wetlands, fencerows, and forest strips, creates valuable wildlife habitat. On the landscape scale, these forest blocks provide habitat for many, if not most, of Vermont's native wildlife. In fact, the Vermont Fish and Wildlife Department developed a GIS layer that illustrates the extent of forest blocks throughout Vermont and serves as a valuable tool for understanding the location, distribution, size, and condition of these habitat features at a broad scale (see Figure 4.1).

Forest habitats consist of many different tree and plant species that comprise an array of natural communities ranging from the large and widely distributed northern hardwood forest to the scarce and sensitive clayplain forest. To fully benefit from the natural community concept for habitat management, you will need to gain an understanding of a wide range of plants and animals that interact together to create the various communities. While not essential for managing habitat for wildlife, this understanding of, and appreciation for, natural communities will allow your land to achieve greater benefits from your management actions.

Fine scale habitat elements, such as snags, stumps, dead and down trees, rock piles, and concentrated areas of nut-producing trees (mast) such as red oak and American beech, are all part of the larger forest habitat conditions and are especially important to identify and understand for effective forest habitat management.

Many of the important concepts covered in **Chapter 3, "Habitat Concepts and Features,"** will help you make informed decisions about how to manage an area of forest to benefit wildlife habitat. For instance, if you wish to develop old forest conditions (a condition that is uncommon in Vermont), you may elect to increase the density of large-diameter live and dead trees within the management area. This in turn requires that consideration be given to retention of snags and down woody material for perch sites, cavity trees, drumming logs, and escape cover. It also requires careful attention and patience to increase the density of large-diameter trees. Old forests are highly complex forest systems and provide important wildlife habitat values not found in mid-aged forests, such as habitat for American marten, a rare, wide-ranging carnivore that is native to Vermont and dependent upon mature, old softwood forests with diverse structure consisting of standing and down woody material that attracts and supports the small mammals it preys upon.

This chapter provides information on some important forest habitat conditions that should be considered when developing a management plan for forest wildlife habitat. Many useful and important references on this subject exist and you are encouraged to supplement the information in this guidebook through the recommended readings referenced at the end of each chapter in **Resources**.

To fully benefit from the natural community concept for habitat management, you will need to gain an understanding of a wide range of plants and animals that interact together to create the various communities.

F5 BLOCK SIZE

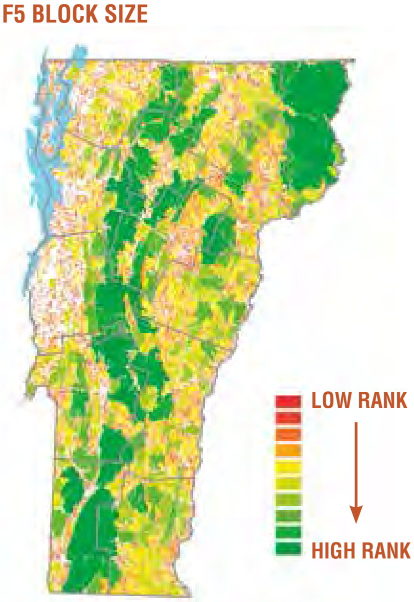

Figure 4.1
Forest blocks in Vermont as seen through GIS

5. MANAGING WITH A FOCUS ON NATURAL COMMUNITIES

When managing significant natural communities, you should strive to maintain or enhance the characteristics of the specific natural community type.

Figure 5.1
Pitcher plants are a rare species found in bogs.

A natural community is an interacting assemblage of plants and animals, their physical environment, and the natural processes that affect them. As these assemblages of plants and animals repeat across the landscape wherever similar environmental conditions exist, these repeating assemblages can be described as natural community types. The Vermont Fish and Wildlife Department (VFWD) recognizes 89 upland and wetland natural community types in Vermont. Natural communities provide a powerful tool for describing the landscape, developing sound management plans for land, determining conservation priorities, and increasing our understanding of the natural world.

Each community type is ranked based on how rare it is in Vermont as well as its size and condition. There are common and widespread natural communities, such as northern hardwood forest and alder swamps; uncommon types such as northern white cedar swamp and dry oak forest, and rare types such as clayplain forest and poor fen. Rarity ranks are based on the number of known examples of the type, the total area occupied by the type, and the degree of threat to the type. For example, calcareous riverside seep is a very rare wetland community type that occurs only in areas of calcareous groundwater seepage over flood-scoured bedrock river shores, whereas northern hardwood forest is a common community type that occurs throughout the state at elevations below 2,500 feet.

The VFWD evaluates each natural community type by comparing it to other known examples of that natural community type. This makes it possible to objectively compare all the known examples of a type (such as poor fen) to decide which examples are the best and most important for conservation and which would benefit from specific management. This quality rank for each natural community is based on an assessment of the size and current condition of the natural community, and the landscape context in which the community occurs. Each of these three factors is assigned an appropriate weight based on the specific community type and its characteristics. Large size, condition reflecting minimal human disturbance, and a surrounding landscape with intact natural communities and minimal fragmentation are all factors that contribute to a highly ranked natural community.

Based on the rarity of the natural community type and the quality of each natural community example, the VFWD considers a subset of the best examples of each natural community type to be state-significant. Significant natural communities are mapped in the Department's Natural Heritage Database (see **Resources** for a link to more information).

Natural communities vary in their sensitivity to human alteration. Some communities are very dependent on specific conditions such as shade or water flow, and even small changes to these conditions from timber harvesting or ground disturbance can lower the value of the community for native wildlife. Other communities, such as cliffs and talus or widespread forests, are more resilient.

When managing significant natural communities, you should strive to maintain or enhance the characteristics of the specific natural community type. For rare, ecologically sensitive, and very small natural communities, such as a rich fen, or a red maple-black gum swamp, this will usually mean taking a passive approach and buffering the area from active management. In some cases, removing nonnative invasive species or planting native species can improve the value of a degraded natural community. For more common and larger natural communities, such as northern hardwood forest, you should have ample opportunity to balance natural community conservation with active management. To maintain or enhance ecological integrity, include forest management practices that favor native species and structural characteristics of mature natural communities, for example, allowing natural processes such as tree death and blowdown, removal or control of invasive exotic species, and restorative planting of native species.

Natural communities provide a powerful tool for describing the landscape, developing sound management plans for land, determining conservation priorities, and increasing our understanding of the natural world.

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Vermont Fish and Wildlife Department. Natural Heritage Inventory. http://www.vtfishandwildlife.com/nnhp_inventory.cfm

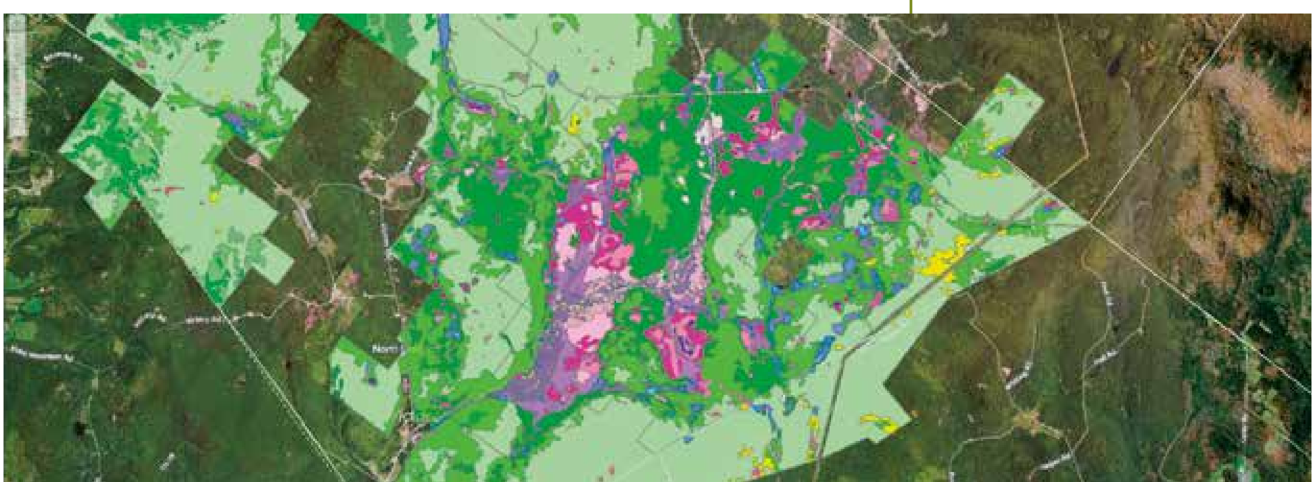


Figure 5.2
Natural community map of Victory Basin Wildlife Management Area

6. MANAGEMENT FOR FOREST SONGBIRDS

Managing local forests to improve habitat for forest birds can greatly improve breeding, nesting, and feeding habitat for many migrant and resident birds.

Vermont supports roughly 200 species of breeding birds, approximately three-quarters of which rely on forests for all or part of their requirements during the breeding season. Among them are the American woodcock, ruffed grouse, barred owl, red-shouldered hawk, pileated woodpecker, scarlet tanager, red-eyed vireo, black-throated blue warbler, ovenbird, wood thrush, and — Vermont's State Bird — the hermit thrush. Vermont's forests are especially important for many species of birds, which rely on the state and New England for a large portion of their breeding habitat (e.g., Bicknell's thrush and American redstart).

Since widespread forest clearing in the 1800s and early 1900s, Vermont's forests have regrown to cover about 80 percent of the state, and more interior forest habitat exists in Vermont now than at any point in the last 150 years. During recent decades some species of forest birds have increased in population (such as golden-crowned kinglet and hermit thrush), while others have undergone worrisome declines (including wood thrush and American woodcock).

Managing local forests to improve habitat for forest birds can greatly improve breeding, nesting, and feeding habitat for many migrant and resident species. Whether you want to manage your forest to help conserve birds — or just to enjoy their color and liveliness — there are many ways you can improve forest habitats for birds.

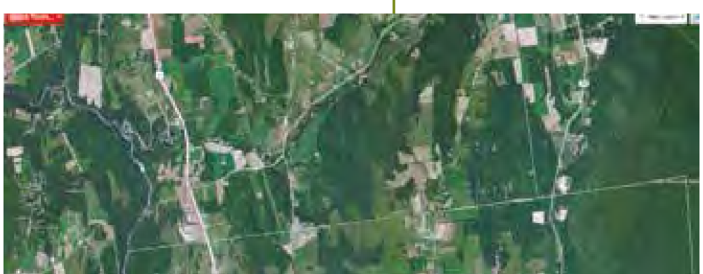


Figure 6.1 Fragmented forest
Small and fragmented forests have less value for forest birds.

KEEP FORESTS AS FORESTS

Keeping forests intact is possibly the most important way Vermonters can support forest birds. Habitat loss and fragmentation are among the most urgent threats to Vermont's forest birds. This is because large patches of forest that are not "fragmented" by roads, buildings, or other development tend to support more forest birds, and the birds living there produce more offspring than birds in smaller, fragmented forests.

An opening in a forest such as a road or house lot alters the environment of the forest for more than 200 meters. Sunlight, wind, humidity, plants, insects, and predators can all change. For example, small (< 30 acres) and fragmented forest patches may support more predators such as raccoons, skunks, and domestic cats and the nest parasite brown-headed cowbird — all of which threaten forest birds.

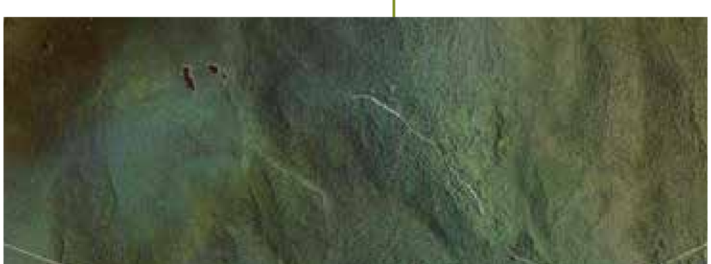


Figure 6.2 Unfragmented forest
Large, intact forests with wetlands and small openings are ideal for forest birds.

Maintain Interior Forest

To avoid fragmenting existing forest, limit the creation of new openings (e.g., roads, large agricultural fields, house lots) and place any openings near existing roads and development, preserving intact forest in the largest blocks possible. Maintaining the quality of forest habitat for songbirds is important. Quality forest habitat for many songbirds provides sufficient space, cover, food, and water to allow the myriad of birds to successfully breed, rear young, find food, and avoid predators. (For more information on this topic see "Foresters for the Birds Toolkit" at http://vt.audubon.org/foresters-birds.)

Plan in Your Town

Find out if birds and wildlife have been considered in your town plan and zoning ordinances. Many resources exist to assist towns in incorporating wildlife into their plans; consider starting with the Vermont Fish and Wildlife Department's Community Wildlife Program or the Vermont Natural Resources Council's Sustainable Communities Program (see **Resources** for links).

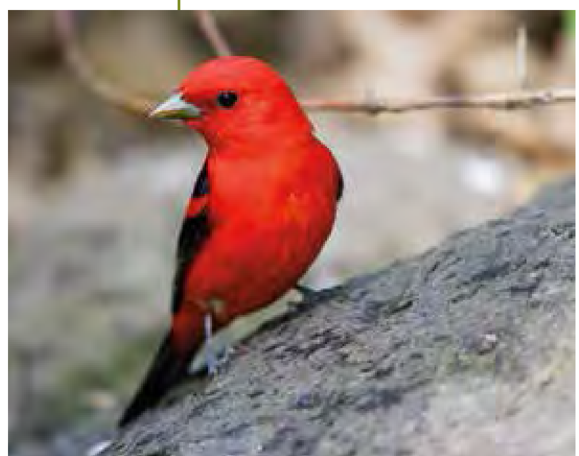
CREATE DIVERSE FOREST HABITATS

A complex forested landscape with many habitats generally supports more species than a less complex forest with few habitats. Knowing this, you can create habitat diversity within forests by increasing their complexity in two ways: increasing the ***horizontal structure*** and ***vertical structure*** of the forest.

Young forest provides important breeding habitat for many species as well as foraging areas for many forest birds, especially before and during migration.

Horizontal Structure: Habitats across the Landscape

The mix of different types and ages of forests across a landscape is called horizontal structure. Walking in a northern hardwood forest in early summer, you will likely notice red-eyed vireos and ovenbirds, while walking in a spruce-fir forest you might see yellow-bellied flycatchers and Swainson's thrush, and in a forested wetland you might spot white-throated sparrows and wood ducks. These different types of habitats across the landscape support a variety of forest birds. Some steps to follow include the following:



Maintain different types of habitat. Plan your forest management to maintain or enhance the diversity of habitats (e.g., hardwood, softwood, wetland, and floodplain) on your property. Given the average property in Vermont is 40 acres, it's becoming increasingly difficult for a single landowner to provide a diversity of habitat conditions. Again, this speaks to the importance of working in collaboration with your neighbors to maximize the benefits of forest and habitat management on a larger scale.

Use buffers for streams and wetlands. To protect sensitive and valuable streams and wetlands, designate limited- or no-harvesting areas along the borders of streams, rivers, lakes, ponds, and wetlands. These areas where terrestrial and aquatic habitats come together tend to support many types of birds, mammals, reptiles, amphibians, insects, and plants. They are used as travel corridors by many wildlife species such as otter and black bear, and offer important feeding areas for moose, waterfowl, wood turtles, and many songbirds. Protecting the health of the forest conditions along these aquatic features is an important management strategy.

Ensuring a variety of *ages* of different forest types on the landscape provides additional diversity for birds. Most of the forested landscape in Vermont consists of forests that are 40 to 100 years old. Older, more mature forests are rare in Vermont. Old forests, more than 100 years in age, tend to have high levels of woody material on the ground, cavity trees, and other features that create complexity within the forest that then provide important habitat for many species of wildlife such as pileated woodpecker and American marten.

In addition, there are regions of Vermont (e.g., Bennington County) where young forest (less than 15 years old) is limited. Young forest provides important breeding habitat for many species as well as foraging areas for many forest birds, especially before and during migration. Providing these underrepresented age classes can benefit forest birds:

Manage for old forest. Designate set-aside areas that will, over time, become old forests, and other areas that will be actively managed to develop the characteristics of old forest.

Manage for young forest. If your landscape is mostly forested, but less than 5 percent of the area is young, regenerating forest, consider creating 1- to 5-acre patches of young forest habitat where appropriate. Creating quality young forest habitat requires a detailed knowledge of the soils, trees, and land use history of your land. Not every patch of forest can be treated by cutting trees and expecting quality young forest habitat conditions. Results from such management actions depend on many factors, including what trees are currently present. If the objective is to create young forest to attract ruffed grouse, American woodcock, and chestnut-sided warbler, you are unlikely to be successful by creating patch cuts in a northern white cedar stand, for instance. On the other hand, if your forest has mature aspen, birch, hophornbeam, and alder, you have a good opportunity to establish quality young forest conditions to achieve your objectives. (See **Chapter 7, "Shrubland and Young Forest Management,"** for more information.)

Vertical Structure: Layers within a Forest

The diversity of vegetation layers within a forest, from ground to tree canopy, is called vertical structure, and it is an important element of forest habitat for many birds. Different species of birds forage and nest within the different layers of a forest — for example, in one patch of forest, you might find nesting pairs of ovenbirds in the leaf litter on the ground, black-throated blue warblers in a thick understory of hobble bush (1 to 5 feet up), blue-headed vireos in the midstory (6 to 30 feet up), and scarlet tanagers in the canopy of mature northern hardwood forest (above 30 feet).

You can enhance each vertical layer of your forest to increase its value for birds by:

Promoting a healthy leaf litter layer. Reduce erosion and compaction by harvesting in winter on snow cover. Maintain canopy cover to prevent litter from drying out.

Promoting a vigorous understory and midstory. If needed, work with a forester or wildlife biologist to release seedlings and saplings from surrounding competition and create gaps to allow light to the understory.

Promoting a vigorous canopy. If needed, work with a forester or wildlife biologist to use thinning or crop-tree release to focus growth on healthy canopy trees. Retain and grow some large-diameter trees (over 2 feet in diameter), which can be particularly important for a variety of wildlife.

Monitoring and controlling invasive plants. In addition to out-competing desirable, native plants, nonnative species may have less nutritional and nesting value to forest birds. For more information, visit www.vtinvasives.org.

Apart from the living layers present in a forest, dead and dying wood creates critical habitat for many species of forest birds. Snags (standing dead trees) and partially decayed live trees are valuable perches and provide nest sites for cavity-nesting birds such as woodpeckers,

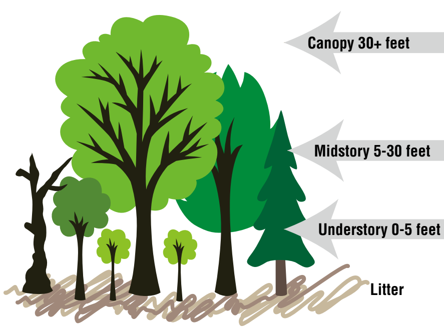


Figure 6.3
Complex vertical layers provide excellent forest bird habitat. (Don't overlook the snag!)

chickadees, and owls. Dead wood on the ground is also valuable to birds as display sites (e.g., for ruffed grouse drumming sites), cover (to forage safely on the ground), and food (many insects live in dead wood). To ensure quality habitat for birds on your land:

Maintain or create snags and downed wood. Maintain at least six snags or cavity trees per acre, with one larger than 18 inches, two larger than 16 inches, and four downed trees per acre. Leave slash (branches, limbs, etc.) on the forest floor. Residual material from timber harvests provides valuable habitat for ground-nesting songbirds, as well as other wildlife.

BEYOND BIRDS

Management for forest birds can brighten the woods with their colors and songs. It also benefits many other wildlife species. Forests that support a variety of birds, with complex horizontal and vertical structure, dead and downed wood, and trees of all ages and sizes, also provide habitat for a wide variety of forest wildlife. These include white-tailed deer, black bear, weasel, fisher, fox, and coyote.

Forests that support a variety of birds, with complex horizontal and vertical structure, dead and downed wood, and trees of all ages and sizes, also provide habitat for a wide variety of forest wildlife.

NEXT STEPS

Before you proceed further with your plan, consider getting a second opinion and double-checking available resources:

- Use a forester or wildlife biologist to help inform your forest management plan. Have a forester or wildlife biologist create and implement your forest management plan, including goals and actions to benefit forest birds.
- Consult with professionals. Contact your county forester or biologists with Vermont Fish and Wildlife Department, Audubon Vermont, or the Natural Resources Conservation Service for more guidance and information on programs that provide technical and financial assistance.
- Read “Managing Your Woods with Birds in Mind.” This free guide is an invaluable resource for landowners and managers created by Audubon Vermont and the Vermont Department of Forests, Parks and Recreation (see **Resources**).

RESOURCES

Audubon Vermont and the Vermont Department of Forests, Parks and Recreation. “Managing Your Woods with Birds in Mind.” http://vt.audubon.org/sites/default/files/documents/landowner_packet_5-2012_small.pdf

—. Foresters for the Birds. http://vt.audubon.org/foresters-birds

Bryan, R.R. 2007. *Focus Species Forestry: A Guide to Integrating Timber and Biodiversity Management in Maine.* Falmouth, ME: Maine Audubon.

DeGraaf, R.M., M. Yamasaki, W.B. Leak, A.M. Lester. 2005. *Landowner’s Guide to Wildlife Habitat – Forest Management for the New England Region.* Lebanon, NH: University Press of New England

U.S. Department of Agriculture. Natural Resources Conservation Service. Forest Birds Info Sheet. http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1243274&ext=pdf

—. Sustainable Communities Program. http://ric.nal.usda.gov/sustainable-communities

Vermont Fish and Wildlife Department. Community Wildlife Program. http://www.vtfishandwildlife.com/cwp_home.cfm

7. SHRUBLAND AND YOUNG FOREST HABITAT MANAGEMENT

Shrubland habitat and young forest differ in the vegetation types and food and cover they provide, as well as where and how they are maintained on the landscape.

"Shrubland" and "young forest" are terms that apply to areas that are transitioning to mature forest and are dominated by seedlings, saplings, and shrubs with interspersed grasses and forbs (herbaceous plants). While some sites such as wetlands, sandy sites, and ledge areas can support a relatively stable shrub cover, most shrub communities in the Northeast are successional and change rapidly to mature forest if left unmanaged.

Shrub and young forest habitats in Vermont provide important habitat functions for a variety of wildlife including shrubland birds, butterflies and bees, black bear, deer, moose, snowshoe hare, and bobcat, as well as a variety of reptiles and amphibians. Many shrubland species are in decline due to loss of habitat. Shrubland bird species in Vermont include common species such as chestnut-sided warbler, white-throated sparrow, ruffed grouse, eastern towhee, American woodcock, brown thrasher, Nashville warbler, and rarer species such as prairie warbler and golden-winged warbler. These habitat types are used by 29 Vermont Species of Greatest Conservation Need.

Figure 7.1
Regeneration-shrub habitat. Courtesy of Paul Hamelin, VFWD.

While small areas of shrub and young forest habitat can be important to some wildlife, managing large patches of 5 acres or more provides much greater benefit to the wildlife that rely on the associated habitat conditions to meet their life requirements. Birds such as the chestnut-sided warbler will use smaller areas of young forest, but less common species such as golden-winged warbler require areas of 25 acres or more.

AREA SELECTION

To practically meet the needs of wildlife that use shrub and young forest habitat, maintain 8 to 10 percent of the property in shrub or young forest cover. As with managing other habitats, managing for young forest or shrubland habitat can be challenging. In order to promote diversity in the age structure of your forest and wildlife therein, maintain large areas of older forest stands with snags and various sizes of coarse woody debris on the forest floor to provide important cover for small mammals, salamanders, and insects. Cut selectively to promote trees that are important food sources for wildlife such as beech, oak, cherry, and apple.

Figure 7.2
American woodcock are in decline due to lack of habitat. Courtesy of Kathy Decker, VFPR.

Working with your county or consulting forester or wildlife biologist can help. Professional foresters and wildlife biologists can provide expertise in managing young forests that will improve your chances for successfully accomplishing your habitat management goals, especially since selecting appropriate sites with appropriate tree and shrub species is essential for realizing your wildlife goals.

Shrubland habitat and young forest differ in the vegetation types and food and cover they provide, as well as where and how they are maintained on the landscape. For these reasons the habitat types will be considered separately.

SHRUBLAND MANAGEMENT TECHNIQUES AND GUIDELINES

Shrubland is generally considered to be an area with high sunlight exposure that remains permanently in a state of low plant cover, ranging from herbaceous plants to woody plants less than 20 feet tall. Shrublands are nature's pantry, providing myriad insects, fruits, seeds, and nuts. Dogwoods, serviceberry, chokecherry, blueberry, blackberry, hazelnut, mountain holly, and wild cranberry are just a few of the numerous shrubs of high value to wildlife. Although a few shrublands such as alder stands are naturally stable, most shrub areas will require periodic brush mowing to maintain their productivity and prevent invading tree species from converting them to forest.

A shrubland is initially established on a forested site by cutting all trees, either by harvesting marketable timber and requiring all smaller trees to be cut, or by contracting a mechanical rotary cutter to chop up non-merchantable trees. Repeated brush hogging every 5 years will suppress the establishment of tree species, allowing shorter-lived shrubs to colonize the area. Old fields can become shrublands by allowing shrubs to become established naturally over time, then mowing as noted above. The primary goal of shrubland management is to concurrently have half of the area in mature, fruit-producing shrubs, and the other half in younger, regenerating shrubs. This is accomplished by brush hogging half of the shrubland area every 5 years.

Shrubland size is determined by your goals, parcel size, and surrounding landscape. For example, if you have a keen interest in conservation of golden-winged warblers, you may be able to maintain a 10-acre shrubland adjacent to a neighbor's 10-acre shrubland, paralleled by a 5-acre power line corridor. The combined 25 acres is sufficient for golden-winged warblers, and will benefit many other birds and mammals.

A practical approach for most landowners is to manage 10 percent of a parcel as shrubland by identifying one or more areas to be maintained in permanent shrub cover. Each site should be no smaller than an acre in size (the minimum size of value for many wildlife species), but ideally as large as possible up to 10 percent of the acreage. For example, a 20-acre parcel would have 2 acres in shrubland, and half of the 2 acres would be mowed every 5 years.

YOUNG FOREST MANAGEMENT TECHNIQUES AND GUIDELINES

Young forest is an area dominated by seedlings and saplings of forest trees, such as aspen, maple, oak, pine, spruce, etc., rather than shrubs. Although young forest provides wildlife with many of the same structural habitat elements as shrubland, it differs in two important ways: the dense cover is a temporary condition that quickly transitions to a more open forest as the trees mature, and it normally provides less forage in the form of fruits and seeds. Left unmanaged, young forest will transition or mature over time. However, this condition can be maintained over time with active management.

Although young forest provides wildlife with many of the same structural habitat elements as shrubland, it differs in two important ways: the dense cover is a temporary condition that quickly transitions to a more open forest as the trees mature, and it normally provides much less forage in the form of fruits and seeds.

When evaluating land for opportunities for young forest management, first identify any stands with "pioneer" species — the first to colonize old field sites — such as pin cherry, aspen, alder, and paper or grey birch, as these sites will produce young forest and shrub habitat very quickly. If creating young forest habitat adjacent to a utility line corridor (power line, pipeline) or existing shrub or young forest cover (old field or orchard, alder or shrub wetland, etc.), this will increase the functional size and benefits of the new habitat patch. If no "pioneer" tree stands exist, then consider stands that have a high percentage of poor-quality trees or have been "high graded" (i.e., all the best trees have previously been harvested). They are also good candidates to regenerate and manage as young forest habitat. Keep in mind that not all sites that have been "high graded" or have a high percentage of poor-quality trees should be considered for creating young forest conditions. These may also be suitable sites for developing old forest conditions if given enough time, patience, and careful stewardship, as discussed previously. Finally, forest stands with high-quality trees that have been identified by a professional forester as mature (ready for harvest) can produce income, wood products, and young forest habitat. Regenerating these stands should only be done under the guidance of a forest management plan prepared by a professional forester or wildlife biologist in order to protect water quality, ensure restocking with desirable tree species, and meet the landowner's expectations for wildlife, recreation, and aesthetics.

MECHANICAL AND MANUAL MEANS

The most common management practice for creating young forest habitat is through manual (chainsaw/brush saw) or mechanical cutting of trees and shrubs. Exactly how and when the cutting takes place is critical to successfully regenerating the desired trees on the site. For example, aspen, paper birch, grey birch, and northern hardwood stands are efficiently regenerated into young forest by cutting all stems greater than 2 inches in diameter (clear-cutting), in a patch a least ½ acre in size but preferably larger, up to 10 acres. However, an oak or pine forest must be harvested in a manner that carefully retains some shade, (a shelter-wood cut), timed carefully with the deposition of seeds from the retained trees. Spruce and fir are regenerated in strips or a patchwork of small patches, 1/2 to 2 acres in size in a manner that accounts for the presence of existing seedlings and saplings. Cedar and hemlock stands are very difficult to regenerate back to the same species, and are not recommended as suitable stands for the creation of young forest habitat. Obviously, proper forest management is complicated and requires the application of the science of silviculture by a professional forester or wildlife biologist. Additional information is available in the **Resources** listed at the end of this chapter, and landowners are strongly advised to consult a professional prior to initiating any work on the ground.

CHECKERBOARD AND NATURAL CUTS

There are a number of ways to configure and distribute new patches of managed young forest. Checkerboard patterns are a traditional approach that can be effective for creating a diversity of interspersed patches of young forest. Alternatively, patches can be configured in a more convoluted fashion. This more closely mimics a natural disturbance and if done correctly can create higher value young forest habitat due to increased forest edge. Figure 7.3, a and b, illustrates these approaches.

CUTTING ON ROTATION

For landowners with large parcels (50 acres or more), managing a number of large blocks (5 to 10 acres) on a rotation is ideal to keep 10 percent of the parcel in forest under 15 years of age. This provides for a wide variety of wildlife species that use open areas, such as bluebirds, to species that use thick vegetation, such as ruffed grouse. When possible, management should occur outside the primary nesting season of April 15 to August 1. Cutting should be done in winter when the ground is frozen and plants are dormant. This will encourage vigorous sprouting of trees, provide an increased number of stems per acre, and protect the soil and duff layer from disturbance. The duff layer, including the organic soil horizon and leaf litter, provides important habitat for salamanders and feeding areas for species such as rufous-sided towhees.

Figure 7.3 a and b
Checkerboard pattern (top) and a more convoluted pattern (bottom) can create a diversity of interspersed patches of young forest.

NEXT STEPS

- In order to promote diversity in the age structure of the forest, maintain large areas of older forest stands with snags and various sizes of coarse woody debris on the forest floor to provide important cover for small mammals, salamanders, and insects.
- Select areas to create young forest ("regenerate") carefully, in order to retain trees that are important food sources for wildlife such as beech, oak, cherry, and apple.
- Do not cut snags, den trees, or nest trees.
- Leave downed logs and brush piles on the forest floor. These will be used by many different species.
- Follow Vermont Department of Forests, Parks and Recreation harvesting guidelines designed to maintain water quality and protect rare or fragile areas or species.
- Control any invasive species such as common buckthorn or honeysuckle prior to harvest because they will likely spread and may dominate the site; continue to monitor for invasive species after harvest.
- Monitor for the presence of invasive plants such as honeysuckle and buckthorn, and remove them as the opportunity presents itself.

RESOURCES

Northeast Habitat Technical Committee. "Managing Grasslands, Shrublands, and Young Forest Habitats for Wildlife: A Guide for the Northeast." http://www.wildlife.state.nh.us/Wildlife/Northeast_Hab_Mgt_Guide.htm

U.S. Department of Agriculture, Natural Resources Conservation Service. "What is Early Successional Habitat?" http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081109.pdf

—."What are Shrubland Birds?" http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081112.pdf

—."American Woodcock: Habitat Best Management Practices for the Northeast." http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=28815.wba

The Young Forest Project. www.youngforest.org

8. DEER WINTERING AREA MANAGEMENT

Stand maturity, canopy closure, crown shape and height, tree species, slope, and aspect are all important factors that determine whether or not deer will overwinter in a particular area.

White-tailed deer in Vermont live near the northern limit of their range in eastern North America. To survive, deer must use very specific winter habitat when severe climatic conditions become a threat.

Areas that are used year after year by deer seeking winter shelter are called *wintering areas* or *deer yards*. These areas consist of two basic habitat components. The *core range* is often characterized by concentrations of softwoods with high crown closure. This provides numerous thermal and microclimatic advantages to the deer such as reduced snow depths, less wind, increased daily mean temperatures, and increased relative humidity. South-facing slopes are often preferred yarding areas because they receive more direct solar radiation. The second component consists of mixed hardwood and softwoods adjacent to or within the core range, which provide accessible browse.

Stand maturity, canopy closure, crown shape and height, tree species, slope, and aspect are all important factors that determine whether or not deer will overwinter in a particular area. For example, snow cover is often melted or blown off steep, south-facing slopes in southern Vermont, and deer may be found on these slopes even when very little softwood cover is available.

IDENTIFYING WINTERING AREAS

Physical evidence of use by deer is the best way to determine whether an area can be considered a wintering area. The most obvious indications of very recent deer use include tracks, trails, and droppings. Other less obvious, though more reliable, indicators of deer wintering area are the more permanent signs of deer use on vegetation, such as browsing and bark scarring.

Browsing on young, small-diameter twigs and branches should be evident, even though the intensity of deer browsing may vary from site to site. Seedlings and saplings in heavily used areas have a deformed or "broomy" appearance. Bark scars from deer feeding can be visible to the trained eye for 20 years. Well-worn deer paths may also be evident.

Maps of currently known deer wintering areas are available from town clerks, regional planning commissions, and at each Vermont Fish and Wildlife Department district office. They are also available from the ANR Natural Resources Atlas at the link in **Resources**. (See Figure 8.2 as an example of a wintering area map.) In addition, upon request, a wildlife biologist can be available to meet with resource managers and interested private landowners for on-the-ground reconnaissance of suspect areas.

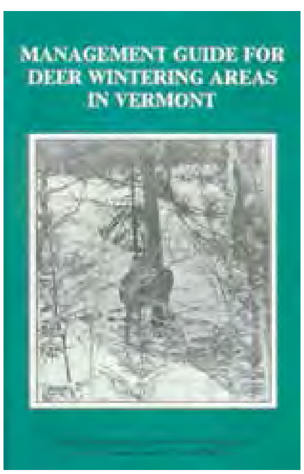


Figure 8.1
Management Guide for Deer Wintering Areas in Vermont

WINTERING AREA MANAGEMENT

The management goal for all deer wintering areas, regardless of species composition, is to prolong the useful life of the habitat by:

- Perpetuating softwood shelter through appropriate timber harvests using single tree and small group selection harvests, focused on releasing advanced softwood regeneration;
- Maintaining deer mobility and access throughout all non-regenerating segments of the wintering area; and

- Providing preferred, accessible browse, where appropriate and without compromising the softwood cover.

In the short term, any cutting of the softwood component reduces the winter shelter value and carrying capacity of the area. Any management plan for a deer wintering area must be designed to provide a minimum of at least one-half (50 percent) of the entire wintering area to be in "functional shelter" at all times. Throughout this book, "functional shelter" is defined as softwood cover at least 35 feet tall, with at least 70 percent crown closure. It is important to recognize, however, that within a wintering area, there will be variability and not all of the habitat may meet these thresholds, yet they are still an important, functional part of the overall winter habitat. For additional information on managing deer wintering areas refer to the *Management Guide for Deer Wintering Areas in Vermont* available from the Vermont Fish and Wildlife Department offices or from the department website. See **Resources** for links.

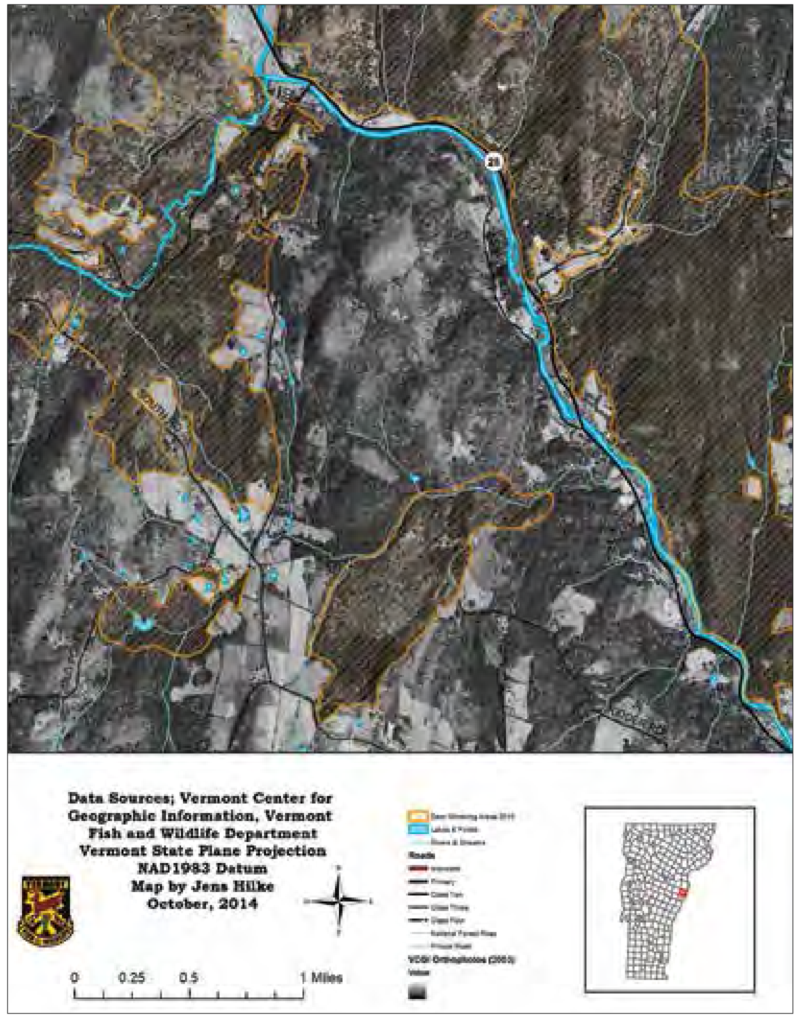


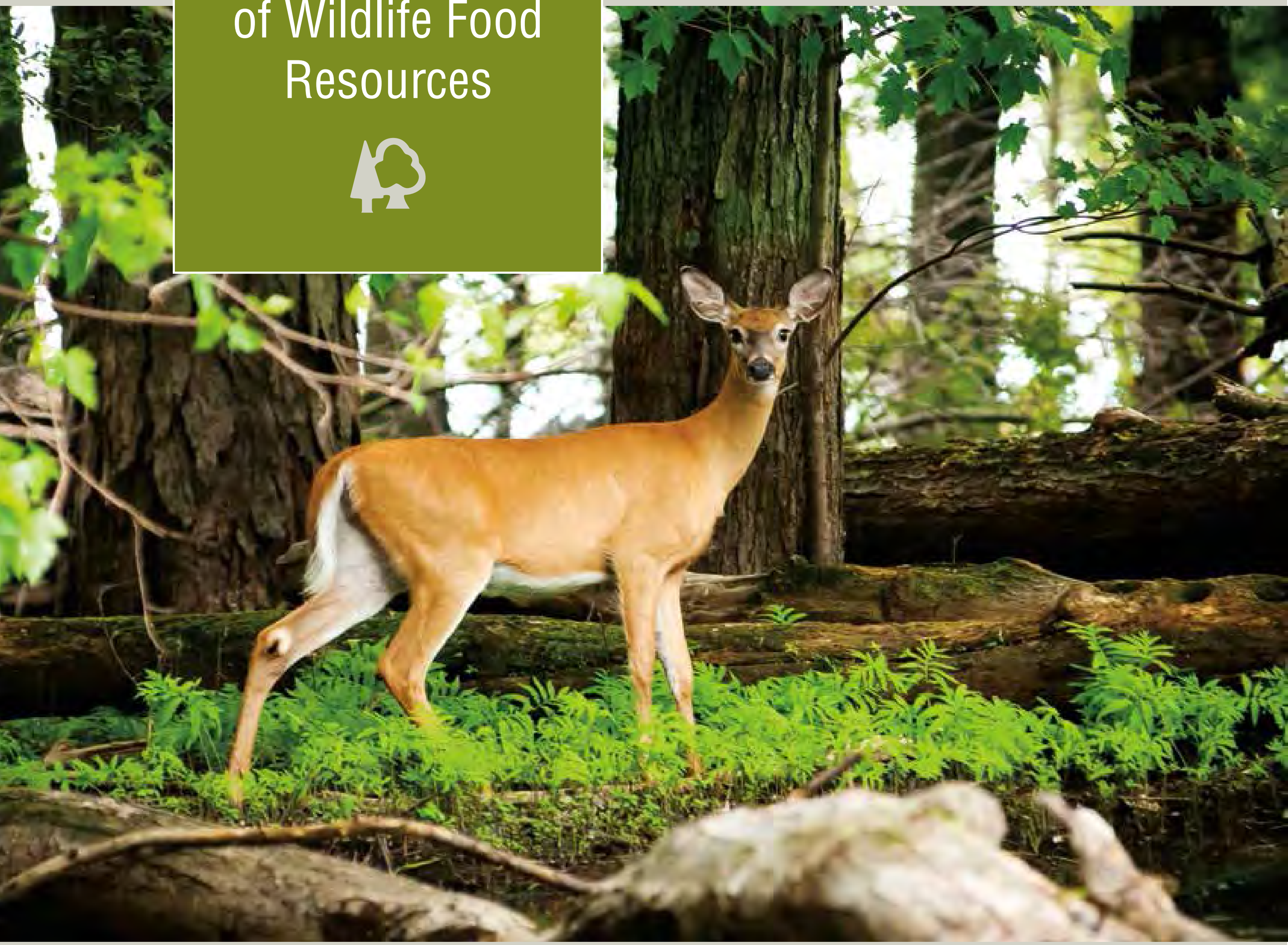
Figure 8.2
Sample of a map of deer wintering areas

RESOURCES

Vermont Agency of Natural Resources. Natural Resources Atlas. http://anrmaps.vermont.gov/websites/anra/

Vermont Fish and Wildlife Department. "Management Guide for Deer Wintering Areas in Vermont." http://www.vtfishandwildlife.com/library/Reports_and_Documents/Fish_and_Wildlife/Management%20Guide%20for%20Deer%20Wintering%20Areas%20in%20Vermont.pdf

PART THREE:
Managing for Production of Wildlife Food Resources



9. BEECH MAST PRODUCTION MANAGEMENT

In a mast production area the most mast is produced by dominant and co-dominant American beech trees, and some trees are much more prolific than others. Evidence of feeding by bears (claw scars on the bark, clusters of broken limbs pulled into a feeding "nest" in the fall) indicates the most prolific, consistent mast producers. Mast production begins when beech trees are about 10 inches in diameter at breast height (DBH). Forest management decisions aimed at maintaining or increasing mast production will focus on larger beech, as well as beech 6- to 10-inch DBH because of their potential for mast production or resistance or tolerance to beech bark disease (BBD). Beech stand management decisions should be made in the summer, as crown condition is an excellent indicator of tree vigor and capacity to produce beechnuts. When greater than 10 percent of the crown of beech trees stressed by BBD turns yellow by midsummer, the tree has an elevated risk for mortality. When more than 50 percent of the crown is yellow and/or has died, the tree has more than a 50 percent chance of dying within a few years. Bark condition is an indicator of the tree's level of resistance to, or tolerance of BBD infection.

Figure 9.1
Beech trees are essential mast producers.

VERMONT AGENCY OF NATURAL RESOURCES GUIDELINES TO ENHANCE BEECHNUT PRODUCTION

Beechnuts ("mast") are a significant staple for many wild animals, ranging from small mammals to black bears, deer, turkeys, ruffed grouse, and other birds. Unfortunately, many beech trees are in poor health due to beech bark disease. Vermont Agency of Natural Resources (ANR) has developed guidelines for identifying *beech mast production areas* with high potential for improvement, and recommendations for management to mitigate the impacts of beech bark disease and maintain beech mast as a significant resource on a landowner's property. The guidelines were developed for ANR lands, but are helpful for managing any land with significant beech mast production. Designed specifically for beech mast production areas, they are not silvicultural guidelines for timber production.

Based upon a synthesis of current literature and knowledge of experts in forest pathology, silviculture, forestry, and habitat management, the recommendations have yet to be field tested and proven effective as a management system. Although the individual components of the recommendations are based upon proven research (for example, mature mast trees do respond to crown release), the guidelines as prescribed have not yet been proven to produce the desired outcome. ANR will implement the guidelines at a few test sites on state lands, but as with many forestry practices, it will be years before the effectiveness can be determined.

The guidelines offer a science-based approach to active management of "bear-scarred" American beech stands for forest managers wishing to try an alternative to "doing nothing" for bear-scarred beech. Worse than "doing nothing" would be harvesting beech or other trees within or near bear feeding stands without the benefit of the latest research on disease resistance and mast production.

The document is available for download on the Vermont Fish and Wildlife Department website, www.vtfishandwildlife.com under the title "VT ANR Beech MPA Guideline."

Figure 9.2 American beech is a common and abundant native tree in Vermont forests whose nuts are an important source of food for many wildlife. Photo courtesy of Tom Rogers, VFWD.

SELECTING CROP TREES TO RETAIN AND ENHANCE

When making decisions on which trees to retain and enhance, consider the following factors (in order of priority):

1. *Resistant to BBD, good mast producer:* Large crown ≥10 inches DBH; smooth bark without any evidence of beech bark disease defects, scale, or Nectria; < 10 percent of branches are yellow or recently dead. Bear claw scarring indicates the great value of these "super beech" as mast producers.
2. *Tolerant to scale/BBD, good mast producer:* DBH ≥10 inches, some smooth bark, raised lesions and/or blocky bark show evidence of repeatedly walling off and coping with BBD. There may be signs of beech scale. Less than 20 percent of circumference is affected by injuries affecting cambium; <10 percent of branches yellow or recently dead. Evidence of bear clawing indicates the importance of these trees as mast producers.
3. *Resistant to scale, poor mast producer:* DBH ≥10 inches with smooth bark not showing evidence of BBD, scale, or Nectria, <10 percent of branches yellow or recently dead. These ultra-smooth barked trees, about 2 to 5 percent of the beech population, are desirable to maintain for their contribution to resistance in the population via sexual reproduction.
4. *Resistance to scale and mast both unknown:* Smooth bark, 6 to 10 inches DBH with broad crown, <10 percent of branches yellow or recently dead. Trees are potentially resistant or tolerant, represent future crop trees, and are desirable to retain for their contribution to resistance in the population via sexual reproduction. To address this and other forest health issues, you should contact your local county forester.

SELECTING TREES TO REMOVE

The objective is to release the crowns of crop trees from competition by thinning on three sides (west, north, and east) and retaining trees of any species to shade and prevent sunscald on beech on the south side. When considering which trees to remove, consider the following factors:

- Beech trees BBD susceptible (i.e., sunken lesions) or >50 percent yellow or recently dead crown
- Beech trees BBD tolerant but poor mast producers, with no bear scarring
- Any beech trees ≥6 inches DBH with poor crown development or severe wind snap defect
- Any other tree species ≥6 inches DBH that will release crop trees on west, north, and east sides

HARVESTING GUIDELINES

As beech reproduce prolifically from root suckering, harvest operations should be conducted in winter conditions (frozen ground or greater than 12 inches of snow) to minimize injury to beech roots and trunks. Timber harvests are best conducted using tracked equipment if possible to minimize root damage. Tree species other than beech can be girdled, and not felled, to avoid damage to crop trees or regeneration. However, beech trees are not to be girdled as the tree will regenerate by sprouting before it dies, creating a dense thicket of disease-prone saplings. For more information see **Resources**.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. “What is Forest Stand Improvement?” http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081110.pdf

Vermont Fish and Wildlife Department. “VT ANR Management Guidelines for Optimizing Mast Yields in Beech Mast Production Areas.” http://www.vtfishandwildlife.com/library/Reports_and_Documents/Fish_and_Wildlife/VT%20ANR%20Beech%20MPA%20Guideline%203-22-2011.pdf

Vermont Department of Forests, Parks and Recreation. “Forestry in Vermont: Vermont Voluntary Harvesting Guidelines.” http://www.vtfpr.org/Harvestguidelines.cfm

10. APPLE TREE AND SOFT MAST SHRUB MANAGEMENT

Prolonged periods of crowding and shading will cause a decline in the vigor of apple trees, eventually leading to death and loss of an important food source for wildlife.

Wild apple trees, along with many soft mast shrubs (hawthorn, chokecherry, dogwood, wild raisin, mountain ash, and so on) can be found scattered throughout the Vermont landscape. They provide an important source of food and cover for many species of wildlife, including white-tailed deer, ruffed grouse, snowshoe hare, cottontail rabbit, and gray squirrel. Apples or apple seeds have also been found in the stomachs of fox, fisher, porcupine, bobcat, and red squirrel. Apple trees also provide good nesting habitat for many songbirds, including bluebirds, flycatchers, robins, and orioles.

While only four species of crabapples are native to North America, none are apparently native to Vermont. Regardless, this nonnative tree is not invasive and is considered an important crop and wildlife tree. Vermont is fortunate to have an abundance of wild apple trees growing in young forests and abandoned fields. Yet, many are being lost to succession, disease, and lack of management.

Some of Vermont's wild apple trees were planted by early settlers, while others have grown from seeds deposited by birds and mammals including domesticated livestock. They normally become established in clearings or on field edges, but as forests grow, these trees are crowded by shrubs and shaded by other mature trees. Prolonged periods of crowding and shading will cause a decline in the vigor of apple trees, eventually leading to death and loss of an important food source for wildlife.

You can improve the life span, vigor, and yield of wild apple trees and other soft mast shrubs with some simple techniques that are commonly used by foresters, wildlife biologists, and orchardists. The most effective way to improve the productivity of apple trees and soft mast shrubs is to provide direct sunlight. To increase sunlight, cut the surrounding trees and shrubs that are competing for nutrients, water, space, and sunlight. This process of "release" removes surrounding competition and improves the crop tree or shrub's vigor and production ability.

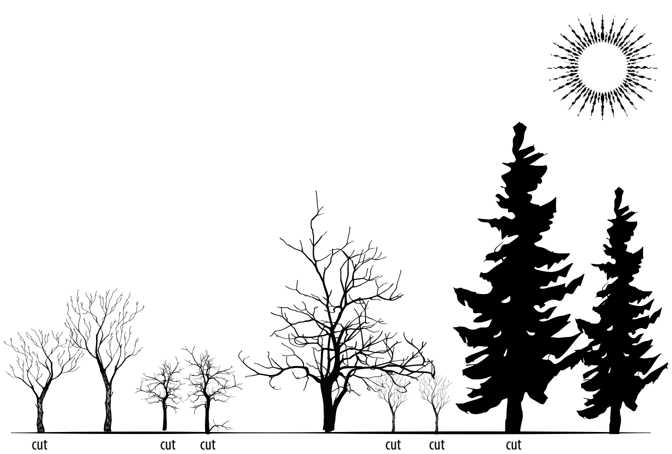


Figure 10.1 a Before release and pruning

Figure 10.1 b After release and pruning

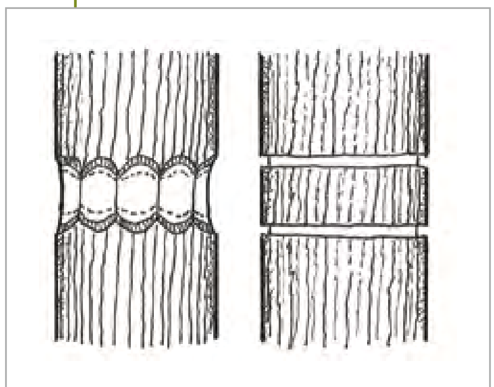
When selecting trees for release, you should consider many factors. If you choose one or two isolated trees to release, it may provide a potential food source but may have limited additional benefits. But if you select an old orchard or areas where there are numerous trees together, this will provide ample opportunities for cross pollination and early successional habitat.

When selecting trees for release, you should choose the healthiest, most vigorous stems, as they have the best chance for survival. Remove any competition that is growing up into the tree, and all other stems that are growing next to or within the drip line of the apple tree's canopy (see Figures 10.1 a and 10.1 b). With direct sunlight being the key factor to successful apple tree enhancement, release may include the removal of large trees outside of the drip line. Focus of sunlight release should be orientated to obtain the most daytime sun. Therefore, release should focus on removal of competition on the south, east, and west sides of the apple tree. To increase the use and value of the tree, try to leave cover on the north side of the tree. You can also girdle trees as an alternative to complete tree removal.

GIRDLING TREES

Girdling is a management technique that involves removing a tree's bark and cambium layer, disrupting the flow of nutrients from the roots to the crown. Girdling may be easier and safer on large trees and can be beneficial to wildlife because a snag (dead/dying tree) can provide feeding, nesting, and roosting sites for a variety of wildlife. Here are some tips:

- Use a chainsaw or ax to cut two encircling cuts through the bark and cambium layer into the wood to a depth of 2 inches.
- The cut band between the encircling cuts should be at least 2 inches wide. ***Note:*** Species such as white pine may require the removal of more wood, as pitch can act as a sealant to heal the wound and allow the girdled tree to survive. See Figures 10.2 a and b for details.



Figures 10.2 a and b
Common girdling techniques

PRUNING TREES

Once a tree has been properly released from the surrounding sunlight competition, pruning is the next step to successful reclamation of these wild apple trees. Pruning should be completed in late winter (December through March) or any time before bud break, while the tree is dormant. When setting up for pruning, before a cut is made, look for the "branch collar," which is a ring of tissue around the base of the branch (see Figure 10.3). Make cuts here and not flush with the main stem to ensure that proper healing of the cut can occur.

The first pruning should focus on removing all the diseased and dead limbs from the apple tree. Cut these off with a pruning saw or shears as close to the living material as possible. Cuts should be made with sharp tools to avoid nicks, stubs, tears, and splits, which can leave the tree vulnerable to insects and disease. Be sure to disinfect pruning tools before starting another tree to avoid transferring viruses or fungi. A simple solution of 1:10 bleach to water or rubbing alcohol, Lysol spray, or flaming tools can also be effective. ***Note:*** Bleach can be corrosive to some metals.

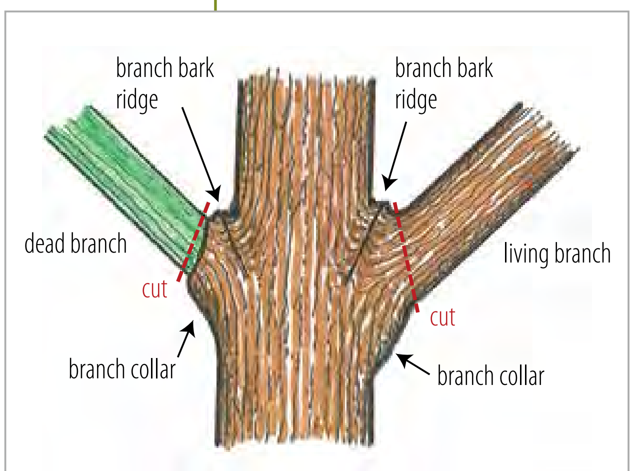


Figure 10.3
Before pruning a limb, look for the branch collar and make your cut here.

Once you've removed dead and dying material, pruning efforts should focus on removing limbs that are crowding out the canopy of the apple tree. In most cases, the removal of one to three limbs is all that is needed to allow sunlight into the remaining canopy. As a rule of thumb, removal should be less than one-third of the overall canopy, as excess removal overstimulates shoot growth. It's always best to spread out large pruning jobs across a few years.

You should also remove branches that cross or rub to prevent areas for insects or disease to take hold. When pruning, be sure to select strong branches with wide crotch angles (near 90 degrees) to the main stem. Limbs with narrow crotch angles (less than 90 degrees) are weak and tend to break under the weight of a crop or heavy snow loads (see Figure 10.4).

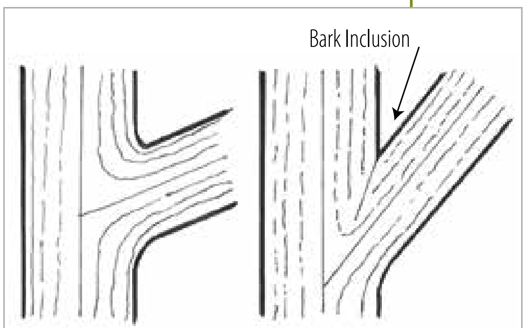


Figure 10.4
Limbs with narrow crotch angles are weak and should be pruned.

Also, remove any upright growing shoots or "water sprouts." These shoots are excessively vigorous and rarely fruit, and often occur in great numbers after "topping" (pruning large upright or vertical branches) or "tipping" (cutting lateral branches between nodes). Minimize tipping and topping by working with the existing form of the tree rather than trying to shape the tree into the way you think it should look. Remember, trees do not have to be in perfect form to provide fruit for wildlife.

Finally, go slow. These trees are wild, may have been neglected for years, or may never have been tended to by humans at all. Pruning apple trees too aggressively or exposing them to sunlight too quickly can shock them and result in poor health or death. With proper maintenance, wild apple trees can be a productive link in the food chain that will lead to years of good wildlife habitat on your land.

RESOURCES

Northeast Habitat Technical Committee. *Managing Grasslands, Shrublands, and Young Forest Habitats for Wildlife: A Guide for the Northeast.* http://www.wildlife.state.nh.us/Wildlife/Northeast_Hab_Mgt_Guide.htm

11. WILDLIFE FOOD PLOT MANAGEMENT

Forest openings may be created artificially through tree harvest, or they may occur naturally due to insect damage, tree disease and mortality, drought, flooding, tree fall, lightning strikes, ice storms, wind, and wild fires. Regardless, openings result in rapid and extensive growth of herbaceous vegetation from increased exposure to sunlight on the forest floor. This growth typically includes sources of nutritious food for some wildlife such as grasses, forbs (herbaceous plants), raspberries, and blackberries. Thus, openings enhance the overall habitat value of the existing landscape by providing areas for foraging, resting, courtship displays, nesting, and brood rearing. For some species of wildlife, the presence of these forest openings is one of the most important factors in their abundance.

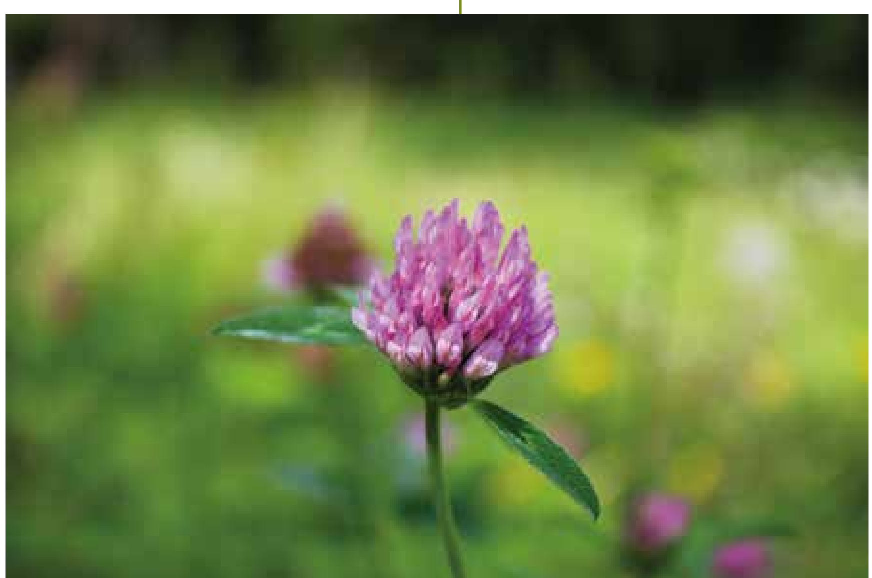
Herbaceous forest openings generally fall into two categories: (1) naturally regenerating openings with mixed forest grasses and forbs, raspberries, and ferns, and (2) cultivated food plots. Natural openings tend to be temporary in nature, and over time they will develop into mature forest. These habitats require regular attention and management over time, so you should be careful not to create food plots that are too large for reasonable future maintenance and management. Keep in mind, however, that food plots over 1 acre in size are not eligible for UVA management plans in Vermont.

Openings as small as 1/4 acre provide benefits to a variety of wildlife, including white-tailed deer, wild turkeys, cottontail rabbits, black bears, ruffed grouse, woodcock, songbirds, owls, and some reptiles and amphibians. Larger blocks of small shrub and herbaceous habitat (e.g., 2 to 5 acres) are more effective in providing value to some species of wildlife, but you should also provide ample amounts of *edge habitat*, or transition zones between openings and forest, to maintain protective cover for larger species.

Forest openings enhance the overall habitat value of the existing landscape by providing areas for foraging, resting, courtship displays, nesting, and brood rearing.

MANAGEMENT GUIDELINES

Generally speaking, food plots should be long and irregularly shaped, and it's best to distribute them throughout your property rather than concentrating them in one area (this assumes you have sufficient space for multiple food plots). The best food plots are planted in long strips adjacent to good escape cover such as hedgerows or on the edge of forest cover. Remember to maintain adequate buffers from waterways and wetlands when tilling soil to create food plots (a minimum 100-foot buffer is recommended).



By using both annual and perennial crops, you will provide a food "buffet" for many wildlife species during all seasons and enhance the natural vegetation that is already present.

As a rule of thumb, 5 percent of your property could be planted to food plots, of which 40 percent should be annuals and 60 percent should be perennials. Ideally, food plots should be at least 800 square feet and should receive approximately 4 hours of sunlight a day.

Cultivated food plots are not recommended in the woods and should be restricted to existing field edges where the introduction of noninvasive, nonnative plants will not pose a hazard to forest biodiversity. Interior forest food plots should allow for the natural establishment only of native forbs, berries, shrubs, and trees. You can cut these plants back periodically to maintain food value over time. Start with existing openings, such as log landings, logging roads, field edges, and old fields to reduce the time and effort required for maintenance. One of the most important first steps in establishing a food plot is to test the soil on the site you are interested in managing. Sampling and testing of the soil can help to determine what needs to be done to ensure good growth of your plantings. Field crop soil test kits are readily available from University of Vermont Extension offices and will provide you with information on measurements such as pH, organic matter, phosphorus, and potassium.

Soil pH, usually between 6 and 7, is a key factor in developing an effective food plot. If a soil test reveals that the pH is low, lime or other similar products should be gradually added to the soil, without applying too much in any given year to avoid excess runoff into streams.

PLANT SELECTION

Figure 11.1
Tools used to spread seeds

Plant a variety of crops that target the particular species you are trying to promote. Annual crops such as corn, wheat, and rye provide a high yield in a short period of time. Wheat provides forage for grazing wildlife during the winter months and produces a beneficial seed head that is highly favored by songbirds. Annual crops left to go fallow also create good nesting habitat for birds and waterfowl. Perennial crops such as alfalfa, chicory, and clover will reseed and spread, providing high-quality forage for a number of years if properly maintained. By using both annual and perennial crops, you will provide a food "buffet" for many wildlife species during all seasons and enhance the natural vegetation that is already present.

PLANTING

Be sure to purchase a seed that exclusively targets wildlife rather than general agricultural seeds because most wildlife are able to tolerate higher protein levels then domesticated animals, and higher protein is the ultimate goal for planting food plots.

Spreading of the seed and fertilizer is typically accomplished using a cyclone spreader, drop-seeder, or grain drill. A single person can spread seed and fertilizer with a hand-crank spreader. Once the seed and fertilizer are spread, the mixture needs to be lightly disked or dragged into the soil. This can be done by using a shallow disk harrow behind a tractor, or by dragging a piece of chain-link fence or tree bows behind a tractor or ATV. With optimal growing conditions, you should expect to see plant growth and wildlife activity almost immediately. Consider using an exclusion cage, a wire cage that protects the plants from grazing wildlife, to serve as a gauge to see how much wildlife is using the plot and then determine how much maintenance is needed.

MAINTENANCE

Management of these cultivated food plots doesn't end once the seed has been planted. Many factors contribute to the prolonged success of both perennial and annual crops. For perennials, once the food plot has begun to establish and growth is well on its way, you should plan on high mowing two to three times during the summer months. Mowing above the lowest growth node on plants such as clover helps to keep the plants young and tender as well as providing the most protein. Periodic mowing also works to keep competing weeds to a minimum reducing the need for herbicides.

Overall, establishing a wildlife food plot can be an enjoyable and rewarding experience. By using all available information, you will be able to create a successful and sustainable food source that wildlife will use for many years to come.

Perennial crops such as alfalfa, chicory, and clover will reseed and spread, providing high-quality forage for a number of years if properly maintained.

Photo courtesy of Wayne LaRoche, VFWD

PART FOUR: Habitat Management for Wetland, Pond, and Riparian Areas

12. WETLAND HABITAT MANAGEMENT

Wetlands are ecosystems characterized by hydric soils that support vegetation adapted to life in a wet environment. Wetland communities include the vegetated, shallow-water margins of lakes and ponds, the seasonally flooded borders of rivers and streams, and an amazing diversity of topographic settings across the landscape, including basins, seepage slopes, and wet flats. There are three characteristics shared by all wetlands. First, they are inundated by or saturated with water for varying periods during the growing season. Second, they contain wetland or hydric soils, which develop in saturated conditions. Finally, they are dominated by plant species that are adapted to life in saturated soils.

Wetlands can be grouped into the following general wetland types. *Swamps* are wetlands dominated by woody plants, either trees or shrubs. *Marshes* are wetlands dominated by herbaceous plants. *Fens* are peat-accumulating open wetlands that receive mineral-rich groundwater. *Bogs* are also peat-accumulating wetlands but are isolated from mineral-rich water sources by deep peat accumulation and therefore receive most of their water and nutrients from precipitation.

Wetlands provide a wide array of benefits including flood storage, water quality improvement, recreation, education and science, and habitat for many species of fish, wildlife, plants, and insects.

WETLAND FUNCTIONS AND VALUES

Wetlands are some of the most biologically rich and diverse ecosystems that exist in Vermont, the United States, and throughout the world. In Vermont, they represent a small percentage of the overall landscape (approximately 5 percent) and, as such, must be protected for the many values they support. Generally speaking, wetlands provide a wide array of benefits including flood storage, water quality improvement, recreation, education and science, and habitat for many species of fish, wildlife, plants, and insects.

The following functions, although mentioned briefly, are important to consider when understanding the importance of wetlands on your property and help provide context for the values they may provide.

Hydrology

Frequency and duration of soil saturation are the primary factors determining the type of wetland that will develop or occur in a particular setting. For example, permanent standing water in deep-water marshes excludes most woody plants and is suitable habitat for only those herbaceous plants adapted to such a stressful environment that is created by this type of hydrology. Other wetlands are only seasonally wet or flooded, such as vernal pools and floodplain forests. These wetland habitats support a different set of plants and trees and, as a result, support different species of wildlife.

Nutrient Availability

The availability of nutrients in wetlands has a significant effect on the plants that will grow there. Fens occur in areas with calcium-rich bedrock. Many marshes receive surface water runoff, which provides a source of dissolved nutrients and minerals. In contrast, mineral-poor wetlands have

Wetlands also provide critical habitat for many animal groups that we know much less about, including dragonflies, butterflies, moths, beetles, and other insects.

low nutrient availability. Bogs are especially low in nutrients. The effects on the plants that occur in a wetland affect the food that is available for some wildlife, or the brood-rearing habitat that may be available for nesting waterfowl.

Attenuation of Flood Flows

Many wetlands, especially those that occur in basins with restricted stream outlets or in the floodplains of rivers, have the capacity to store large volumes of water generated by heavy rainfall, rapid snowmelt, and floods. These wetlands release stored water slowly back into rivers or streams and, in some cases, allow the water to percolate into the ground.

Surface Water Quality Protection and Groundwater Recharge

Wetlands are effective in trapping sediments and removing nutrients and pollutants from surface water runoff before that water reaches streams or lakes. The location of a wetland relative to sources of runoff and the receiving stream or lake is important in determining how effectively a wetland will protect the quality of surface waters. Groundwater discharge may be evident as seeps or springs where water comes to the surface. These wetlands have characteristic features such as stable water levels and soil saturation, defined outlet channels, and water chemistry and vegetation that reflect mineral-enriched conditions.

Fish Habitat

Certain freshwater fish species require wetlands as spawning grounds and as nursery areas for their young. Spring spawning by northern pike in the emergent wetlands adjacent to Lake Champlain is a particularly good example. Other fish, like black bullhead, yellow perch, pumpkinseed, and bluegill, leave open water to spawn in shallow-water wetlands. Wetlands are also important for maintaining the quality of fish habitat by providing shade or discharging water from cold springs, both of which moderate surface water temperatures.

Wildlife Habitat

As previously mentioned, wetlands provide essential habitat for numerous species of wildlife. The dense vegetation found in most wetlands provides a variety of foods and also nesting sites that are relatively safe from predators. Many species, such as Canada goose, wood duck, great blue heron, muskrat, beaver, snapping turtle, and bullfrog, are wetland dependent, meaning that they rely on wetlands for some or all of their life cycles. For others, such as black bears, moose, deer, wood frogs, and marsh hawks, wetlands are not primary habitat but are important for a part of their life cycle or during certain times of the year. Wetlands also provide critical habitat for many animal groups that we know much less about, including dragonflies, butterflies, moths, beetles, and other insects.

Habitat for Rare, Threatened, and Endangered Species

Wetlands occupy only 5 percent of the land area in Vermont, but they provide necessary habitats for the survival of a high percentage of the threatened and endangered species in the state. Examples of such wetland-dependent species are Calypso orchid, Virginia chain fern, marsh valerian, common loon, spruce grouse, sedge wren, spotted turtle, and western chorus frog.

Shoreline Stabilization

Vegetated wetlands along the shores of lakes or the banks of rivers can protect against erosion caused by waves and strong currents. These wetlands dissipate wave and current energy, trap sediments, and bind and stabilize the wetland substrate. Wide wetlands with dense woody vegetation are most effective, but as can be observed in many locations along the shores of Lake Champlain, emergent wetlands such as deep bulrush marshes also contribute significantly to stabilizing the shoreline.

Beavers and Wetland Communities

Beaver alteration of wetlands is a form of natural disturbance and generally occurs in cycles that may span decades. Wetlands created and influenced by beavers are widespread and represent some dynamic and diverse wildlife habitats. These wetlands provide important habitat for a wide array of wildlife from wood ducks and Canada geese to mink, otter, and of course, beaver. Dam construction and the creation of an impoundment typically kills all woody plants in the affected area and can drastically alter species composition. Over a period of years, however, beavers typically deplete their local food supply — woody species that grow near their pond — and move to other suitable habitat. Although the impoundment may persist for years, eventually the dam may fail and the pond drains. The resulting wet mud flats are colonized by annuals, then perennials, and finally woody plants after several years. All the successional wetland types created as part of this cycle are important habitats for numerous species of plants and animals.

Wetlands created and influenced by beavers are widespread and represent some dynamic and diverse wildlife habitats.

FORESTED WETLANDS TYPES

Floodplain forests are usually dominated by silver maple, red maple or sugar maple, with abundant ostrich fern or sensitive fern. They are closely associated with river and lake floodplains and have exposed mineral soils of alluvial origin.

Hardwood swamps are dominated by broad-leaved deciduous trees, but may have lesser amounts of conifers. Dominant trees may be red maple, silver maple, black ash, green ash, or black gum. Soils are mineral or organic.

Softwood swamps are dominated by conifers, including northern white cedar, red spruce, black spruce, balsam fir, tamarack, and hemlock. Broad-leaved deciduous trees may be present but are less abundant than conifers. Soils are mineral or organic.

Seeps and vernal pools typically are very small and occur in depressions or at the base of slopes in upland forests. Trees in the wetland may be scarce, but there is an overhanging canopy from the adjacent forest. Seeps have abundant groundwater discharging at their margins and usually a lush growth of herbs. Vernal pools are depressions that fill with water in the spring and fall and typically have little herbaceous cover.

OPEN WATER WETLANDS TYPES

Open peatlands have stable water tables at or near the soil surface, and generally lack seasonal flooding; mosses and liverworts are consistently abundant. Trees are generally absent or sparse, except in black spruce woodland bogs and pitch pine woodland bogs.

Marshes and sedge meadows have standing or slowly moving water with depths that may fluctuate seasonally. The soils are primarily mineral, with well-decomposed organic mucks in some cases. Herbaceous plants are dominant.

Wet shores are sparsely vegetated wetland communities occur along the shores of rivers and lakes and are subject to seasonal flooding and scouring. The soils are mineral and include mud, sand, gravel, and cobble.

Shrub swamps typically have significant seasonal flooding and variable soil types. Shrubs that typically dominate include speckled alder, willow, sweet gale, and buttonbush.

HOW TO PROTECT, ENHANCE, OR CREATE A WETLAND

Wetlands are one of the most sensitive and biologically rich habitats that occur in Vermont, and the best way to manage wetlands is by protecting them from development or other disturbance. Establishing wide buffers around the perimeter of a wetland may be the best approach for managing to conserve the wildlife functions of the habitat. Natural wetlands, which developed across thousands of years, are hard to duplicate because of their complexity. Preserving those that are not currently altered by humans is often the best way to maintain existing functions, including wildlife habitat.

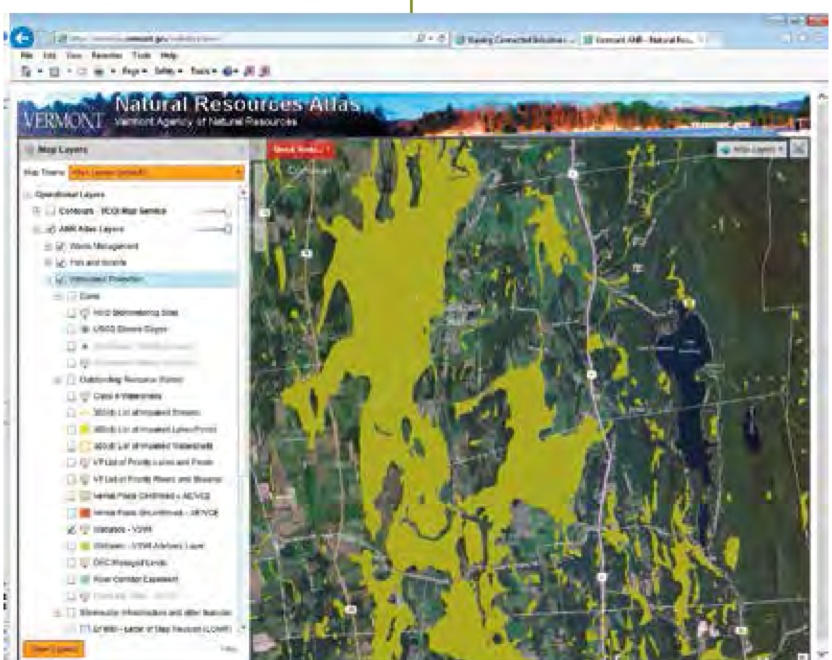


Figure 12.1
Map of wetlands as shown by the ANR Atlas

The Vermont Fish and Wildlife Department can provide detailed information on occurrences of significant wetland natural communities as well as technical assistance on wildlife habitats and use in wetlands. In addition, vernal pools are being mapped throughout the state; more information is available online or through the Vermont Fish and Wildlife Department (see Figure 12.1 and **Resources** for link).

Wetlands that have been dredged, drained, filled, or otherwise altered may offer an opportunity for restoration. Often, blocking a ditch or removing a portion of a field tile line may be all that is needed to restore water levels that support wetlands. Contact the Vermont Department of Environmental Conservation Wetlands Program or the U.S.D.A. Natural Resources Conservation Service for more information. Websites for both programs can be found in **Resources.**

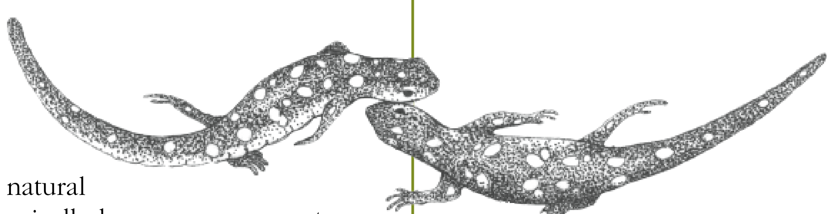
"Enhancement" of an existing wetland can be difficult, and improving surrounding upland habitats is generally more effective. Enhancement efforts, however, may include removing nuisance plants and adding nest structures and other habitat improvements. Maintaining and increasing the size of naturally vegetated wetland buffers provide for wildlife travel corridors and screening for wildlife that are feeding and resting in wetlands. Refer to the Chapters 24 and 25 on waterfowl and beaver management for more information.

Other management options for enhancing the wildlife value of wetland habitats include the following:

- Install nesting structures to encourage ducks, geese, or other wetland-dependent birds to use the wetland for reproduction.
- Retain mature standing dead trees for nesting habitat for wood ducks and other cavity-nesting birds and to serve as perches for raptors and other birds.
- If possible, control water levels. This is typically not possible and is not recommended without advice from a qualified wildlife biologist. Draw down during the growing season encourages prolific growth of smart weed and other native wetland plants that are of high food value to waterfowl and other wetland wildlife.
- Plant nut-producing trees, such as white oak, along the edge of the wetland to produce a valuable food resource.
- Where beavers occur, allow them to create wetlands, where appropriate — beaver influenced wetlands can become highly productive wildlife habitat.
- Retain shrub and herbaceous cover adjacent to within 1/2 mile of a wetland where it occurs — this serves as important nesting cover for mallards and other ground-nesting waterfowl that will use the wetland once their eggs hatch (delayed mowing or brush hogging is a useful approach).
- Carefully remove invasive plants such as phragmites and purple loosestrife. Follow proper protocols to prevent the seeds and roots from being dispersed to other locations.

Creating wetlands can also help wildlife, but this process may be both difficult and expensive depending on site characteristics. Wetland creation is most often done for mitigation of wetlands. Often, created wetlands do not function correctly and fail as a result of incorrect soils, vegetation, and other factors. Wetland creation and restoration is a complicated science that involves engineering expertise and is not recommended without the guidance of an experienced wetland restoration expert. The U.S.D.A. Natural Resources Conservation Service and the U.S. Fish and Wildlife Service (links for which are provided in **Resources**) may provide guidance on opportunities for wetland restoration.

VERNAL POOLS



What Are Vernal Pools?

Vernal pools are small (generally less than 1 acre) ephemeral pools that occur in natural basins within upland forests. Vernal pools typically have no permanent inlet or outlet streams and have very small watersheds. These temporary pools generally last only a few months and then disappear by the end of summer, although some pools may persist in wet years.

During their dry period, vernal pool depressions may be recognized by the sparse vegetation and by stained leaves marked by seasonal high water. Vernal pools typically lack trees but are shaded by trees growing in the surrounding upland forest, with highly variable vegetation within the depression.

For vernal pools to be effective breeding habitats for amphibian populations, they must retain water for at least three months during the spring and summer breeding season in most years so that amphibians can complete their larval stage.

Why Are Vernal Pools Important?

Vernal pools are perhaps best known as breeding habitat for amphibians. Typical Vermont species that rely heavily on vernal pools for reproduction include the mole salamanders (spotted salamander, blue-spotted salamander, and Jefferson salamander), eastern four-toed salamander, and wood frog. For vernal pools to be effective breeding habitats for amphibian populations, they must retain water for at least three months during the spring and summer breeding season in most years so that amphibians can complete their larval stage.

The periodic drying of a vernal pool excludes populations of predatory fish and diving beetles that prey on amphibian larvae. Other animals use the pools as well, such as fairy shrimp, fingernail clams, snails, eastern newts, green frogs, American toads, spring peepers, and a diversity of aquatic insects. The amphibians and invertebrates found in vernal pools constitute a rich source of food for various species of mammals, reptiles, and birds such as wood ducks, mallards, black ducks, and great blue herons. Despite their small size and temporary nature, vernal pools are highly productive ecosystems. For more information on vernal pools, see the U.S. Department of Agriculture's Natural Resources Conservation Service website at the link in **Resources**.

Threats to Vernal Pools

Vernal pools and the species that depend on them are threatened by activities that alter the earth and water in and around the pool, as well as by significant alteration of the surrounding forest. Construction of roads and other development in the upland forests around vernal pools can block salamander migration. Poorly managed timber harvesting can have significant effects on vernal pools, including altering the vernal pool depression, changing the amount of sunlight and organic debris that reaches the pool, and disrupting amphibian migration routes by creating deep ruts. Even when the pool is dry, altering the depression may affect its ability to hold water and may disrupt the eggs of invertebrates that form the base of the vernal pool food chain.

Management Recommendations

Management of a vernal pool needs to include the surrounding upland habitat as well as the breeding pool. The area used by an amphibian population can be represented by three management zones: the breeding pool, a zone that extends to 100 feet around the pool, and a third zone that extends to 600 feet from the pool edge.

Breeding pool. This area includes the pool depression measured at spring high water. During dry periods, you can determine the high-water mark using such evidence as watermarks on trees within the depression; water-stained, compressed, or silted leaves; or an obvious change in topography at the pool edge.

Leave breeding pools undisturbed, with no cutting, heavy equipment, skidding, storage of slash or other woody debris, or sedimentation within these depressions during any season.

100-foot zone. Avoid land clearing; development, including roads and driveways; the use of pesticides, herbicides, or fertilizers; and barriers to amphibian movement. Consider only light cutting or no cutting, such that at least an 80 percent canopy cover remains within this zone. Harvesting within this area should only occur on completely frozen ground in midwinter.

100- to 600-foot zone. To provide adequate amphibian habitat and canopy cover, practice uneven-age forest management. Leaving some large, mature hardwoods is especially helpful for protecting and enhancing habitat. To provide adequate shading, a minimum of 60 percent of the canopy cover composed of trees at least 25 feet tall should remain intact. Try to maintain a moist forest floor with deep leaf litter and abundant coarse woody debris of various sizes. Timber harvesting should not happen during the amphibian movement period in early spring and preferably should be done on frozen ground.

Avoid using pesticides within 600 feet of a breeding pool. Avoid any activities that direct water away from a breeding pool, as this reduces the amount of water held in the depression and increases the chance that the pool will dry before amphibian larvae complete their development. Do not direct additional runoff into a breeding pool from outside its natural basin. This can change the hydrology of the pool and introduce pollutants and sediments, both of which can kill eggs and developing larvae.

Check with your town or other local government office to see if there is a wetland protection ordinance that applies to your property.

REGULATIONS FOR PROTECTING WETLANDS

In Vermont, most wetlands are protected by the Vermont Wetland Rules. Some towns in Vermont have local rules that also protect wetlands. The federal Army Corps of Engineers and the U.S. Environmental Protection Agency also protect wetlands through federal laws. No wetland management should occur without a complete understanding of whether any of these laws or rules apply. Check with your town or other local government office to see if there is a wetland protection ordinance that applies to your property. State and some federal regulations can be addressed by contacting the Vermont Wetlands Program in the Vermont Agency of Natural Resources — they have numerous fact sheets on their website — and the U.S. Army Corps of Engineers. Furthermore, the Natural Resources Conservation Service administers a federal wetland compliance program for landowners who participate in U.S. Department of Agriculture programs. Allow enough time for permit application and approval so as not to upset the time frame for your project.

RESOURCES

Austin, J.A., C. Alexander, E. Marshall, F. Hammond, et al. 2013. *Conserving Vermont's Natural Heritage: A Guide to Community-Based Planning for the Conservation of Vermont's Fish, Wildlife, and Biological Diversity*. 2nd edition. Montpelier, VT: Vermont Fish and Wildlife Department

U.S. Army Corps of Engineers. *1987 Corps of Engineers Wetland Delineation Manual*. http://el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf

U.S. Department of Agriculture. Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home

—. Vermont Biology Technical Note 1. "Vernal Pool Habitat in Conservation Planning." http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_010203.pdf

U.S. Fish and Wildlife Services. http://www.fws.gov

Vermont Agency of Natural Resources. Department of Environmental Conservation, Vermont Wetlands Program. http://www.watershedmanagement.vt.gov/wetlands.htm

—. Vermont Wetland Rules. http://www.watershedmanagement.vt.gov/rulemaking/docs/wrprules/wsmd_VWR%207-16-10.pdf#zoom=100

13. POND HABITAT MANAGEMENT

A farm pond can provide years of enjoyment if it is carefully planned and managed.

While no current estimates exist for the number of private (a.k.a., farm) ponds in Vermont, there are undoubtedly thousands of ponds dotting the landscape with the number increasing annually. Farm ponds are built for a variety of purposes: recreation (fishing and swimming); water supply (livestock watering, irrigation, fire protection); wildlife habitat; landscape enhancement; and water storage (flood control, stormwater runoff, sediment retention). A farm pond can provide years of enjoyment if it is carefully planned, constructed, and managed. However, not all uses are compatible with one another. You should think carefully about why you want to invest the money and time into constructing a new pond.

As an example, a pond that livestock use to access drinking water is not likely to provide good fishing and certainly is not compatible with swimming. Likewise, if your primary use is to support trout for recreation and food, prerequisite requirements need to be considered before breaking ground; otherwise, you may well be sorely disappointed by the outcome. The discussion of farm ponds in this chapter will focus on their use as fish and/or wildlife habitats.

Figure 13.1
Hamilton Pond is an example of an excavated pond.

TYPES OF PONDS

Generally ponds fall into two categories: embankment ponds and excavated ponds. *Embankment ponds* are typically constructed by damming a stream or a ravine to catch surface runoff or in some cases spring outflow. *Excavated ponds*, on the other hand, involve digging a basin below ground level allowing water to be supplied by overland runoff, the water table, a spring, or a drilled well (see Figure 13.1). The damming of streams, whether intermittent or perennial, can be detrimental to natural stream ecosystems — the animal and plant life they support, including public fisheries — as well as natural stream channel forming and maintenance dynamics. For example, in-stream ponds often increase stream temperatures, degrade stream habitat, and restrict the movement of trout and other aquatic populations. The construction of ponds on streams or in wetlands requires prior review and may be subject to state or federal regulation (specific contact information is provided in this chapter under **Permits and Technical Assistance**).

SITE SELECTION

As in the real estate trade, the "location, location, location" axiom is equally important to proper pond design and construction. Location and size of the pond will be dictated by the lay of the land (topography), soil structure, and the quantity and quality of the available water. Porous, gravelly soils lacking sufficient clay can make it nearly impossible to hold water or at best maintain a desired water level throughout the year. Sites with shallow underlying bedrock can constrain excavation and prevent constructing a pond with adequate depth. While there are solutions to both situations, they can increase construction costs substantially. Your local office of the U.S. Department of Agriculture, Natural Resources

Conservation Service (formerly Soil Conservation Service) may be able to provide assistance with identifying the best location for a pond on your property.

Available water is also critical, but is frequently given inadequate attention during pond siting. Not only must water be ample without being excessive, but it also must come from a reliable source and be of high quality especially if your objective is to raise trout.

The placement of ponds on streams or in wetlands may have negative effects on critical fish and wildlife habitats; endangered, threatened or rare species; unique natural communities; as well as the natural physical and ecological functions of these landscape features. From a pond management perspective, in-stream ponds are faced with problems, such as retention of natural sediment load carried by streams requiring periodic costly dredging and permit acquisition and increased vulnerability to aquatic nuisance species and difficulties associated with their control. Therefore, the Vermont Fish and Wildlife Department does not recommend — and in some cases may oppose — construction of ponds in critical habitats. In addition, Vermont's Stream Obstruction Law (10 V.S.A. Section 4607) prohibits the installation of a structure that prevents fish movement, such as a rack, weir, or other obstruction, unless an approval has been granted by the commissioner of the Vermont Fish and Wildlife Department. Projects in which this is commonly an issue include culvert installation and dam construction or reconstruction. In cases in which other agency permits are required, such as a dam order or stream alteration permit, this issue is addressed as part of that permit process. When other permits are not involved, a request may be sent to the department. This is usually the case only if the stream involved is in a small watershed with a drainage area of less than 10 square miles. For more information on the application procedure and required information, contact a permit specialist in the Agency of Natural Resources.

DESIGN CONSIDERATIONS

Ponds with the best potential for fish management and fishing measure at least 1 acre in size. However, most Vermont farm ponds are smaller with maximum water depths less than 12 feet. Consequently, average pond depth is much less (< 6 feet). At best, such small farm ponds end up being marginal habitats for cold water-dependent fish, such as trout, and are difficult to manage for quality-size warm-water fish, such as bass and sunfish. Shallow ponds are particularly prone to warming up with lowered dissolved oxygen levels during the summer months reducing the amount of habitat needed to support trout. Oxygen depletion during the winter months can also occur after the pond ices over and snow accumulates on top shutting off light penetration. Extremely shallow ponds may even freeze to the bottom.

Additionally, shallow ponds are more vulnerable to promoting aquatic vegetation growth that is capable of spreading throughout the water body. Excessive vegetation not only interferes with other pond uses, such as swimming or aesthetics, but also, depending on the type of plant, it can add annually large volumes of organic matter to the pond. Decomposition of this organic material may lower dissolved oxygen below levels needed to support fish life, possibly resulting in periodic fish kills. So from a fish-rearing viewpoint the largest, deepest pond your budget can support is the best path to follow. A minimum of 25 percent of the pond bed area should be at least 12 feet deep.

Ponds with the best potential for fish management and fishing measure at least 1 acre in size.

To manage the pond for quality or catchable-size fish, you must be able to exert effective control over fish abundance.

Most ponds are excavated with shallow, low slope shore areas that can be conducive to allowing aquatic vegetation to take hold and provide wading fish-eating birds (e.g., herons) easy access to a meal. A couple of design features can help address this. The pond shoreline can be excavated to have a minimum water depth of 3 feet. Or, the pond basin can be constructed with 3:1 side slopes. ***Caution:*** If the pond is also to be used for swimming, particularly by young children, deep water along the shore should not be provided for safety reasons.

Important design features of any farm pond are the built-in water control structures. These include the water control stand or drain pipe and an overflow emergency spillway. The primary function of the drain pipe is to maintain a desired pond water level during periods of normal or typical water inflow. If properly designed, it also allows draining the pond to conduct maintenance when necessary. The emergency spillway, on the other hand, provides an alternate route to release excessive inflow such as from high spring runoff and flood events, thus lessening damage or even failure of the dam structure. Dam failure may result in loss of property, including land, buildings and roads, and possibly human life. Therefore, a professional engineer should be consulted to develop a pond design that not only will best achieve your own objectives but also will be structurally sound and safe.

FISH MANAGEMENT

If your interest is managing the pond for fishing, design and environmental considerations touched upon previously will determine whether the pond is best suited for cold-water fish (trout) or warm-water species (bass, sunfish, and so on). To manage the pond for quality or catchable-size fish, you must be able to exert effective control over fish abundance. This is most easily achieved in ponds stocked with trout, as most ponds do not provide all the necessary conditions for trout to reproduce naturally; therefore, you control population size simply by adjusting the number of fish stocked and managing for any losses resulting from fishing, predation, or old age mortality. On the other hand, if spring seeps are present in the pond and the bottom consists of coarse sand and gravel, conditions may be suitable for natural brook trout spawning, but rarely does fish production in these situations attain problem proportions.

In contrast, bass, sunfish, and other warm-water fish are more apt to find habitat in the typical farm pond more suitable and thus reproduce freely. Consequently, they require effective population control to maintain the appropriate balance between populations of predator fish (bass) and forage fish (sunfish, minnows). This may sound easier than it actually is, but inappropriate population and harvest management can lead to stunting (population excessively dominated by small fish) and/or too few game fish to provide good fishing. All things considered, managing a pond for trout is simpler with more predictable outcomes than managing a pond for warm-water species.

Trout require water that is relatively free of pollutants, is high in dissolved oxygen (>5 ppm), and maintains cool temperatures (< 70°F) consistently throughout the year. The summer season tends to be the critical period of the year when these factors may be difficult or impossible to maintain, which results in fish stress leading to poor fish health and possible fish mortality. Surface waters, such as streams, all too frequently are not reliable water sources to deliver the required quantity of cool water to prevent excessive fish losses. Springs or a drilled well may be better options.

Trout must be purchased from a private hatchery that has been inspected for possible diseases by the Vermont Fish and Wildlife Department Fish Health Program. (For a list of in-state and out-of-state private hatcheries that are certified to sell and transport trout into Vermont, contact the department at (802) 828-1000 or consult the website provided in **Resources**.)

Be aware: In Vermont it is illegal to capture fish, including trout, from the wild and transport them alive for stocking a pond without prior approval of the department to do so. Moving wild fish can introduce harmful diseases and parasites to your pond as well as to public waters threatening the health of captive fish and wild fish populations.

Table 13.1 below is intended to provide general guidance on the number of trout to stock into your pond and when. Fish numbers given are not absolute but may be adjusted to take into account your particular situation: habitat quality, the rate at which fish are harvested, and the cost of the fish. These numbers are for ponds where the fish are not provided with supplemental feed.

Table 13.1 Guidelines for trout stocking numbers for ponds

AGE CLASS	SIZE	# PER ACRE	WHEN TO STOCK	COMMENT
Spring fingerling	2–3"	200–300	April, May	Recommended only for ponds with no other fish
Fall fingerling	5–6"	50–150	Sept., Oct.	For initial stocking and restocking
Spring yearling	6–7"	50–150	May, June	For initial stocking and restocking
“Adult”	Over 7"	25–50	Spring or Fall	For initial stocking and restocking; can be expensive

Source: Schrouder, J. D., C. M. Smith, P. J. Rusz, R. J. White, and D. L. Garling. 1989. Managing Michigan ponds for sport fishing. Michigan State University Cooperative Extension Bulletin E-1554, East Lansing.

Spring stocking is generally recommended as opposed to other times of the year. The two most frequently stocked species in Vermont farm ponds are rainbow and brook trout. Because rainbow trout can tolerate slightly warmer water than brook trout, it may be the best one to stock in a pond that may approach the upper thermal limit for trout during the summer season. Brown trout may be offered for sale by some private hatcheries but are not recommended for stocking small ponds. They are generally more difficult to catch, therefore living to an older age and attaining sizes capable of feeding on smaller stocked trout.

Ponds that provide year-round requirements for trout, assuring good survival, may only need to be stocked every other year or so. If your pond has characteristics that do not promote trout surviving through the summer (water too warm, insufficient dissolved oxygen), you may want to consider put-and-take stocking; that is, purchasing harvestable size (>6 inch) trout in the spring and fishing them for consumption before midsummer losses occur. Under this type of management the pond will need to be restocked annually.

Because rainbow trout can tolerate slightly warmer water than brook trout, it may be the best one to stock in a pond that may approach the upper thermal limit for trout during the summer season.

If the pond supports fish, stocked or otherwise, fish-eating mammals and birds, such as otter, mink, mergansers, and herons, may become regular visitors.

If your pond does not provide the environment needed by trout, the alternative is to stock it with warm-water fish. However, introducing bass or any other fish other than trout to your pond cannot be done legally without first obtaining the approval of the Vermont Fish and Wildlife Department. Vermont law prohibits the stocking of any fish other than trout into waters including private ponds that have connections (water discharge) to waters of the state. A department fisheries biologist will determine whether the introduction of bass or other species poses a threat to fisheries occurring in public waters should they escape from your pond.

In more recent years releasing goldfish and koi (ornamental carp) into private ponds has become popular. However, these fish are nonnative species in Vermont that have the potential of becoming aquatic nuisances. Should they escape your pond, they may become established in natural waters. Once acclimated to your pond or in the wild, they are difficult and costly to control and can deteriorate water quality, such as by promoting turbid or muddy water and algae growth. Goldfish and koi are best left in an aquarium or in a completely self-contained garden pool. No aquarium fish should be released into the wild or in situations in which they may have access to state waters.

WILDLIFE MANAGEMENT

A farm pond will invariably become habitat for a variety of other wildlife (frogs, newts, turtles, aquatic insects and other invertebrates, birds, and mammals). This is natural and should be expected as ponds, unlike artificial swimming pools, can provide many of the habitat needs of wild animals including food, water, shelter, and breeding areas. If the pond supports fish, stocked or otherwise, fish-eating mammals and birds, such as otter, mink, mergansers, and herons, may become regular visitors. Use by wildlife can be very rewarding for nature observation and education. Adopting the following practices will make your pond more suitable habitat for wildlife:

- Refrain from maintaining the entire shoreland in mowed lawn.
- Plant native shrubs, flowering plants, and grasses along the shoreline to provide wildlife with food, shelter, and nesting sites. Fruit-producing trees and shrubs are particularly attractive to wildlife.
- Retain some dead trees (snags) in the vicinity of the pond. These can serve as natural nest trees for certain cavity-nesting birds.
- Place nesting boxes designed to attract tree swallows, wood ducks, and other cavity nesters.
- Leave a few downed dead trees, logs, and boulders in shallow water to serve as sun basking sites for turtles and refuge cover for fish.
- Be cautious with some emergent and submergent plants in shallow areas not used for swimming because they benefit fish and wildlife. Because cattails and water lilies can become invasive, they are not recommended in farm ponds.
- Construct or purchase a bat house to locate near your pond. Bats nightly consume tremendous quantities of flying insects.

Of course, wildlife may include “unwanted” species that are incompatible with your primary uses of the pond. Examples are the otters or heron that makes daily forays to feed upon the trout you stocked, or the snapping turtle that takes up residence in a pond intended for swimming. Should these situations develop, effective solutions can be challenging. Nonlethal deterrents, such as electric fencing and predator-scaring devices, are available; however, their effectiveness can vary considerably. Lethal control (trapping or shooting) may be appropriate but is legally controlled and must have prior state, or in some cases federal, approval.

Occasionally, farm ponds attract beavers, which can pose problems with regard to keeping pond discharge structures free of woody debris. Beavers also can cause destruction of nearby trees and shrubs and bring health concerns associated with the *Giardia* parasite, which may be spread to humans and pets through the ingestion of infected water. Pond owners faced with nuisance beavers should consult the document *Best Management Practices for Resolving Human-Beaver Conflicts in Vermont* available on the Vermont Fish and Wildlife Department website (link provided in **Resources** below).

Beavers also can cause destruction of nearby trees and shrubs and bring health concerns.

PERMITS AND TECHNICAL ASSISTANCE

If you are contemplating building a new pond, renovating an existing one, or carrying out certain forms of management, note that in many cases state and even federal permits may be required. Permits are necessary to protect public safety; maintain environmental quality; and avoid negative impacts to certain fish, wildlife, plants, and unique natural communities. Frequently, a representative of the agency charged with issuance of the permit will arrange to visit the proposed pond site to determine whether a permit is needed and if so under what conditions the project can be permitted to move forward.

RESOURCES

Bat Conservation International. Bat House Construction Design. www.batcon.org

U.S. Department of Agriculture. Natural Resources Conservation Service. *Farm Pond Ecosystems*. ftp://ftp-fc.sc.egov.usda.gov/WHMI/WEB/pdf/TechnicalLeaflets/FarmPond.pdf

Vermont Department of Environmental Conservation. “Aquatic Nuisance Control Permits.” http://www.anr.state.vt.us/dec/permit_hb/sheet30.pdf

—. “Stream Alterations/Stream Crossing Structure Permits.” http://www.anr.state.vt.us/dec/permit_hb/sheet32.pdf

—. “Wetlands Permit.” http://www.anr.state.vt.us/dec/permit_hb/sheet29.pdf

—. “What You Should Know about Constructing a Pond or Dam.” http://www.anr.state.vt.us/dec/permit_hb/sheet32_1.pdf

Vermont Fish and Wildlife Department. “Best Management Practices for Resolving Human-Beaver Conflicts in Vermont.” http://www.vtfishandwildlife.com/library/reports_and_documents/Furbearer/Best_Management_Practices_for_Human-Beaver_Conflicts.pdf

—. Pond Stocking Information. http://www.vtfishandwildlife.com/library.cfm?libbase_=Factsheets/fisheries/Pond_Stocking_Information

University of Vermont, School of Natural Resources. “Algae in Farm Ponds.” http://pss.uvm.edu/vtcrops/articles/Algae.pdf

14. RIPARIAN HABITAT MANAGEMENT

Riparian areas are ecosystems comprising streams, rivers, lakes, wetlands, banks, and floodplains that form a complex and interrelated hydrological system.

"Riparian" is defined as the land along the bank of a river or lake. Riparian areas are ecosystems comprising streams, rivers, lakes, wetlands, banks, and floodplains that form a complex and interrelated hydrological system. Because of the diverse and dynamic nature of riparian ecosystems, they support a wide variety of plant and animal communities, including insects, reptiles, amphibians, fish, waterfowl, songbirds, bats, mink, and otter. Many species are dependent upon healthy riparian ecosystems.

An intact riparian area functions as both a *buffer* and a *corridor*. By providing habitat and filtering runoff, a riparian area buffers the water body from the impacts of adjacent land uses. Riparian areas also act as a travel corridor to provide movement and dispersal routes for wildlife and plants on your land. When planning riparian conservation and restoration strategies, you should consider both the buffer and corridor functions of riparian areas.

BUFFERS

Riparian areas are important not only for the plants and animals that inhabit them, but also for the influence they have on adjacent waters. Forested areas between the water and developed land maintain habitat suitable for riparian species. The downed wood, leaves, and other organic material that riparian areas contribute to aquatic systems are important components of the food base and habitat structure in Vermont's water bodies. Fallen trees provide loafing areas for ducks, snakes, and turtles and important protective cover for fish. Mature trees and overhanging vegetation in riparian areas provide shade in the summer and insulate stream channels in the winter, moderating the effect of extreme temperatures. Cold-water species such as brook trout require water temperatures well below 70° F. While many of Vermont's larger streams regularly exceed 80° F during warm summer months, small tributary streams often provide cool-water refuge for fish and other aquatic organisms inhabiting these systems. Wide forested buffers along riparian areas are also crucial for absorbing and filtering overland runoff, thereby protecting water quality. Roots of trees and other woody vegetation bind soils and help to maintain stable stream banks, preventing excessive stream bank erosion and sediment buildup in aquatic habitats.

CORRIDORS

Forested riparian areas serve as travel and dispersal corridors for wildlife. They are vital connections that enable wildlife to move safely from one habitat to another to feed, breed, and nest, and for young to disperse and set up new territories. Many species of amphibians and turtles rely on stream and river habitats during the breeding season and then spend most of their lives in upland habitat, often at a considerable distance away. Larger wildlife species also depend on these areas for travel. A Vermont Fish and Wildlife Department study shows the use of riparian corridors to be important for black bear movement, particularly at road crossings (Hammond, 2002).

In addition to the ecological values of riparian areas, they serve other important functions for our everyday lives. These ecosystems protect water quality for drinking and recreation, protect property from flood and ice flow damage, and provide for recreation, aesthetics, and educational opportunities.

RECOMMENDED FOREST BUFFER WIDTHS FOR WILDLIFE

Naturally vegetated riparian buffer widths of 100 feet from the top of the stream bank often provide for many of the functions necessary to protect aquatic habitats on stable streams and rivers. However, a vegetated riparian area of more than 500 feet may be required to provide suitable habitat for most bird species. Some riparian-dependent bird species, such as bald eagle, great blue heron, and wood duck, may require buffers 600 feet or wider. Table 14.1 provides additional information on buffer width needs for various wildlife groups.

Table 14.1 Buffer width needs for wildlife

WILDLIFE GROUP	BUFFER WIDTH (in feet)
Most wildlife	660
Hawks	330
Riparian mammals	100 to 330
Reptiles and amphibians	100 to 330 (> 1,000' for some species)
Songbirds	200 to 660
Nesting waterfowl	300 to 600
Bald eagle, nesting heron, cavity-nesting ducks	600
Cold-water fish	100 to 300

In general, the larger or wider the buffer is, the more likely it is to have value to wildlife. It is unlikely that most buffers that can practically be implemented will meet the needs of all riparian-dependent wildlife and riparian-associated rare species. Thus, due consideration to wildlife habitat in upland forest management is essential for protecting riparian species. Larger streams and those that naturally meander will generally require larger buffers than small, steep, and stable stream channels. A wider riparian area provides better protection of water quality and aquatic habitats, generally contains a greater diversity of habitats within, and creates greater distance between the aquatic resource and surrounding human development, ultimately protecting both ecological and property interests.

BUFFER MANAGEMENT

The best way to protect both aquatic and terrestrial wildlife habitat functions within the riparian area is to maintain as much of it as possible in an *undisturbed, naturally vegetated state.* A diversity of natural vegetation (trees, shrubs, and so on) is far superior to cropland, lawn, or other heavily managed areas for supporting wildlife. Where alteration of the riparian area is unavoidable, it should minimize impacts to buffer functions and connection to adjacent habitats. Natural features within the riparian area that may be of particular value to wildlife should be

A wider riparian area provides better protection of water quality and aquatic habitats, generally contains a greater diversity of habitats within, and creates greater distance between the aquatic resource and surrounding human development, ultimately protecting both ecological and property interests.

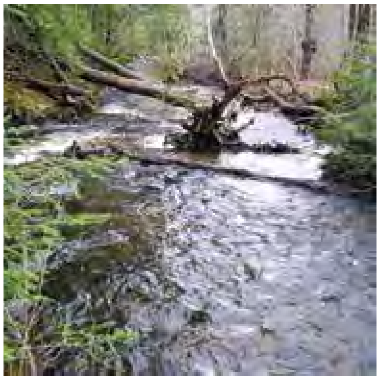


Figure 14.1
Woody debris in stream channels provides cover and shade. Courtesy of VFWD.

Table 14.2 Natural features used by wildlife in a riparian area

NATURAL FEATURE	WILDLIFE SPECIES
Large dead standing trees	Hawks, osprey, and eagles use for nesting
Large cavity trees	Owls, wood ducks, hooded mergansers, and others use for nesting
Large dying trees	Bats roost under loose bark
Seasonal and vernal pools	Amphibians use for breeding
Understory tangles	Cover for many species
Large woody debris in streams	Turtles use for basking, fish for cover
Stream bank burrows	Weasels, otters, and muskrats use for homes
Sandy soils with good sun exposure	Turtles use for nesting
Stone walls and rock piles	Snakes and small mammals use for cover/dens
Large overhanging trees	Flycatchers, kingfishers, osprey, and other birds use as perches
Large stands of conifer trees	Deer use as wintering areas
Hollow trees and logs	Some mammals and birds use as dens
Fallen shaded logs	Some salamanders use as dens

identified and safeguarded (see Table 14.2). Other general rules of thumb for riparian buffer management include the following:

- Exclude livestock and vehicles from the buffer except for designed stream crossings. Cows and other livestock can trample plants, promote erosion, and degrade water quality.
- Control invasive plants to promote, establishment of native trees and shrubs (see **Chapter 17, "Corrective Strategies for Invasive Species"**).
- Do not dispose of refuse in the buffer. Dumping leaves, grass clippings, and other yard refuse can kill existing vegetation and result in stream bank erosion due to the loss of stabilizing roots. Remove urban debris such as tires and old appliances.
- Leave natural woody debris in stream channels to create pools and provide cover and shade for fish and other aquatic organisms (see Figure 14.1). Logging debris is not considered natural debris as it may be in violation of Vermont Acceptable Management Practices.
- Minimize the use of stream crossings. If stream crossings are unavoidable, bridges are preferred over culverts as they present less of a potential barrier to fish and wildlife movements. Stream crossings often require state or federal permits. Contact a state river management engineer if you are planning to cross a stream with a culvert or bridge, or plan to conduct any activity involving a stream or river.

Timber harvest is regulated by the *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont,* which are intended to prevent discharges of sediment and petroleum products into surface waters. To further protect the broader functions provided by riparian areas, harvest of timber within or adjacent to riparian areas should be done with great care. Recommendations include the following:

- Locate logging trails and roads as far away from the waterway as possible to avoid erosion and any alteration to the stream flow.
- Maintain continuous and dense canopy along streams and ponds to maximize shading.
- Keep soil disturbance to a minimum and do not operate wheeled or tracked logging equipment when soils are wet. Consider harvesting during frozen conditions.
- Monitor for erosion before, during, and after harvesting. Look for cloudy water, algae growth, silt, or muck deposits on gravel streambeds, and new runoff channels or gullies. Suspend harvest or alter practices to minimize erosion if you see any of these signs.
- Try to spare nut- and fruit-producing trees for their wildlife value.
- In areas directly adjacent to the stream, leave dead or dying trees that may eventually enter the stream channel. In areas farther from the stream, try to leave at least one to six snags or den trees per acre for those birds and mammals that rely upon them.
- Consider using vegetable-based, biodegradable oils and lubricants. These oils are nontoxic to fish. Keep fuel and maintain machinery well away from watercourses.

(For more information, consult "ANR Riparian Buffers and Corridors Technical Papers" at the link in **Resources**.)

Previously disturbed or degraded riparian areas may present opportunities for restoring wildlife habitat functions. For example, any work that removes pavement or lawn at the water's edge and replaces it with a vegetated buffer of native trees and shrubs is likely to benefit wildlife as well as fisheries and provide other functions of riparian areas (see Figure 14.2). Simply creating a no-mow zone along the water's edge will result in a naturally vegetated buffer over time.

If you desire quicker results or want to encourage certain plants through active revegetation, several experts — such as the Natural Resources Conservation Service, the Vermont Fish and Wildlife Department, local conservation commissions, and watershed associations — have expertise in this area and can provide guidance for effective riparian wildlife habitat restoration. These experts can help design the project, recommend beneficial plants, and direct you to sources for financial assistance for installing a riparian buffer. Their contact information can be found through the Vermont Fish and Wildlife Department website in **Resources.**

Figure 14.2
Riparian planting project along the Barton River. Courtesy of Paul Hamelin, VFWD.

RESOURCES

Hammond, F.M. 2002. "The Effects of Resort and Residential Development on Black Bears in Vermont." Final Report. Waterbury, VT: Vermont Fish and Wildlife Department, Agency of Natural Resources.

Vermont Agency of Natural Resources. "Riparian Buffers and Corridors Technical Papers." http://www.watershedmanagement.vt.gov/rivers/docs/Educational%20 Resources/rv_RiparianBuffers&CorridorsTechnicalPapers.pdf

Vermont Department of Environmental Conservation. Water Crossing Permits. http://www.anr.state.vt.us/dec/waterq/permits/htm/pm_streamcrossing.htm

Vermont Fish and Wildlife Department. Contacts for Other Organizations. http://www.vtfishandwildlife.com/links.cfm

Vermont Forest, Parks and Recreation. Acceptable Management Practices (AMP) Programs. http://www.vtfpr.org/watershed/ampprog.cfm

U.S. Department of Agriculture. Natural Resource Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

PART FIVE:
Grassland and Field Habitat Management for Birds

15. GRASSLAND HABITAT MANAGEMENT FOR BIRDS

Some of Vermont's most imperiled birds rely on the fields that many Vermonters manage as part of homes and farms. These birds, including the iconic bobolink and meadowlark, migrate north for the summer to breed in Vermont's fields. Due to a century of fields growing back into forests, increased development, and intensified agriculture, many of these species are declining across the continent. They depend on large, grass-dominated fields with other herbaceous plants but few woody plants. In addition, fields should have a period of minimally disturbed time each summer for birds to breed and should be located in open landscapes. By managing your land for grassland habitats through a variety of strategies, including the timing and location of mowing and grazing, you can maintain or enhance these features, and can successfully support breeding birds in a working landscape.

By managing your land for grassland habitats through a variety of strategies, including the timing and location of mowing and grazing, you can maintain or enhance these features, and can successfully support breeding birds in a working landscape.

VERMONT'S GRASSLANDS AND GRASSLAND BIRDS

Before European settlement, New England was mostly forested, and grasslands dotted the landscape in small areas of floodplains, beaver meadows, sandplains, barrens, and Native American settlements. From the 1600s through the late 1800s, as much of the land was cleared, grasslands became common in the Northeast. In Vermont, populations of grassland birds likely reached their peak in the late 1800s, when a large part of the state was managed as open land for grazing sheep.

However, the total area of grasslands usable by nesting birds in Vermont and in the Northeast declined greatly across the last century. Fields became overgrown with woody vegetation, were converted to row crops such as corn, or were lost entirely as a result of development.

Other grasslands have declined in quality due to more frequent cutting of hay, more intense grazing, or fragmentation from development. These changes have caused the direct loss and decreased quality of grassland habitat.

Currently, most of Vermont's grassland habitats are associated with agriculture in the Champlain Valley and, to a lesser extent, the Connecticut River Valley and the area around Lake Memphremagog. Grassland habitats in Vermont vary in their size, shape, and plant species. They can be wet or dry depending on soil type and topography. Vegetation is typically dominated by nonnative cool-season forage grasses and forbs (herbaceous plants) but may also include native warm-season grasses and forbs. Fields that are cut for hay are often dominated by grasses, while fields that are cut less frequently tend to have a high percentage of forbs.

Many bird species rely on Vermont's grasslands. Returning each spring from wintering grounds in the southern U.S. and Central and South America, these birds establish territories, build nests, breed, and raise their young — all in grasslands. Some of the better-known grassland birds are bobolink, meadowlark, killdeer, savannah sparrow, northern harrier, and American kestrel. Many of these species are experiencing range-wide population declines and are considered species of greatest conservation

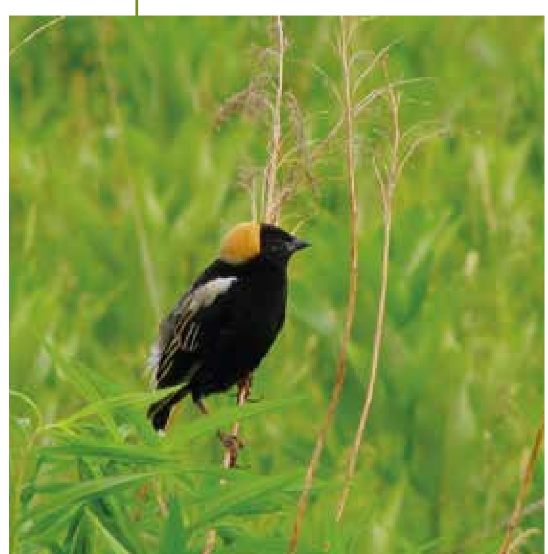


Figure 15.1
Bobolinks thrive in unmown pastures.

Even smaller patches of grassland habitat may provide suitable nesting conditions for grassland birds if situated within a landscape of other large, high-quality grassland habitats.

need in Vermont's Wildlife Action Plan. In addition, some of the less well-known grassland birds are facing even more grave threats: Three species, Henslow's sparrow, upland sandpiper, and sedge wren, are listed as endangered in Vermont. The grasshopper sparrow is listed as threatened. Overall, grassland birds are some of the fastest-declining species across the Northeast.

In addition to the grassland specialist birds, many other birds take advantage of grasslands for part of their habitat requirements, including short-eared owl, blue-winged teal, and eastern bluebird. This guide, however, focuses on management for grassland specialists including upland sandpiper, bobolink, eastern meadowlark, and grassland sparrows. Other species will benefit too, but may also require some other conditions such as proximity to wetlands and the presence of cavity trees or nest boxes for nesting. See **Chapters 6** and **7** on songbirds and early successional habitat for more information.

HABITAT REQUIREMENTS

The habitat requirements for grassland birds vary from species to species, but in general, include large, grass-dominated communities, with other herbaceous plants, few woody plants, and open landscapes, often dominated by agriculture. More specifically, these habitats are characterized by the following:

- ***Size:*** Grasslands larger than 25 acres will be most productive for birds. Grasslands as small as 10 acres, however, will support some birds (especially in open landscapes, as described below). In addition, grassland birds avoid edges with forests and development, so circular or square fields provide more prime interior habitat than long, narrow fields with a greater degree of edge.
- ***Vegetation condition:*** Grassland birds prefer a habitat with 50 to 75 percent grass cover and the remainder as forbs. Grasslands composed primarily of grasses will support more birds than those dominated by goldenrods, thistle, and other forbs or row crops such as corn (row crops are not considered quality habitat for grassland birds). In addition, the absence of woody plants such as shrubs (e.g., dogwood, alder, cherry) create better-quality habitat for grassland birds (see Figure 15.2). These species require the open character provided by the low, dense nature of grasses and forbs.
- ***Landscape:*** Grasslands surrounded by other open fields, or located within a region where other large, open grasslands occur, will support more birds than those surrounded by forests or development. Even smaller patches of grassland habitat may provide suitable nesting conditions for grassland birds if situated within a landscape of other large, high-quality grassland habitats. Generally speaking, the Champlain Valley and parts of the Lake Memphromagog watershed provide important focus areas for grassland habitats and the birds that require them.
- ***Limited disturbance:*** Grassland birds also need a period of time when they can breed without risk of disturbance from agricultural equipment and farm practices. Birds typically arrive in early May and initiate breeding almost immediately. After 49 to 52 days, young birds should be developed enough to escape mowing equipment, livestock, predators, or other disturbances. Because some birds will breed multiple times in one year, and others will start new nests after failed attempts, a field will be continuously used for breeding until

about early to mid-August. Since much of the suitable grassland habitat in Vermont is supported by working farms, this is perhaps the most important consideration when managing for the benefit of birds such as bobolink, meadow lark, and vesper sparrow.

Figure 15.2
An ideal grassland for birds includes large, wide-open landscapes with few woody stems.

MANAGEMENT RECOMMENDATIONS

Managing grasslands for bird habitat involves the following three basic steps:

- ***Maintain or restore large grasslands.*** The size of grassland habitats is a critical component to the quality of the area for grassland birds. Bobolink and other grassland-dependent birds typically require areas of at least 50 acres, although they will utilize smaller patches of habitat if they are of high quality, free of disturbance during the critical nesting period, and within a landscape of other grassland and open habitats. Therefore, an important consideration is to identify and maintain those large patches of good-quality grassland habitat.
- ***Manage fields for grasses.*** Mowing fields annually, or semi-annually, will maintain dominant grasses, preventing the establishment of shrubs and colonizing saplings. In addition, removing grass cuttings after mowing will provide the best conditions for grasses to regrow the following season. In large areas, rotational mowing and/or burning can provide a mosaic of grassland types, attracting a greater diversity and abundance of grassland birds.
- ***Avoid or minimize nest loss from mowing.*** The timing of management activities is perhaps the most crucial factor for the successful breeding of grassland birds. Management of fields that are not used to grow hay for livestock forage should be mowed after August 15 to allow for successful breeding of grassland birds. If this is not feasible, delaying mowing until mid-July allows most birds to successfully raise young to the point of being fledged and able to fly and avoid mowing equipment.

  Where forage is desired, managers should consider late-cut refuges and delayed second cuts. Late-cut refuges are certain areas of fields left uncut until August, to allow some successful breeding on the property. These refuges may be chosen for their wet or poor soils, to minimize any lost forage production, but should be centrally located in the field, away from edges. Delayed second cuts allow a window for birds to breed throughout the property in early summer. Early/first cuts are made before June 1, then the second cut is delayed 65 days after the first, to allow time for the grass to regrow (14 days), the birds to nest (42 days), and young to develop flight (9 days). On productive sites, a third cut may still be possible.

Bobolink and other grassland-dependent birds typically require areas of at least 50 acres, although they will utilize smaller patches of habitat if they are of high quality, free of disturbance during the critical nesting period, and within a landscape of other grassland and open habitats.

Although not a replacement for delayed mowing, other mowing strategies can help reduce the loss of birds and nests, as well as impacts to other wildlife such as newborn deer fawns and wild turkey poults. These include avoiding mowing areas where birds are frequently seen, and instead mowing field edges first (edges of fields are not the highest quality habitat), raising mower blades to 6 inches or more, avoiding mowing at night while birds and other wildlife sleep, and using flushing bars on haying equipment to encourage birds and other wildlife to escape mowing equipment.

Where grazing is a primary management strategy, fallow paddocks may be left to allow birds to breed undisturbed. Because grazing animals may trample or cause birds to abandon nests, more concentrated and frequent grazing will prevent birds from breeding. Like late-cut refuges discussed above, leaving certain areas free from grazing for at least 50 days will allow birds to breed successfully.

By following these guidelines, you can maintain and enhance crucial grassland bird habitats. Landowner incentives may also be available for some practices. Contact the Natural Resources Conservation Service for more information about the programs available to landowners who wish to manage wildlife habitat. (See **Resources** for links.)

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. *Management Considerations for Grassland Birds in Northeastern Haylands and Pasturelands*. http://www.bobolinkproject.com/docs/NRCS_Grassland_leaflet.pdf

Vermont Fish and Wildlife Department. "Wildlife Action Plan." http://www.vtfishandwildlife.com/SWG_home.cfm

16. OLD FIELD MANAGEMENT FOR BIRDS

"Old field" is a broad term that applies to many open habitats transitioning from field to forest. They are dominated by forbs, grass, shrubs, or small trees based on the length of time since abandonment and management history. Similar to grasslands, the benefits of this habitat to wildlife depend on the size, configuration, vegetation height, percentage of woody vegetation cover, as well as density and composition of the area.

Old field habitats in Vermont are important for shrubland birds, which use a variety of habitats, including old fields, shrublands, and young forests. Old fields are also used by other wildlife such as butterflies and bees, cottontail rabbits, deer, snipe, turkeys, bobcats, green and rat snakes, frogs, and many others. Shrubland birds are the focus of many management plans because 22 of 40 birds associated with shrubland habitats are currently undergoing significant population declines in eastern North America. Additionally, 139 species of reptiles, amphibians, birds, and mammals prefer shrub and old-field habitats. Shrubland bird species in Vermont include common yellowthroat, white-throated sparrow, field sparrow, eastern towhee, American woodcock, brown thrasher, and more rare species such as prairie warbler, golden-winged warbler, and vesper sparrow.

Shrubland birds are the focus of many management plans because 22 of 40 birds associated with shrubland habitats are currently undergoing significant population declines in eastern North America.

Figure 16.1 Although larger areas of old fields provide better-quality habitat for wildlife, even old fields less than 5 acres in size can be important to a variety of wildlife.

Management for old field habitat is largely focused on maintaining areas that already exist, rather than creating new nonforested habitat.

While small areas of old field less than 5 acres in size can be important to a variety of wildlife, as a land manager, you should prioritize the management of large blocks or within large blocks of similar habitat. Some shrubland birds are "area sensitive" which means they prefer and select large areas of contiguous habitat for breeding. Birds such as the brown thrasher will use smaller fields, but the more uncommon species such as vesper sparrows and golden-winged warblers require areas of 25 acres or more.

AREA SELECTION

As the term implies, old fields are habitats that were previously used for agricultural activities on the landscape. Therefore, management for old field habitat is largely focused on maintaining areas that already exist, rather than creating new nonforested habitat. These areas are best maintained by removing larger trees and periodically mowing or brush hogging.

Focus your attention on areas that are still primarily open and that are more than 5 acres in size. Large, wide areas of old field habitat are favored because they have a more interior nesting habitat relative to the amount of edge where predators often search for food. Long, narrow fields have less interior nesting habitat relative to the amount of edge.

The actual field size for shrubland birds becomes less important when the field is within a landscape of similar habitat, so it is important to consider the landscape when determining your management plan. Managing old fields, pasture, or hayfields with hedgerows, scrub-shrub wetlands, young forest, power line rights-of-way, or similar habitats is a great way to maintain or improve conditions for shrubland birds.

MANAGEMENT TECHNIQUES AND GUIDELINES

Wildlife that use old field habitat tend to rely on the short, woody vegetation for cover and for hunting prey. Maintain a minimum range of 10 percent shrub and young tree crown cover. A lower percentage of woody cover in the field may limit abundances of some species and favor others. Allow some areas to become shrubby by brush hogging around them or by maintaining the field in its current condition and incorporating even-aged forest management on adjoining lands. You should also maintain herbaceous habitat including bare ground, grasses and forbs. These are productive areas that provide food such as insects, nectar, and fruits, as well as courtship areas that are critical to many species. They also serve other important habitat functions.

Proper management of old field habitat increases plant species diversity, structure (the different heights of vegetation), and patchiness (the arrangement of vegetation) in order to provide a mosaic of different vegetation conditions. Brush hogging should not take place on the entire field at once; the field should be broken up into sections that will be mowed on a rotation. This is particularly important for late-nesting birds, migrating birds, small mammals, and pollinators that may be active late in the summer.

Recent research indicates that old fields and wildlife openings should be managed on much longer rotations than managers have historically used. Many species will use low woody vegetation for cover, but many others need taller wood vegetation in these successional areas. Maintaining these types of old field habitats on a 10-year rotation with a brush hog can be difficult. A good alternative would be to mow the field in a mosaic, in which certain areas will be disturbed on long rotations (10+ years) and others on 1- to 2-year rotations. This will create a diverse habitat with patches of woody vegetation dominated by shrubs of different heights interspersed with grass/forb areas with a few taller trees about the field. By selecting, designating, and retaining patches of valuable wildlife shrubs across the field and limiting taller trees, you can prolong the successional process, as shrubs will not grow very tall and shade out the habitat below. This approach will provide valuable habitat for a long period of time.

Scattered tall trees can serve as mast sources and perches. But too many tall trees can come to shade the management area reducing the amount of low cover. Tall trees can be cut, girdled, or treated with herbicide. Cut trees can be used to construct brush piles. Girdled trees will become snags that provide perches for hawks, roosting sites for bats, and cavity sites for nesting birds.

Mowing or brush hogging must occur outside the primary nesting season, which is April 15 to August 1. Tree cutting should also take place outside the primary nesting season. Minimum mower deck height should be 6 inches. Where wood turtles, rat snakes, or other reptiles of concern are known to occur, mow after October 1. Mow or brush hog in old fields every 2 to 5 years depending on site conditions and prescriptions for different parts of the field. Leave shrubs that are valuable for wildlife such as serviceberry, elderberry, alder, viburnums, willows, dogwoods, and hazelnut.

MAINTENANCE

The benefits of old field habitat decline over time as trees mature and outcompete grasses, forbs, and shrubs. Be sure to monitor old fields and remove trees as they detract from the old field habitat (generally by excessive shading from groups of trees). In some cases, shrubby areas may need to be set back to reinvigorate the patch. Winter cutting is recommended to maximize resprouting. Also, monitoring is critical for invasive plant species that tend to thrive in old fields such as bed straw, honeysuckle, multiflora rose, and buckthorn.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service, 2012. “Conservation Practices Benefit Shrubland Birds in New England.” http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046969.pdf

—. “Early Successional Habitat Management, Old Field Management, Job Sheet (647)” http://efotg.sc.egov.usda.gov/references/public/VT/JS647VT_OldField_FillableForm.pdf—.

2007. “Ecology and Management of Scrub-shrub Birds in New England: A Comprehensive Review.” ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/schlossbergkingreport.pdf

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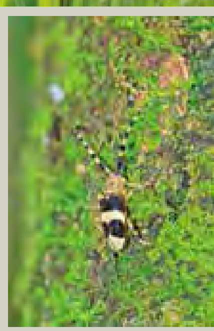
—. 2009. “What is Early Successional Habitat?” http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081109.pdf

By selecting, designating and retaining patches of valuable wildlife shrubs across the field and limiting taller trees, you can prolong the successional process as shrubs will not grow very tall and shade out the habitat below.

PART SIX:
Invasive Species Management



17. CORRECTIVE STRATEGIES FOR INVASIVE SPECIES

Often hardy and sometimes toxic, invasive species have become widespread on roads and ditches, deep in the forest and throughout meadows, on wetland edges, under water, and in the air. An *invasive species* is "an alien species whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Most alien species (also referred to as exotic or nonnative) are not a threat to Vermont's ecosystems. However, exotic species become invasive and a nuisance when they develop self-sustaining populations and outcompete native species, potentially impacting timber quality, soil chemistry and structure, wetland dynamics, and native species diversity.

Whether accidental or intentional, the introduction of invasive species must be avoided, and current populations must be managed.

ORIGINS AND CHARACTERISTICS

Plants

Plants have been moved around the globe for centuries, carried across oceans for food, shelter, medicine, and ornament. Today, the sale, importation, and propagation of exotic plants is heavily regulated by various state and federal laws. In Vermont, the Plant Quarantine Rule was passed by the Vermont Legislature in 2002, making it illegal to "sell, distribute, or transport" specific exotic species. Lists were subsequently created that aid gardeners and landscapers with finding substitutes for quarantined species.

Despite regulations, exotic invasive species continue to alter Vermont's landscape. Established invasive populations of plants spread through natural dispersal mechanisms. People are also responsible for their inadvertent spread by seeds and fragments attaching to shoes, clothing, equipment, and boats, which are then dispersed to unaffected areas. Whether accidental or intentional, the introduction of invasive species must be avoided, and current populations must be managed.

Figure 17.1
Image of common buckthorn. Courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Exotic invasive plants succeed in new ecosystems for a number of reasons. For instance, each multiflora rose plant can produce 500,000 fruits, and the plant forms dense thickets, thus outcompeting native species. Common buckthorn is highly adaptable and also forms dense thickets (see Figure 17.1). Exotic species are typically less susceptible to local pests and diseases, and some, such as garlic mustard, produce toxins that deter native plants from growing. Invasive species tend to thrive in areas that have been or continue to be heavily disturbed.

Wildlife

Species of nonnative wildlife have been introduced through the ballast of cargo ships; these ships are now under the oversight of the U.S. Coast Guard to minimize the introduction of invasive species. Some nonnative insects have also succeeded in becoming pests. The hemlock woolly adelgid is a species that has caused widespread mortality of hemlock by sucking sap (see Figure 17.2). The Asian longhorn beetle and emerald ash borer are also invasive pests that are causing devastating effects on forest health in the Northeast. Invasive pests and the effects they have on forest

Figure 17.2
Wooly adelgid on hemlock. Courtesy of Robert L. Anderson, U.S. Forest Service, Bugwood.org.

health are important for you to consider when developing management plans for your property. For up to date information on infestations and new species accounts, visit the Vermont Invasives website at www.vtinvasives.org.

Illegal importation, bait bucket dumping, release of aquarium species, and escapees from private facilities are the likely causes of invasive species into Vermont's lakes and ponds. Goldfish, tench, rudd, and alewife are all baitfish species that Vermont anglers and fisheries managers are currently battling.

Recognized by the International Union for the Conservation of Nature as an invasive species, outdoor, feral, or stray cats are also one of the most controversial. As domesticated descendants of a Middle Eastern wild cat, the house cat is the most common pet in the United States. Unfortunately, the impact on native wildlife can be tremendous when these hunters stray from home or become feral. If you own a cat, be mindful of this phenomenon and keep them indoors or have them wear a collar with a bell to warn birds and other wildlife of their presence.

Impacts

Invasive species can negatively affect native ecosystems in myriad ways. Forest regeneration is reduced as a result of intense shading and competition for space with exotic species. Soil chemistry is altered by chemicals produced by some exotic plants and European earthworm activity. Native species decline or may even disappear from a site. Since native insects and animals often find exotic species unpalatable, food chains are disrupted and habitat is degraded. These are just a few examples of the ecological changes resulting from invasive species. Table 17.1 highlights several common invasive species and their known impacts.

The ecological impacts of exotic invasive species on Vermont are vast, but the economy, human health, and recreation are also affected. The zebra mussel is an invasive species in the Lake Champlain region detested for its prolific colonies that clog intake pipes, potentially damage underwater cultural resources, and outcompete native mollusks. Additionally, invasive aquatic species that reproduce rapidly can soon outnumber native species and dominate their habitat. The result is often reduced numbers of native species, reduced habitat and water quality, and a diminished experience for anglers and paddlers alike.

It can be especially disconcerting when an exotic invasive species poses a threat to human health. Giant hogweed, wild parsnip, and wild chervil all contain a phototoxic sap (see Figure 17.3 a and b). If exposed to sunlight after touching this sap, a reaction occurs that causes

Figure 17.3 a and b
Giant hogweed (left) and wild chervil (right). Courtesy of Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Table 17.1
Selected invasive species and their associated ecological impacts

SPECIES	ECOLOGICAL IMPACT(S)
Hemlock wooly adelgid	Loss of hemlock stands could severely impact the quality and quantity of deer wintering habitat and potentially affect the health of the state's deer population. Lack of shade along streams could impact fish habitat.
Invasive fish (Asian carp, alewife, tench, etc)	These species outcompete native sport fish for food and habitat. Some species will prey on the eggs and fry of native species such as smelt and walleye.
Aquatic invasive plants (water chestnut, Eurasia milfoil, and so on)	Thick stands of aquatic invasive plants impede water-based recreation such as boating, fishing, and swimming.
Japanese knotweed	Frequently found along rivers and streams, this plant's early spring emergence and dense growth prevent native species from establishing in these traditionally species-diverse areas. Less food and habitat occur in knotweed monocultures.
Garlic mustard	Notorious for quickly dominating groundcover plants and excluding native species through dispersion and chemical disruption of native root associations, this species alters suitable habitat for native birds, mammals, and amphibians.
Purple loosestrife	Although a beautiful plant, it quickly replaces native wetland species such as cattails and sedges, and holds little value as a food or habitat source for wildlife.
Common and glossy buckthorn	Both species produce fruits that are eaten and distributed by wildlife, thus enabling the creation of dense, even-aged thicket stands that crowd and shade out native species and the impact success of native nesting birds.

burns, blistering, and skin discoloration. Gloves and long sleeves are recommended when working with these and any of the knapweed species. In addition, outdoor cats spread parasites through feces and are common carriers of the rabies virus.

MANAGEMENT

The myriad impacts resulting from exotic invasive species can be overwhelming and discouraging. However, with careful management and the right attitude, you will have some success at prevention and control of them on your land. Even if full eradication is not achieved, habitat for wildlife can be improved and native species will benefit.

The first step in successful control is to positively identify exotic invasive species on your property. There are many resources for identification online or in publication. If you are unable to identify invasive plants or animals using the **Resources,** seek the help of a professional botanist or other natural resources professional.

Once invasive species have been identified on your property, a plan of attack is needed. Visual documentation through pictures can be used to measure management success over time. Some landowners may opt

There are three categories for managing invasive species: chemical, mechanical, and biological.

to hire a professional consultant to write a plan and create a map, while others will conduct their own research and use a hand-drawn map. Regardless, mapping the location of invasive populations on your land can be helpful in future monitoring efforts as well as for measuring the success of your management efforts.

The Vermont Invasives collaboration has included a feature on their website that enables landowners to map invasive plants or animals on their property. This feature can be very useful in your own land management efforts. It is a good idea to approach the management of invasive populations on your land while considering other features within an area. Some infestations may vary by site, and Table 17.2 below can help narrow down an appropriate management approach.

If your land is enrolled in the Use Value Appraisal (UVA) Program and a management plan has been developed, speak with your county forester about recommendations for maintaining forest health through the prevention and control of invasive species. Integrating invasive species management into any forest or wildlife management plan is an important step to avoid their inadvertent spread. Whether or not a management plan is in place, early detection and rapid response is essential to stopping the spread of invasive species onto your property. There are three categories

Table 17.2

Strategies for managing invasive species based on infestation level

SITE CHARACTERISTICS	MANAGEMENT APPROACH
Pristine: less than 10% cover of invasives	Prevention is key. Eradicate all populations of invasive species. Monitor "cleaned" sites and adjacent areas to remove new plants. Look for new species known to be in the area.
Somewhat disturbed: 10-30% cover of invasives (monocultures not yet formed)	Prioritize management activities based on the following: 1. Level of threat invasives pose to the site 2. Special natural features (vernal pools, sugarbush, etc), wildlife habitat, or native species that warrant special effort 3. Practical and economic feasibility of species-specific treatment options Treat small infestations from the edge into the center and focus on controlling seed-bearing individuals first. Total eradication may not be possible.
Heavily infested: greater than 30% coverage of invasives	Don't get discouraged! Focus on protecting remnant patches of native vegetation and special natural features from invasives. Prioritize management based on the 10 to 30% cover scenario. Revegetation with native species will likely be necessary.

Source: Cusack, C., Plumb S, and D. Prince. 2011. Best Management Practices for the Prevention and Treatment of Terrestrial Invasive Plants in Vermont Woodlands. Montpelier: Vermont Chapter of the Nature Conservancy.

for managing invasive species: chemical, mechanical, and biological. Some methods are better for certain species and levels of infestation than others, and an understanding of these techniques and applications will help determine what is most suitable for your site.

Chemical

For invasive plants, chemical management involves the use of herbicides. In the State of Vermont you may apply a nonrestricted use herbicide to your own land, but certification is required through the Vermont Agency of Agriculture for application of herbicides on land other than your own or to apply restricted use herbicides. Use of herbicides needs to be in accordance with the label. ***The label is the law!*** You could also hire a professional contractor who specializes in invasive species control.

Two types of herbicides are most commonly used in invasive species management — glyphosate and triclopry. *Glyphosate* is a nonselective herbicide that can kill any plant it comes in contact with by interrupting its photosynthetic process. Aquatic, restricted use formulations exist for use near wetlands, but a permit from the Department of Environmental Conservation is required and these herbicides can only be purchased and applied by a certified pesticide applicator. *Triclopyr* is more selective and is used on plants that are more difficult to control without impacting monocots (grasses, orchids, lilies, and so on). Most formulations of this herbicide require a license to purchase and use. When dealing with chemicals, employing the correct formulation and concentration at the right time of year for your target species is critical. Consideration should also be given to the impacts of chemicals on nontarget species.

Small-scale problems typically require a *foliar* application, or spraying leaved and flowering plants with the herbicide. This can be done with a backpack sprayer or even a handheld spray bottle with a low concentration of active ingredient, conducted on a day when there is no wind and no threat of rain for the next 3 to 48 hours (depending on the chemical). Some plants respond to treatment best if the existing stems are completely cut in spring and re-growth is sprayed in early fall. Remember that every species has different application rates and times to spray, and that using the least amount to work effectively on the target species will save money and minimize impacts to nontarget species.

Cut stem treatments involve cutting the stem close to the ground and immediately applying herbicide to the stump. These treatments are most effective in the fall, and only the living tissue on the outer layer of the stem needs to be treated. Mixing a dye with the herbicide solution will stain treated surfaces and prevent reapplication and overuse of the herbicide. Care should be taken with this method so as not to exceed per label allowed rates.

Mechanical

Mechanical control can be very intensive and involve several years of management, but it can also be effective. Many techniques are utilized on various species of invasive plants, and finding the right method based on plant biology is the most effective approach to eradication.

Hand pulling limits the eradication effort to only the target species. It is most easily accomplished when the ground is moist and soft such as

Figure 17.4
Foliar spray approach.
Courtesy of Steve Manning, Invasive Plant Control, Bugwood.org

Figure 17.5
Regular mowing to control invasive species. Courtesy of VFWD.

Girdling refers to the use of a chainsaw or ax to make two to three circular cuts set at 3 inches apart around the circumference of trees or shrubs with a single stem.

in the spring or after a rain. If working in those conditions isn't possible, a shovel or weeder may help remove the plant stem. With or without tools, remove the entire plant, including the root and rhizomes to avoid resprouting. Avoid hand pulling when berries are ripe or seeds are set to minimize accidental spreading. Pulling causes site disturbance, and you should make an effort to put disturbed soil back in place to minimize recolonization.

Cutting or mowing is best used where invasive plants exist in large monocultures or have extensive root systems (such as with Japanese knotweed), and at sites that can be visited often. This method works by continually stressing the root system and depleting carbohydrate reserves in the plant through multiple cuttings over a period of time. It may take several years to accomplish this, and a commitment should be made to continue this method as long as it takes to eradicate the problem species.

Smothering a site with UV-stabilized plastic will effectively kill most plants underneath. It is helpful to remove all above-ground vegetation prior to covering, and extending the cover 3 to 5 feet from the affected area as a "buffer zone." Secure the plastic with rocks or stakes and leave in place for a full growing season. For species such as knotweed, goutweed, and wild chervil, leaving the plastic in place 2 to 4 years proves more effective.

Girdling refers to the use of a chainsaw or ax to make two to three circular cuts set at 3 inches apart around the circumference of trees or shrubs with a single stem. The living tissue of the cambium layer (inner bark) will no longer be able to transport essential nutrients and sugars, which will eventually kill the plant. The cut should not be too deep to avoid creating a hazard under high wind situations. Resprouts can be a problem with this approach.

Biological

Biological management usually involves the introduction of an invasive species' natural predator to the ecosystem. In Vermont, two species of leaf-eating beetles and a root-boring weevil have been released, each feeding on purple loosestrife in their native Europe. Sites where beetles have been released have seen reduced growth rates of loosestrife and signs of native plant recovery. This method is overseen by Vermont's Department of Environmental Conservation and is unavailable for private landowners without permission.

SUMMARY

Having so many options available for exotic invasive species control and management may be confusing, but ample resources for information and education are available. For instance, specific species information can be found at www.vtinvasives.org. In addition, the suggested links that follow in **Resources** are a good place to start in your effort to manage your land. As you move forward with management, replanting will be a likely step in reclaiming your land. Planting native species at a site or stocking native fish in a pond is always recommended over the alternative, which can lead to ongoing problems for Vermont's economy, ecology, health, and recreation. Be sure to check with the Vermont Department of Forests, Parks and Recreation for sources to obtain native stock of plants and for any quarantines that may be in effect that apply to the transportation of woody plants in Vermont.

RESOURCES

Cusack, C., S. Plumb, and D. Prince. 2011. *Best Management Practices for the Prevention and Treatment of Terrestrial Invasive Plants in Vermont Woodlands.* Montpelier: Vermont Chapter of the Nature Conservancy.

Lake Champlain Basin Program. "Aquatic Nusiance Species in Lake Champlain and the Basin." http://www.lcbp.org/water-environment/aquatic-invasive-species/ais-in-the-lak/

U.S. Department of Agriculture. Natural Resources Conservation Service. Exotic Invasive Plant Info Sheet. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081111.pdf

Vermont Department of Agriculture. Pesticide regulations. http://www.vermontagriculture.com/ARMES/pest.htm

Vermont Invasives. http://www.vtinvasives.org

—. Management Tools. http://www.vtinvasives.org/plants/prevention-and-management/tools-resources

—. Vermont Invasive Exotic Plant Committee. http://www.vtinvasives.org/plants/vermont-invasive-exotic-plant-committee

—. "Impact of Invasive Plants." http://www.vtinvasives.org/plants/impact-invasives

—. Quarantine Rule. http://www.vtinvasives.org/plants/state-quarantine-rule

—. Watch List. http://www.vtinvasives.org/searchsite/results/Watch%20List

Vermont Invasive News Updates. http://www.vtinvasives.org/news

PART SEVEN: Habitat Management for Game Species

18. WHITE-TAILED DEER

Odocoileus virginianus

SUMMARY

White-tailed deer are one of the most popular game species in Vermont. They occupy a wide variety of habitats, from lowland farm fields to upland forests. Protecting wintering habitat is crucial for deer. Deer survive the winter by seeking the shelter of large areas of multi-aged softwood forests to protect them from deep snow and cold temperatures. When humans or dogs move into their wintering areas, deer are forced to expend valuable winter energy. Feeding deer in winter is illegal in Vermont and frequently kills the animal because deer have evolved to eat course woody browse in winter. In other seasons, deer feed on shoots and leaves, agricultural crops, and mast crops such as beechnuts, acorns, apples, and other fruits.

Maintaining the functional cover and safety properties of deer yards is important for long-term sustainability of Vermont's deer herd.

NATURAL HISTORY

The white-tailed deer is one of five members of the deer family (*Cervidae*) found in North America; the others include mule deer, elk, caribou, and moose. The white-tailed deer is widely distributed with more than 30 described subspecies found from Venezuela to southern Canada. The subspecies found in Vermont is known as the northern white-tailed deer (*Odocoileus virginianus borealis*).

Generally speaking, white-tails are very adaptable and occupy a wide variety of habitat types. The deer of Vermont thrive as a forest edge species. Habitats that feature a mosaic of large woodlots and agricultural openings provide ideal living conditions for deer. Because they are so adaptable, deer are found in the forest land of the Green Mountains, the Northeastern Highlands, the farmlands of the Champlain Valley, and the Connecticut River valley.

Deer are ruminant herbivores meaning that they are plant eaters with a four-chambered stomach like a cow. Deer are more selective than cows and require more easily digested plant matter. The chambered stomach allows deer to eat a large variety of woody and succulent plant types. Deer are also known to occasionally eat protein-rich items such as bone, dead fish, and bird eggs.

More than 600 different foods have been identified as deer food. Forbs (herbaceous plants), leaves, twigs, and agricultural crops such as alfalfa and oats make up the bulk of the deer's spring and summer diet. Deer build reserves of body fat to survive the winter months by replacing some of the green forage in their diet with foods high in fat and protein in the fall, such as acorns, nuts, mushrooms, apples, and other fruits.

Figure 18.1
Deer habitat components consist of large woodlots and herbaceous openings.

During the critical wintering period when snows are deep, potentially from December 1 through April 15, it is essential that deer stay in wintering areas, forested areas containing stands of mature softwood trees with large contiguous crowns.

During the winter (which can last up to five months in Vermont), food is either scarce or difficult to obtain because of deep snow. Until snow conditions become too restrictive, deer will paw the ground in search of the forbs, nuts, and apples remaining from the previous autumn.

Deer mostly rely on fat accumulated in late summer and early autumn to survive winter. They also grow a winter coat to minimize heat exchange with the environment. Deer conserve energy during winter by seeking shelter from cold winds and deep snow in softwood forests. Deer also restrict their daily movements to those absolutely necessary and reduce their feeding in winter, entering a state of semi-hibernation. When they do eat, their food is primarily the buds of small trees and woody shrubs and the needles of evergreen trees such as cedar and hemlock, and fir to a lesser extent. These winter foods, referred to as browse, are high in fiber and low in energy and do not fully meet a deer's daily winter energy demands. Windstorms often bring nutritious tree litter and lichens down to within the reach of deer. However, deer are very dependent on their fat reserves to survive the winter. Even captive deer fed an unlimited nutritious diet reduce their forage intake and lose weight during severe winter weather. This is a natural adaptation allowing a large herbivore to survive the long annual dormant period for vegetative growth. When spring approaches, deer's metabolism increases and they must find emergent vegetation to meet this increased energy demand.

Deer mate in the fall (early November to mid-December in Vermont). Gestation is just beyond 200 days with fawns born from mid-May to early July. Doe fawns can occasionally conceive offspring under optimal habitat conditions but breed and give birth later than mature does. Reproductive potential is highest at 2 years of age, and does frequently produce twins or even triplets when deer densities are not too high. Bucks in good habitat become sexually mature as yearlings, and they begin to challenge older bucks for breeding rights. About half of yearling bucks produce more than two antler points in Vermont. In Vermont, does can live 15 years, but bucks usually do not survive more than 5 years.

A healthy deer herd has tremendous reproductive potential. When determining the annual harvestable surplus, deer managers subtract adult mortalities from the rate of fawn survivorship to 1 year old (called recruitment). Starting in 1979, the Vermont Fish and Wildlife Department decided to reduce a chronically overabundant deer herd through antlerless deer harvests. While the deer herd is now in better condition, it still has the potential to grow and become overabundant. Landowner actions to improve deer habitats need to be coupled with the willingness to harvest antlerless deer in order to prevent deer overabundance. Deer overabundance has many costs that include degraded habitats and lack of forest regeneration, unhealthy deer, increased incidents of deer-vehicle collisions, crop and garden losses, and Lyme disease.

HABITAT REQUIREMENTS

Optimal deer habitat is a landscape mosaic of fields and forests. The average home range of a deer is approximately 1 square mile (640 acres), and this area must contain these various habitat conditions to best meet the needs of deer. During the critical wintering period when snows are deep, potentially from December 1 through April 15, it is essential that deer stay in wintering areas, forested areas containing stands of mature softwood trees with large contiguous crowns. Wintering areas range in size from about 10 acres to several thousand acres. They comprise less than 10 percent of the total forested area in the state. Even though the wintering area occupies such a minor component of the deer's home range, it is by far the single most important habitat type. The best tree species are, in descending order of value, eastern hemlock, northern white cedar, red and white spruce, balsam fir, and white pine. Spruce and fir trees comprise the most common softwood tree that make up deer winter habitat in Vermont.

Preferred trees range in height from 35 to more than 75 feet, and from 6 to 20 inches in diameter at chest height.

Typically, the best deer winter habitat does not provide much food for deer because the low level of sunlight reaching the forest floor restricts the growth of young forest plants. Although deer rely greatly on their fat reserves to endure the winter, they still must eat throughout this stressful period if they are to survive until spring. Some mixture of hardwoods (deciduous trees) along with the softwoods (evergreen trees) provides some food along with cover. Optimal wintering areas have large softwood canopies interspersed with small (less than 1 acre) openings. Within these forest openings, succulent plants such as forbs and sedges, woody shrubs such as hobblebush, dogwood, witch-hazel, and striped maple, and young trees such as yellow birch, ash, maple, and hemlock provide deer with food in winter.

The amount of softwood required in wintering areas decreases in southern Vermont due to shorter winters. In southern parts of the state, deer often winter on steep south-facing slopes scattered with small groups of large softwoods.

Outside of the wintering period, deer can be found just about anywhere that shrubs and young trees interspersed with small grassy openings or forest edges next to fields and farm crops can be found. Unlike during the winter period, deer tend to be adaptable to a wide variety of habitat conditions. In addition to an abundance of food resources, deer also need fawning habitat. This is typically areas of tall grass or shrubby cover that provides protection for fawns from predators.

MANAGEMENT PRACTICES

Habitat management activities that provide food, escape cover, or winter shelter are recommended for landowners wishing to provide deer habitat. Because deer inhabit an area of more than 600 acres, most landowners shouldn't feel they must provide for every aspect of the deer's needs. If deer habitat management is a priority, most landowners should consider coordinating efforts with neighboring landowners.

Winter Habitat

Before you begin your management plan for deer, you should first determine if deer winter habitat (a.k.a. deer yards) exists on your property. Winter habitat is the cornerstone of the deer's annual life cycle in Vermont. Because deer return to the same wintering areas each year, often traveling many miles to access these important areas, evidence of their continued presence is recognizable to the trained eye. Look for the browsed twigs of young trees, indicated by the presence of compressed and bushy stems, as well as scarring on the stems of young trees, and concentrations of deer pellets. After a few weeks with more than 18 inches of snow, winter trails, concentrated deer pellets, and deer beds become evident in deer yards.

Deer yard maps are available from town clerks, regional planning commissions, and from the Vermont Fish and Wildlife Department. In addition, digital GIS maps of deer wintering areas are available on the ANR's Natural Resources Atlas; see **Resources** for links to more information. However, deer use of winter habitats may change over time

Figure 18.2
Looking up at mature hemlock cover illustrating 70 percent crown closure

Because deer return to the same wintering areas each year, often traveling many miles to access these important areas, evidence of their continued presence is recognizable to the trained eye.

Figure 18.3 a,b,and c
Deer browse; bark stripping; trails and beds in snow

for various reasons, so inspect forest habitats after an extended period of deep snow depths to determine current deer usage. Contact your local Vermont Fish and Wildlife Department office for more information on assessing deer winter habitat. (For more information on managing deer wintering areas, refer to **Chapter 8, "Deer Wintering Area Management**.")

The primary goal of deer wintering area management is the promotion of softwoods. To improve deer wintering areas on your land, you should pursue two basic objectives. First, strive to retain and enhance mature softwood trees with large, vigorous crowns with winter canopy closure of 70 to 90 percent. These trees will be the ones that are most effective in reducing snow accumulation and wind chill. Second, provide a source of food by making small, selective patch cuts. Alternatively, you may want to clear-cut small strips of hardwoods adjacent to softwood cover, which will promote tree and shrub regeneration and other herbaceous growth.

Without a deliberate approach to deer yard management, softwood stands can become too mature and overgrown. Overly mature, single-aged stands are more susceptible to disease and being blow down during storms. You should seek additional information from county foresters, private consulting foresters, or state biologists in addition to reviewing the detailed management guide provided by the Vermont Fish and Wildlife Department. The link to download this document is in **Resources.**

Spruce, white cedar, and hemlock are optimal tree species due to their thick canopy and longevity. Fir and white pine are also acceptable and provide useful cover and capture sufficient snow to minimize snow depth within the wintering area. You may cut tall, dominant trees of these species if it releases a smaller tree of the same species. When selectively harvesting trees in a deer yard, take care not to damage nontarget softwood trees. You may choose to harvest during the winter when regenerating trees are protected under deep snow cover.

Uneven-Age Stand Management

Maintaining functional cover in a deer yard usually requires uneven-age stand management with group selection cuts that range from 1/4 to 2 acres. Your goal should be to maintain at least 50 percent functional cover in a deer yard at all times. Stand entry should occur every 10 to 20 years, with stand maturity ages ranging from 60 years for predominantly fir stands, 80 to 100 years for predominantly spruce stands, and more than 100 years for hemlock stands. The amount of area to be regenerated is equal to the cutting interval divided by rotation age. For instance, in a stand on an 80-year rotation and treatment scheduled every 15 years, 15/80 (19 percent) of the stand should be regenerated during each treatment. Thus, only 38 percent of the stand would be 30 years old or less at any one time.

Even-age stand management with clear-cuts, or preferably shelterwood cuts, larger than 1 acre may be acceptable in deer yards greater than 200 acres, but maintaining 50 percent cover at all times in the yard should still be your primary goal. For even-age management, shelterwood systems are a more reliable regeneration method than clear-cutting.

In a two-stage shelterwood system, the first cut should be in late summer to prepare a seedbed for spruce regeneration and reduce residual stand damage during this bark-tight period. The second cut should be during winter to protect regeneration that has reached 6 inches to 3 feet in height, depending on brush competition. A three-stage shelterwood system is preferred when risk of windthrow is high. Clear-cutting is the least preferred strategy for deer yard management, but you may find it necessary to quickly regenerate a nearly pure stand of fir or when dealing with Armillaria in certain situations. Regeneration should already be present, and logging should occur in winter with greater than 15 inches of snow depth to protect the seedlings.

With any harvest strategy, overmature, diseased, and insect-damaged trees should be cut first, but care should be taken not to spread disease. Wind-blown stands can also be salvaged. When converting an even-age stand to an uneven-age stand, remove the biggest fir first and leave spruce until the final cut of the first rotation because it lives longer, is more wind-firm, and is more resistant to spruce budworm.

Deer Yards

Hemlocks provide superior cover and can live up to 600 years; they are difficult to regenerate from seedlings in deer yards, so landowners are advised not to harvest hemlock stands. However, there may be very little forage for deer under pure hemlock stands, so browse management in adjacent hardwoods should be a priority. You should release advanced hemlock regeneration where it exists, but avoid releasing hemlock regeneration prematurely as it is susceptible to sunscald and can cause die-back of the regeneration.

Narrow deer yards should not be fragmented, and yards should have corridors of cover that connect larger patches of cover. Such travel lanes are best if at least 200 feet wide. Permanent travel lanes, such as those along stream corridors, should be regarded as separate stands and managed very lightly so as to maintain maximum shelter value at all times.

Pre-commercial thinning may be done before a stand is 20 years old or 15 feet tall to encourage rapid tree growth and prevent stand stagnation. Aspen may be left uncut because it will eventually succumb to late-succession trees. Other hardwoods may be cut more frequently than softwoods to produce browse, but mature mast-producing trees (mast is nuts and fruits) such as beech, oak, and apple are desirable. Hardwood stumps cut low to the ground sprout more vigorously than those that are 1.5 to 2 feet tall.

Perhaps the simplest management practice you can follow to help deer survive winter is to not allow domestic dogs to roam free through deer yards and report such incidences of dogs chasing deer to game wardens. Chasing deer throughout winter causes fat reserves to be expended prematurely, which leads to death before spring.

Maintaining the functional cover and safety properties of deer yards is important for the long-term sustainability of Vermont's deer herd. Maintaining healthy habitats and healthy deer should help minimize the historical boom and bust cycle of the deer population. Deer yards are maintained on state lands by protection from development and with carefully planned timber harvests. Through the Act 250 review process, between 1,000 and 2,000 acres of deer wintering areas are protected

Perhaps the simplest management practice you can follow to help deer survive winter is to not allow domestic dogs to roam free through deer yards and report such incidences of dogs chasing deer to game wardens.

The proper way to help deer forage in winter is by increasing the availability of palatable woody browse from sucker growth or treetops that results from pruning, apple tree release, or logging operations.

every year by working with developers to mitigate adverse impacts on deer yards. However, most development and timber harvesting occurs on private lands with operations exempt from Act 250 review. It is largely up to private landowners and town planning boards to determine how the bulk of Vermont's deer wintering habitats are managed.

Winter Feeding

Artificial feeding of white-tailed deer is currently illegal in Vermont. While well-intentioned, this practice can actually reduce the animals' ability to survive the winter by making them more vulnerable to starvation, predation, disease, and vehicle collisions. Attracting deer away from wintering habitats can cause them to burn valuable energy and put them at greater risk of conflict with dogs, coyotes, and automobiles. Changing a deer's diet suddenly is a quick way to kill it. Deer have evolved to eat coarse browse with low digestibility in winter. Feeding deer corn or other high-carbohydrate foods can kill the microorganisms in their stomachs needed for proper winter digestion. Deer have been known to starve to death in winter with stomachs full of corn. When fed in winter, deer are often killed by humans with the best of intentions. The proper way to help deer forage in winter is by increasing availability of palatable woody browse from sucker growth or treetops that results from pruning, apple tree release, or logging operations.

Nonwinter Habitat

Habitat management for deer outside wintering areas should meet the needs of the various life cycle activities. Manage small forest stands of less than 1 acre with trees less than 10 years of age through small clear-cuts. Larger hardwood or mixed-wood clear-cuts and shelterwood (understory) cuts are best for deer if irregularly shaped and less than 200 feet wide to provide deer with residual escape cover.

You should also maintain additional small herbaceous openings by mowing or brush hogging every 3 years. Log landings, permanent skid roads, wastewater leach fields, and other small openings can be seeded with legumes (such as alfalfa, clover, peas, and beans) and brassicas (cabbage and turnip type plants such as kale and rapeseed) as food plots for deer. Such food sources provide protein and fat energy for lactating does and buck antler growth in the spring. Plant on south-facing slopes to encourage early snowmelt following severe winters when access to emergent vegetation may be critical for deer. Autumn brassicas will help deer build fat reserves for the upcoming winter; autumn body condition is essential for winter survival. Also, many brassica species become palatable after one or two frosts, which usually coincide with archery season. Such food plots can enhance bowhunters' success, particularly where localized deer overabundance is an issue for garden, crop, or forest land damage. When localized population reduction is the objective, antlerless deer should be targeted by bowhunters.

Active farmland within deer home range is one of the best complements to their natural habitat. While agricultural crops such as alfalfa, oats, and corn promote poor health in a deer's winter diet, they are perfect supplements to a deer's spring and summer diet. During autumn, beech and oak trees become an important source of food. The nuts, called hard mast, make a vital contribution to deer's fat reserves and their chances of surviving the winter.

Beech and oak trees begin producing nuts at about age 50, and continue to do so at regular 3- to 5-year intervals for up to 150 years. In most regions of the state, beech and oak are found sparingly; oak is more common in the river valleys, while beech is found in the upland forests. Both species often grow in small homogeneous groups within the forest. You should practice selection harvests that maintain and enhance the crowns of mature trees and promote the regeneration of future mast producers, removing trees with bark disease evident on the stems first.

Apples, blueberries, and other soft mast-producing plant species can be managed to provide fruits to supplement the deer's fall diet. Remove trees that shade these plants; most soft mast producers require full or nearly full sunlight to remain vigorous and productive. While existing plants are easiest to enhance, apple, blueberry, and other fruit plants can be purchased from local nurseries and raised to provide food for deer. Some types of apple trees will hold apples well into winter.

The Natural Resources Conservation Service may in some cases provide landowners with financial assistance for habitat management through Farm Bill Conservation Programs. Deer habitat improvements are easily combined and complementary with the direct management of other species of greater conservation concern.

In areas where deer have become overabundant, successful regeneration of desirable tree species such as white ash, red oak, and maples may become uncommon or nonexistent. Large clear-cuts in such areas can help establish desirable regeneration of species that are palatable to deer by overwhelming deer with enough browse and ensuring that some seedlings escape consumption by reducing browsing pressure on seedlings that grow through the remaining slash.

RESOURCES

Vermont Agency of Natural Resources. Natural Resources Atlas. http://anrmaps.vermont.gov/websites/anra

Vermont Fish and Wildlife Department. "Management Guide for Deer Wintering Areas in Vermont." http://www.vtfishandwildlife.com/library/Reports_and_Documents/Fish_and_Wildlife/Management%20Guide%20for%20Deer%20Wintering%20Areas%20in%20Vermont.pdf

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19. MOOSE

Alces alces

The best moose habitat in Vermont occurs in the forests of the Northeastern Highlands and along the entire spine of the Green Mountains.

SUMMARY

Moose are large animals that are well adapted to the dense forests and deep snow found in the mountains and highlands of Vermont. They are generally solitary, and males may roam great distances during the fall rut. Moose are semi-aquatic and utilize ponds, bogs, and stream habitats for food and to maintain body temperature in the summer. They also require regenerating forest for food, upland hardwoods and mixed forests for food and cover, and softwood stands for winter cover habitat.

NATURAL HISTORY

Moose are Vermont's largest wild animal. Adults may stand 6 feet or taller at the shoulder and weigh between 600 and 1,200 pounds. Moose are able to lift their feet nearly shoulder high to move easily over fallen trees or through deep snow.

Historically, moose were plentiful in Vermont until the nineteenth century when widespread clearing of forests and subsequent conversion to farmland eliminated most of the state's moose habitat. Moose became so rare in Vermont that by 1896 the Legislature afforded the animals complete protection. The moose population has since responded to the regrowth of forests and now occupies three-quarters of the state. The best moose habitat in Vermont occurs in the forests of the Northeastern Highlands and along the entire spine of the Green Mountains.

Moose generally occupy distinct seasonal home ranges to which they return from year to year. Summer ranges are about 4 to 10 square miles in size. Home ranges may expand during the fall mating (rutting) season and decrease in the winter. Moose are not territorial, and individual ranges overlap considerably.

Moose are not as gregarious as deer and, although it is not uncommon to encounter several moose together during the post-rut period, by late winter moose are usually seen as solitary animals or in groups of two or three. Bull moose generally do not associate with cows except during breeding season (September to November). Although usually one bull is seen with a cow, occasionally two or more bulls follow a cow in heat.

Bulls in their prime (ages 6 to 9 years) reach the peak of the rut earlier than younger bulls, and due to their size, strength, and social dominance, are more successful breeders. The larger antlers of prime bulls are shed after the rutting season, usually in late November or December. Young bulls may retain their smaller antlers as late as mid-April.

Calves are born from mid-May through early June. Younger cows (ages 2 and 3 years) generally give birth to a single calf, but twins are common for older cows if adequate browse is available. Just prior to calving, pregnant cows drive away their offspring of the previous year.

Moose are mainly browsers, eating new leaves and the twig growth of trees and shrubs, but they also graze on grasses, forbs, lichens, and mushrooms. Tender shoots of water lilies and other aquatic plants are sought during the summer because of their high concentrations of sodium, a mineral necessary for lactation, antler growth, and rapid body growth of calves. Moose are excellent swimmers and occasionally dive to feed on plants in deep waters. An adult moose may eat up to 100 pounds (green weight) of high-quality food per day in the summer. After the fall frosts and winter snows either kill or cover up herbaceous foods, moose turn to woody twigs for food until the next spring.

Winter browse is neither very nutritional nor easily digestible. Consequently, moose on winter ranges usually lose weight and must rely on fat reserves to survive harsh winters. Moose in the Northeast browse on aspen, maple, birch, willow, ash, pin cherry, hobblebush, and balsam fir. Scars from winter bark stripping remain on trees for many years.

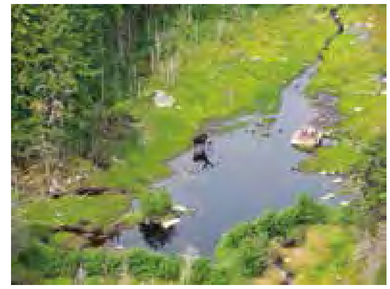


Figure 19.1
Moose feeding in a wetland

HABITAT REQUIREMENTS

The moose is a northern forest species and utilizes different habitats during various seasons of the year. In general, moose prefer thick, brushy habitat for concealment and as sources of abundant food.

Lowland softwood forests, beaver ponds, and other shallow bodies of water are favorite spring and summer habitats for moose. During the hot summer months, moose can suffer from overheating and must have access to dense shade or water for cooling. Moose also use ponds to escape biting insects and predators.

Upland hardwood or mixed forests are frequented by moose during the fall and winter. Younger age classes of these forest types provide abundant browse, especially in recently logged areas. Optimal year-round moose habitat for their region consists of the following:

Figure 19.2
The combination of wetlands, softwoods, and hardwoods makes good moose habitat. Courtesy of Eric Sorenson, VFWD.

- 40 percent feeding grounds (regenerating forest less than 20 years old)
- 10 percent winter cover (spruce and fir stands more than 20 years old)
- 40 percent hardwoods or mixed forest greater than 20 years old (for both food and cover)
- 10 percent wetlands (for summer feeding and cooling)

These conditions are believed capable of supporting a density of five moose per square mile.

Figure 19.3
Aerial photo of moose in winter habitat. Courtesy of John Hall, VFWD.

In Vermont, increasing moose densities from 1980 to 2005 resulted in growing conflicts with humans, namely, collisions with motor vehicles and damage to livestock fencing and maple sap tubing. During this same time period, in the Northeast Kingdom, moose densities greater than three per square mile caused widespread damage to regenerating forests. Not only did this heavy browsing reduce future economic returns for forest landowners, but habitat conditions for many other species of wildlife that utilize shrubs and dense forest understory for feeding, nesting, brooding, and escape cover were negatively affected.

Experience has shown that because of these conflicts with human land uses and damage to the environment, moose densities throughout Vermont shouldn't be higher than two moose per square mile, and public surveys indicate that less than one moose per square mile is generally more acceptable. Adequate forage for moose at these lower densities can be provided by lowering the amount of regenerating forests to 10 to 20 percent as opposed to the 40 to 50 percent suggested for the Midwest.

Figure 19.4
Recent clear-cut with good regeneration

Ten to 20 percent of moose range should be in regenerating forest (trees up to 20 years of age).

During severe weather, softwood stands are used for shelter, particularly when snow depths in open areas exceed 30 inches. Softwood trees also provide shade needed by moose to avoid overheating in late winter.

MANAGEMENT PRACTICES

Managing habitats specifically for moose is difficult because of the animal's large home range. Few landowners have the ability to control habitat management over an animal's entire 8 to 16 square miles. Nonetheless, you can maintain or improve specific moose habitat attributes under your control by applying a few general guidelines:

1. Moose generally benefit from the abundant browse that grows on recently logged areas. Ten to 20 percent of moose range should be in regenerating forest (trees up to 20 years of age).
2. Although clear-cuts provide plenty of food, moose prefer to remain close to cover, and their use of browse in the interior of large cut areas is low, particularly during the winter. Square clear-cuts, therefore, should not exceed 10 acres in size. Larger rectangular or irregularly shaped clear-cuts are acceptable as long as the maximum width is kept below 200 yards.
3. Softwood stands managed as winter shelter should comprise 5 to 15 percent of a moose's home range and should be located adjacent to regenerating hardwood or mixed forest (browsing areas) at elevations higher than 1,000 feet (where most Vermont moose winter). These shelter areas should be at least 10 acres in size with a moderately dense overhead canopy and average tree heights of at least 35 feet.
4. You should also protect any existing shallow wetlands, such as beaver ponds, used by moose. Manage these wetlands as indicated in **Chapter 24, "Beaver."**

20. BLACK BEAR

Ursa americanus

SUMMARY

Black bears inhabit remote forested habitats throughout much of Vermont. They require large tracts of unfragmented landscapes with a variety of food sources. In the spring, emerging succulent plants such as jewelweed, often associated with forested wetlands, as well as plants such as Jack-in-the-pulpit are critical for bear survival. At other times of the year, bears rely on fruits and nuts such as apples, acorns, mountain ash berries, and beechnuts to add fat stores for winter dormancy. Maintaining white clover food plots, releasing and retaining old apple trees, and maintaining intact beech and oak stands are all recommended to promote black bear populations. A forested buffer around wetlands is also critical when managing for bears. The most important habitat management consideration for black bears, however, is to avoid fragmenting remote forested habitat so they have refuge from humans and are able to move over wide areas and find food and mates.

Maintaining white clover food plots, releasing and retaining old apple trees, and maintaining intact beech and oak stands are all recommended to promote black bear populations.

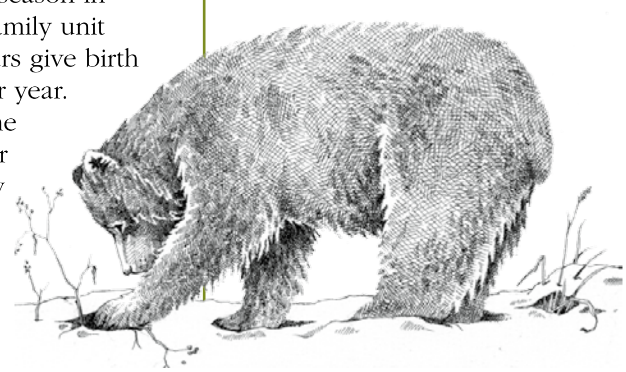
NATURAL HISTORY

The black bear is Vermont's only species of bear and is the only bear species that occurs east of the Mississippi River. Adult female black bears are commonly 150 pounds, while adult males often weigh 200 pounds or more. Black bears have bulky bodies and short, stout legs that can carry them more than 25 miles per hour for short distances.

Black bears are well known for their acute senses of hearing and smell. The snap of a twig or a slight change of wind bringing human scent causes a bear to flee immediately. Bears are quite intelligent, but their behavior can be unpredictable so they should always be given a respectable distance when encountered.

Black bears are inherently wary due to a long history of hunting in Vermont. Bear bounties lowered bear populations to an estimated 100 to 200 animals statewide until the bounties were ended in 1941. Today, Vermont's bear population is carefully managed and has expanded to where bears are common in most towns that have large tracts of forest. Under the Vermont Fish and Wildlife Department's Big Game Plan (2010–20), the statewide bear population goal is to maintain the population between 4,500 and 6,000 animals.

Black bears are solitary creatures outside of the breeding season in early summer. Several bears together are almost certainly a family unit when spotted outside the breeding season. Female black bears give birth to an average of two cubs in mid- to late January, every other year. Only 8 to 10 ounces at birth, cubs weigh 6 to 8 pounds by the time they emerge from the den in April. Only the female bear cares for the young; she is extremely attentive and vigorously defends them. The cubs remain with their mother through the year and into the following spring until the female once again comes into season during the June to July breeding season.



HABITAT REQUIREMENTS

Black bears are creatures of the forest, and except for large timber company holdings and some public lands, few people own sufficient acreage to satisfy all of the annual home range requirements of black bears. The annual home range of a female bear may comprise 10 to 25 square miles, and the home range of a male black bear may extend 50 square miles or more. Smaller parcels may still be important, however, if they contain critical feeding habitat, are very remote, or contain safe travel corridors.

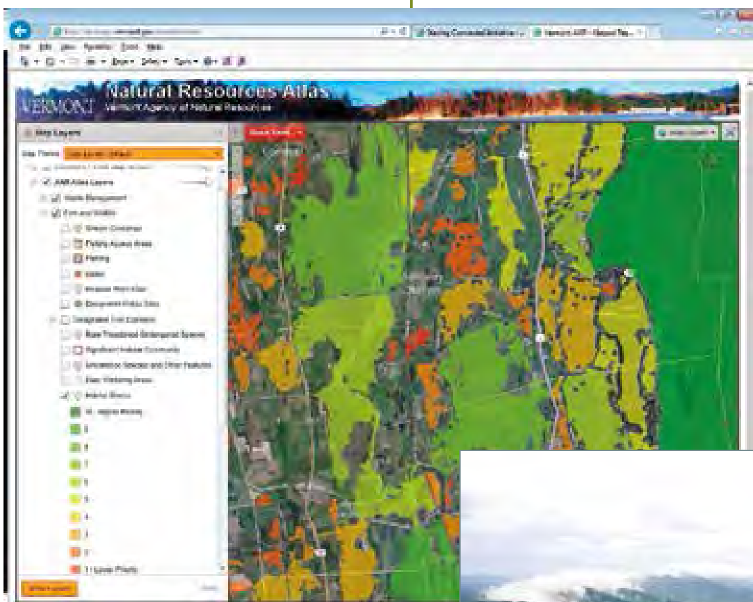
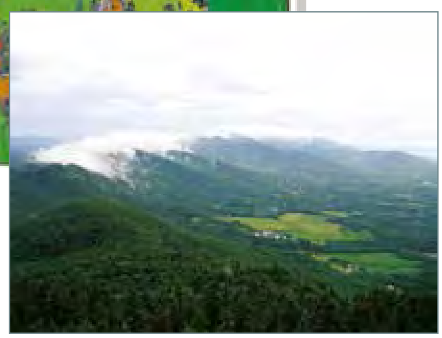


Figure 20.1
Map of large forest block

Unlike white-tailed deer, which may flourish in fragmented habitats and close to civilization, black bears are intolerant of both. Distributed along the length of Vermont's Green Mountains and in the remote areas of northeastern Vermont, bears haunt remote forests. Ransacking excursions close to civilization are the exception rather than the rule. Construction of roads, buildings, or other developments that encourage permanent or seasonal human occupation, diminishes or excludes the presence of bears.



Even though the cover of forested remote areas is one of black bears' greatest habitat needs, bears also require water and food. Wide-ranging bears have little trouble fulfilling their needs for water in Vermont's forests, but their food requirements vary seasonally and, when in short supply, can be life-threatening. The size of a bear's home range is directly related to the productivity of the habitat; if bears have to search far and wide to satisfy their annual requirements, the annual home range is much larger.


Figure 20.2
Wetlands with sedge and jewelweed

Few Vermont animals have food habits as diverse as black bears'. Black bears are typically thought of as carnivores, and while they do eat some meat, black bears are principally herbivores. Bear diets vary seasonally, and spring is the most difficult period for Vermont's black bears. When the bears first emerge from their dens in late March or April, food supplies are scarce. Although bears may feed on evergreen needles, buds, roots, bulbs, carrion, and overwintered acorns and beechnuts, they usually must turn to the succulent, emergent vegetative growth of wetlands and seeps. Forested wetlands often provide the only food bears will have during their first month or two out of the den, and bears may perish if their fat stores are depleted in spring or they are unable to find adequate access to wetlands.

As spring progresses, more and more herbaceous plants appear and bears may become grazers of lush meadowlands — particularly secluded fields or forest openings. Being opportunistic feeders, bears will occasionally eat the eggs or young of low-nesting birds, rodents, or other animals.

During the summer, bears have a greater choice of foods such as raspberries, blackberries, blueberries, wild cherries, hazelnuts, and insects. Course woody debris on the forest floor provides cover for insects and larve thereby providing a valuable food source to bears. Roots and tubers are also a food source for Vermont bears, particularly plants such as Jack-in-the-pulpit and jewelweed. Wetlands continue to provide an important food source for bears as well as areas for cooling off and for seclusion. Found in wet areas until frost arrives, the orange-flowered jewelweed plant may be consumed to ground level by feeding bears.

In autumn, bears enter a state of hyperphagia, or a heightened feeding state, as they frantically attempt to store sufficient fat to carry them through the 5 to 6 months of winter. Bears may become more visible as they expand their range looking for fruits and nuts. Apples are a staple as are mountain ash berries, where available. Beechnuts, acorns, and other hard mast (nut) crops are especially critical to bear survival and reproduction as they are highest in fat content and allow bears to quickly build up fat supplies.

Figure 20.3
A bear's diet consists of apples, mountain ash berries, beechnuts, and acorns.

Unless a shortage of food supplies forces them to den early, black bears begin their search for denning sites late in the fall. Bears may den in mountain ledges, hollow logs and trees, partially uprooted trees, or lowland brush piles, or excavate dens between the roots of large trees. Denning needs of bears are sufficiently flexible that virtually any forested habitat can provide den sites. By late November or early December, Vermont's bears are denned for the winter.

MANAGEMENT PRACTICES

You can improve habitat for bears on your land by adopting practices that increase the diversity of the forest as well as the diversity and abundance of bear foods. Prior to any active management, you should develop a map of existing habitat conditions on your property and then create a plan to maintain and improve those habitats. Small clear-cuts (from 1 to several acres in size) can create sunlit openings for the development of herbaceous growth and early successional fruiting plants such as berries and cherries. Decayed stumps and logs from logging debris provide insects for foraging bears. Trees with large cavities should be retained whenever they occur as they are favored by bears as well as many other animals for denning and nesting.

You can also create long-term 1-acre openings by bulldozing, seeding, and maintaining clovers and grasses (see **Chapter 11, "Wildlife Food Plot Management,"** for specific information on food plots and resources). Occasional mowing or brush hogging during the growing season will prevent invasion of woody plants and ensure tender, young grasses and forbs on which bears feed. Woods roads and managed openings should be seeded and maintained in grass cover. Burning cycles of 3 to 5 years will maintain species such as blueberries and improve the palatability and nutrition of understory plants, while removing shrubs and trees that suppress desirable herbaceous growth. Raspberries and blackberries can persist in dense stands under power line rights-of-way for decades. Contact your power company forester to ensure that the open space is managed to produce and maintain fruiting plants preferred by bears and other wildlife.

If you can have concentrations of beech and oak trees utilized by bears, you should exercise caution when logging on the periphery of these areas. Concentrations of beech trees showing evidence of recent and historical use by bears may be a critical food source for many bears. In general, the greater the evidence of bear use (claw marks on the

The release, protection, and fertilization of soft mast-producing crops will promote and ensure bear use.

trunks, "bear nests" in tree crowns), the greater the value of those trees to bears. Bears' use of oak is not as easily distinguished. Claw marks on the bark are not readily apparent, and the bears may not create "nests" of broken branches as they do with beech. Bears may simply "windrow" piles of leaves as they pick acorns off the ground. If you suspect or know that your beech or oak stand is being utilized by bears, it is recommended that you enlist the advice of a wildlife biologist or forester for site-specific recommendations on how to maintain and improve these important wildlife trees. However, a good rule of thumb is to maintain all healthy beech and oak trees in a variety of age classes in order to ensure that they continue to provide food for bears and other wildlife for many years (see **Chapter 9, "Beech Mast Production Management,"** for more information on managing American beech for mast production).

Abandoned farmland offers an ideal mix of food and cover for bears, particularly lands where apple trees, chokecherries, black cherries, and other food-producing shrubs abound. The release, protection, and fertilization of soft mast–producing crops will promote and ensure bear use. Nut-producing trees should be released and retained. Bears are notoriously crude in their feeding habits, crushing plants and breaking branches. When attempting to grow new apple trees, you should remove the first few crops of apples while they are still green to prevent black bears from damaging the young limbs in their attempts to get to the fruit.

When implementing habitat improvement practices, you must keep in mind the bears' need for cover and seclusion. Cover is not a necessity for protection from the weather as much as a means of concealment. It is essential that sufficient forested or vegetative cover be provided to and from food sources as a travel corridor.

Protection of forested wetlands can be as important as increasing other food supplies. Cover (preferably softwood) around wetlands and allowing secluded travel to and from them is important. Bears are also attracted to wetlands during the summer months where they can cool off in the water and bed in the surrounding dense softwood cover. A minimum 100-foot undisturbed buffer is recommended around forested wetlands when managing for bears.

Before you begin habitat improvement practices for bears, be certain that your property is within bear range (contact any district Agency of Natural Resources Office for this information or go to the website shown in **Resources**). Even if your property is mapped as "Occasional Use" bear range, you may have critical habitats worthy of management and protection. Keep in mind that many of the habitat practices intended to benefit bears will also benefit a variety of wildlife species — birds as well as mammals.

RESOURCES

Hamelin, P. 2011. "Beech Management Guidelines." Waterbury, VT: Vermont Fish and Wildlife Department.

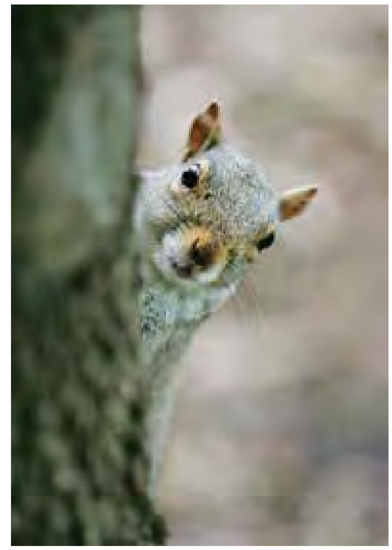
Hammond, F.M. 2002. "The Effects of Resort and Residential Development on Black Bears in Vermont." Final Report. Waterbury, VT: Vermont Fish and Wildlife Department, Agency of Natural Resources. http://www.vtfishandwildlife.com/books/Stratton_Mountain_Black_Bear_Study_-_Final_Report/___Cover.pdf

Vermont Agency of Natural Resources. Natural Resources Atlas. http://anrmaps.vermont.gov/websites/anra

Vermont Fish and Wildlife Department. 2010. *Big Game Management Plan 2010-2020. Creating a road map for the future.* Montpelier, VT

21. GRAY SQUIRREL

Sciurus carolinensis



Although gray squirrels can be found throughout much of Vermont, the best habitat and highest populations occur in the oak-dominated hardwood forests of the Champlain Valley, Connecticut River Valley, and southern Vermont.

SUMMARY

Gray squirrels live primarily along the Lake Champlain and Connecticut River valleys in Vermont in hardwood forests of oak, hickory, and beech. They require mast-producing oak trees in conjunction with other mast- or seed-producing trees (see the wild turkey and mast tree sections of these guidelines for more information). As a landowner, you can promote gray squirrel populations on your land by selectively thinning around large, prolific hard mast trees and by leaving several trees with small cavities for den sites.

NATURAL HISTORY

Gray squirrels are not only found in backyards but also in mature hardwood forests dominated by hard mast-producing trees such as oak, hickory, and beech. Gray squirrels seldom utilize pole stage hardwood or pure softwood stands, unlike red squirrels. Although gray squirrels can be found throughout much of Vermont, the best habitat and highest populations occur in the oak-dominated hardwood forests of the Champlain Valley, Connecticut River Valley, and southern Vermont.

Home ranges of gray squirrels vary from 1 to 25 acres depending upon habitat quality. Normal daily movements average only 160 feet.

Squirrels reach sexual maturity at 8 to 11 months. They undergo two breeding periods each year, January and June. The gestation period is 60 days, with litter size normally two or three blind and hairless young. Food availability greatly influences survival and reproductive success. In good food years, up to 40 percent of females produce second litters; in poor years, almost none will. Average life expectancy for a squirrel is 1 to 2 years, although some individuals may live up to 10 years. Annual mortality rates average 50 percent for adults and 75 percent for juveniles.

Gray squirrels feed on a variety of foods including acorns, nuts, seeds, buds, flowers, fungi, insects, and small bird eggs. Hard mast (acorns, hickory nuts, and beechnuts) makes up the bulk of their diet throughout the year and is critical to their survival. Several consecutive years of mast failure can trigger increased movements of squirrels in search of food, resulting in heavy mortality. During such times, populations can drop by 15 to 25 percent, though they may recover to former levels after a couple of good mast years.

HABITAT REQUIREMENTS

In Vermont, good gray squirrel habitat consists of mature hardwood forest with a high component of oak, in combination with hickory or beech. A closed or nearly closed canopy is also necessary. The availability of alternate food-producing trees such as ash, maple, butternut, hophornbeam, and black cherry can buffer against years of poor mast crops.

Den trees provide winter shelter, escape cover, and nest sites. Squirrels select cavities that are 1 to 3 feet deep and 6 to 10 inches in diameter with

Figure 21.1
Lowland hickory and oak forests are excellent gray squirrel habitat.

entrance holes 3 to 4 inches wide. Gray squirrels avoid larger entrance holes because these allow raccoons to enter their dens. Leaf nests are constructed to provide alternate escape and nesting cover, but cavities provide better shelter than leaf nests.

A permanent source of water such as woodland streams and ponds is important to squirrels, especially lactating females.

MANAGEMENT PRACTICES

In Vermont, the best management opportunities for gray squirrels are in mature hardwood forests and woodlots dominated by oak. The presence of mature hickory and beech in these stands further enhances their value. Gray squirrels can be managed for in woodlots as small as 5 to 10 acres. Gray squirrel density of one per acre is a reasonable goal in good habitat, with two to five per acre possible in the very best habitats. Small woodlots, riparian zones, and field borders can be managed for gray squirrels if they are 5 acres or more in size, are at least 50 feet wide, and have nearly complete crown closure.

A minimum of 150 pounds of acorns and nuts per acre is required to maintain viable gray squirrel populations and accommodate use by other wildlife (more than 80 species of birds and mammals are known to feed on acorns alone). To provide this amount, trees producing hard mast must be a major component of the forest stand. Quality habitat should have two or more primary hard mast tree species plus several alternate food species to buffer against poor mast crop years. Stands of mixed hardwoods or hardwoods and pine can be improved by selective thinning. Mark trees in the autumn to identify and favor the best mast producers. To promote crown vigor and increase mast production, select trees with crowns equal in feet to twice the diameter of the tree's base in inches (example: a 16-inch tree should have at least a 32-foot crown width). During thinning, release the best mast producers, but retain a diversity of mast species. Areas managed for gray squirrel will benefit a variety of wildlife.

Provide at least two to five den trees per acre, distributed throughout the managed area. Den tees should be live, durable hardwood species 10 inches or greater in diameter with holes 3 to 4 inches in diameter.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. "What Is Forest Stand Improvement?" http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081110.pdf

—. Forest Stand Improvement, Mast Tree Release Job Sheet (666). http://efotg.sc.egov.usda.gov/references/public/VT/JS666VT_(Mast)_FillableForm.pdf

22. SNOWSHOE HARE

Lepus americanus

SUMMARY

Snowshoe hares are targeted by recreational hunters, but they are also an important prey item for many species of wildlife. Snowshoe hares are most often found in large unbroken patches of young softwood and mixed-forest stands, particularly in northern and high-elevation climates with deep winter snowpack. They require a mosaic of densely forested and open shrublands, and thrive in areas with large numbers of woody stems and berry bushes.

Snowshoe hares are an important part of the ecosystem because of their role as prey for so many wildlife species, including coyote, fisher, bobcat, lynx, great horned owl, and marten.

NATURAL HISTORY

Snowshoe hares are an important part of the ecosystem because of their role as prey for so many wildlife species, including coyote, fisher, bobcat, lynx, great horned owl, and marten. Although, sometimes referred to as a rabbit, the hare has characteristics that are very different from the cottontail. The back feet of a hare are much larger than a rabbit's (hence the "snowshoe"), allowing it to travel through deep snow. Unlike the rabbit, the hare turns white in winter, an adaptation that allows it to blend in with a snowy environment. The hare's young are born fully furred with their eyes open, whereas rabbits are born blind and naked. These adaptations allow snowshoe hares to thrive in northern and upper-elevation climates where cold and snow make survival for the cottontail much more difficult.

Snowshoe hares are active at dawn, dusk, and throughout the night. During the day they take cover under exposed tree roots, ledges, clumps of small trees, or logs; shelter spots referred to as a "form."

Young hares are born from May through August in litters that vary in size from one to six. A female produces one to three litters per year. After winters with low temperatures and high snow accumulations, litters tend to be larger. Snowshoe hares are promiscuous breeders, and males sometimes fight each other to the death during the breeding season.

HABITAT REQUIREMENTS

Optimal hare habitat occurs in and around young softwood stands. Dependence on softwood is related to hares' need for concealment and thermal cover. The more difficult it is for a predator to see through a forest stand, the better the area is for hares. Understories with high stem densities that result in cover of greater than 60 to 85 percent provide optimal habitat for snowshoe hare in winter. All of the habitat needs of a snowshoe hares should be met within a 20-acre home range. Extended periods of low temperature can impact hare survival due to the fact that they rely on limited fat reserves.

In boreal forest habitats to the north, hare populations exhibit 9- to 11-year density cycles generally assumed to be linked to lynx and other predator populations. Although the cycling may occur in Vermont, it appears to be less pronounced than in northern boreal forests.

Figure 22.1
Softwood stands make optimal snowshoe hare habitat.

Managing at the landscape level to provide areas of large unfragmented forests and coarse woody debris for species such as marten, some neotropical songbirds, and wintering deer should help to guide where management for snowshoe hare occurs.

When hare populations are at their highest point, good habitat could support an excess of one hare per acre.

Food requirements of the hare shift seasonally. Hare are able to adapt to whatever vegetation is close to the cover they require. In summer, herbaceous plants such as clover, grasses, and ferns are favored. Berries and the succulent parts of woody vegetation are also consumed in summer. Winter foods include twigs, buds, the tender bark of shrubs and small evergreen trees, the stems of berry bushes, and seedlings of alders, aspens, spruces, hemlocks, balsam firs, birches, willows, white pines, and cedars. Small, scattered openings adjacent to softwood cover improve survival by reducing travel distances to food.

Softwood cover is the single most important habitat need for snowshoe hare and can be described as having two basic components:

- Base cover is the dense conifer cover from 8 to 16 feet in height where hares spend the day.
- Travel cover consists of softwood corridors or tracts that allow hares to move from base cover to a food source. Travel cover is not necessary if browse supplies are available immediately adjacent to base cover. Good travel cover effectively increases the range over which a hare may roam safely in search of browse.

MANAGEMENT PRACTICES

Within the snowshoe hare's 20-acre range, the following conditions provide optimal habitat (can be extrapolated over a larger area):

1. Maintain at least 20 percent of the stand in base cover of trees 8 to 16 feet in height.
2. Maintain 30 to 50 percent of the area in travel cover. In spruce-fir stands, optimal cover will average 30 years and older, and from 16 feet in height until the stand is harvested.
3. Plan for 5 to 10 percent in permanent herbaceous vegetation such as grasses and forbs for a source of summer food, maintained in 1/4-acre openings scattered around the unit.

The habitat requirements that target snowshoe hares should be balanced with the optimal needs of other species that require older forests. Managing at the landscape level to provide areas of large unfragmented forests and coarse woody debris for species such as marten, some neotropical songbirds, and wintering deer should help to guide where management for snowshoe hares occurs.

23. EASTERN COTTONTAIL RABBIT

Sylvilagus floridanus

SUMMARY

Vermont has two species of rabbits: the nearly extirpated New England cottontail and the eastern cottontail. Eastern cottontails are found mostly in Vermont's southernmost portions, as well as along the Champlain Valley and Connecticut River Valley. Cottontails require thick cover to hide in, particularly during the winter when they are not well camouflaged due to their brown coats. Maintaining thick hedgerows and early successional forest as well as brush piles and hay or croplands is the best way to manage for cottontails.

Maintaining thick hedgerows and early successional forests as well as brush piles and hay or croplands is the best way to manage for cottontails.

NATURAL HISTORY

Vermont historically has been home to two species of cottontail rabbits that look so similar that they are almost impossible to tell apart in the field. The New England cottontail rabbit, *Sylvilagus transitionalis*, is a native species that has resided in this state since pre-colonial times, but which is extremely rare today due to changes in habitat. The eastern cottontail rabbit, *Sylvilagus floridanus*, occurs throughout the United States. It was introduced into New England in the 1800s and is now common in Addison, Rutland, and Bennington counties. It is less common in Chittenden and Grand Isle Counties. Eastern cottontails have moved up the Connecticut River Valley from Massachusetts in recent decades.

HABITAT REQUIREMENTS

Eastern cottontail habitat is found in the valley farmland region where fields and pastures are interspersed with hedgerows and low, dense brush. Winter is the most difficult time of year for rabbits. In Vermont, snow cover limits the distribution and densities of the cottontail population. Because they are poorly camouflaged in snow, they need thick winter cover in which to hide. Because preferred foods such as agricultural crops and herbaceous plants are not available in winter, they depend on low-growing woody vegetation for food as well as for escape cover and thermal cover.

The average home range size for the eastern cottontail rabbit is 10 acres; although in high-quality habitat it may be much smaller. The cottontail tends to inhabit the same home areas throughout its life, although it may range in a smaller portion in winter when cover availability is lowest. Home ranges of rabbits tend to overlap, particularly in the best habitat.

Cottontails will select areas of better cover over areas with abundant food if both are not found together. Rabbits have two different cover requirements: feeding cover and resting/escape cover. Dense woody vegetation can provide adequate summer cover, but for the rabbit to survive the Vermont winters, dense woody vegetation such as that found in old fields is critical. Clean farming and a lack of brushy fencerows in agricultural fields has led to the decline of the eastern cottontail rabbit in Vermont since the 1940s. Because of the animal's need for cover throughout its life cycle and the yearly seasons, cover availability is the

Figure 23.1
Eastern cottontail

Figure 23.2
Cottontail habitat often consists of fencerows with shrub habitat. Courtesy of John Gobeille, VFWD.

most limiting factor for cottontails. Cover is also important for the rare New England cottontail rabbit. However, it seems to prefer dense understory in regenerating woodlots or shrubby wetlands. The isolation of these patches of habitat may have led to the extinction of local populations of New England cottontails.

MANAGEMENT PRACTICES

Because the eastern cottontail is truly a species associated with old fields and edge-type habitat, woody vegetation interspersed in agricultural fields provides the best habitat. Maintenance and enhancement of hedgerows is an important practice for the species. Hedgerows should be of dense woody vegetation 3 to 6 feet high and at least 20 feet wide. Mowing adjacent to hedgerows further enhances the habitat. Old fields reverting back to forest also provide the critical cover requirements of cottontails. In the Champlain Valley, brushy areas of gray dogwood, prickly ash, red cedar, and low-growing juniper near mowed meadows of grasses and legumes provide optimal conditions for eastern cottontails. Pastures containing red cedar and low-growing juniper provide excellent habitat.

Within every 10-acre area, all of the following habitat requirements of the eastern cottontail rabbit should be available:

1. Between 20 and 75 percent of the managed area should be maintained as brushy cover. Reverting field or pasture should be kept in early successional stages by actively mowing, burning, or light grazing on half of the area every 5 to 10 years.
2. Areas lacking early successional habitat can be enhanced with brush piles, or log or stump piles. Piles should be 3 to 7 feet high and 13 to 20 feet in diameter. Place them adjacent to the edges of fields, pastures, and woodlots, spaced 50 to 100 feet apart. Brush piles will break down in 3 to 5 years, so one-quarter of them should be replaced annually.
3. The remaining acreage should be composed of hay or cropland and/or deciduous forest.

If you are considering managing your land for rabbit habitat, you should create or maintain a matrix of woody vegetation and herbaceous vegetation. Land is enhanced for rabbits when brushy cover is distributed throughout the area and not concentrated in one large block. Densities of one to three cottontails per 2 acres can be expected under optimal habitat conditions.

24. BEAVER

Castor canadensis

SUMMARY

Beavers play an important role in creating wetland habitat for many other species of wildlife. Ducks, songbirds, reptiles, amphibians, moose, bears, and insects all use beaver-created wetlands. Practically any habitat that is suitable for beavers will soon have a resident population. They eat bark and small woody shoots. Beaver habitat can be enhanced through selected cutting along stream banks in order to regenerate small-diameter woody vegetation. Beaver activity can create problems for some landowners due to their ability to flood areas. Landowners dealing with problems from beavers may choose to implement methods of water control or tree protection, because removing individual beavers does not usually solve the problem.

Beavers are referred to by biologists as a keystone species because they can dramatically affect ecosystem structure and dynamics.

NATURAL HISTORY

Beavers are referred to by biologists as a keystone species because they can dramatically affect ecosystem structure and dynamics. Wetlands created by beavers can benefit a landowner in a variety of ways, from creating habitat for wildlife species such as fish and waterfowl, to controlling downstream flooding and filtering sediment to improve water quality.

Beavers were removed from most of New England by the early 1800s due to unregulated harvest and habitat degradation. Beavers eventually made dramatic recoveries following wildlife agency reintroduction programs and habitat regeneration starting in the 1920s. However, many of Vermont's roads and villages were developed after beavers were eliminated from the state and were located with little regard to the location of potential beaver habitat. Not surprisingly, as both the beaver and human populations have expanded throughout the latter part of the twentieth century, there has been a corresponding increase in conflicts.

Figure 24.1
Beaver within a beaver-influenced wetland

Beavers are one of the few animals capable of modifying their habitat to meet their needs, constructing elaborate dams, lodges, and bank dens and storing food for winter retrieval. Beavers live in family groups comprising a monogamous adult pair, three or four newborn kits, and kits from the previous year. Beavers do not readily accept unrelated beavers into their family groups.

Figure 24.2
Wood ducks enjoy beaver-made wetlands. Courtesy of George Gentry, USFWS.

Beaver-created wetlands are focal points for many other wildlife species, including muskrats, otters, raccoons, and moose. Birds such as mallards, wood ducks, black ducks, red-winged blackbirds, and great blue herons thrive in these small wooded wetlands. Beaver ponds are so important to waterfowl that the return of the beaver in New York State resulted in the production of about 60,000 more ducklings annually. Many amphibian and reptile species also benefit from beaver modifications to wetlands, which provide an important food source for fish, birds, and mammals.

Despite the ecological benefits brought about by beavers, flooding caused by beaver dams may sometimes damage roads, houses, and agricultural and timber lands. Although many anglers do not look favorably on beavers, studies indicate that beaver-created wetlands actually benefit trout populations.

Beaver ponds are so important to waterfowl that the return of the beaver in New York State resulted in the production of about 60,000 more ducklings annually.

HABITAT REQUIREMENTS

Beaver habitat includes low-gradient streams and rivers, as well as ponds and small lakes with consistent water levels. Beavers prefer streams that are wider than 150 feet with a gradient less than 6 percent.

Most people are familiar with beavers' industrious efforts to fell trees within their habitats. The beaver's food requirements vary seasonally. During the summer months, beavers rely almost exclusively on herbaceous foods such as duckweed, duck potato, and water lilies as well as leaves and grasses. Tree cutting and consumption of woody material generally occurs in the fall and winter; beavers favor hardwood tree species such as aspen, willow, and alder. They prefer stems under 4 inches in diameter and within 100 feet of the water's edge, but readily fell larger trees and trees up to 300 feet from water. Beavers in a colony will cache enough woody material to support them throughout the winter months if the surrounding habitat is suitable.

Beaver activity revolves around the lodge. Lodges and burrows (or bank dens) surrounded by water provide escape and thermal and reproductive cover for beavers. Water serves as concealment and easy access for beavers when traveling to and from food sources.

Although they generally stay within 300 feet of water, beavers may range within a .5-mile radius of their lodge. Beaver colony territories do not overlap and usually contain a series of lodges, dams, and ponds of various ages and sizes along a stream's drainage.

MANAGEMENT PRACTICES

A site with an adequate water supply and a stream gradient of less than 15 percent will probably support beavers if enough small-diameter hardwood trees are within 300 feet of the water's edge. Where only large-diameter trees of preferred species are present, you can enhance beaver habitat by cutting .5 to 1-acre patches perpendicular to the water's edge.

Figure 24.3 Beaver baffle control system

These cuts should be pie-shaped and on shallow slopes to minimize the potential for erosion and impacts to the wetland buffer. The cuts should extend no more than 300 feet from the water and should range from 50 to 120 feet wide. Depending on the size of the water body and the availability of hardwood trees, one strip should be cut every 10 to 20 years to ensure a continuous supply of small-diameter woody material. Cutting during the dormant season (November through March) will promote tree sprouting and increase regeneration.

Because beaver ponds are most productive for the 7 years immediately following flooding, abandoning an area for a period of time is often beneficial. Once habitat conditions again become favorable, beavers will return.

If you are experiencing problems with beavers, there are options that can help. In well-established beaver habitats, most conflicts cannot be permanently resolved with the removal of the beavers (they or others will return). You can protect individual trees from beaver damage if you encircle their trunks with hardware cloth or welded wire. In addition, several designs of water control structures are available that may solve flooding problems. Not all sites lend themselves to water control structures.

Regulated trapping is also an effective strategy for managing beavers in wetlands. The removal of beavers during the legal trapping season is a method that ensures utilization of the pelt. Live trapping and transfer of beavers is no longer recommended in Vermont because most appropriate habitat is already occupied. See **Resources** for a link to more options.

If you are experiencing problems with beavers, there are options that can help.

RESOURCES

Vermont Fish and Wildlife Department. "Best Management Practices for Resolving Human-Beaver Conflicts in Vermont." http://www.vtfishandwildlife.com/library/reports_and_documents/Furbearer/Best_Management_Practices_Beaver_Conflicts.pdf

25. WATERFOWL

Wetlands are the critical habitat required for waterfowl because they provide areas to rest, strengthen pair bonds, feed, and establish nesting territories.

SUMMARY

Waterfowl are intimately connected with wetland habitat; they perish or thrive based on the availability of wetlands. Landowners can best promote waterfowl by maintaining and protecting wetlands and by maintaining a forested or grassy buffer around open water. Maintain wetlands with a mixture of plants and open water, and avoid the use of herbicides or pesticides near wetlands or other water systems. Monitor wetlands annually for invasive plant species, particularly knapweed and purple loosestrife, and pull those plants up to help promote the growth of native plants. Leave dead snags or large live trees up near wetlands as nesting sites for cavity-nesting ducks, or consider erecting a wooden nest box.

NATURAL HISTORY

Due to the diversity of waterfowl species and their migratory nature, management of our waterfowl resource must be shared among various countries, states, provinces, private organizations, and individuals. Vermont hosts 30 species of waterfowl during various seasons. As with all wildlife, food, water, and cover are essential seasonal needs of waterfowl. Although the protection and management of essential habitats such as Lake Champlain, riverine systems, and large wetlands are primarily within state and federal responsibility, much of the habitat needed by waterfowl in Vermont involves small privately owned wetlands. You can assist in waterfowl management efforts by supporting state and federal programs to restore quality habitat, or by directly implementing proven waterfowl management practices on wetlands in your ownership. With an increasing human population and ongoing loss of habitat, wetland protection and enhancement on private land is one of the most critical wildlife habitat conservation actions.

HABITAT REQUIREMENTS

Waterfowl usually breed and rear their young in northerly latitudes and spend the winter months in more southern climates. During these semi-annual migrations, birds utilize a variety of habitat types to feed, rest, preen, and escape from predators. Waterfowl may nest on the ground, in cavities, on stumps, or in tree crotches, and lay clutches of 9 to 16 eggs. Predation pressure on nests and the flightless young is generally proportional to the quantity and quality of the habitat. Larger clutch size and the ability to re-nest help waterfowl to offset losses from predators.

Waterfowl feed on everything from insects and small invertebrates found in shallow wetlands, to snails, mussels, and small fish in deeper water. Aquatic vegetation and seeds in shallow- and deep-water wetlands comprise a major portion of the diet for many species. Agricultural field crops and grain have become important food sources, especially for geese, during migration.

Black ducks, mallards, wood ducks, blue-winged teal, hooded mergansers, common goldeneyes, and Canada geese are Vermont's principal breeding waterfowl, and benefit most from habitat management. Improvements in habitat aimed at these species will generally also benefit other migrating waterfowl species.

Canada geese are short-distant migrants that arrive back in Vermont in mid-March and remain into late fall; they are present as long as open water and a food source is available. The resident population of Canada geese generally only migrates as far south as New Jersey, and they can sometimes become a nuisance problem in urban and agricultural landscapes. True migratory Canada geese (Atlantic population) migrate from the northern Québec tundra nesting grounds to the Chesapeake Bay region and are managed as a separate population.

Wetlands are the critical habitat required for waterfowl because they provide areas to rest, strengthen pair bonds, feed, and establish nesting territories. The Champlain Valley and Connecticut River Valley are the main flight corridors for waterfowl migrating through Vermont.

Wetland productivity is a measure of how well the needs of wetland species are met. For waterfowl, this translates into the quality and quantity of available water, food, cover, and nesting sites. Pollutants and disturbance are important factors when assessing wetland productivity. Most Vermont wetlands have excellent productivity and are worthy of continued protection and enhancement. A variety of wetlands and adjacent uplands are needed to fulfill the seasonal requirements of waterfowl. A complex of different wetland types is desirable to provide a diversity of foods and cover for a variety of waterfowl species.

Small wetland units are best managed in their natural condition. Improving specific deficiencies in open-water-to-cover ratios as well as nesting and brood-rearing habitat, or enhancing wetland soil productivity, may be beneficial in certain situations as explained in the next section.

MANAGEMENT PRACTICES

The rich and diversified system of wetlands present in Vermont was left in place by the last glacier. Waterfowl have used these wetlands for thousands of years. Most natural wetlands need little, if any, human manipulation. Rather, wetlands need protection from human manipulation such as draining, filling, livestock grazing, shoreline development, excessive sedimentation, and harmful chemicals.

The most important management practice you can implement to benefit wetland habitat is to buffer them with at least 100 feet of grassland or forested cover. Minimize disturbances from natural predators, pets, and people, especially during nesting and brood rearing from April to July. Disturbances can cause waterfowl to abandon breeding attempts or established nests. When you observe waterfowl, do so quietly from a distance with binoculars or spotting scopes.

Figure 25.1
Wood duck in nesting box.

Wetlands are dynamic systems and continually undergo changes in appearance, productivity, and wildlife value. The sequence of wetland succession occurs as shallow-water areas fill in and become vegetated marshes, then shrub swamps, and finally forested areas. Although all phases are important to individual species of wildlife, waterfowl derive optimal habitat value from intermediate wetland stages.

Areas of emergent plant cover, shrub vegetation, or fallen timber should be interspersed with swimmable water to provide optimal habitat. Cut or pull undesirable cover species, but do not use herbicides to kill native aquatic plants because this is generally prohibited by the Vermont Department of Environmental Conservation and the Agency of Agriculture.

Waterfowl generally prefer shallow depths of 1 to 2 feet of water, although periodic cycles of high and low water increase productivity over time because soil nutrients are renewed and the soil and organic material is exposed to the air. Seasonal water cycles or beaver activity regulate this naturally; however, you may construct artificial water level control structures where you need more intensive water level management.

Figure 25.2
A common type of nest box for wood ducks

Waterfowl food and cover plants are usually well established on older wetlands and will appear in a reasonably short time on new impoundments without a helping hand. Seeds from aquatic plants adapted for this climate are dispersed naturally so it is usually unnecessary to supplement native food and cover species with artificial plantings. However, you should monitor annually for noxious weeds (exotics) such as phragmites, water chestnut, and purple loosestrife and eradicate them because they have little value for waterfowl and quickly crowd out desirable native aquatic plants. Exotic wildlife such as mute swans and carp can also damage wetland systems. Swans should be reported immediately to your local Vermont Fish and Wildlife Department office.

Although adequate nesting cover should be near a wetland, waterfowl may nest up to a half-mile from brood-rearing habitat. Ducks may nest on the ground near wetlands in areas with dense vegetative cover, near beaver ponds in over-water tree stumps or tree crotches, or on small islands with good cover. You can help by delaying mowing hayfields in close proximity to wetlands until after July 15 or preferably August 1 to decrease nest destruction by mowing equipment. Avoid grazing livestock on lands adjoining wetlands prior to July 15 and stop grazing in late August to allow for adequate regrowth of nesting cover for the next spring. Rotate grazing areas to ensure adequate nesting cover, and use perimeter fencing to avoid livestock damage to wetlands. For technical and financial assistance with the design of a rotational grazing system, see your local Natural Resources Conservation Service office. Contact information follows in **Resources**.

Wood ducks, hooded and common mergansers, and common goldeneyes are cavity nesters; they prefer live trees such as maple and oaks, although they may use dead snags. These species also benefit from nest boxes on trees or sturdy poles near the wetland. These nest boxes must be built to specific dimensions, filled with wood shavings, and cleaned and maintained annually, and they must have a predator guard to protect the hen and nest. Specifications and technical advice on nest box construction and placement are available through the Vermont Fish and Wildlife Department.

The increase in beaver populations in Vermont has led to the creation and maintenance of excellent natural waterfowl habitat. Management of beaver colonies provides a great opportunity to assist waterfowl (see **Chapter 24, "Beaver"**). Consider the use of a beaver baffle to control water levels before eradicating beavers. Vermont's regulated trapping season for beavers provides a good opportunity to combine the sustainable use of a renewable natural resource (beavers) with effective wetland management.

Canada geese are grazers and will readily clip grasses and legumes planted in buffer strips and agricultural fields. If you wish to discourage geese from feeding on your lawn or agricultural field, allow shrubs and trees to grow along the wetland border. Shrubs and brush obscure the grass areas and trigger the geese's predator-avoidance behavior.

To attract waterfowl to your cropland areas, you can leave standing grains to provide food plots. Grains must be left standing or harvested under normal agricultural practices to avoid the practice of baiting waterfowl during the hunting seasons. Never mow standing grains during the hunting seasons. Contact the Vermont Fish and Wildlife Department for clarification of acceptable practices. Avoid fall tillage whenever possible to allow utilization of waste grain during both the fall and spring, but do not place piles of supplemental feed out because of the potential to spread disease and problems with concentrated droppings on lawns and waters.

If you are interested in wetland restoration, consult the Partners for Wildlife Program. Sponsored by the U.S. Fish and Wildlife Service, this program is tailored to restoring previously converted wetlands into functioning wetlands with financial support to qualified landowners. The Natural Resources Conservation Service and Vermont's Clean and Clear programs have technical and financial assistance available to landowners interested in wetlands restoration and/or protective easements on wetland parcels.

To attract waterfowl to your cropland areas, you can leave standing grains to provide food plots.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home

U.S. Fish and Wildlife Service Northeast Region. Partners for Wildlife Program. http://www.fws.gov/northeast/EcologicalServices/partners.html

Vermont Fish and Wildlife Department. "Fact Sheet on Wood Duck Nest Boxes and Predator Shields"

26. RUFFED GROUSE

Bonasa umbellus

This upland game bird is best known for its explosive flushes when approached too closely and for the reverberating drumming sound males produce to attract mates in the spring.

SUMMARY

Ruffed grouse, or partridge, are found throughout Vermont and are targeted by hunters and other carnivorous birds and mammals. They thrive in dense, younger forests with a mix of shrubs and softwood and young hardwood trees. Ruffed grouse feed primarily on fruits, berries, and nuts such as beechnuts and acorns. They require small openings of bare ground and fallen logs or rock walls for breeding. Maintaining a mosaic of dense softwoods, mast-producing hardwoods, and fruit and berry trees will help promote ruffed grouse.

NATURAL HISTORY

Ruffed grouse, commonly known as partridge, are one of Vermont's two members of the grouse family (spruce grouse being the other). Ruffed grouse can be found in every region in the state. This upland game bird is best known for its explosive flushes when approached too closely and for the reverberating drumming sound males produce to attract mates in the spring.

Annual mortality rates for ruffed grouse are quite high, approaching 70 percent. Grouse serve an important ecological role as a significant prey base for a host of ground predators such as foxes, raccoons, coyotes, skunks, bobcats, and avian predators such as goshawks, Cooper's hawks, and great horned owls. In the northern latitudes of Vermont, winter's cold temperatures and lack of food can result in poor survival as well. Deep snows, however, may actually enhance grouse survival by enabling them to dive below the snow's surface to the security and insulation of a "snow roost." The birds thrive best in the cover of dense young forests (especially aspen) and produce prolific numbers of young.

The polygamous male grouse interact with females only during the spring breeding season. The males select drumming sites on logs or rock walls above ground level that are surrounded by dense vegetative cover. They beat their wings rapidly to create a low-frequency drumming noise that penetrates the forest and attracts resident female grouse. Females incubate their eggs in a well-camouflaged nest at the base of a tree, and chicks hatch in late May and early June.

Figure 26.1
Grouse drumming

Grouse eat a wide variety of foods, primarily grasses and insects, during spring and summer. Other favorite foods include the leaves, fruits, and seeds of aspen, blackberries, raspberries, elderberries, clover, and wintergreen. In fall, beechnuts and acorns are primary sources of energy-rich fat. When these fruits are no longer available, grouse feed on the buds and catkins of mature aspen, birches, hophornbeam, and hazel.

HABITAT REQUIREMENTS

Habitat consisting of several age classes of early successional tree species, such as aspen and paper birch, is most preferred by ruffed grouse. Superior grouse habitat contains three "critical" age classes of forest (0–10, 10–25, 25+ years), all located within a 40-acre home range. Quality grouse habitat also includes seasonal food sources close to thick, woody cover. Patches of softwood cover provide thermal protection during Vermont's stressful winter season.

Figure 26.2
Young forest grouse habitat

Ruffed grouse require cover for breeding, nesting, brooding, and winter roosting. Breeding cover consists of 10- to 25-year-old hardwood stands that contain a few scattered logs (at least 8 inches in diameter) elevated off the ground, large stones, or rock walls to be used as drumming sites. The best drumming sites provide adequate overhead cover from adjacent tree crowns or overhanging branches to protect from avian predation, as well as dense horizontal cover surrounding the drumming site. Horizontal cover is provided by thickets of young saplings, brush, and/or logging slash that reduces visibility and provides some security cover to vulnerable drumming males from ground predators.

Nest sites are often found in open hardwood stands at the bases of trees or in cutover areas just under the edge of slash piles. These sites offer protection from at least one direction, reducing nest vulnerability.

Brood cover is typically found in brushy areas or seedling/sapling stands. Lowland areas with a mixture of young hardwoods or alders provide excellent brooding habitat. The edges of openings also offer excellent brood habitat. These areas have abundant herbaceous vegetation and high insect populations. Both conditions are important to meet the high-energy demands of young birds.

In the winter when powder snow depths are sufficient, grouse prefer to use snow roosts, as they provide the most thermally favorable protection from severe weather. In the absence of suitable snow cover or in crusted snow conditions, winter roosting habitat is also provided by deciduous saplings or softwoods that provide some thermal cover from wind and cold temperatures.

Figure 26.3
Aspen bud

Figure 26.4
Wild cranberry is a favored food source for rufted grouse.

MANAGEMENT PRACTICES

Aspen is widely recognized as a key tree species in ruffed grouse management. Buds of mature male aspen trees serve as a preferred winter food source, and young stands of aspen provide necessary dense cover. As such, you should give aspen stands, which sprout prolifically when cut, priority over other timber types when managing for grouse habitat. Stands with only a minor component of aspen can usually convert to predominately aspen if clear-cut during dormancy (in the fall once the leaves are off the trees).

Maintenance of dense, young forests should be your highest priority in grouse habitat management. Once you have identified an area to be managed for grouse (preferably one that includes some component of aspen), divide the area into stands of 2 to 5 acres. Every 10 years, rotate treatment on one-quarter of the stands as described below in a checkerboard pattern. Stands with the oldest aspen trees should be treated first.

Within each stand of roughly 5 acres:

1. **Prune apple and other fruit-producing trees and shrubs** such as hawthorn, cherries, dogwoods, nannyberry, and sumac, and release them by cutting adjacent trees that are competing with and crowding them. Successful release of such species will allow them to be free to grow with no overtopping vegetation. The main crown area of the trees to be released should not have competition within the drip line and preferably beyond.
2. **Retain small patches of softwood trees** (1/4 to 1/2 acre in size) for winter cover. Preferred species include eastern hemlock, northern white cedar, or areas of spruce-fir, but any softwood that intercepts snow and wind thereby decreasing snow depths and wind chill is beneficial.
3. **Maintain rock walls free of vegetation** and/or leave several large, elevated logs as drumming sites during the stand treatment.
4. **Provide openings with herbaceous vegetation** on 10 percent of the area being managed (4 acres of a 40-acre management area). Create herbaceous acreage by seeding log landings and woods roads. Maintain by periodic mowing.
5. **Maintain mast trees** as sources of fall foods such as oaks, hophornbeam, or beech as long as they do not total more than 20 percent of the area. Be mindful, however, that a key mast area such as a high-value oak or beech stand is not an appropriate site to clear-cut for grouse. Look for an alternative, more appropriate area to manage for this type of early successional stage grouse management.
6. **Clear-cut the remainder of each stand** being treated during the winter dormant season to promote prolific aspen sprouting in the newly created open sunlight. Keep in mind that just because an area is clear-cut, it is not guaranteed that aspen will regenerate. In order to ensure a higher likelihood of regenerating aspen, there should be vigorous aspen already in the stand to be clear-cut.

If your woodlot has not been managed before and consists of older aspen trees (more than 40 years of age), the management activities need to be accelerated. Treat half of the stands of 5 acres or less as prescribed above and follow with a second treatment of the remaining half of the area in 10 years. Throughout the process, maintain groups of mature aspen on the property for winter food supplies.

27. AMERICAN WOODCOCK

Scolopax minor

SUMMARY

American woodcock are an important game species that spend the breeding season in Vermont. They require moist areas of dense alder, dogwood, and willow for nesting and roosting, and open grassy areas for their spring courtship rituals. To manage for this species, you should maintain young alder, dogwood, and willow thickets, and regularly mow and clear adjacent areas to keep them open and grassy.

Woodcock do not need large tracts of land; an area of 25 acres can suit their needs and can be managed effectively.

NATURAL HISTORY

The American woodcock is an important game species in Vermont and throughout the northeastern United States. Woodcock are members of the shorebird family, which includes dowitchers, yellowlegs, and snipe. With their distinctive long, flexible bills, woodcock spend much of their day satisfying their voracious appetite by probing the moist soils of alder and dogwood swales and other moist depressions for earthworms and other soil invertebrates.

Woodcock are a migratory species. They are distributed throughout eastern North America during the breeding season and the summer, but retreat to the southeastern U.S. (principally Louisiana and east Texas) to spend the winter. Woodcock arrive in Vermont as early as March. Males usually arrive first to establish their territories. Male woodcock seek abandoned fields and forest openings to perform their elaborate courtship flights with alternating nasally "peents" or songs while they are on the ground. These areas are commonly referred to as singing grounds.

Woodcock usually nest, rear young, roost, and feed on moist soils near their breeding grounds. Chicks hatch in late May and early June; they are well developed at birth and mature rapidly. The chicks remain with their mother for about one month until they are capable of flight. The males do not take part in any brood-rearing activities.

When autumn weather is cold enough to freeze the soil, making it impossible to probe for food, the birds begin the annual trek to their wintering grounds. In Vermont, this journey occurs between mid-October and early November.

Figure 27.1
Woodcock courtship habitat

HABITAT REQUIREMENTS

Woodcock make use of two distinct types of cover. The first are swales commonly composed of alder, dogwood, and willow in which they feed, nest, and rear their young. They also use recently abandoned fields or forest openings to roost and perform their courtship flights. Woodcock do not need large tracts of land; an area of 25 acres can suit their needs and can be managed effectively.

Figure 27.2
Alder swales make excellent woodcock cover habitat.

Woodcock seek out wooded and shrubby areas for protection from avian predators, but that also have a good line of sight at ground level to easily spot ground-dwelling predators. Typically these are stands of speckled alder and gray dogwood.

Singing grounds used for courtship displays are typically surrounded by shrub species such as blueberry, goldenrod, and red osier dogwood.

The woodcock's diet is composed primarily of earthworms and other invertebrates found in rich, moist loam and sandy loam soils found along borders of water bodies, the floodplains of most water courses, and the edges of beaver flowages. Other important foods include the larvae of flies and ground beetles. Studies have shown that a single woodcock can eat up to 90 percent of its body weight in a 24-hour period. Habitat management efforts should focus on maintaining and enhancing the feeding areas.

MANAGEMENT PRACTICES

The woodcock's home range is relatively small, so as an individual landowner, you can have a very positive impact on local woodcock habitat. Alder and dogwood, the tree species that provide optimal cover, lose much of their value for woodcock after 20 years of age. To renew this cover, 25 percent of the feeding area should be clear-cut in patterns of narrow strips (10 to 20 feet) or in small patches (1/4 acre) every 5 years.

Maintain open areas in a grassy or herbaceous condition near feeding areas for roosting and the performance of courtship rituals. They are best maintained by mowing or brush hogging every 3 to 5 years. Controlled burning and pasturing may also be effective, but they do not provide the same degree of control over undesirable vegetation that mowing does. Small forest openings can be created and maintained if they do not already exist, but abandoned fields are preferred by the birds.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. Wildlife Habitat Insight 89, "American Woodcock: Habitat Best Management Practices for the Northeast." http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=28815.wba

28. WILD TURKEY

Meleagris gallopavo silvestris

SUMMARY

Wild turkeys were reintroduced to Vermont starting in 1969 and are now abundant throughout the state. They are omnivorous birds, feeding on grasses, leaves, grains, insects, nuts, and berries. They thrive on a matrix of forest and fields, particularly with intact hardwood forests with mast-producing trees such as beech and oak. To manage your land for turkeys, you should maintain these hardwood forests in addition to promoting agricultural fields, open grassy areas for breeding, and small, dense softwood for winter roost sites. Promoting fruit- or berry-producing trees and shrubs also attracts turkeys.

To manage your land for turkeys, you should maintain these hardwood forests in addition to promoting agricultural fields, open grassy areas for breeding, and small, dense softwood for winter roost sites.

NATURAL HISTORY

Vermont's wild turkey is a forest game bird closely associated with mature hardwood stands of mast-producing trees such as beech and oak. These stands were largely eliminated from the state in the late 1800s due to heavy logging, and agricultural expansion resulted in the disappearance of the wild turkey from the state. After the regeneration of Vermont's hardwood forests in the twentieth century, suitable turkey habitat was created and 31 turkeys were relocated from New York to Vermont in 1969 and 1970. There are now an estimated 50,000 turkeys found throughout Vermont, exceeding the bird's ancestral range in the state.

The reproductive cycle for the wild turkey begins in April when the males can be found gobbling and strutting to attract hens. Turkeys are polygamous, and most of the breeding is done by a relatively few dominant gobblers. Turkey chicks usually hatch in late May at which time herbaceous clearings and pastures are used intensively by the hen and her brood in search of the protein-rich insect food necessary for rapid growth. During this stage of development, the poults are quite vulnerable to cold, wet spring weather as well as to predation.

Turkeys are social birds, and their flocking instinct is very strong. Hens and their poults flock in groups of 30 or more with a small flock of attending gobblers from summer through the winter months until breeding season, when courtship and mating rituals resume. Turkeys travel mainly on foot with occasional short flights if alarmed. At dusk, the birds fly up into mature trees to roost, which protects them from ground predators during the night.

Figure 28.1
Turkeys were successfully reintroduced into Vermont more than 40 years ago. Courtesy of John Hall, VFWD.

The initial insect diet of the young poults is gradually replaced by a diet of grasses and grains, ripening fruit, and nut crops of midsummer and fall. In winter, the birds scratch through the accumulating snow for foods such as nuts and seeds. Their search for food becomes very difficult in snow depths over one foot. During these stressful periods, turkeys seek warmer south-facing slopes with less snow and snow-free areas around spring seeps where water continually percolates from the ground.

HABITAT REQUIREMENTS

The wild turkey is a highly mobile species, capable of exploiting a wide range of forest types. In optimal habitats, turkeys may restrict themselves to less than 1,000 acres, depending upon season, food supplies, and cover. In poorer habitats, the birds may fly from one ridge to another, exceeding 4,000 acres in home range.

Good turkey habitat contains a diversity of forest types and age classes, dominated by mast-producing hardwoods, such as oak and beech, which are relatively open under the canopy. Quality habitat includes clearings and openings, groups of conifers, and cultivated land well interspersed within the forest matrix. Edge openings and forest roads are used in the spring breeding season for courtship activities and strutting displays.

The sites selected by females for their nests vary greatly. The nest itself is a slight depression in the forest litter, usually well concealed by dense vegetation. Thickets, brush piles, fallen trees, and the bases of standing trees between root flares are often used as nest sites.

Brooding habitat is found in sunlit openings, grassy clearings, meadows, or savannah-like areas such as a pure stand of hophornbeam with a grassy understory, which is used intensively by the hen and her chicks to search for insects. Adult turkeys are primarily herbivorous ground feeders. In the spring, mature birds occasionally eat insects but favor succulent grasses, sedges, tubers, and blossoms. Their summer diet includes ripening fruits and the seeds of grasses and clovers. Acorns, beechnuts, and hickory nuts are utilized most in the fall and winter, making up a significant portion of the bird's diet when available. In northern Vermont, where oaks are lacking, mature stands of seed-bearing trees including maple and ash supplement beechnuts, and soft mast such as apples, cherries, and hawthorn fruits are very valuable foods.

In winter, when snow conditions make foraging difficult, spring seeps are sought where turkeys can glean insects and herbaceous vegetation. In winter, turkeys forage on fruits that persist above the snow such as hophornbeam, burdock ash seeds, red cedar berries, grapes, highbush cranberries, beech and hemlock buds, and waste grains from spread manure and corn silage.

Turkeys roost in large-diameter trees with strong, horizontal branches and prefer white pine and hemlock in winter for cover from wind and cold temperatures.

MANAGEMENT PRACTICES

Ideally, an area managed for turkeys is about half forested and half open lands. Manage the woodland portion to result in mature forest composed primarily of masting hardwood species, particularly oak and beech, with roughly a quarter consisting of conifers such as hemlock and pine. Small, interspersed clear-cuts, pastures, and cultivated land in the balance of the managed area will provide the diversity needed to meet breeding, nesting, and brooding requirements. Maintain these openings through regular brush hogging or haying, and seed log landings, logging roads, and rights-of-way with a grass and legume mix.

Maintain a varied composition of food-producing species such as oak, beech, hickory, cherry, ash, and hophornbeam throughout the area to act as a buffer against the natural variability of mast production. During thinnings, favor mast producers and encourage understory species that provide fruit or soft mast. Crop tree management techniques, commonly referred to as mast tree release where there is a wildlife objective, can be used to increase mast production by releasing crowns of mast producers (e.g., oak) from crowns of competing trees. Culling these competing trees will make mast production better in both poor and good mast years. Studies have found that released oak trees may produce up to seven times more acorns than unreleased trees. Even in poor acorn years, released red oak has been found to produce twice the amount of acorns as unreleased trees. At a stand level this difference can be significant, particularly to wildlife experiencing a bad mast year.

One method to create additional brushy habitat is to cut back or heavily thin 50-foot borders around the edges of fields to stimulate brushy growth and provide nesting and feeding cover. This work should be accomplished on a periodic basis so that cutting does not occur all at one time. When reclaiming abandoned fields or pastures, or clearing brushy areas, avoid doing work during the nesting season (mid-April to August 1). For agricultural hayfields, mowing should preferably be delayed until August.

Spring seeps occur where warm groundwater percolates to the ground surface and provides open, snow-free areas during the winter months that are used by wildlife as feeding sites. In addition to their value as winter food sources for turkeys, spring seeps are also critically important habitats for a number of species of mammals, aquatic invertebrates, and amphibians and should therefore be protected from disturbance.

Maintaining wooded corridors and brushy fencerows, or establishing hedgerows across large fields (10 acres or more) provides valuable travel and escape cover for turkeys between woodlots. Establishing brushy "islands" of hardwoods, conifers, and shrubs can be favorable to help to break up large open areas. Native plantings can include apple species, hawthorn, elderberry, sumac, highbush cranberry, serviceberry, viburnums, cherries, and dogwoods. Turkeys should be allowed access to manure piles and spreadings during winter months. Rows of standing corn can also be left for winter use.

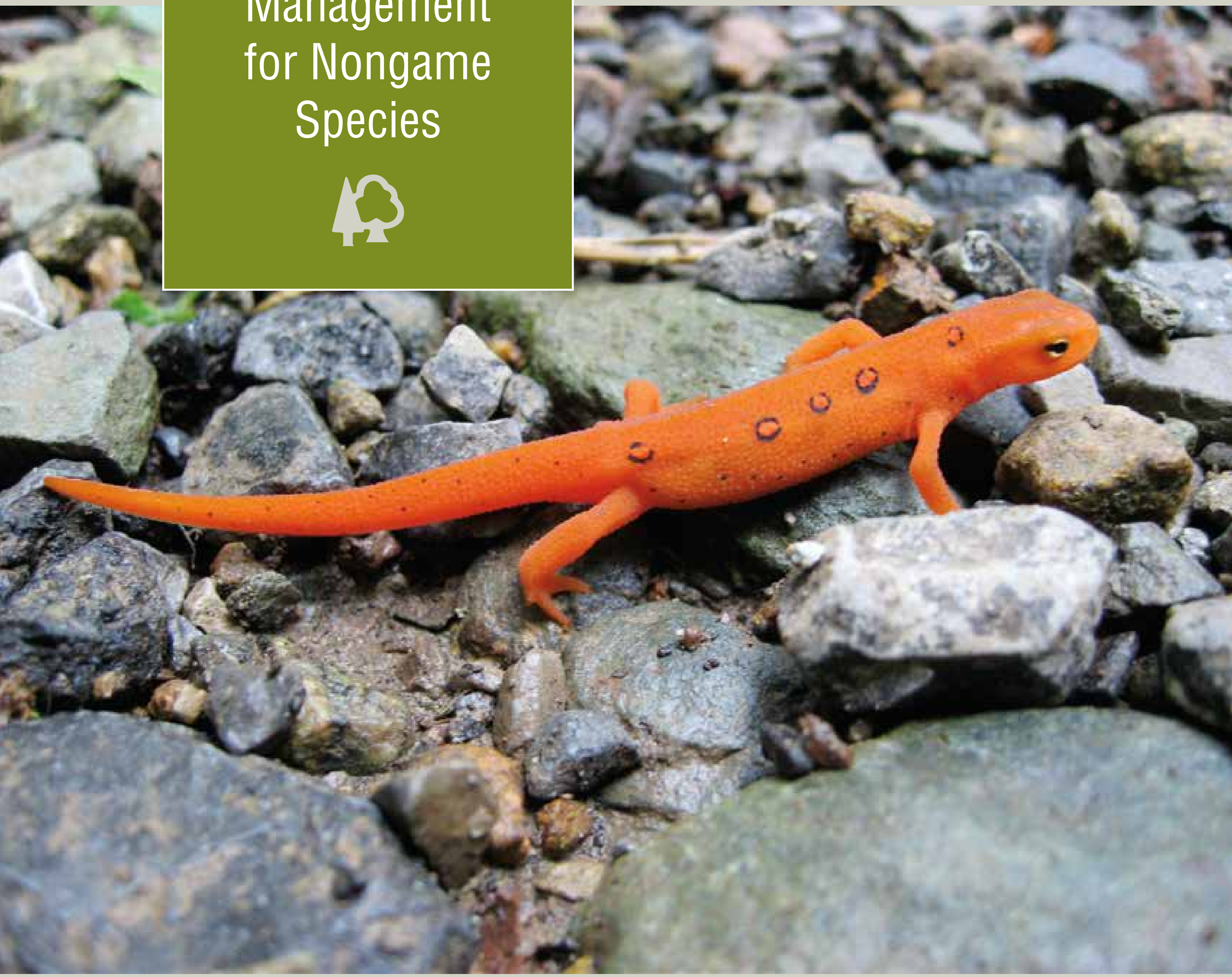
Small, interspersed clear-cuts, pastures, and cultivated land in the balance of the managed area will provide the diversity needed to meet breeding, nesting, and brooding requirements.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. "What is Forest Stand Improvement?"http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081110.pdf

—. "Mast Tree Release." http://efotg.sc.egov.usda.gov/references/public/VT/JS666VT_(Mast)_FillableForm.pdf

PART EIGHT:
Habitat Management for Nongame Species



29. BATS

SUMMARY

Bats play an important role in Vermont's ecosystem, eating one-half of their weight in insect pests each night. Many Vermont bat populations, already in decline from habitat loss, have been decimated over the last several years due to a fungus that causes white-nose syndrome. To help bats thrive on your land, leave dead snag trees standing, particularly trees with sloughing bark or cavities. Consider building a bat house for your property or allowing bats to enter any old barns or abandoned buildings on your land. Maintain forest connectivity among forest patches and wetlands, streams, and other bodies of water. If you think bats may be using a cave on your land as a hibernaculum, do not alter or block cave entrances or visit the cave during the winter when bats are hibernating.

To help bats thrive on your land, leave dead snag trees standing, particularly trees with sloughing bark or cavities.

NATURAL HISTORY

Bats are one of the most diverse groups of mammals and play a significant role in keeping insect populations in balance with our ecosystems. Bats comprise one-fourth of the world's mammals. Of the nearly 50 species of bats found in the United States, 9 occur within Vermont. All of Vermont's bats are insectivorous, meaning they eat insects, primarily beetles, moths, and smaller flying insects such as mosquitoes. Bats' importance in controlling both native and nonnative insect pests has been demonstrated in studies that document feeding rates of more than 1,000 insects per hour!

Most of the world's bat species are declining in numbers, and many are considered endangered, likely due to the negative effects of deforestation, contaminants, and persecution by humans. Five of Vermont's bat species are now officially designated as either threatened or endangered, most of which have been severely decimated by the spread of white-nose syndrome, a condition caused by an invasive fungus spreading to many bat caves and abandoned mines throughout the state.

Bats are long-lived mammals (i.e., 20 to 30 years) with low reproductive rates; most Vermont bats produce only one pup per year. For these reasons, Vermont landowners can play an important role in providing both artificial and natural habitats to enhance the survival and productivity of Vermont's bats.

Vermont's nine species of bats can be separated into two groups: the smaller cave bats, which hibernate in caves and mines during the winter season and congregate in maternity colonies during the summer to give birth to young, and the larger tree bats, which roost (i.e., spend the day) among tree foliage and migrate south for the winter (see Table 29.1).

At least 30 caves and mines in Vermont are known to serve as significant winter hibernacula for Vermont's six species of cave bats. Many of these caves have seen precipitous declines in bat numbers due to white-nose syndrome. In some instances, bats found in Vermont during the summer are known to hibernate in mines in New York. Bats travel to their hibernacula in late summer or early fall and "swarm" to breed near cave entrances for a month or more prior to hibernation.

Figure 29.1
This snag contains sloughing bark, solar exposure, and probably cavities or crevices — key summer roost elements for many bat species.

Given the variety of habitats used by bats in Vermont, if your property has forest land, streams, or wetlands, it likely provides suitable habitat for bats.

Table 29.1
Winter and summer roosting habitats of Vermont's bat species

Species of Bat	Winter Habitat	Summer Roose Type
CAVE BATS		
Little brown bat (*Myotis lucifugus*)*	Cave/mine	House, barn, bat house, dead or dying trees
Big brown bat (*Eptesicus fuscus*)	Cave/mine, House attic or cellar	House, barn, bat house, dead or dying trees
Northern long-eared bat (*Myotis septentrionalis*)*	Cave/mine	Dead or dying trees, live shagbark hickories
Indiana bat (*Myotis sodalis*)*	Cave/mine	Dead or dying trees, talus
Small-footed bat (*Myotis leibii*)*	Cave/mine	Rock ledges and cliffs, dams
Tri-colored bat (*Perimyotis subflavus*)*	Cave/mine	Live and dead foliage
TREE BATS		
Red bat (*Lasiurus borealis*)	Migrates south	Live foliage
Hoary bat (*Lasiurus cinereus*)	Migrates south	Live foliage
Silver-haired bat (*Lasionycteris noctivagans*)	Migrates south	Dead or dying trees

* Threatened or Endangered

Upon emergence from caves in the spring (usually mid-April through May in Vermont), cave bats travel to their traditional summer range where the females set up maternity colonies in house attics, barns, large dead or dying trees, or even rock cliffs. Male bats may remain near hibernacula or travel to summer ranges where they remain solitary or in small bachelor groups. Bats are very sensitive to cool temperatures and need to roost with groups of other bats in places that receive solar radiation in order for their young to develop and survive.

In contrast, tree bats migrate back to Vermont in the spring, often hanging among the foliage of large live trees that provide optimal cover and thermal conditions.

Given the variety of habitats used by bats in Vermont, if your property has forest land, streams, or wetlands, it likely provides suitable habitat for bats. Recent research on Indiana bats indicates that this federal and state endangered species establishes summer maternity colonies in the southern Champlain Valley of Vermont. If you live within this region, you are strongly encouraged to consider maintaining quality maternity roost trees and foraging habitat so that this species can be maintained and, preferably, recovered.

Figure 29.2
Bats hibernate in caves and mines that offer a constant temperature just above freezing.

HABITAT REQUIREMENTS

The keys to providing quality habitat for Vermont's bats are as follows:

- Protecting caves and mines used by hibernating bats
- Maintaining a mixture of suitable summer roosting sites such as roost trees, bat houses, and rock ledges
- Maintaining a diversity of forested habitat conditions that includes a variety of stand structure
- Maintaining forest connectivity among roosting sites, foraging habitats, and aquatic features such as streams, rivers, and wetlands

Vermont's cave bats must hibernate in caves and mines that offer a constant temperature just above freezing. These temperatures allow bats to maintain torpor to reduce energy consumption. Bats are extremely vulnerable to disturbance during this period, with each arousal costing the animals many days of critical energy reserves. Because bats are extremely concentrated during winter, they are vulnerable to disturbance by humans, predators such as raccoons, weasels, and domestic cats, and changes to the cave environment caused by human or natural alteration of the cave entrance or passages. Vermont bat hibernacula range in numbers of bats from as few as 30 to more than 25,000.

It is important for forest land surrounding hibernacula to provide suitable roost trees such as large snags in various stages of decay with loose bark, crevices, and cavities. These trees are particularly used in the fall and spring as the cave bats swarm or emerge, respectively.

As a general rule for Vermont's bats, lands providing a matrix of openings and interconnected forest land composed primarily of sawtimber-sized or older stands provide the most suitable habitat for bats. Hardwoods generally provide better forest structure than softwoods for foraging habitat.

Access to sources of water is extremely important as bats do not store much water in their bodies due to the high-energy cost of flying. Open water also provides a concentrated source of insects. Forest connectivity and riparian corridors that connect streams, wetlands, vernal pools, and ponds are important in providing access to sources of water. Lastly, forest roads often serve as flight corridors that enable bats to quickly move between roosts and feeding sites.

You can create quality bat habitat by maintaining a mixture of forest age classes available in adequate supply, openings that provide forest edge habitat, and access to forested buffers along streams, wetlands, and water bodies.

MANAGEMENT PRACTICES

In general, bat habitat management is very compatible with most forest management activities, provided there is an adequate supply of current and future roost trees. You can create quality bat habitat by maintaining a mixture of forest age classes, openings that provide forest edge habitat, and access to forested buffers along streams, wetlands, and water bodies.

Landowners within the southern Champlain Valley of Vermont should pay particular attention to the likelihood that their forestland serves as habitat for a summer maternity colony of federal and state endangered Indiana bats. More detailed forest management guidelines are available from the Vermont Fish and Wildlife Department when considering this species. (See **Resources** for contact and other information.)

Summer Range Habitat

Summer habitat comprises two components: *maternity roosting sites* where young are born and raised, and *foraging habitats* that provide a plentiful supply of insects upon which to feed.

Maternity Colonies in Trees. Bats species across the state use dead and dying trees to roost during the day and raise their young before they are able to fly. To provide this habitat you can do the following:

- Maintain and establish five to seven large roost trees of various stages of decay and size classes per acre. Roost trees should be represented within each of three size classes (less than 10 inches in diameter at breast height (DBH), 10 to 18 inches DBH, and greater than 18 inches DBH). These trees should either be live shagbark hickories or dead or dying trees showing signs of cracks, crevices, loose bark, or cavities. These trees should be dominant or co-dominant in the forest stand.
- Enhance the value of roost trees by increasing solar radiation by removing some or all of the adjacent trees. Roost trees should not be isolated, however, from forest cover.
- Limit the dense vegetation directly at cave or mine entrances in order to provide space for swarming activity.
- Where an inadequate supply of dead or dying trees exists, large cull hardwood trees should be girdled to allow for decay to create a roost tree for the coming 3 to 5 years.
- Enhance existing and potential roost trees through selection harvesting or small group selection that opens up the canopy and improves solar exposure of the roost tree. Roost trees should not be isolated from forest cover.
- Maintain or recruit a supply of large-crowned live hardwood trees for tree bat roost sites. These trees should be dominant or co-dominant in the forest stand with an open understory beneath. Trees along forest edges or riparian areas are also most likely to be used by tree bats.

Maternity Colonies in Buildings and Barns. Landowners with bat colonies in their buildings or barns are encouraged to contact the Vermont Fish and Wildlife Department for information on how to exclude bats from buildings. Bats should not be killed, and entrances in buildings should not be sealed until the young are able to fly and all bats have exited the roost. (For more information, refer to the Vermont Fish and Wildlife Department pamphlet “Bats in Your House” at the link in **Resources**.)

Maternity Colonies in Bat Houses. Bat houses are valuable structures to establish or enhance maternity colonies of little brown and big brown bats. In Vermont, you should paint bat houses black and place them at least 10 feet off the ground in a location that will receive at least 8 hours of direct sunlight. Bat houses may be placed near dwellings, but can also be located on poles near aquatic features such as rivers, streams, and wetlands (See Figure 29.3). Bat houses should be checked for leaks and wasp nests each fall or winter, after bats have left for the season. (For more information on attracting bats, refer to **Resources**.)

Maternity Colonies in Rock Cliffs and Ledges. All rock cliffs and ledges receiving any solar exposure are potential roosting sites for the state threatened small-footed bat. Where these habitats exist on the parcel or within 2 to 3 miles, maintain them with contiguous forest cover in sawtimber or older stands and with forest connectivity to aquatic features such as streams, rivers, and wetlands.

Bat houses are valuable structures to establish or enhance maternity colonies of little brown and big brown bats.

Figure 29.3
Two bat houses, located on opposite sides of a pole, can provide a variety of roost temperatures suitable to Vermont's climates.

Foraging Habitat

In general, both even-aged and uneven-aged forest management are compatible with suitable foraging habitat for bats. Foraging habitat is best provided through maintaining forest patches and connectivity to roosting sites and aquatic features.

You can provide optimal bat foraging habitat through the following land management activities:

- Maintain a matrix of forest land (primarily comprised of sawtimber-sized and older forest stands), openings that provide for forest edge, and forest connectivity to sources of water.
- Favor hardwood stands for establishing or enhancing bat foraging habitat.
- Thin forest stands to enhance the site for bat flight, and make small group selections to create gaps in forest cover that provide edge habitat.
- Create openings in young stands to develop edge habitat.
- Maintain or establish forest roads as flight corridors between quality roost trees and older forest stands and sources of water.
- Maintain forested buffers along sources of water (e.g., streams, rivers, and wetlands), including forest cover near ponds. Forested buffers large enough to provide in-stream structures from fallen trees enhance bat habitats by creating slow-moving pools of water for drinking and feeding.
- Maintain forest cover surrounding vernal pools.
- Maintain or expand hedgerows between forest patches and aquatic features.

Winter Hibernacula

If you have a cave or mine on your property, you should contact the Vermont Fish and Wildlife Department to determine if the site serves as a hibernaculum for bats. If so, you should make plans to maintain the cave/mine and minimize human disturbance of the site during the period from September 1 through May 31. Landowners with property within a 5-mile radius of a bat hibernaculum are more likely to have resident bat populations, particularly during the spring and fall. By following the guidelines preceding for maternity colonies in trees, you will satisfy the roost tree requirements for bats as they congregate around caves/mines during the fall and spring.

RESOURCES

Vermont Fish and Wildlife Department. "Attracting Vermont's Bats." http://www.vtfishandwildlife.com/library/factsheets/nongame_and_Natural_Heritage/Attracting_Vermont's_Bats.pdf

—. "Bats in Your House." http://www.vtfishandwildlife.com/library/factsheets/nongame_and_Natural_Heritage/Bats_in_Your_House.pdf

30. REPTILES AND AMPHIBIANS

Most reptiles and amphibians, or "herps" as they are commonly referred to, require water for some stages of their lives.

SUMMARY

Reptiles and amphibians represent an interesting group of species in Vermont and play an important role in the overall ecology of the landscape. Many species of reptiles and amphibians perform tasks that benefit people, such as insect and rodent pest control. Most reptiles and amphibians, or "herps" as they are commonly referred to, require water for some stages of their lives. To manage your land for reptiles and amphibians, conservation of streams, ponds, wetlands, and vernal pools is essential for these animals' survival. Other habitat features that benefit herps include intact forest buffers along water, rock walls, brush piles, downed trees, and hollowed stumps. On stream banks with low levels of erosion, maintain sandy areas for turtle nesting. For more information, check out the *Vermont Reptile and Amphibian Atlas* referenced in **Resources**.

NATURAL HISTORY

Vermont has a rich diversity of salamanders, frogs, snakes, and turtles living in the state. With 40 different species, we should be mindful of the vital role these often overlooked species play in our ecosystems.

Reptiles and amphibians are beneficial to Vermonters. Salamanders, frogs, toads, lizards, and some snakes can consume large quantities of harmful insects. The larger snakes eat mice, rats, and other rodents. Some turtles act as scavengers in lakes and ponds, and others prey on snails, which act as intermediate hosts for parasites. In addition, reptiles and amphibians provide an important food source for other animals, including fish and birds. These creatures are interesting to observe and study, and most species carry out their ecological roles without conflict with people.

Amphibians and reptiles are vertebrates, much like birds and mammals. However, unlike mammals and birds, herps are cold-blooded, meaning that they do not produce their own body heat but instead absorb heat from their environment. Because body heat comes from external sources rather than from their own metabolism, herps do not need to feed on a regular basis and can be inactive for extended periods of time. For example, some large snakes require only one large meal per year. Terrestrial salamanders feed primarily during several warm, wet nights within their active seasons. Most herps are inactive during cold seasons. Without the protection of fur or feathers, temperature and moisture dictate when and where amphibians and reptiles are active.

Figure 30.1 a,b,and c
(l-r) Vernal pool; spotted salamander; wood frog

HABITAT REQUIREMENTS

Amphibians and most reptiles require water for some part of the year. Turtles usually inhabit permanent water resources such as lakes, ponds, and slow-moving sections of rivers. Aquatic snakes spend much of their lives in and near the shallow edges of lakes and streams. Frogs, toads, and most salamanders lay their eggs in water and spend the early part of their lives as gill-breathing larvae or tadpoles. Many breed in temporary ponds such as vernal pools and other shallow wetlands free of fish. Some frogs remain in or near lakes and ponds, but others disperse into surrounding areas. Northern leopard frogs, for example, prefer damp meadows with permanent ponds, but gray treefrogs, wood frogs, spring peepers, and many salamanders inhabit shady, wet woodlands with temporary seasonal ponds. (Refer to **Chapter 12, "Wetland Habitat Management,"** for more information on vernal pools.)

MANAGEMENT PRACTICES

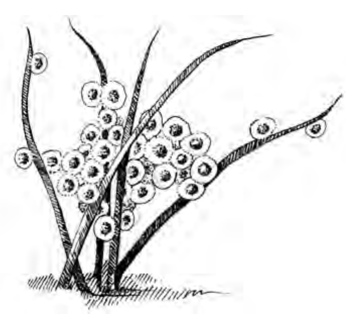
Frogs, Toads, and Salamanders

Although more than 3,400 species of frogs and toads occur worldwide, only 11 of these species live in Vermont. Of these 11 species only 1, the boreal chorus frog, is listed as endangered, while the Fowler's toad is considered a species of special concern. Vermont is also home to 10 species of salamanders, including the eastern newt, Jefferson salamander, blue-spotted salamander, four-toed salamander, and mudpuppy, a species of special concern in the state.

Water is critical to the survival of most frogs, toads, and salamanders, because they seek shallow wetlands and vernal pools in which to breed and lay eggs. When the shallow wetlands or vernal pools remain wet and free of egg- and larvae-eating fish, young, gill-breathing amphibians will make the transition from egg to larvae to adult in one summer. Dry years can result in few eggs and/or hatchings. Species that do not require large wet areas may lay their eggs in ditches with just enough water to encourage breeding.

Some frogs and salamanders lay their eggs attached to submerged sticks and vegetation. Others, like the bullfrog and green frog, lay their eggs in a large film that floats on the surface. Mudpuppies look under rocks and logs in warm, shallow water for their nest chambers, and the four-toed salamander lays its eggs under sphagnum moss near the edges of wetlands.

Salamanders consume worms, snails, slugs, and both waterborne and terrestrial insects and their larvae. In the woodlands, salamanders seek leaf mold, decaying logs, and moist spots under rocks for food and shelter. The diets of frogs and toads include insects, spiders, mites, and worms. Leaving intact leaf litter and rotten logs in your woods will help provide these animals with important cover. Toads in particular are beneficial



Vermont is home to 11 species of snakes, and most of these species are less than 3 feet long.

to gardeners because they consume insects that are harmful to flowers, vegetables, and other plants. Attract toads by placing an old stump or hollow log in your garden. Propping up pieces of wood or turning a flower pot on its side, will give toads a damp, shady daytime haunt.

When working in the woods, leave lots of coarse woody debris in the form of branches, downed logs, and dead trees. Woods that look like city parks are not good habitat for amphibians, reptiles, or other wildlife. This organic material provides moisture, food, and cover. Abundant shade keeps the woods cool and moist.

Many amphibians depend on streams or seepage areas to feed, lay their eggs, overwinter, or maintain their body moisture. Keep streams shaded and free of sediment and leave a naturally vegetated buffer where they can feed during nighttime rains. (For more on this, see **Chapter 14, "Riparian Habitat Management**.")

Snakes

Unlike amphibians, reptiles do not have a water-dependent larval stage. However, many species live in or near wetlands and waterways where they find food and shelter. Creating, restoring, and enhancing wetlands is generally beneficial to snakes and turtles as well. Aquatic snakes spend much of their time in or near the shallower edges of lakes and streams. Nearby uplands are the feeding grounds favored by most snakes, Vermont's one lizard species, the wood turtle, and the eastern box turtle.

Figure 30.2
Brown snake. Courtesy of Jim Andrews.

Vermont is home to 11 species of snakes, and most of these species are less than 3 feet long. However, most Vermonters would be surprised to learn that Vermont is home to one of the largest snakes in North America. The eastern ratsnake can grow up to 8 feet long and has been seen at lengths of nearly 6 feet here in Vermont. Unfortunately, this docile snake is often killed out of fear. Vermont is also home to the timber rattlesnake, a venomous snake that inhabits rockslides, ledges, and nearby forests. Although this snake is not at all aggressive, it is venomous and should not be handled.

Vermont's most abundant snake is the common garter snake, which occupies open woodlands, meadows, and old fields. Another Vermont snake that prefers a similar habitat type is the eastern milk snake, which can also frequent barns and sheds. Wet lowland meadows, marshes, and the grassy edges of lakes and streams are preferred by the eastern ribbon snake. The smooth green snake prefers upland pastures, power lines, and beaver meadows. Vermont's only water snake, the northern water snake, inhabits lowland shallow wetlands with emergent vegetation and nearby rocks. This snake is primarily found near scattered marshes in the Lake Champlain Basin.

Following are some options you should consider when managing habitat for snakes:

- When trimming trees or shrubs or harvesting timber, leave brush in piles to provide shelter.
- Maintain stone piles and stone walls that get lots of sun on well-drained slopes, which are attractive basking and hibernation locations and also provide shelter from predators.
- Maintain open, sunny places for basking within dense woodlands to help snakes regulate temperature.

- Leave at least a 50-foot uncut buffer around ponds and water edges for feeding sites and cover.
- Mowing fields and bailing hay are threats to snakes. Cut open areas only as frequently as necessary, cut as high as possible, and leave the clippings if not being used for hay.
- Be careful how and where you use a string trimmer. Snakes will hide from predators in tall grass on the edge of lawns, and are often killed by electric trimmers.

Turtles

Vermont is home to seven species of turtles. Probably the most-recognized turtles in Vermont are the snapping turtle and the painted turtle. These turtles require slow-moving or still water with soft bottoms and emergent vegetation such as cattails. Vermont's less common turtles include the wood turtle and the northern map turtle. Wood turtles are primarily river turtles that prefer streams with moderate slopes and speeds. They feed primarily in the upland and field sites adjacent to the stream systems and rely on the streams for refuge and wintering sites. Map turtles in Vermont are primarily aquatic; they come on land only to bask and lay eggs. Vermont's rare turtles are the spiny softshell, spotted, and eastern musk or stinkpot turtles. Spiny softshells are entirely aquatic and are found only in the northeastern region of Lake Champlain. Spotted turtles are both terrestrial and aquatic; they travel between uplands and wetlands. Eastern musk turtles are also entirely aquatic, preferring shallow, weedy still water.

All of Vermont's female turtles dig a nest hole in the ground with their hind legs to bury their eggs. Nest sites are located in moist soils or sand in open, sunny areas near water with little or no obstructing vegetation. When nesting sites are not available, turtles may travel a considerable distance to find them, thus increasing their vulnerability. Stream bank stabilization, though an excellent conservation tool, can often eliminate nesting sites for wood turtles.

Most female turtles lay their eggs in May to early June and the young hatch in late summer or early fall. Because some hatchlings may overwinter in the nest, these sites must remain undisturbed all year. Turtle eggs are a popular food for nest predators such as raccoons, skunks, and opossums.

As a landowner, you can provide nesting habitat by creating small sand or gravel piles in slightly elevated, sunny places near pond or lakeshores to prevent flooding of the nest. These piles need to be kept free of all tall vegetation. Turtle eggs can tolerate grass roots, but other roots will kill them. Because some aquatic turtles spend the winter on the bottoms of lakes and ponds, the sites must not freeze to the bottom in the winter. Lakes and ponds with depths of 5 feet or more are proven wintering habitat for aquatic turtles. Eastern box turtles (a possible Vermont breeder) dig into the leaf litter and hibernate in the forest.

Many species of turtles need to bask in order to raise their body temperatures. Leave downed trees along the edges of ponds, rivers, wetlands and lakes to provide adequate basking locations.

Vermont is home to seven species of turtles. Probably the most-recognized turtles in Vermont are the snapping turtle and the painted turtle.

RESOURCES

Partners in Amphibian and Reptile Conservation. 2006. *Habitat Management Guidelines for Amphibians and Reptiles of the Northeastern United States – Technical Publication HMG-3*

Vermont Reptile and Amphibian Atlas. http://vtherpatlas.org/

31. BEES AND OTHER PLANT POLLINATORS

Plants critical to wildlife that benefit from animal pollination include blueberry, blackberry, apple, and serviceberry. Without bees, these plants that sustain bear, deer, turkey, and moose would be far less productive.

Figure 31.1
Yellow-banded bumblebees enjoy white sweet clover. Courtesy of Leif Richardson.

SUMMARY

Bees are an important pollinator for many plants upon which other wildlife depend. Promoting bees on your property helps the pollination of maples, apple trees, berries, and other fruits, which in turn promotes both nongame and game species such as deer, bear, and turkey. Landowners wishing to manage for bees and other pollinators should maintain a diversity of forest types, promote the growth of native flowers and flowering plants, and avoid the use of many types of pesticides on their gardens and crops.

NATURAL HISTORY

Plants form the base of the food chain, the structure of the habitat, and the cover necessary for all species of Vermont's wildlife. To manage plant-based habitats effectively for birds, mammals, and other wildlife, we must understand the processes that sustain them. And critical to plant reproduction is the role that bees, flies, beetles, moths, butterflies, and other animals play in moving pollen from one flower to the next. This section will focus on managing bee habitats, since bees are by far the most important pollinators.

The recent population crashes of commercial honeybee colonies have raised awareness of bees' importance to people and wildlife as crop pollinators, as 60 to 80 percent of wild plants are dependent on bees and other pollinators. Plants critical to wildlife that benefit from animal pollination include blueberry, blackberry, apple, and serviceberry. Without bees, these plants that sustain bear, deer, turkey, and moose would be far less productive.

Approximately 4,000 species of bees are native to North America, and about 275 of these are found in Vermont. Honeybees are not native to this continent and, in their current state, are relatively unimportant pollinators in natural settings. These bees all have one important habit in common: they feed their offspring pollen. In gathering this food from flowers, bees inadvertently transfer pollen grains from one plant to the next, thus allowing the plants to form seeds and fruits. Bumblebees are highly visible examples of this foraging strategy, readily switching from one type of plant — and habitat — to the next. About 20 percent of our bees are pollen specialists, meaning that they are adapted to gather pollen from just one plant family, genus, or even species.

Most of our wild bees are known as solitary bees, meaning that they lack the complex social structure of honeybee colonies. Females of these species establish solitary nests, provision their eggs with pollen, then die before their offspring emerge. Though some solitary bees nest in communal aggregations, the adult bees have little interaction with each other.

By contrast, the societies of our social species feature cooperation, a division of labor, and much communication. The most visible of these are the bumblebees, which establish colonies in spring to early summer.

HABITAT REQUIREMENTS

Figure 31.2
Meadow with native flowers

Bees have three basic habitat requirements: nesting sites, overwintering sites, and access to the plants to which they are adapted. Most of Vermont's wild bees nest in tunnels they dig in sandy, silty, or loamy soils. Flat or gently sloping substrates are generally preferred, and the bees often choose areas with sparse vegetation. Examples of ground-nesting bees are the many species of mining bees and sweat bees found here. About one-quarter of the bees in this area nest in preformed cavities they find in twigs, acorns, snail shells, tree trunks, and other wood. Many of these bees seal their nests with doors made of chewed leaves, which has earned them the name leafcutter bees. Bumblebees nest in old rodent dens, in above-ground cavities in dead trees, under tussocks of dry grass, in heaps of decomposing plant matter, and many other places. And, a small number of bees actually excavate their own nest cavities in sound wood. This includes the large carpenter bees, which are found only in extreme southernmost Vermont.

When managing for bees and other pollinators, maintaining an abundance and diversity of flowering plants throughout the growing season is critical. Trees such as maples, willows, and apples are important sources of bee food in early spring. Spring wildflowers found in the understory of hardwood forests are critical to large number of bees that also pollinate the fruiting trees and shrubs many other animals depend on. Open wetlands feature many pollen and nectar sources for bees, including blueberries, cranberries, Labrador tea, water lilies, Joe-Pye weed, and asters. Fields and other openings usually support suitable bee forage. Farms and gardens can offer excellent bee forage. Plants that do not offer forage to bees include those that are wind pollinated, such as beech, birches, oaks, grasses (including corn), sedges, and nonflowering plants such as ferns and horsetails.

When managing for bees and other pollinators, maintaining an abundance and diversity of flowering plants throughout the growing season is critical.

Adult bees do not migrate, but seek winter shelter in underground cavities, hollow twigs, and other places. Little is known of the requirements of bees in winter, but they are thought to seek shelter that is protected, dry, and relatively stable in temperature.

MANAGEMENT PRACTICES

Loss of habitat is implicated in the declines of some bumblebees and other pollinators. Subdivision, development, and greatly intensified agricultural operations have been shown to reduce bee abundance and diversity.

Fortunately, managing for bees and other pollinators involves many of the same practices employed for other wildlife. In general, habitat diversity will lead to a diversity of bees and other pollinators. Bees must have continuous access to an array of native flowering plants, which can be achieved by maintaining a patchwork of mature forest, forests with sunny openings, functioning wetlands, old fields with a mix of flowering forbs and shrubs, and fields with areas that are not heavily cropped for corn or hay. Patches of flowers on the margin of farm fields and lawns and in hedgerows can be critical to bees, and should be maintained. Bees are attracted to the flowers of some invasive plants (e.g., purple loosestrife), but others may impoverish bee habitat by crowding out native flowering plants. Plants favored by bees include goldenrod, aster, sunflower, willow, blueberry family plants (including blueberries, cranberries, and maleberry), dogwood, spring beauty, native species of loosestrife, and pickerel weed.

To manage your property for bees, consider the nesting needs of the bees at work on your land. The sparsely vegetated and uncompacted soils of hedgerows, dry banks, and forest roads are often inhabited by nesting bees. Tilling is detrimental to nesting bees, so leave some areas fallow among row crops. Maintain an abundance of woody material that might house cavity nesters, including pithy plant stems, sumac, and logging slash. When conducting habitat improvement work such as apple tree release, consider leaving some dead wood as nesting habitat for bees. And just as you can provide nesting boxes for wood ducks and bluebirds, you can augment nesting habitat by providing blocks of wood with pre-drilled holes in them, as well as shoebox-sized wooden boxes for bumblebees.

One of the greatest detriments to bees is the widespread use of pesticides. Limiting the use of these chemicals in agricultural and other settings will benefit bees and the wildlife that depend on their services. Of particular concern are pesticides applied as dusts or small pellets, those applied to flowering plants, and the neonicotinoid class of pesticides.

Finally, you should pay attention to the activities of bees on your property. Noticing trends in bee abundance on plants from year to year can help you evaluate whether you are getting this valuable ecosystem service. Poor fruiting of apple trees, blueberry bushes, and other plants mentioned above may signal a need to increase pollinator habitat. Becoming familiar with a few of the more obvious pollinators may aid you in this type of monitoring.

RESOURCES

U.S. Department of Agriculture. Natural Resources Conservation Service. “How Farmers Can Help Pollinators.” http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/farmers

U.S. Department of Agriculture, “Agroforestry Notes.”

—. “Improving Forage for Native Bee Crop Pollinators.” http://www.plants.usda.gov/pollinators/Improving_Forage_for_Native_Bee_Crop_Pollinators.pdf

—. November 2009. “New England Pollinator Handbook.” http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_010204.pdf

—. “Pesticide Considerations for Native Bees in Agroforestry.” http://www.plants.usda.gov/pollinators/Pesticide_Considerations_For_Native_Bees_In_Agroforestry.pdf

Xerces Society for Invertebrate Conservation. “Managing Habitat for Pollinators.” http://www.xerces.org/pollinator-conservation-managing-habitat

APPENDIX

SAMPLE TEMPLATE FOR HABITAT PLAN

FOREST AND WILDLIFE HABITAT MANAGEMENT PLAN

TEMPLATE

While there are many ways to develop and format a forest and wildlife habitat management plan, how a plan is developed can be affected by the size of the property, the complexity and diversity of the habitat conditions, and the types of interests the landowner may have. Reasons for developing a plan, such as the Vermont UVA requirements for forest management plans, may also dictate the format used. Maps are also an important part of the planning process. Consider using the ANR Atlas (http://anrmaps.vermont.gov/websites/anra) to create yours. **Note:** This template is one example of how a habitat management plan could be constructed and organized, and should be used as a general guide.

I. Describe the Property

- Property name, location, and owner

  ____
  ____
  ____

- History of land use (agricultural use, past timber harvesting, old roads, recent development)

  ____
  ____
  ____

- Acreage of the property ______________________________

- Boundary descriptions (attach a map of the property boundaries)

  ____
  ____
  ____
  ____
  ____
  ____

- Infrastructure (access and roads, historic sites such as cellar holes, stone walls, parking areas — these will need to be added to your plan map)

  ____
  ____
  ____

- Landscape context — how and where the property fits into the neighboring landscape relative to other property owners, conserved lands, forest blocks, nearby development

- Significant features — any rare species or unusual geological conditions

- Create a map that illustrates these various features and provides a context for where the property is located and how the boundaries are configured relative to other natural resource and cultural resource features. The ANR Atlas tool is a good resource for this.

II. Explain the Purpose and Outline Goals of the Plan

- Why are you developing a management plan for your property (what is the purpose of the plan)?

- What is your vision for the future of your land?

- What feature/s is/are most important to you about your land?

- What are your goals and objectives for the property?

III. Inventory and Assess the Habitat Conditions and Other Natural and Cultural Resources

As mentioned previously, a map is critical for illustrating much of this information. Creating a comprehensive map will be one of the most important tools for guiding the application of management strategies.

- Describe past and current habitat conditions such as meadows, forest types, natural communities, wetlands, streams, ponds, vernal pools, seeps, ledges, areas of concentrated mast trees.

- Describe fine-scale habitats such as number of dead and dying trees per acre, presence or absence of brush piles, number of downed logs per acre.

- Describe observations and evidence of wildlife that occur on the property such as types of songbirds observed or heard, ruffed grouse drumming, animal tracks (e.g., fox, coyote, deer, moose), browsing of saplings by deer or snowshoe hares, nest sites of wood ducks or Canada geese, photos of wildlife from game cameras, and so on.

- Describe the broader landscape beyond the property boundaries. For instance, if the property is located in the northern Green Mountain biophysical region, it would be important to note whether the property is located within a large block of unfragmented forest habitat (**see websites for ANR Natural Resources Atlas and BioFinder for more information**), or instead, if it is located within an agricultural landscape. Another important landscape factor to consider is where the property fits into any wildlife travel corridors or linkage areas (see the same references above).

- Create a map that illustrates the locations of stone walls, roads, old home foundations, monuments, or other important cultural features of the property as described in Part I. It may be important to avoid and protect those areas.

- Describe the forest conditions of the property for purposes of managing forest resources. This is important because many habitat management plans will be part of forest management plans that have goals for timber management and production.

IV. Develop Management Strategies and a Schedule

- Describe specific actions that you intend to take in order to achieve the goals and objectives of the plan. These may include harvesting timber, mowing meadows, brush-hogging young forest, pruning apple trees, planting trees along stream buffers, controlled burning of grasslands, delayed mowing of grasslands, and installation of artificial nest structures, among many others detailed in these guidelines.

- Develop a schedule that establishes dates when the various strategies will be implemented and when they will be complete. If those dates need to be adjusted over time, make the necessary revisions because it will force you to ensure that you complete all the necessary strategies to achieve the goals and objectives.

- Using the map of features you developed in Part III, create an overlay that depicts the location and extent of the strategies that will be applied on the property.

- Take and date photos of the areas where various actions will be implemented prior to and after they have been applied. Photo documentation can be a rewarding way of appreciating the effort that goes into implementing your strategies.

INDEX

A Landowner's Guide

Wildlife Habitat Management for Lands in Vermont

Vermonters place high value on the state's environment, rural working landscape, and wildlife. Time and again, these values are highlighted in surveys that illustrate strong public support for conservation of wildlife and land. As the Vermont landscape comprises largely private land, Vermont landowners play a critical role in ensuring the future health of Vermont's lands, waters, habitats, and wildlife. And, time and again, Vermont landowners provide outstanding examples of managing land in thoughtful ways to benefit the shared interests of wildlife.

This guide is intended to assist you as a landowner to manage your land to benefit wildlife in tandem with other management goals you might have, such as for timber or hiking trails; many of these goals are compatible, if not complementary. Managing your land to enhance its value for wildlife requires careful attention to the species of plants and animals currently using the land as well as those desired from your management. Whether you are a landowner, forester, biologist, or other land manager, this guide will help you understand how to recognize various wildlife habitats and how to manage them for the future, for many generations of Vermonters yet to come.

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