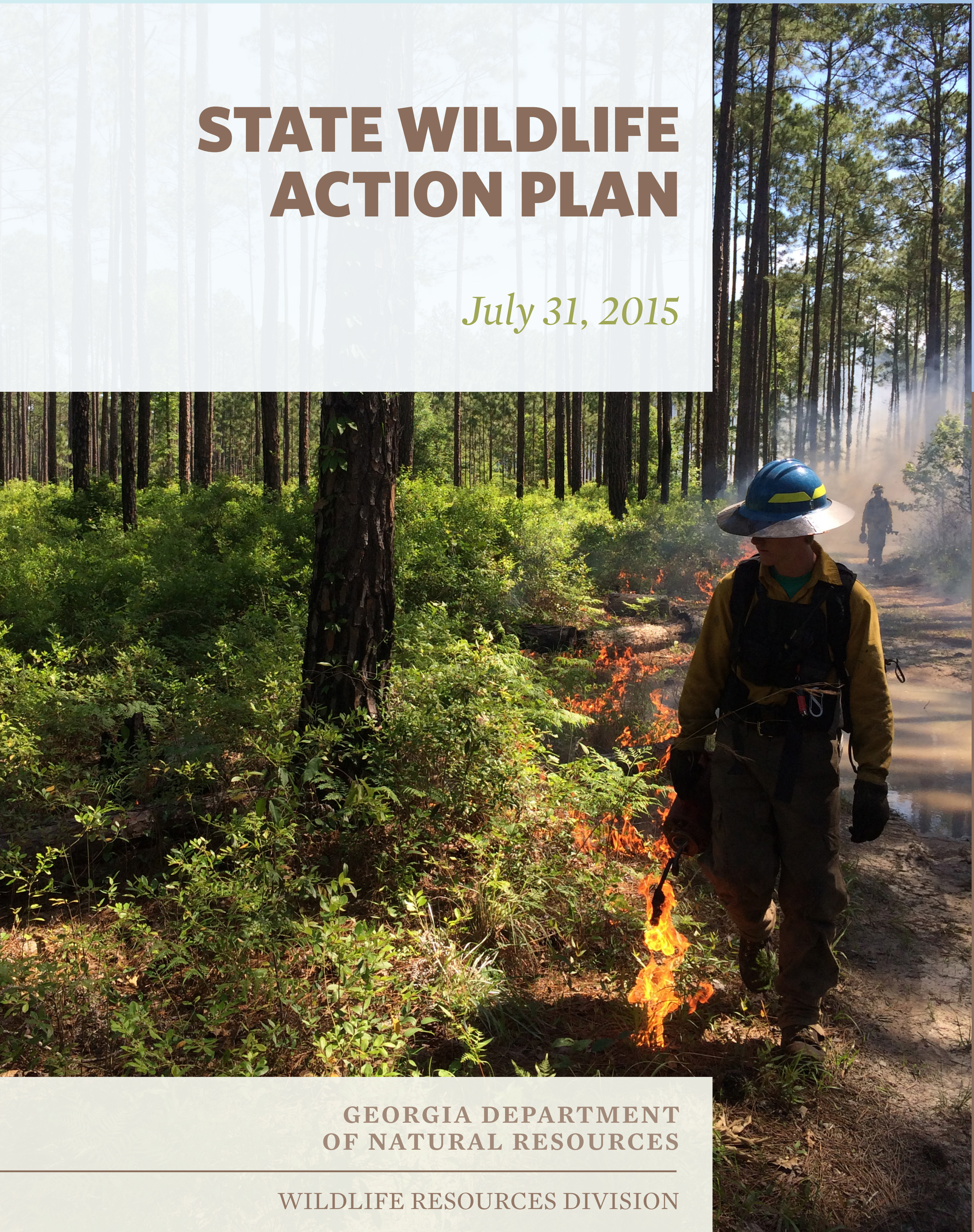
STATE WILDLIFE ACTION PLAN

July 31, 2015



GEORGIA DEPARTMENT
OF NATURAL RESOURCES

WILDLIFE RESOURCES DIVISION

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Executive Summary

In 2013 the Wildlife Resources Division (WRD) of the Georgia Department of Natural Resources (DNR) began a process to revise the Comprehensive Wildlife Conservation Strategy developed in 2005. Support for this revision effort came from a federal grant to WRD through the State Wildlife Grants program; matching funds were provided through Georgia's Nongame Wildlife Conservation Fund. The goal of the Comprehensive Wildlife Conservation Strategy, now known as the State Wildlife Action Plan (SWAP), is to conserve Georgia's animals, plants, and natural habitats through proactive measures emphasizing voluntary and incentive-based programs on private lands, habitat restoration and management by public agencies and private conservation organizations, rare species survey and recovery efforts, and environmental education and public outreach activities.

The best available wildlife data were used to review and revise the SWAP. The review process included an assessment of habitats required by these species, as well as problems affecting these habitats. This process included an evaluation of research and survey needs, habitat restoration needs, and monitoring needs. It also included an assessment of existing programs and policies for wildlife conservation in Georgia and recommendations for improvements in these areas. Coordination with other organizations that manage land or administer conservation programs in Georgia was a key component of this effort.

The SWAP revision process involved staff within DNR, representatives of private and public conservation organizations and land managers and owners in Georgia. An advisory committee composed of representatives of various agencies, organizations, and land management groups provided project oversight. Technical teams addressed specific components of the revised SWAP; these teams included DNR staff and representatives of other agencies and organizations. Input from the advisory committee, stakeholders, representatives of other conservation organizations, consulting biologists, academic researchers, and the public was used in the revision process. Educational materials were developed to inform the public about the project's goals and milestones. These materials were posted on the DNR website and distributed to the public.

Components of this review and revision included the following: 1) updating databases on rare species and natural communities; 2) reassessing high priority species and habitats; 3) identifying high priority research, survey, and monitoring needs; 4) conducting surveys for rare species on public and private lands; 5) updating databases of conservation lands and high priority watersheds and landscapes; 6) identifying conservation, education, and habitat protection needs for priority species and habitats; 7) collaborating with state and federal agencies on state and regional conservation plans; 8) consulting with private conservation organizations, corporate land managers, and other groups on local conservation plans; 9) reviewing existing laws, rules, and policies for wildlife conservation; and 10) communicating with stakeholder groups and the general public.

Four technical teams focused on biodiversity database development and use, ecosystem/habitat mapping, education, and outreach and communications, respectively. The database enhancements team reviewed current sources and uses of biological diversity data. This team developed specific recommendations for exchange and application of biodiversity information, including improved Web-based access to rare species/natural community information and methods for more efficient incorporation of field data on the status of species and natural communities. The ecosystem/habitat mapping team reviewed existing GIS datasets and mapping efforts in the state and region and developed recommendations for future mapping and assessment projects to support wildlife conservation. The environmental education team developed recommendations for improvements in wildlife-related education programs in Georgia. The outreach and communications team reviewed the findings of the education team and other technical teams and outlined methods for improving outreach to the general public as well as in-reach to members of the conservation community.

Six technical teams focused on the following groups of species: birds, amphibians and reptiles, mammals, fishes and aquatic invertebrates, terrestrial invertebrates, and plants. Although conservation efforts for plants could not be addressed under this grant, a parallel conservation planning process was undertaken, funded in part through a federal grant to the Wildlife Resources Division, with matching funds provided from the Nongame Wildlife Conservation Fund. These technical teams consulted numerous data sources and used a variety of criteria to revise the lists of high priority species for Georgia; this group of species includes critically imperiled species, habitat indicator species known to be in decline, species endemic to Georgia, and rare or uncommon species in need of further research to determine conservation objectives.

The habitat restoration technical team reviewed the efforts of DNR and other agencies and organizations involved in habitat management and restoration over the past decade. This team documented the progress made by these conservation partners and outlined goals for future habitat restoration management efforts. These recommendations included expansion of prescribed fire programs, management of invasive species, and restoration of natural communities on public and private lands. The monitoring technical team assessed needs for monitoring programs to support habitat and species conservation and developed recommendations for implementing or expanding monitoring programs and coordinating these programs among conservation organizations.

The climate change adaptation technical team reviewed current data sources and research efforts related to climate change impacts on species and habitats in Georgia and the Southeast. This group outlined key concepts to consider in undertaking conservation efforts for high priority species and habitats in a changing landscape and identified information needs and survey and monitoring efforts that can help inform these efforts in the years to come.

Results of the various biological and ecological assessments undertaken in this planning effort are presented in this document. Many of the details of these analyses can be found in the appendices that follow the main report. Ranges of distribution, habitat associations, conservation needs, and research priorities for high priority animals and plants are described in this report and in the appendices. Similarly, high priority habitats are defined for each ecoregion and management needs for these habitats are discussed.

In this document, conservation goals are defined broadly, while discussions of strategies and partnerships more specifically address the objectives that must be met to achieve these goals. Conservation goals, strategies and partnerships are identified for each of the five ecological regions of the state in Section IV of this report. In addition, statewide wildlife conservation themes and strategies are addressed in Section V. Lists of specific high priority conservation actions were also developed. These conservation actions were first identified by the technical teams, advisory committee, and other stakeholders and included specific programs for improvements in habitat protection, conservation of high priority habitats and species, research and surveys, and environmental education and public outreach. These identified conservation actions were then evaluated using a set of seven ranking criteria. The complete set of prioritized conservation actions can be found in the Conservation Actions table in Section VI of this report. Summaries of existing programs and resources for habitat protection and recommendations to increase capacity for wildlife conservation in Georgia are provided in Section V of this document. The following goals represent important conservation themes in this document:

- Maintain viable populations of all high-priority species and functional examples of all high priority habitats through voluntary land protection and incentive-based habitat management programs on private lands and habitat protection and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Facilitate restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic enhancements, and vegetation restoration.
- Conduct statewide assessments of rare natural communities and habitats that support species of conservation concern and complete a statewide habitat mapping effort to inform future land conservation efforts.
- Improve efforts to protect vulnerable and ecologically important habitats such as isolated wetlands, headwater streams, and caves.
- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance, and working cooperatively on early detection and rapid response protocols.
- Minimize impacts from development and other activities on high-priority species and habitats by improving environmental review procedures and facilitating training for and compliance with best management practices.
- Update the state protected species list and work with conservation partners to improve management of these species and their habitats.
- Conduct targeted field inventories of neglected taxonomic groups, including invertebrates and nonvascular plants.
- Continue efforts to recover federally listed species through implementation of recovery plans, and restore populations of other high priority species.
- Work with other states and with the U.S. Fish & Wildlife Service to assess species proposed for federal listing and engage in proactive programs to conserve these species so as to preclude the need for federal listing.

- Establish a consistent source of state funding for land protection to support wildlife conservation, and increase availability and use of federal funds for land acquisition and management.
- Continue efforts to monitor land use changes statewide and in each ecoregion, and use predictive models to assess impacts to high priority species and habitats.
- Monitor high priority species and habitats as well as the results of conservation actions and share monitoring results to inform adaptive management programs.

Monitoring needs for species, habitats, and conservation programs are addressed in Appendix J as well as in the Conservation Actions table in Section VI. Monitoring programs are acknowledged as critical components of adaptive management efforts in wildlife conservation, and specific recommendations are provided to improve existing monitoring programs. In addition, partnerships with other organizations involved in monitoring efforts are recommended. The approach taken in this planning effort was to identify the types of data to be collected and relevant performance indicators for every high priority conservation action as a first step to development of monitoring programs.

Several projects undertaken as components of this planning effort represent efforts to develop new analytical tools and methods that can inform future conservation plans at various geographic scales. The fishes and aquatic invertebrates technical team completed a GIS-informed analysis of priority watersheds based on mapped occurrences of high priority species. Highest priority watersheds were identified based on the potential contribution of conservation efforts to populations of rare or declining species. This approach will serve as a model for assessments of other priority conservation areas in the future. This technical team also conducted a statewide assessment of watershed condition based on land use, existing impacts, and other factors. This report can be found in Appendix F.

One of the results of discussions in the database enhancements team was the development of a new online mapping tool that provides information on the distribution of species of conservation concern in Georgia using a variety of alternative mapping units, including counties, watersheds, ecoregions, hexagons, and quarter-quads (1/4 of a 1:24000 topographic map). This online mapping tool is based on current information in the Biotics database managed by WRD and will be expanded and updated as new information is incorporated into the database. The mapping units are color-coded to indicate the range of dates of the occurrence data. The goal of this project is to depict the current known range areas of these high priority species as well as areas of historic occurrence where surveys may be needed to confirm their continued existence.

One of the goals articulated in the 2005 SWAP was the development of a new natural community classification system that will serve as a standard for habitat mapping on conservation lands. A three-year mapping effort focused on the 11-county coastal region of Georgia served as the pilot effort for this mapping approach. The new classification system is based on ecological systems and vegetation alliances described by NatureServe and the Natural Heritage Network. One of the highest priority goals identified in this SWAP revision is the expansion of this mapping approach statewide to provide a detailed map of ecological systems that will inform conservation efforts at a variety of scales. WRD staff also collaborated with a group of volunteers working on a detailed guide to Georgia's natural communities. This document, which was published by The University of Georgia Press in 2013 as "The Natural Communities of Georgia", was based on the NatureServe ecosystem classification and written for a broad audience including teachers, science students, and practicing biologists. We hope that this document will facilitate surveys of natural communities across the state and increase public awareness of Georgia's ecological and biological diversity.

This revised SWAP reflects an assessment of wildlife conservation needs and programs to address those needs based on data available in 2013-2015. Our understanding of the conservation needs of Georgia's species and habitats is likely to change based on the result of additional surveys, results of monitoring efforts associated with management efforts, or new trends in land uses. In addition, the development of new analytical techniques, funding programs, or legislative mandates may result in a need to reassess some of the conservation priorities described in this document.

The intent of the Wildlife Resources Division is to begin a formal process of reviewing the current wildlife conservation strategy within the next ten years and to adopt revisions to the strategy as deemed necessary based on this review. In order to do this, we propose to reconvene the technical teams and advisory committee and hold meetings to assess and address changing conservation needs for species and habitats in Georgia. The proposed procedure for this review is outlined in Section VII of this document.

The changes that are occurring in the Georgia landscape as a result of population growth and increasing development pressures present daunting challenges to those involved in wildlife conservation. The trend of increasing fragmentation and degradation of natural habitats is likely to continue in the coming decades, driven by local, national, and global economic and demographic factors. In addition, changing climatic conditions, emerging wildlife diseases, and introductions of invasive species will exacerbate problems affecting the viability of native species.

The following elements are critical for conservation of Georgia's natural heritage: (1) increased emphasis on field research focused on the identification and assessment of species, biotic communities, and ecosystems; (2) greater commitment of resources to identify and protect those habitats that contribute most significantly to biodiversity; (3) further development and funding of conservation programs that emphasize public-private partnerships for broad-scale conservation of "working landscapes"; (4) greater emphasis on land use planning to minimize impacts of future developments on natural habitats; and (5) increased collaboration between researchers and educators to heighten public awareness of the magnitude and significance of biodiversity decline in the state. The Department of Natural Resources will continue to work with a wide array of public agencies, private conservation organizations, research institutions, sportsmen's groups, educators, local governments, and landowners in the coming years to address these critical elements of wildlife conservation.

I. Introduction and Purpose

A Plan to Protect Georgia's Biological Diversity

This document represents the latest iteration of a conservation planning effort that began officially in December of 2002, but which builds upon many years of research and data accumulation by staff of the Georgia Department of Natural Resources (DNR) and other organizations. In 2000 the Wildlife Resources Division, Nongame Wildlife & Natural Heritage Section produced a document entitled "Georgia's Wildlife Diversity: An Overview". This unpublished technical report provided a summary of the biological diversity of the state and described some of the problems affecting this biological diversity within each physiographic province. It also gave examples of important habitats and landscape features, provided summaries of laws and regulations pertaining to wildlife in Georgia, and described some of the essential components of wildlife conservation (e.g., monitoring, habitat management, and land protection). Information from this report, as well as data from more recent analyses of wildlife diversity patterns and threats by DNR and other cooperating agencies and organizations, was later incorporated into "A Comprehensive Wildlife Conservation Strategy for Georgia", which is now known as Georgia's State Wildlife Action Plan (SWAP).

Funding for the current revision of Georgia's SWAP came from the State Wildlife Grants Program administered by the U.S. Fish & Wildlife Service; matching nonfederal funds came from the Nongame Wildlife Conservation Fund administered by the Wildlife Resources Division (WRD).

The goal of this effort was to develop an updated wildlife conservation strategy based upon the best currently available data on the distribution and abundance of wildlife species in the state, particularly rare and declining species. The strategy assesses the extent and condition of habitats required by these species, as well as existing and potential problems and conservation opportunities for these habitats. Further, this SWAP addresses research and survey needs, habitat restoration needs, and monitoring needs. It also includes an evaluation of existing programs for wildlife conservation in Georgia. Existing and potential partnerships are outlined, and priorities for implementing specific conservation actions are provided.

Coordination with other agencies and organizations that manage land or administer conservation programs in Georgia was a key component of this effort. The planning team included Georgia DNR staff as well as representatives of private and public research, education, and conservation organizations and land managing entities in Georgia. An advisory committee composed of representatives of various agencies, organizations, and land managing groups provided general oversight for the project. Technical teams were formed to address specific components of the conservation strategy; these teams included DNR staff as well as representatives of other agencies and organizations. Input from the advisory committee, technical teams, other stakeholders, and the general public was used in the development of the revised conservation strategy

The goal of the revised SWAP is to provide an informational and strategic framework that will support the conservation of Georgia's biological diversity over the next 5 to 10 years. While this revision builds on the work of previous planning efforts, it attempts to define a set of prioritized conservation strategies that may be applied locally and statewide to achieve the goal of maintaining Georgia's diversity of native species and natural habitats.

The purpose of this document is to outline objectives and partnerships for wildlife conservation in Georgia. It is a broadly focused strategy that indicates areas in which resources should be concentrated and emphasis placed to facilitate the conservation of Georgia's animals, plants, and natural communities. Where data are currently lacking to provide a clear picture of conservation objectives, research priorities to provide needed data are indicated. Where the data are sufficient to provide direction for species and habitat protection, restoration, or management, these recommendations are stated.

This document is not intended to be a conservation blueprint or statewide land use plan. It is not intended as an assessment or critique of land management practices by any segment of society. We acknowledge that nearly every activity by humans on the Georgia landscape has positive or negative impacts on wildlife populations and their habitats. The purpose of developing this strategy is to provide information that may help minimize negative impacts and maximize positive impacts in a changing landscape. Finally, the emphasis of this document is not on development of new regulations, but on more effective implementation of existing regulations and development of new cooperative relationships to protect and maintain habitats for native wildlife species.

Essential Elements of a State Wildlife Action Plan

In enacting the authorizing legislation for the State Wildlife Grants program, Congress provided guidance on the essential elements that comprise a Comprehensive Wildlife Conservation Strategy (State Wildlife Action Plan). These elements are as follows:

(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; and,

(2) Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1); and,

(3) Descriptions of problems which 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; and,

(4) Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions; and,

(5) Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions; and,

(6) Descriptions of procedures to review the strategy at intervals not to exceed ten years; and,

(7) Plans for coordinating 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; and

(8) Broad public participation in the development and implementation of the conservation strategy.

Species of Greatest Conservation Need

Congress further directed that the strategies must identify and be focused on "species in greatest need of conservation," yet address the "full array of wildlife" and wildlife-related issues. No definition of "species of greatest conservation need" was provided in the authorizing legislation; instead, the task of defining and identifying these species was left to each state wildlife agency working in collaboration with its conservation partners. The purpose of focusing on species of greatest conservation need is to ensure that those most imperiled species are adequately addressed in the conservation strategy.

The directive to emphasize species of greatest conservation need is not meant to imply that these species are of greater intrinsic value than other species. The ultimate goal of a SWAP is to protect and maintain the full complement of species native to a state or region. While many species of wildlife (particularly generalists, species adapted to a wide range of conditions and habitats) are able to maintain viable populations in spite of significant land use changes, other species (particularly those species adapted to a narrow range of habitat conditions) are becoming increasingly imperiled due to loss or degradation of natural habitats, direct mortality from human activities, and other factors. It is intuitively logical that in developing a set of conservation strategies to maintain the whole of Georgia's natural heritage, one should prioritize conservation actions based upon an objective assessment of need.

Species that are globally imperiled and clearly threatened with extinction are an obvious choice for conservation action. However, there are many other species that are experiencing significant population declines in Georgia. The directive to address the "full array of wildlife" requires that the agency consider these species as well, to ensure that the conservation strategy meets the dual objectives of "keeping common species common" as well as preventing or minimizing further extirpations or extinctions of the state's most imperiled species.

The approach taken in this planning effort has been to define species of greatest conservation need based on a number of factors, including global and state rarity rankings, population and habitat trends, range of occurrence, number of protected populations, and importance of Georgia efforts to the global conservation of the species. Some species that are not globally imperiled but are considered indicators of habitat quality over a large area or region were included as well. Finally, rare or uncommon species for which additional research is needed in order to develop specific conservation strategies were included, since one of the required elements of the planning process is identification of high-priority research and survey needs. The term used in this document for this more inclusive group is "high priority species". A discussion of the procedures used in selecting these species can be found in the "Approach and Methods" section.

Scales of Biological Diversity

In general terms, diversity means variety or heterogeneity within some defined group or area. Biological diversity can be expressed at several scales of concern, from subcellular to global. For example, genetic diversity refers to the variety of genes or genotypes within a species, population, or subpopulation. This diversity is often measured or indicated by laboratory research methods such as electrophoresis. Individual populations within a species may exhibit high or low levels of genetic diversity. The amount of genetic diversity within a population is a reflection of various biological and physical environmental factors operating over time on the genetic resources of that population (e.g., spontaneous mutations, interbreeding, isolation, habitat variability). The level of genetic diversity within a population is often reflected in variability in form or function (e.g., body structure, metabolism, blood type, leaf shape, hair color or disease resistance) and may have important implications for the capability of that population to sustain itself through time.

Another type of biological diversity is expressed in terms of the number of species in a given habitat. This has been referred to as "alpha diversity" by some researchers. The simplest type of alpha diversity is known as "species richness", and is based on presence/absence data. Species richness is simply the number of species observed within a given habitat. Other measures of within-habitat diversity are based on formulae that take into account the relative abundance of different species within the habitat. These diversity indices require counts of individuals within species, and are often used for purposes of comparison across habitat types within certain taxonomic groups.

A great deal of ecological research has been devoted to investigation of the patterns of species richness, and development of theories to explain why some habitats support great numbers of species, while other support relatively few. Some of the factors that are important in determining alpha diversity include successional stage of the habitat, structural complexity in the habitat, climatic stability, nutrient availability, degree of isolation from other similar habitats, variability of natural disturbance patterns, competition, predation and parasitism. As with most things in nature, it is difficult to detect the relative importance of these various factors for a given habitat.

A third type of diversity, known as "beta diversity", refers to the amount of biological diversity across habitats within a given region or landscape. Beta diversity is a reflection of the variety of habitats within the landscape, which in turn is indicative of the heterogeneity of topography, soils, climate, geology, disturbance patterns, etc. in the region. Regions with more complex environmental gradients typically have greater beta diversity, even though the alpha diversity values for each habitat may be relatively low.

In this document, we are mostly concerned with beta diversity, that is, the diversity of wildlife species across the entire Georgia landscape. However, reference is made at various points to habitats that are particularly rich in species ("alpha diversity"). It is important to keep in mind that the diversity of life forms represented in a particular habitat depends on many factors. Nevertheless, conservation planners agree that the best approach to maintaining biological diversity over a broad region is maintenance of the full suite of natural communities on which native species depend.

Wildlife Diversity Databases

Our knowledge of species diversity patterns in Georgia and elsewhere is based on a long history of field studies and taxonomic research. Occurrence data for species are derived from a variety of sources, including natural history museums, herbaria, published scientific literature, and reports prepared by field researchers. In each state, natural heritage programs compile and analyze data on species and natural communities to develop a picture of biological diversity. An international network of natural heritage programs known as NatureServe provides a standardized data framework for assessing the global distribution of these species and natural communities.

The Nongame Conservation Section (NCS) of WRD develops and maintains information on animal and plant species and the natural communities they comprise within the state of Georgia. The NCS staff maintains manual and digital files on approximately 750 plant species and 500 animal species, including 318 state-protected species. The section's databases currently include over 11,500 documented occurrences of rare species and significant natural communities in Georgia. The NCS staff also maintains digital landcover databases as well as a GIS database of conservation lands.

Database management programs developed and maintained by NatureServe are used within WRD and throughout the United States by natural heritage programs to manage diversity data and to generate detailed, site-specific information. Significant natural communities and plant and animal species of special concern are termed "elements of biodiversity", and one of the central data features of WRD biodiversity databases is the element occurrence record. These records contain information on occurrences of rare species or natural communities at particular sites, including location, size, and condition of the population or community and date of observation.

Rarity ranks are used to characterize elements and to facilitate conservation planning. These ranks are assigned after reviewing pertinent status information at the state level and globally. Rarity ranks are based on a scale of 1 to 5; the higher the number, the more secure that species is thought to be at the state (or global) level. Therefore, an S1 species is considered very rare or imperiled in the state, while an S5 species is considered common and secure. A species with a rarity rank of G5 S1 is globally secure but occurs in very small numbers in the state. Thus it is not of global conservation concern, but may be considered a priority for conservation within the state, depending on other factors. This ranking system helps to assure that conservation efforts are directed to those species needing the most help in order to maintain biological diversity in a state or region. More detailed information on global rarity ranks and state rarity ranks can be found at the following website: http://www.natureserve.org/explorer/ranking.htm.

II. Approach and Methods

The guidelines for development and revision of the SWAP stipulate that state wildlife agency will conduct a comprehensive review and revision of the plan at least once within a ten-year period. Thus, while the current strategy is based upon the best available information and analyses, we recognize that it is part of an iterative process that allows adaptation to changing conditions and newly identified conservation needs. The general approach taken in this planning effort was to emphasize activities that would help build an infrastructure to ensure more efficient and effective conservation planning in the future. Emphasis was placed on updating and expanding the biodiversity databases and conservation lands databases maintained by WRD and taking advantage of existing information networks, monitoring programs, and land conservation programs wherever possible. The objective was to build capacity for consistency in conservation efforts and to take advantage of methodologies that would facilitate development of broader-scale (e.g., regional or national) wildlife conservation strategies. Information from assessments completed by DNR, The Nature Conservancy, Partners in Flight, Partners in Amphibian and Reptile Conservation, and other organizations was utilized in the current SWAP revision effort, and an effort was made to share information on approaches and products with neighboring states in the Southeast.

At the same time, some novel analytical approaches and methods were utilized to explore new ways of identifying and addressing conservation priorities for species and habitats in Georgia. Examples include the development of new interactive online maps depicting historic and recent occurrences of species of conservation concern using a variety of mapping units; a GIS-informed statewide prioritization of HUC 10 watersheds based on occurrences of high priority aquatic species and associated assessments of watershed condition and threats; and a draft "Georgia Greenway Opportunities" map based on multiple data layers, including public and private conservation lands, natural and semi-natural vegetation, models of landscape diversity and connectivity, and species-based habitat connectivity models.

Organizational Structure

The primary responsibility for revising the State Wildlife Action Plan was assigned to the Nongame Conservation Section of WRD. Early in the process a SWAP Revision Advisory Committee was established. The purpose of this committee was to provide general guidance and direction for the revision of the conservation strategy. An attempt was made to include representatives from all major conservation agencies and organizations operating within the state, as well as many of the major land-managing entities. The advisory committee met periodically throughout the course of the revision effort and provided feedback to the project staff on the objectives, methods, and products of the planning effort.

Representation on the committee changed during the course of the planning effort due to staff changes in the participating organizations and identification of additional organizations that could facilitate the planning process. Individuals serving as members of the Steering Committee and other participants in Steering Committee meetings are listed below:

State Wildlife Action Plan Revision Advisory Committee

Joanne Baggs, USDA Forest Service, Chattahoochee-Oconee National Forest
Leah Barnett, Georgia Conservancy
Carolyn Belcher, DNR, Coastal Resources Division
Liz Caldwell, USDA Forest Service, Chattahoochee-Oconee National Forest
Fuller Callaway, Georgia Environmental Finance Authority
Jim Candler, Georgia Power Company
Dr. Ron Carroll, University of Georgia, Odum School of Ecology (retired)
Becky Champion, Georgia DNR, Environmental Protection Division
Kyla Cheynet, Plum Creek Timber Company
Deron Davis, The Nature Conservancy
Shaw Davis, USFWS, Savannah National Wildlife Refuge
Sim Davidson, Georgia DNR, Parks, Recreation, and Historic Sites Division
Glenn Dowling, Georgia River Network
Carrie Fowler, Georgia State Soil & Water Conservation Commission
Laurie Fowler, University of Georgia, River Basin Center
Susan Gibson, US Department of Defense
Dr. Robin Goodloe, USFWS, Ecological Services
Jane Griess, USFWS, Savannah Coastal Refuges Complex
Deborah Harris, USFWS, Ecological Services
Wade Harrison, The Nature Conservancy
David Hedeen, Georgia Department of Transportation
Dr. Don Imm, USFWS, Ecological Services
Betty Jewett, USDA Forest Service, Chattahoochee-Oconee National Forest
Carolyn Johnson, USFWS, Piedmont National Wildlife Refuge
Mike Joyce, USDA Forest Service, Chattahoochee-Oconee National Forest
Jan MacKinnon, Georgia DNR, Coastal Resources Division
Steve McWilliams, Georgia Forestry Association
Hans Neuhauser, Georgia Land Conservation Center
Brian Nichols, Georgia DNR, Parks, Recreation, and Historic Sites Division
Tim Pinion, National Park Service, Southeast Region
Tom Putnam, Langdale Industries
Gina Rogers, Georgia Wildlife Federation
Brandon Rutledge, Joseph W. Jones Ecological Research Center
Jenny Cruse-Sanders, Atlanta Botanical Garden
Andrew Schock, Conservation Fund
Curt Soper, Trust for Public Land
Gary White, Georgia Forestry Commission
Marshall Williams, US Department of Defense

Others attending the advisory committee meetings:

John Bowers, Georgia DNR, Wildlife Resources Division
John Doresky, USFWS, Ecological Services
Brent Dykes, Georgia Soil and Water Conservation Commission
Sara Gottlieb, The Nature Conservancy
Patti Lanford, Georgia DNR, Wildlife Resources Division
Chris Manganiello, Georgia River Network
Jared Teutsch, The Nature Conservancy

Technical teams were formed to address various components of the plan. These technical teams were chaired by WRD staff members and included representation from a wide variety of organizations and agencies. These teams and their leaders are listed below:

State Wildlife Action Plan Revision Technical Team Leaders

Birds: Todd Schneider, Tim Keyes
Mammals: Jim Ozier, Trina Morris
Fishes and Aquatic Invertebrates: Brett Albanese, Jason Wisniewski, Andrew Gascho Landis
Aquatic Habitat: Brett Albanese
Reptiles and Amphibians: John Jensen
Plants: Tom Patrick, Mincy Moffett
Terrestrial Invertebrates: Matt Elliott
Ecological Systems/Habitat Mapping: Jason Lee, Chris Canalos
Habitat Restoration: Shan Cammack, Eamonn Leonard
Monitoring: Lisa Kruse, Jacob Thompson
Database Support and Enhancements: Greg Krakow, Anna Yellin
Outreach and Communications: Rick Lavender
Education: Linda May
Climate Change Adaptation: Jon Ambrose, Mary Pfaffko

Complete lists of technical team members can be found in appendices B through O and in the Acknowledgements section.

Public Involvement

Throughout the planning period the current SWAP was available for review, and the public was notified of the timeline for revision of the document. Questions about the current SWAP and the revision process were answered by email and telephone. The public review draft of the SWAP was posted on the WRD website on June 1, 2015 and was accompanied by news releases. Announcements about the availability of the SWAP were included in the WRD e-newsletter and in other agency publications. In addition, other conservation organizations such as the Georgia Land Conservation Center and Georgia Forestry Association posted notices or articles about the draft SWAP document. Public meetings were held to solicit public input on the draft plan.

The public review period for the draft SWAP was June 1, 2015 through July 15, 2015. All verbal and written comments were recorded and reviewed, and this public input was used to develop the final draft of the SWAP.

Other Presentations and Meetings

During the course of the planning period five meetings of the advisory committee were held. In addition, presentations were given at meetings of public agencies, private conservation groups, civic groups, and academic institutions. Examples include the Georgia Wildlife Federation, Forestry for Wildlife Partnership, University of Georgia River Basin Center. These presentations focused on the goals and objectives of the SWAP revision process and the conservation programs implemented under the original SWAP. In addition, presentations on the SWAP revision were provided to the Georgia DNR Board.

Coordination with Other Agencies and Organizations

Development of the conservation strategy was accomplished through coordination with a variety of public wildlife agencies, private conservation organizations, and corporate land managers operating in Georgia. This coordination was ensured by inclusion of representatives of these agencies and organizations on the advisory committee and technical teams. Below is a list of agencies and organizations that provided input in the revision of the plan. A complete list can be found in the Acknowledgements section.

Federal agencies:
National Park Service
Natural Resources Conservation Service
Tennessee Valley Authority
U.S. Department of Defense
U.S. Geological Survey
U.S. Fish & Wildlife Service
U.S. Forest Service
U.S. Geological Survey

State agencies:
Coastal Resources Division, Georgia DNR
Environmental Protection Division, Georgia DNR
Florida Fish and Wildlife Commission
Georgia Department of Transportation
Georgia Environmental Finance Authority
Georgia Forestry Commission
Georgia Soil & Water Conservation Commission
Law Enforcement Division, Georgia DNR
Parks, Recreation, and Historic Resources Division, Georgia DNR
Wildlife Resources Division, Georgia DNR

Private conservation organizations:
Altamaha Riverkeeper
Animals A-Z
Atlanta Audubon Society
Association of Fish & Wildlife Agencies
Captain Planet Foundation
Conservation Fund
Defenders of Wildlife
Georgia Botanical Society
Georgia Conservancy
Georgia Forestry Association
Georgia Land Conservation Center
Georgia Native Plant Society
Georgia Ornithological Society
Georgia Plant Conservation Alliance
Georgia River Network
Georgia Wildlife Federation
Habitat for Bats
Land Trust for the Little Tennessee
Little St. Simons Island
National Wildlife Federation
NatureServe
North American Land Trust
St. Catherines Island Foundation
The Nature Conservancy

Corporate landowners:
Georgia Power Company
International Paper
Langdale Industries
Plum Creek Timber Company

Environmental consultants:
CCR Environmental
Conservation Fisheries, Inc.
Dinkins Biological Consulting
Eco-Tech Consultants
Ecological Solutions, Inc.
Golder Associates, Inc.

Academic / research institutions:
Abraham Baldwin Agricultural College
Alabama Aquatic Biodiversity Center
Alabama Natural Heritage Program
Appalachian State University
Atlanta Botanical Garden

Auburn University
Avian Research and Conservation Institute
Berry College
Clayton State University
Clemson University
Columbus State University
Cumberland Island Museum
Dalton State College
Florida State University
Georgia College and State University
Georgia Highlands College
Georgia Sea Turtle Center
Columbus State University
Georgia College & State University
Georgia Southern University
Georgia Southwestern University
Georgia State University
Gordon State College
Joseph W. Jones Ecological Research Center
Kennesaw State University
LaGrange College
Lanier Museum of Natural History
Mississippi State University
New York Botanical Garden
North Alabama University
North Georgia College
North Carolina Natural Heritage Program
Piedmont College
Reinhardt College
Roanoke College
Savannah-Ogeechee Canal Museum
Savannah State University
Skidaway Institute of Oceanography
South Georgia College
State Botanical Garden of Georgia
Tall Timbers Research Station
The University of Georgia
Tennessee Aquarium Research Institute
Tennessee Natural Heritage Program
Tennessee Technological University
University of California at Los Angeles
University of Florida
Valdosta State University
Virginia Tech University
Young Harris College
Zoo Atlanta

In addition, WRD staff interacted with representatives of wildlife agencies and conservation organizations from other states through regional and national meetings. These included annual meetings of the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) and the Association of Fish and Wildlife Agencies (AFWA), annual meetings of the Wildlife Diversity Program Managers working group coordinated by AFWA, and national meetings of SWAP coordinators. In addition, staff participated in numerous webinars organized by AFWA focused on revision and implementation of SWAPs and assisted with the development of "Best Management Practices for State Wildlife Action Plans: Voluntary Guidance to States for Revision and Implementation" (AFWA, 2012).

At these meetings, SWAP coordinators shared information on designation of high priority species and habitats, identification of problems affecting wildlife, opportunities for collaboration with other agencies and organizations, and techniques for encouraging public involvement. Within the SEAFWA Wildlife Action Plans committee meetings, efforts were made to share information and approaches with other southeastern states to promote greater consistency in the plans of adjacent states. These efforts have been only partially successful to date due to varying administrative responsibilities, interagency relationships, and planning mechanisms of different state wildlife agencies as well as time constraints on the planning and revision process. However, representatives of the southeastern state wildlife agencies are continuing discussions in this area with a goal of achieving greater consistency across state boundaries, allowing for development of regional conservation strategies for high priority species and habitats. In addition, the recent establishment of Landscape Conservation Cooperatives by the U.S. Fish and Wildlife Service provides a foundational framework for interagency cooperation in landscape-scale conservation. Three Landscape Conservation Cooperatives intersect Georgia's boundaries: The South Atlantic, the Appalachian, and the Gulf Coastal Plain and Ozarks.

Because Georgia has no federally recognized Indian tribes or tribal lands, there was no opportunity for coordination with federally recognized tribal governments. The State of Georgia officially recognizes three tribes (the Georgia Tribe of Eastern Cherokee, the Lower Muscogee Creek Tribe, and the Cherokee of Georgia), but these tribes do not manage significant areas of land or water within the state.

Coordination with Other Planning Efforts in Georgia

State Planning Efforts

The SWAP revision effort was initiated shortly before an internal WRD planning effort, namely the update of the Wildlife Resources Division Strategic Plan. In addition, WRD staff had previously been involved in the development of the State Forest Action Plan coordinated by the Georgia Forestry Commission. In 2012, the Open Space Institute initiated a study to identify areas in which state wildlife and forestry agencies could expand collaborative efforts on common conservation goals. Staff of WRD and the

Georgia Forestry Commission staff identified three areas in which further collaboration would be mutually beneficial: Implementation of prescribe fire programs, control of invasive species, and restoration of longleaf pine forests and savannas. In 2007 through 2009, WRD staff coordinated the development of the Georgia Invasive Species Strategy with assistance from 30+ state and federal agencies and private conservation and education organizations, and in 2009 joined with the Georgia Forestry Commission, Georgia Department of Agriculture, and University of Georgia to formally establish the Georgia Invasive Species Task Force. More recently, WRD and other organizations collaborated in the development of a Cooperative Invasive Species Management Area in the coastal region of Georgia and in the expansion of the Interagency Burn Team. All of these efforts provided opportunities to share information and improve coordination of agency functions that contribute to wildlife conservation efforts in Georgia.

Federal Agency Planning Efforts

The SWAP revision effort provided opportunities to share information and ideas with individuals involved in various conservation efforts at the federal level. These included U.S. Forest Service staff in the Chattahoochee-Oconee National Forests; staff of the National Park Service involved in development of NPS site management and monitoring plans and biodiversity databases; staff of the U.S. Fish & Wildlife Service involved in revision of management plans for the Savannah Coastal Complex, Okefenokee/Banks Lake, Piedmont, and Bond Swamp National Wildlife Refuges; U.S. Fish & Wildlife Service staff involved in listed species recovery efforts, assessments of species petitioned for federal listing, and environmental project reviews; and Department of Defense staff involved in management of lands at Ft. Stewart, Ft. Gordon, Ft. Benning, Robins Air Force Base, Moody Air Force Base, Albany Marine Corps Logistics Base, and Kings Bay Naval Base as well as efforts to protect buffer lands adjacent to these bases. In addition, information from studies funded by the U.S. Geological Survey and the U.S. Environmental Protection Agency was consulted in the revision of the SWAP.

Other Planning Efforts

Before and during the course of the SWAP revision WRD staff met periodically to discuss ways to more effectively incorporate conservation objectives for rare species and significant natural communities into management plans for Division-managed lands. Annual work plans were developed for Wildlife Management Areas and Natural Areas. WRD biologists also provided technical assistance to the Parks, Recreation, and Historic Sites Division to facilitate development of habitat restoration and management plans for state parks. These efforts continued throughout the course of the project period.

Identification of Priorities, Problems and Actions

High Priority Species

Six of the technical teams were focused on taxonomic groups – birds, amphibians and reptiles, mammals, fishes and aquatic invertebrates, terrestrial invertebrates, and plants.

Although conservation efforts for plants could not be addressed under the State Wildlife Grant, a parallel conservation planning process was undertaken. This effort was funded in part through a federal Cooperative Endangered Species grant to the Wildlife Resources Division, with matching funds provided from the Nongame Wildlife Conservation Fund.

Members of the species technical teams are listed in the individual technical team reports in the appendices and in the Acknowledgements. Over 250 individuals were contacted and invited to participate on the technical teams. The majority of these individuals accepted the invitation and provided assistance and expertise.

The species technical teams were provided lists of uncommon or rare species from databases maintained by the Nongame Conservation Section of WRD ("Special Concern Species"). All animals and plants designated as High Priority Species in the 2005 SWAP were included on the initial species lists. The "Special Concern Species" list includes species currently protected by state or federal law as well as those species considered imperiled at the state or global level with no formal protection under state or federal law. In recognition of the fact that many species in the lesser-known taxonomic groups have not received adequate attention, other globally imperiled (G1 and G2) species of terrestrial invertebrates, aquatic invertebrates, and nonvascular plants were added to the list. The technical teams evaluated these and other species to revise the lists of High Priority Species. Factors considered in these assessments included global and state rarity, range in Georgia, endemism, threats, population trends, and importance of Georgia efforts to conservation of the species. These technical teams also identified research, management, and monitoring needs for these species of conservation need.

In order to make this assessment an exercise that would improve the quality of the WRD biodiversity databases, an effort was made to use existing criteria found within the Biotics database management system used by the Nongame Conservation Section. Fields and field descriptions were exported from this database, and some additional criteria were added to augment the assessment. These were populated as spreadsheets and relational databases. Guidance was provided to the technical teams as to the important criteria for selecting high priority species, but the decision to include or exclude species was up to each team. The technical teams also developed recommendations for revisions to the list of state-protected species.

Population sizes and recovery objectives for all Georgia species protected under the federal Endangered Species Act were considered in the assessments. In addition, the technical teams included federal Candidate species and species that have been petitioned for listing as Endangered or Threatened under the Act. However, these species were not automatically afforded higher priority in the planning process due to their status as federally listed, candidate, or petitioned species. Instead, the emphasis of this process was on selection of highest priority taxa based on the factors listed above. The technical teams also developed specific recommendations for changes to state and global rarity ranks and state protected status as part of this assessment process. Further review and assessments will be undertaken for all species for which changes in state protected status have been recommended.

A revised list of 349 high-priority animal plant species and 292 high-priority plant species was developed as a result of this process. The current animal list includes 40 birds, 25 mammals, 17 amphibians, 18 reptiles, 78 fishes, 57 mollusks (freshwater mussels and gastropods), 24 crayfishes, 7 aquatic insects or other invertebrates, and 83 terrestrial invertebrates (see Table 1). Each list was reviewed by the technical teams and by other experts and formed the core group of species upon which components of the revised conservation strategy were based. The complete lists of high priority animals and plants are found in Appendix A. High priority species identified for each ecoregion are listed in Section IV (Conservation Landscape Assessments and Conservation Strategies), along with descriptions of their range and habitat in Georgia.

Table 1. Number of High Priority Species in 2005 and 2015 SWAP

High Priority Species	**2005**	**2015**
Birds	33	40
Mammals	23	25
Reptiles	22	18
Amphibians	22	17
Fishes	74	78
Mollusks	75	57
Aquatic Arthropods	47	31
Terrestrial Arthropods	0	83
Plants	323	292
Total	619	641

Marine Species Not Addressed in This Strategy

Several marine species and species groups occurring in Georgia waters are covered by federal or multi-state agency conservation plans. The following list includes the administrative organization and the Georgia species that are covered under these plans:

Atlantic States Marine Fisheries Commission (effective in Georgia's territorial waters)

- American Eel
- Atlantic Croaker
- Atlantic Menhaden
- Atlantic Sturgeon
- Bluefish
- Horseshoe Crab
- Red Drum
- Shad and River Herring

Spanish Mackerel
Spiny Dogfish and Coastal Sharks
Spot
Spotted Seatrout
Weakfish

Management plans for these species can be found at http://www.asmfc.org/

South Atlantic Fishery Management Council (effective in Exclusive Economic Zone)

Calico Scallop
Coral
Coastal Migratory Pelagics (king and Spanish mackerel, cobia)
Dolphin-Wahoo
Golden Crab
Sargassum
Shrimp (penaeid and rock)
Snapper-Grouper
Spiny Lobster

Management plans for these species can be found at http://www.safmc.net/library/

United States Secretary of Commerce (effective in Exclusive Economic Zone)

Atlantic tunas
Billfish
Sharks

Management plans for these species can be found at http://www.nmfs.noaa.gov/sfa/hms/

Specific conservation priorities for these species are not addressed in this strategy, since their needs are addressed in plans developed under the direction and auspices of the aforementioned organizations. Ongoing efforts by DNR to conserve shad and red drum constitute conservation priorities that are not specifically addressed in this document. The Coastal Resources Division of Georgia DNR is the primary state agency responsible for management of marine fisheries and shellfish populations.

High Priority Habitats

In this planning effort, habitats were addressed using two separate approaches. The brief habitat descriptions developed by the species technical teams were used to develop lists of high priority habitats for each ecoregion. These habitat types generally have non-technical names and correspond to habitats or groups of similar natural communities. In some cases, these high-priority habitats represent groups of small-patch habitats or edaphically controlled communities that are not easily mapped. The high priority habitat types identified for each ecological region are listed in Section IV of this report.

The land cover types used for the Georgia Gap Analysis Program (GAP) represent a statewide GIS land cover dataset derived primarily from 1998 satellite imagery with augmentation from aerial photographs and other sources. This 44-class dataset has great value for broad-scale mapping and assessment of vegetation types and land use changes, but cannot be used to address the quantity or condition of most small-patch habitats. The GAP land cover types do not adequately address the variety of Georgia's aquatic systems, but do work well for mapping and assessment many of the large-patch terrestrial habitats. Similarly, the NLCD dataset is current as of 2011, but includes only 15 land cover classes in Georgia. We used the 2006 and 2011 NLCD datasets to update general patterns of land use change in Georgia.

One of the long-term goals related to this wildlife conservation strategy is revision of the natural community classification system used by WRD and its conservation partners. During the course of this planning and revision effort WRD staff worked with other individuals involved in development of a new natural community classification system based on the ecological systems classification system used by NatureServe and the international network of natural heritage programs. This effort led to the publication of "The Natural Communities of Georgia" by the University of Georgia Press in 2013. In coming years the classification will be field tested to assess its utility for habitat mapping at a local level. It is hoped that this revised natural community system will become the standard for habitat mapping on state lands as well as the basis for education and outreach activities relating to natural habitats in Georgia. A document linking the natural community types identified in "The Natural Communities of Georgia" with the high priority habitat types used in this document can be found online at: http://georgiawildlife.com/sites/default/files/uploads/wildlife/nongame/pdf/natural_communities_thumbnail_accounts.pdf

The emphasis of this wildlife conservation strategy is on protection, restoration, and maintenance of natural habitats. We acknowledge that data on abundance and condition of these natural habitats are not sufficient to assign quantitative scores or values for most habitat types. In addition, the correspondence of these habitats to mapped units derived from satellite imagery is often problematic, as is a strict correlation of high priority species with a particular habitat type (this is especially true for those species that have received little attention from field researchers to date). However, we can state generally that conserving viable examples of all representative natural habitats in a given ecoregion will provide the greatest benefits for the widest variety of native species. The approach taken in this planning effort was to describe the general location and condition of high priority habitats, with the recognition that much more field inventory and mapping work must be done in the coming years in order to provide a more accurate picture of the specific status of most of these habitats in a given ecoregion. Increased emphasis on statewide assessments of rare or declining natural communities is one of the highest priority conservation actions identified in this strategy.

While this strategy emphasizes conservation of natural habitats, we recognize that many habitats that are heavily influenced by human activities (e.g., agricultural fields, pine plantations, suburban forests) provide benefits for native wildlife, including some high priority species. These habitats may provide nesting sites, foraging areas, or migration corridors for wide ranging species. In addition, they often provide a landscape context or matrix that is compatible with protection of embedded natural habitats, especially if care is taken to limit impacts from human activities on these natural habitats. There are many opportunities to provide benefits to native species and natural habitats by modifying management of these human-altered systems. For example, minor modifications of field border management practices can provide significant benefits for birds that require early successional habitat. These issues are discussed in more detail in Section V.

As noted above, one of the goals articulated in the 2005 SWAP was the development of a new natural community classification system that will serve as a standard for habitat mapping on public lands. Since the completion of the original SWAP, the WRD staff has been using the NatureServe classification system to map habitats on state-owned natural areas. A three-year mapping effort focused on the 11-county coastal region of Georgia served as the pilot effort for implementation of this mapping approach at a larger scale. One of the highest priority goals identified in this SWAP revision is the expansion of this mapping approach statewide to provide a detailed map of ecological systems that will inform conservation efforts at a variety of scales. This project will involve a significant investment of staff, funds, and other resources, but will result in an unprecedented level of understanding of Georgia's ecosystems and natural habitats.

Problems Affecting Species and Habitats

One of the tasks of the technical teams was to identify problems affecting high priority species and their habitats. There are several different approaches noted in the literature, but most rely on identification of "stresses" and/or "sources of stress" in the environment (Salafsky et al., 2003). For example, a stress might be excess sediment in streams that chokes out mussel beds and interferes with fish reproduction. The source of this stress might be any number of activities, including road construction or maintenance, residential development, lack of stream buffers adjacent to agricultural fields, or any other type of land disturbing activity that is accompanied by inadequate sediment control.

It is important to note that these problems may be historic, current, or potential. For example, conversion of natural forest stands to traditional agricultural uses in Georgia represents an impact that is mostly historic. Little conversion to agricultural uses is occurring today, and in fact many agricultural lands have been converted to forestry or residential uses in recent decades. However, it is important to mention that wildlife populations have been impacted by these past land uses in the context of a long-range conservation plan that considers potential for recovery of these species. Similarly, the impacts of past land practices on soils and vegetation greatly influence our consideration of the potential restoration of natural communities.

The plan must also take into account predicted patterns of land use changes in Georgia. Most people recognize that the primary long-term threat to wildlife populations in Georgia and elsewhere is loss of habitat due to development pressures. This development pressure is fueled by a tremendous increase in the state's human population.

In order to assess the historic, current, and potential impacts of various sources of stress on high priority species and habitats, a list of 25 general problem categories was developed. This list was derived from several different assessment approaches found in the scientific literature. The technical teams were asked to assign each high priority species to one or more of these general problem categories, which in turn correspond to sources of stress. For some of the high priority species, especially those that represent priorities for future research, no problem category could be assigned. The 25 general problem categories used in this assessment are listed below.

1. Acidified Rainfall and Other Atmospheric Pollution
Includes acid deposition from the atmosphere (both wet and dry) and other air-borne pollutants or nutrients. Acidified rainfall generally has a pH lower than 5.5. It is typically, but not exclusively, related to aerosols, volatile compounds, and semi-liquid pollutants. Impacts include acidifying aquatic systems, impairing plants' ability to evaporate water and exchange gases, and nutrient leaching and toxic accumulation in soil.

2. Altered Fire Regimes
Includes fire exclusion, fire suppression, alteration of habitats through unnatural timing, frequency, or intensity of prescribed burns, and other incompatible fire management practices. Fire regimes are affected by altered community composition (e.g., increase of non-pyric species such as oak) and habitat fragmentation. Fire is an important ecological process that drives many of the terrestrial habitats in Georgia.

3. Altered Hydrology
Includes construction and use of ditches, levees, dikes, and drainage tiles, flow diversion, dredging, channelization, filling of wetlands and headwater streams, destabilization of stream banks or channels, head-cutting, and other alterations to stream morphology or hydrologic regimes. Results in degradation or destruction of aquatic and wetland habitats.

4. Altered Water Quality
Includes various forms of point and non-point source pollution, such as herbicides, pesticides, sediments, nutrient loading, and thermal modifications that directly impact water quality. Sources are quite varied and include wastewater discharges, excessive soil disturbance near streams, increased impermeable surface area resulting from development, and loss of vegetation in riparian buffers.

5. Commercial/Industrial Development
Includes development of structures and infrastructure (buildings, utilities, driveways and roads) for commercial or industrial purposes, usually in an urban setting. Impacts may include direct habitat destruction, fragmentation, altered thermal regimes, and indirect pollution sources that alter water quality.

6. Conversion to Agriculture or Silviculture
Includes the conversion of natural habitats to anthropogenic habitats managed for agricultural crops, pasture, horticulture, or monospecies silviculture. Usually involves removal of native vegetation, site preparation, and planting of off-site or nonnative species. Results in habitat destruction or fragmentation and may impact water quality.

7. Dam and Impoundment Construction
Includes the construction of dams and impoundments (from agricultural ponds to large reservoirs) that directly affect stream flows and fragment aquatic habitat. Results in impacts to the impounded portion of the stream as well as habitats above and below the dam.

8. Development of Roads or Utilities
Includes construction of new roads (interstate highways, state highways, and county roads) and utility right-of-ways (e.g., electrical transmission lines, water/sewer, gas pipelines) that result in habitat destruction or fragmentation and creation of new avenues for invasion by exotic species.

9. Disease
Includes fatal or debilitating disorders resulting from infections, poisons, pathogenic microorganisms, or parasites. The most serious impacts generally result from introduced vectors or pathogens (e.g., sudden oak death, white nose syndrome, hemlock wooly adelgid, chestnut blight). Impacts can be devastating to the species directly attacked as well as natural communities.

10. Excessive Groundwater and Surface Water Withdrawal
Includes direct groundwater and surface water withdrawals for agricultural, industrial, and municipal water supplies. Excessive withdrawal can result in lowered water tables, diminished local aquifer discharges, and reductions in water available to sustain stream base flows, spring discharges, isolated wetlands, karst environments, and seepage communities.

11. Excessive Herbivory
Involves high, generally unsustainable rates of herbivory that intensively affect species or entire natural communities. Usually attributed to the impacts of herbivorous species that are either non-native or native but have been released from typical natural population limiters (e.g., white-tailed deer in areas of limited hunting).

12. Excessive Predation
Includes impacts to animal populations caused by predators that extensively and intensively impact the demographics of either a select species or entire species assemblages. These predators may either be non-native species or native species that are released from typical natural population limiters.

13. Global Warming/Climate Change
Defined as consistent, directed change in climatic conditions at regional scales. Such changes may include increases or decreases in average temperatures, changes in the distribution, frequency, or timing of precipitation, changes in the frequency and intensity of storm events, and changes in sea levels.

14. Illegal Dumping
Includes all forms of illegal dumping of by-products, ranging from household trash to light industrial waste, to chemical toxins, as well as the impacts resulting from the movement of these wastes from the original site of dumping. Effects on high-priority habitats may range from minor to serious (e.g. dumping in an ephemeral pool on a granite outcrop).

15. Incompatible Agricultural Practices
Includes agricultural practices that impact the environment well outside the actual agricultural operation through releases of excess nutrients, toxins, or sediments. Includes practices that degrade stream or wetland habitat quality.

16. Incompatible Fisheries Practices
Includes harvest or management of fish or shellfish by methods that are destructive to native species or aquatic habitats. Includes forms of harvest that result in heavy rates of by-catch, losses of reproductively critical age classes, or increased mortality of imperiled species.

17. Incompatible Forestry Practices
Involves poor forestry BMP implementation and site management activities that result in altered structure and composition of adjacent natural habitats or degraded stream or wetland habitats.

18. Incompatible Mining/Mineral Extraction
Includes extraction of minerals, oil, or gas or similar activities that result in the disturbance or destruction of natural habitats as well as secondary impacts such as sedimentation or releases of toxins. Impacts may include increased sediment loads, downstream scouring, habitat destruction and disturbance, fragmentation, and creation of migration routes for invasive exotic species.

19. Incompatible Road/Utility Management
Includes management of roads or utility corridors that results in excessive releases of sediment or provides access for non-native species, as well as vegetation management practices that are environmentally “unfriendly” (e.g. indiscriminant use of herbicides).

20. Industrial/Municipal Pollution
Includes toxins and air-borne pollutants, thermally altered effluent, and other point source pollutants derived from industrial/commercial land uses in an urban or suburban setting. Involves direct impacts in the form of chemical or thermal stresses to species or natural communities.

21. Invasive/Alien Species
Includes exotic species as well as native species that have become invasive due to past habitat alterations (e.g. hardwood encroachment of longleaf pine habitats following fire suppression). Impacts include competition, hybridization, and predation as well as long-

term alterations of ecological systems and processes (e.g. hydrologic changes, changes in soil attributes, altered fire regimes).

22. Poaching or Commercial Collecting
Includes commercial exploitation, poaching, and unscrupulous or excessive collecting of animals or plants by individual or corporate operators. Impacts may include mortality of individuals, population declines, and changes in community composition.

23. Residential Development
Includes primary and secondary home construction as well as development of associated infrastructure (e.g. subdivision roads and driveways, sewer and stormwater utilities). Impacts may include habitat destruction, disturbance, fragmentation, and introduction of invasive species.

24. Unmanaged Recreation
Includes recreational overuse, particularly by ATVs (all terrain vehicles), but also hiking, biking, caving, horseback riding, rock climbing, and boating (or use of jet skis) in sensitive areas or at rates considered unsustainable in the environments where they occur. Impacts may include habitat destruction and disturbance as well as impaired water quality.

25. Vehicle-Induced Mortality
Includes mortality of animals resulting from collisions with automobiles, boats, or other vehicles. Also includes impacts to plants resulting from vehicular traffic along roadsides, trails, or waterways.

Database and Information Needs

The Database Enhancements technical team included representatives from WRD, U.S. Fish & Wildlife Service, U.S. Forest Service, National Park Service, Georgia Department of Transportation and the University System of Georgia, as well as biological consultants. This group met to discuss ways in which the biodiversity databases maintained by WRD and other conservation partners could be used more effectively for wildlife conservation. Specific items discussed in these meetings included providing financial and technical support for acquisition of LiDAR data, developing better access to rare species location data for conservation planners, researchers, biological consultants and the general public, providing funding for field surveys, and developing Web-based templates for submission of species or habitat data to WRD.

The need to provide protection for site-specific data on rare species or sensitive natural habitats was a recurring theme in these discussions. Participants discussed methods for ensuring the protection of these data as well as the rights of private property owners under provisions of Georgia's Open Records Act. The group also discussed implementation of standards for documenting the types of data produced and maintained by each organization (i.e., metadata standards). A summary of recommendations from this team is provided in Section V of this document (Statewide Wildlife Conservation Themes and Strategies).

Some funds from this planning project were used to upgrade the database management system for biodiversity data used by WRD and to provide training to WRD staff in the use of this system, known as Biotics 5. In addition, members of the Nongame Conservation Section added hundreds of new occurrence records for rare species, developed natural habitat descriptions, and updated information on rarity for all high priority species.

GIS Support and Mapping

Wildlife Resources Division staff provided GIS and mapping support for this project. WRD staff continued efforts to build data layers for conservation lands and sites in Georgia. These data layers included polygons representing ecologically significant sites (e.g., high priority watersheds and streams) identified from field research and previous conservation planning projects. Information on land cover developed by the Natural Resources Spatial Analysis Laboratory at the University of Georgia was used in an ecoregion-based analysis of land use trends in the original SWAP. Data from the Georgia Land Use Trends project (Natural Resources Spatial Analysis Laboratory, 2001) were used to assess land use changes from 1974 to 1998 in each ecoregion. This change detection was based on an 18-class land cover dataset derived from Landsat Thematic Mapper imagery. Maps and statistics on land cover for each of four reference years (1974, 1985, 1992, and 1998) were developed for each ecoregion. For this revision, we updated information on land use changes in each of the ecoregions using 2006 and 2011 data from the National Land Cover Database (www.mrlc.gov). Summaries of these land use trends are noted in Section IV.

Another pilot project was undertaken with NARSAL to identify potentially important conservation areas in the state for the original SWAP. This project used land cover data in combination with information on documented and predicted occurrences of rare species. The objective of this project was to complement the expert-driven approach to identification of important habitats and sites with a broad-scale assessment of existing natural habitat facilitated by GIS.

Land cover data for a “natural vegetation subset” of the 44-class statewide data layer were used to identify areas of the state with significant acreage of natural vegetation. A computer program known as FRAGSTATS was used to categorize and rank these patches of natural vegetation based on size, shape, contiguity, and proximity. Species-habitat models developed for the Georgia GAP project as well as documented occurrences of rare species from the WRD databases were also used to prioritize the patches. One product of this project was a map of “potential conservation areas”, areas that may represent important sites or regions for wildlife conservation emphasis (Figure 1).

In this revision, we used GIS tools and the Biotics database to update maps of high priority watersheds using a new approach outlined in detail in Appendix We also

updated the map of "potential conservation areas" using a combination of landcover and conservation land coverages, connectivity models, and expert opinion to develop a draft "Georgia Greenway Map". In addition, WRD staff developed a new tool that provides online maps of species of conservation concern. These maps can be found on the WRD website at the following address:
http://georgiawildlife.com/about_rare_species_range_maps

Education and Outreach

The Environmental Education technical team included members of DNR's Wildlife Resources Division, Environmental Protection Division, Pollution Prevention Assistance Division, and Parks, Recreation and Historic Sites Division as well as a representative of the Georgia Wildlife Federation. This team was charged with development of environmental education objectives related to the SWAP. Specifically, this group was asked to:

- Identify and describe existing educational programs and sources of information relating to wildlife conservation in Georgia.
- Assess the effectiveness of existing environmental education programs in promoting wildlife conservation statewide and develop recommendations for improving the effectiveness of existing programs.
- Develop recommendations for future programs or areas of emphasis in environmental education and identify major resource needs (funding, staff, facilities, etc.).
- Suggest ways to overcome existing resource limitations.

The Education Technical Team report can be found in Appendix K.

The Outreach and Communications Team addressed needs for both outreach and inreach to further goals of the SWAP. Linking an assessment of communications methods and priorities by various conservation organizations with objectives outlined by the Education Team, the Outreach and Communications Team report identified opportunities for facilitating understanding of SWAP goals by partner organizations and the public. This report can be found in Appendix L.

High Priority Conservation Actions

Technical team leaders, Advisory Committee members, and other stakeholders contributed draft recommendations for high priority land protection, habitat restoration, rare species recovery, research, survey, database development, and education efforts. For each high priority conservation action, target habitats or species, watersheds, and ecoregions were listed as appropriate (many of the recommended actions were statewide in scope). In addition, information on lead organizations, potential partners, performance measures and funding sources was compiled. This draft list was provided to the

Advisory Committee for review and comment, and was revised based on the committee's input. Each conservation action on the list was evaluated and assigned an importance score using the following seven criteria:

1) *Providing Multiple Benefits for High Priority Species/Habitats*
The conservation action provides direct, measurable benefits for several high priority species and/or globally rare natural communities.
(Rating =1 to 3; Weight: = 2)

2) *Addressing Un(der)funded Needs:*
The conservation action represents a significant improvement or advance in wildlife conservation in that it provides support for a conservation effort that is not addressed by other funding sources, programs, or organizations.
(Rating =1 to 3; Weight = 1)

3) *Overall Importance of Georgia Efforts*
The conservation action addresses wildlife conservation needs that are unique to Georgia (e.g., endemic species) or for which Georgia serves a key role geographically or strategically.
(Rating =1 to 3; Weight = 3)

4) *Timeliness or Urgency*
The conservation action addresses a problem that is particularly urgent. If this specific action is not implemented or continued in the next ten years, Georgia will experience a significant loss of biological diversity or habitat quality.
(Rating =1 to 3; Weight = 3)

5) *Connections with Other Conservation Actions*
The conservation action serves as a critical component that enables or facilitates one to several other important conservation measures. Without this component, other efforts will be crippled or made ineffectual.
(Rating =1 to 3; Weight = 2)

6) *Building Public Support for Wildlife Conservation*
The conservation action is likely to increase overall public support for wildlife conservation. The benefits of the action will be readily apparent to the public, or the project itself will focus on increasing public support for conservation.
(Rating =1 to 3; Weight = 2)

7) *Probability of Success*
The conservation action is likely to succeed because it employs tested methodologies, has strong support from stakeholders, and has clearly identified and readily achievable objectives.
(Rating =1 to 3; Weight = 2)

In this rating system, the score assigned to a particular conservation action indicates the relative contribution or significance of that action for a particular criterion (1 = Low; 2 = Medium; 3 = High). The weight is a multiplier of the rating and indicates the relative contribution of that criterion to the total score (maximum total score = 45 points).

Numeric scores totaled for all criteria were used to assign each conservation action to one of three levels of priority: Very High (41-45 points); High (36-40 points); and Medium (27-35 points). The complete table of prioritized conservation actions is found in Section VI. Highest priority conservation actions identified for each ecoregion are summarized in Section IV (Conservation Landscape Assessments and Conservation Strategies), and highest priority conservation actions for the state as a whole are discussed in Section V (Statewide Conservation Themes and Strategies).

High Priority Conservation Areas

In the original SWAP, the Fishes and Aquatic Invertebrates technical team identified 212 high priority watersheds in Georgia. These watersheds represented important sites for at least one high priority aquatic species or contained examples of high quality aquatic communities. Information used in this analysis included rare species occurrence data in biodiversity databases maintained by WRD and other organizations, recommendations provided by participants in CWCS stakeholder meetings, data from the WRD Stream Assessment Team, and information from a previous aquatic assessment completed by The Nature Conservancy (Smith et al 2002).

The 2015 revision of Georgia's State Wildlife Action Plan provided an opportunity to update and improve the existing high priority waters dataset. U.S Geological Survey Hydrologic Unit Code 10 digit watersheds (HUC10) were chosen for the identification of high priority watersheds. Based on species occurrence data, land cover, and expert knowledge, the Fishes and Aquatic Invertebrates Species Technical Team identified 165 high priority watersheds to protect the best known populations of 168 high priority aquatic species. These watersheds were then prioritized by calculating a Global Significance Score (GSS), which was based upon the number of species identified in each watershed as well as the global rarity of each species. Watersheds with the highest GSS clustered in the Coosa and Tennessee drainages of northwest Georgia, but also occurred in the Tallapoosa, Chattahoochee, Flint, and Savannah drainages. Watersheds with high and moderate GSS occurred in all of Georgia's five ecological regions and 14 major drainages, except the Satilla. An additional 56 watersheds were designated as "significant" high priority watersheds, but were not further prioritized. These watersheds contained important habitat for coastal or anadromous species, recent occurrences or critical habitat for a federally listed species, or occurred in a region of the state where high priority watersheds were poorly represented.

The team also conducted a GIS assessment of all of Georgia's HUC 10 watersheds (n = 366) to characterize the degree of protection, existing condition, recent landcover trends, and future threats. Existing conservation lands are concentrated in the Blue Ridge of northeast Georgia, but there are significant parcels of protected land scattered throughout the state. Important patterns affecting watershed condition include high forest in northeast Georgia, high row crop agriculture in southwest Georgia, and extensive development within and fringing the Metro Atlanta area and along the I-75 corridor. The density of impoundments varies across watersheds, but impacts aquatic connectivity in almost every watershed in the state. Trends in land cover changes between 2001 and 2011 include significant declines in forest cover in the Piedmont and Southeastern Plains, little change in row crop agriculture, and increases in developed landcover in urban areas throughout the state. Urban growth models predict that extensive urbanization will occur throughout the Piedmont and Blue Ridge provinces and at scattered locations throughout the state between now and 2050.

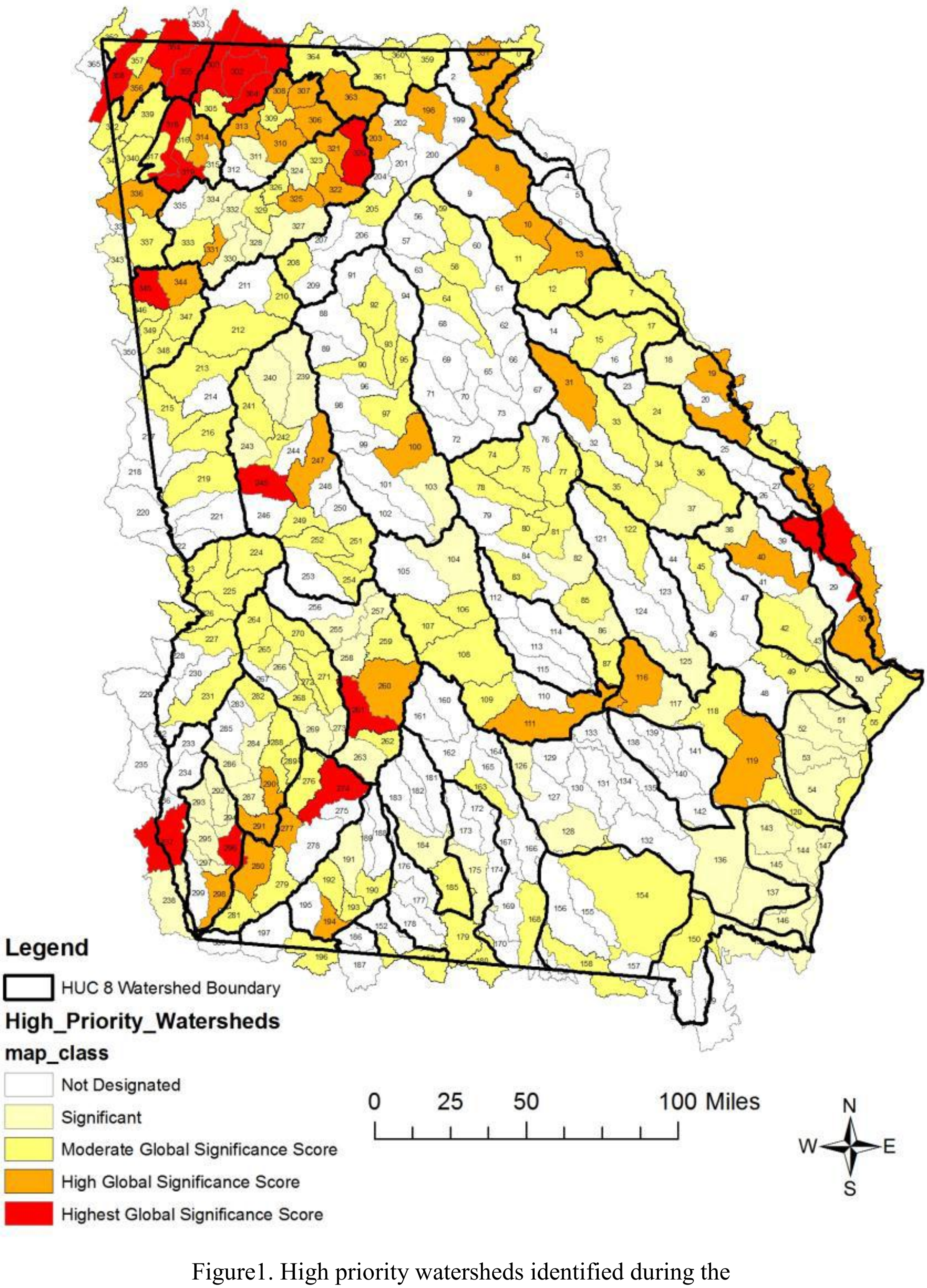

Figure1. High priority watersheds identified during the 2015 revision of Georgia's State Wildlife Action Plan.

Many of the other high priority conservation areas mentioned in this document were identified previously through a series of ecoregion-based conservation planning projects coordinated by The Nature Conservancy with assistance from WRD and other organizations. These are listed and described briefly for each ecoregion in Section IV of this document. Some of these sites correspond to or contain existing conservation lands, while others represent lands with no formal protection. While the general locations of these sites are mentioned in this document, no attempt has been made to depict the boundaries for these priority conservation areas in this document, for two reasons. First, the draft boundaries for many of these priority conservation areas represent an initial attempt to delineate major landforms or hydrologic features of biological significance, and we recognize that additional work needs to be done to refine these preliminary delineations to a level that could be considered "conservation site boundaries." Secondly, some of these high priority areas represent specific sensitive habitats whose precise locations should not be made part of a publicly accessible document.

In the 2005 SWAP another approach to delineation of high priority conservation areas involved the aforementioned GIS-informed pilot project completed by NARSAL and WRD. A set of potential "conservation opportunity areas" based on analyses of the size and configuration of natural vegetation patches was derived from 1998 Georgia GAP land cover data and documented and predicted occurrences of species of conservation concern. A prioritization scheme was devised to sort these conservation opportunity areas into general categories of significance using combinations of these three factors.

Original values for three GIS layers were recoded for each of three data layers before combining these to produce the final potential conservation opportunity area layer. The three data layers used in this prioritization scheme included core area of natural vegetation patches, weighted density of rare species (plant and animal) occurrences, and predicted occurrences of terrestrial vertebrate species of conservation concern. The use of these three factors together provided a mechanism for ranking patches of natural vegetation based on combinations of size, predicted value for species of conservation need, and documented value for species of conservation need. Finally, the prioritized patches identified from this analysis were mapped along with existing conservation lands. The resulting map is shown in Figure 2.

The 2005 map of potential conservation opportunity areas has been employed in a wide variety of conservation planning projects and has been useful in the context of identifying relatively large patches of natural habitat. Together with the maps of high priority streams and watersheds, the conservation opportunity areas dataset was used to prioritize properties for a regional conservation effort in Northwest Georgia coordinated by the Open Space Institute. The Northwest Georgia Land Protection Fund was established to protect ecologically significant landscapes through the efforts of local land conservation partners. With support from two private foundations, this fund provided $1,696,000 in grants from 2007 through 2010, helping land trusts protect 5,255 acres with a full market value of $23,323,000 (Open Space Institute, 2012).

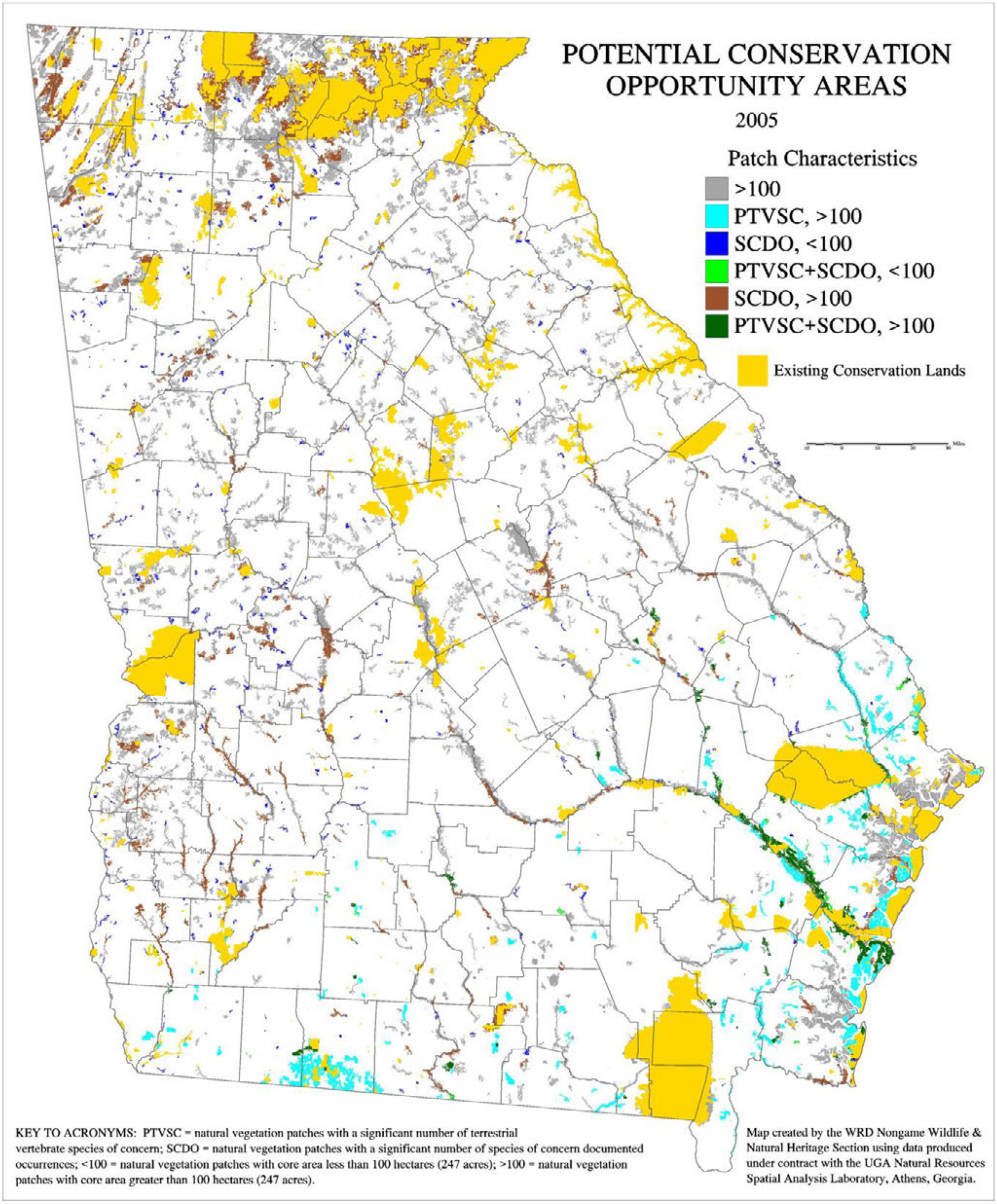

Figure 2. Potential conservation opportunity areas map from 2005 SWAP.

In 2006 staff of Georgia DNR modified the potential conservation opportunity areas map to highlight six large landscapes that represented priorities for land conservation by the agency. Over the past nine years this map has been used to prioritize land conservation projects involving fee-simple acquisitions by Georgia DNR. The "six priority areas" map was developed based on expert opinion as well as mapped locations of rare species and natural communities (Figure 3).

From 2008 through 2010, DNR staff conducted a field-based habitat mapping project focused on the 11-county coastal region of Georgia. Using digital aerial photography, soils, topography, and other data, they completed a comprehensive map of natural, semi-natural, and anthropogenic habitats using NatureServe associations, alliances, and ecological systems. The resulting dataset has been widely applied in planning efforts by conservation organizations, private landowners, and local governments, serving as the foundation for the Coastal Georgia Land Conservation Initiative coordinated by the Georgia Conservancy, Association County Commissioners of Georgia, and Georgia DNR
http://www.georgiaconservancy.org/coast/cglci.html
http://www.georgiawildlife.org/node/267

In this current revision of the SWAP, the ecosystem/habitat mapping technical team utilized a mapping approach that incorporated data from the Southeast Resilient Landscapes Project conducted by The Nature Conservancy, models of habitat connectivity, and other data to develop a draft "Georgia Greenways" map (Figure 4). This map includes large patches of natural habitat as well as areas that could be conserved or restored to provide for greater habitat connectivity within the Georgia landscape. More information on this mapping approach is found in the habitat/ecosystem mapping team report in Appendix N.

While useful as broad-scale depictions of biologically significant areas, the delineated high priority streams, watersheds, and other conservation areas are not intended to represent a "conservation blueprint" for Georgia. Each of these approaches to delineation of high priority conservation areas has its own limitations, and these maps should be considered aids to conservation planning rather than conservation plans. For example, limiting future conservation activities to designated high priority watersheds would ignore the very real need to address opportunities for habitat improvements in the remaining waters of Georgia. Similarly, the potential conservation opportunity areas delineated in this project are based on analyses of existing natural vegetation, and therefore ignore many habitats that represent important restoration or enhancement opportunities. Further, in no instance should these maps be seen as an attempt to limit, expand, or define regulatory authority of the Georgia Department of Natural Resources or any other agency. While many of the high priority conservation areas mentioned in this document are considered deserving of special emphasis for habitat protection, we do not mean to imply that other areas should be ignored or considered unworthy of protection, or that state or federal laws protecting wildlife should be applied unevenly over the Georgia landscape.

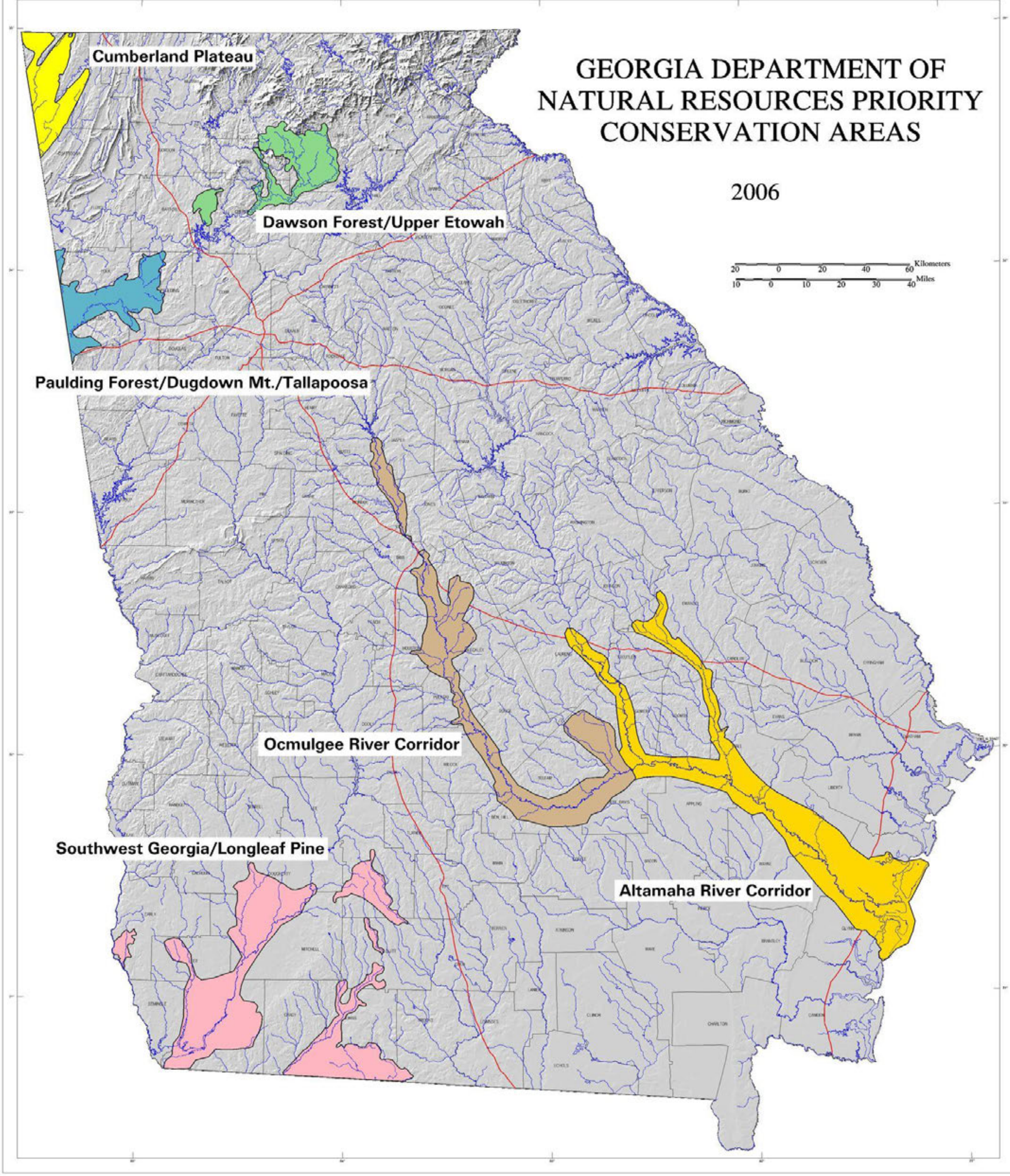

Figure 3. Georgia DNR Priority Conservation Areas Map

The depiction of high priority conservation areas in this document represents the compilation and assessment of large volumes of biological and ecological data. However, it must be acknowledged that any such delineation of biologically important areas inevitably reflects the quality and quantity of data available at a given point in time. Given the large number of high priority species for which additional field research has been identified as a conservation emphasis, the picture of high priority conservation areas must be considered subject to change. We expect to be able to provide a clearer and more precise picture of the most biologically significant areas of Georgia in coming years as implementation of this conservation strategy continues.

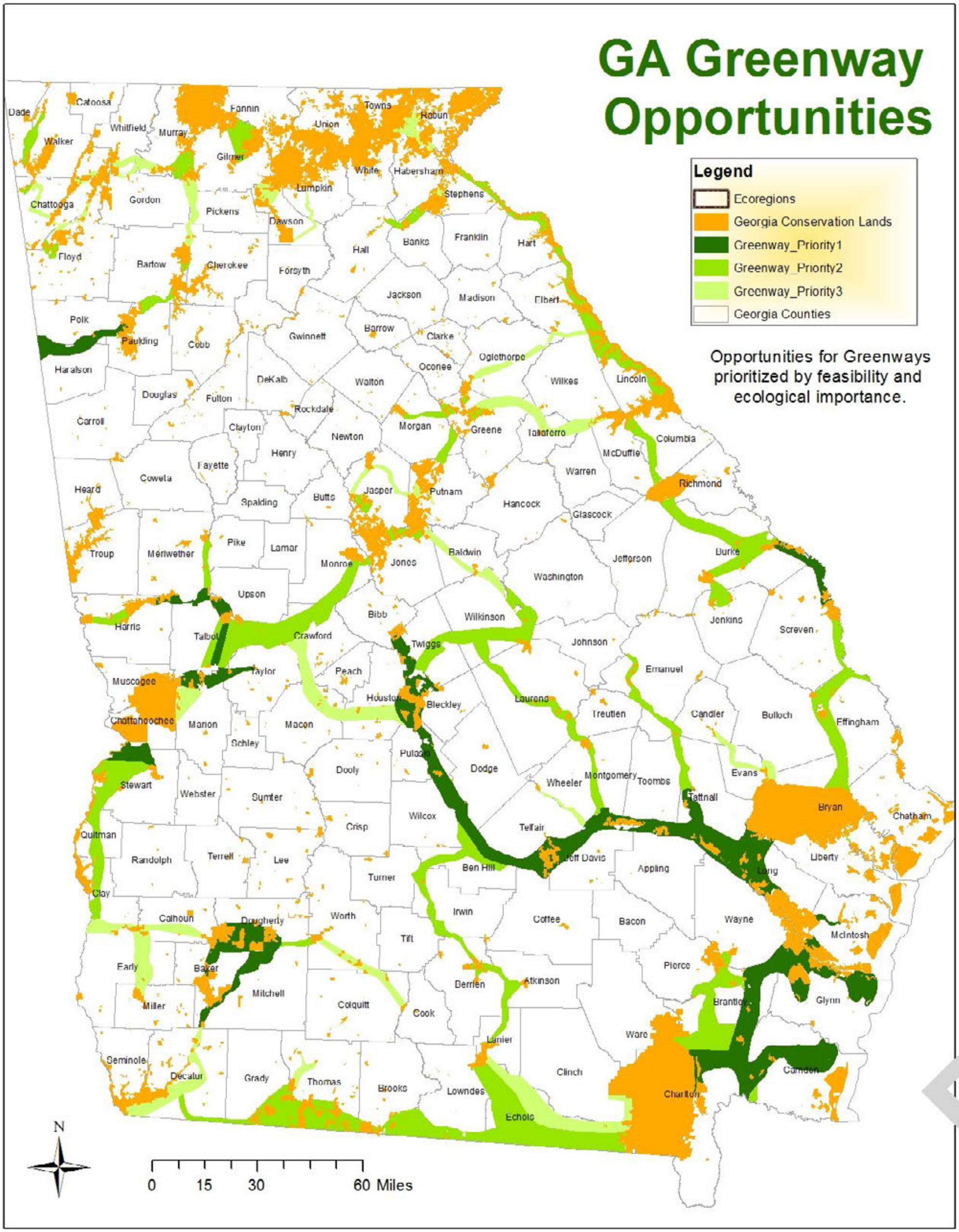

Figure 4. Draft Georgia Greenway Opportunities Map

Review and Revision

The first draft of the SWAP revision was submitted to the SWAP Revision Advisory Committee in May 2015. Comments and recommendations from the advisory committee were addressed and a public review draft was developed. This public review draft was posted on the WRD website on June 1, 2015 and its availability was publicized through email notices and statewide news releases. The public comment period for this draft of the strategy extended from June 1, 2015 to July 20, 2015.

III. State Overview- Ecological Framework

Physiography

The variety of species and natural communities found in Georgia is in part reflective of its physiographic diversity. The boundaries of Georgia include portions of five physiographic provinces. Each physiographic province has its own distinctive representative habitats and landforms (Clark and Zisa 1976), and the history of human land use and resulting impacts on species and habitats vary by province.

The Cumberland (Appalachian) Plateau in extreme northwest Georgia is composed of nearly flat-topped mountains capped with sandstone, with the valleys between them underlain by limestone. Escarpments on the margins of the mountains drop more than 1000 feet to the valley floor, and are breached by numerous streams that have their sources on top of the upland and reach the valley through deep notches in the cliffs. This province supports forests dominated by chestnut oak and white oak, with shortleaf and Virginia pine also present.

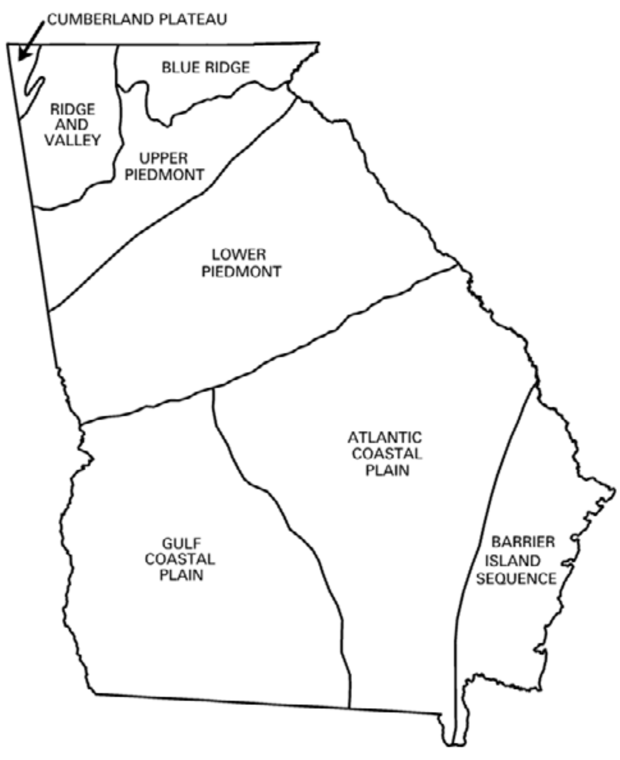

Figure 5. Georgia Physiographic Provinces and Districts

To the south and east of the Cumberland Plateau lies the Ridge and Valley Province, characterized by the low, linear, parallel ridges of the Chickamauga Valley district and the more prominent, narrow ridges of the Armuchee district. Farther east, the Great Valley district is typically broad and open with a few scattered ridges and hills, underlain with shales and limestone, as are the valleys between the linear ridges to the west. The relatively flat, fertile valleys are dominated by agriculture, such that the province is only about 65% forested. These range from mesic forests to those composed of dry-tolerant species. Longleaf pine is found at its northernmost extent in Georgia on some of the ridges in this district, and other examples of coastal plain biota can be found in the valley of the Coosa River and its tributaries (Wharton 1978).

The Blue Ridge Province is characterized by the rounded, eroded crystalline rock masses of the Blue Ridge and Cohutta mountains with dendritic drainage patterns, contrasting with the linear, steep-sided elevations of the Ridge and Valley Province with its trellis drainage patterns. Forests account for more than 90% of the landcover in this province, a higher percentage than any other Georgia physiographic province. Examples of forest types found in this province include broadleaf deciduous cove forests on moist, cool north-facing slopes, the stunted oak forests of the ridges, and the oak-hickory forests that comprise the bulk of the Appalachian slope forests. Agriculture and other land uses are limited primarily to the flat floodplains of creeks and rivers in this province.

While containing slightly higher percentages of forested landcover than the Ridge and Valley Province, the forests of the Piedmont are more fragmented, as agricultural land uses are more or less evenly distributed throughout a matrix of second-growth and industrial forests. Urban land uses reach their greatest extent in the Upper Piedmont. Although this province is characterized by gently rolling topography throughout, some areas of high relief are found in the Upper Piedmont, on slopes associated with river valleys, and in the Fall Line area of transition to the upper Coastal Plain, where the metamorphic rock of the Piedmont gives way to sedimentary rock and sandy soils. Rivers and creeks in this transitional area are characterized by shoals and rapids.

South of the Fall Line, streams open into the wide floodplains characteristic of the Gulf and Atlantic Coastal Plains. In the former, upland forested landcover decreases to 38%, as nearly half of the province is in agricultural and other open landcover types. Bottomland forests associated with the broad, meandering streams of these provinces provide contiguous wildlife habitat to a greater extent than do the streams traversing the Piedmont in narrower floodplains. The Atlantic Coastal Plain province contains a higher percentage of wetlands than the Gulf Coastal Plain, due in part due to the presence of the Okefenokee Swamp in the former and the relative lack of surface waters in the karst-influenced lower Flint River basin. Broadleaf evergreen forests are found in areas not converted to pine monoculture, although remnants of the original longleaf pine matrix are few and widely separated.

The lowest elevations in the state and highest percentage of wetlands are found in that part of the Atlantic Coastal Plain known as the Barrier Island Sequence. This district is composed of the barrier and marsh islands, the extensive saltwater and brackish marshes, and the low-lying forests immediately to the west. Only the Cumberland Plateau and the Blue Ridge provinces have a lower percentage of non-forested landcover types, as many of the soils of the Barrier Island Sequence are too wet for agriculture. In addition to bottomland hardwoods along the rivers flowing to the marsh, and the extensive industrial pinelands, maritime forest types can be found on the barrier islands and on upland bluffs in this district. The terraces of ancient shorelines account for most of the topographic relief in this otherwise flat and lowlying district.

Geology

Georgia is divided into five major geologic provinces (Georgia Geological Survey 1976). These provinces are the Cumberland Plateau, Valley and Ridge, Blue Ridge, Piedmont, and Coastal Plain. Because of their geological similarity, the Cumberland Plateau and the Valley and Ridge provinces are considered together in this summary, as are the Blue Ridge and the Piedmont provinces. The Cumberland Plateau and Valley and Ridge provinces, in northwest Georgia, are composed of folded and faulted Paleozoic sedimentary rocks. The Blue Ridge and Piedmont provinces, in the northeast and upper-central part of the state are composed of Precambrian to Paleozoic igneous and metamorphic rocks. The Coastal Plain Province, in South Georgia, is composed of Cretaceous to Holocene sediments.

Cumberland Plateau and Valley and Ridge Provinces

The Cumberland Plateau and Valley and Ridge Provinces of northwest Georgia are composed of folded sedimentary rocks that range in age from Cambrian to Early Pennsylvanian (approximately 570 to 326 million years ago) (Georgia Geologic Survey 1976, Patchen et al 1984). They are predominantly composed of ridge-capped cherts and sandstones alternating with valleys underlain with carbonates (limestone and dolostone), shales and slates. These strata are strongly folded and locally cut by relatively shallow thrust faults in the Valley and Ridge, and only gently folded with little faulting in the Cumberland Plateau. Fold axes in the area have varied orientations, but they generally trend northeast to southwest as evidenced by the trends of major ridge lines. Thrust fault surfaces generally dip at relatively shallow angles to the southeast. The major episode of faulting and folding occurred late in the Paleozoic Era (approximately 286 million years ago) at which time the Paleozoic strata were overthrust by igneous and metamorphic rocks of the Blue Ridge Province along the Great Smoky-Cartersville fault.

Blue Ridge and Piedmont Provinces

The Blue Ridge and Piedmont provinces are composed of igneous and metamorphic rocks: gneisses, amphibolites, schists, phyllites, slates, quartzites, and granites of Late-Precambrian to Pennsylvanian age (approximately 1,100 to 305 million years ago) (Higgins 1986, Georgia Geologic Survey 1976). These rocks were intensely folded and faulted during at least three episodes of mountain building during the Paleozoic Era. During these episodes older sedimentary, volcanic, and plutonic igneous rocks were highly compressed, very tightly folded, thrust-faulted, intruded by several pulses of magma, and metamorphosed at high pressure and temperature several miles below the surface of the earth. At the peaks of these metamorphic episodes, some of these rocks were partially melted. The axes of folded layers generally trend northeast-southwest and metamorphic layering is almost invariably inclined at low angles to the southeast. As in the Valley and Ridge, these features reflect a predominant compression from southeast to northwest during metamorphism.

Fine-grained metamorphic rocks, especially slate and phyllite, are most typically found along the western flank of the Blue Ridge and at the eastern portion of the Piedmont Province. Tectonically sheared rocks (e.g., mylonite, phyllonite, and button schist) are locally well-developed along the major faults and shear zones within these Provinces (especially the Brevard, Towaliga, and Goat Rock faults). Elsewhere, coarser grained rocks such as gneiss, schist, and amphibolite, as well as granite and gabbro, are more typically encountered.

Locally, there are narrow vertical dikes of diabase (a dark grey, fine-grained, intrusive, igneous rock) of probable Jurassic age (190 to 170 million years ago) (Higgins 1986).

These represent the youngest rocks of these provinces as they cut across all the other metamorphic and igneous rocks. These dikes are generally basaltic in composition and almost invariably trend in a northwest-southeast direction (roughly perpendicular to the regional trend of the metamorphic layering). Individual dikes are rarely more than a few tens of feet wide but can be traced for tens of miles. They represent the intrusion by mafic magma into the rock of the region as a result of tensional rifting of the crust during the Mesozoic Era (245 to 66 million years ago) (Palmer 1983). Much of the bedrock in this area is blanketed with a thick residual clay mantle (saprolite). Quaternary to Recent alluvium is common along the major drainage basins.

Coastal Plain Province

The Coastal Plain Province occupies the southern three-fifths of the State and is composed of poorly consolidated sediments (predominantly clays, sands, and marls). Sediments exposed at the surface range in age from Late Cretaceous to Holocene (approximately 97 million years ago to the present day) (Georgia Geologic Survey 1976, Huddlestun et al 1988). Older rocks, including possible Jurassic sediments, Triassic basin fills, and Paleozoic sediments of African origin occur in the deep subsurface (Huddlestun et al 1988). The sediments of the Coastal Plain are essentially undeformed and dip very gently toward the coast to the south and southeast. These sediments form a wedge with the thin edge of the wedge at the Fall Line and the thick edge at the Atlantic Ocean.

There are four broad subareas of the Georgia Coastal Plain. Within each of these subareas, sediments are generally similar but differ markedly from adjacent areas of the Coastal Plain. These are the Fall Line Hills area, The Dougherty Plain area, Coastal Georgia, and the large intervening region that may be called the Altamaha Upland area. The Fall Line Hills, Dougherty Plain, and Coastal Georgia geologic areas approximately correspond to the Fall Line Hills, the Dougherty Plain, and the Barrier Island Sequence physiographic districts, respectively. The Altamaha Upland geologic area approximates the combined Tifton Upland and Vidalia Upland physiographic districts.

The Fall Line Hills area is predominantly underlain by soft, unconsolidated sands and clays that are of late Cretaceous and Early Tertiary age. Because the Fall Line Hills area lies adjacent to the more uplifted Piedmont, this sequence of sediments is the most deeply dissected region in the Georgia Coastal Plain. West of the Flint River, Cretaceous and early Tertiary sediments consist mostly of nearshore marine sands and grey clays. However, east of the Flint River these same deposits become more coarsely sandy (and locally gravelly) and the clay consists predominantly of kaolins. The kaolinitic sediments east of the Flint River were originally deposited by rivers, and they consist of channel-fill deposits and floodplain deposits along a narrow Cretaceous and early Tertiary Coastal Plain.

In southwestern Georgia the Dougherty Plain is underlain by limestones of middle Tertiary age (mostly upper Eocene and Oligocene limestones). These limestones were deposited when sea levels were unusually high and the Piedmont was deeply eroded into a low-lying, undulating plain. At that time, the shoreline of the Atlantic Ocean and Gulf of Mexico approximated the present-day Fall Line Hills. The limestones in southwestern Georgia were deposited on a relatively shallow water continental shelf similar to that of the modern Bahamas and Florida Bay, north of the Florida keys.

In western Georgia, between the Fall Line Hills area to the north and the Dougherty Plain area to the south, there is a band of moderately rolling and dissected hills. This region has commonly been included in the Fall Line Hills area, although the geology and topography differ. The deposits of this region consist mainly of variably limey, locally fossiliferous, shallow-water, marine sands and clays of early Tertiary age.

To the south of the Fall Line Hills and east of the Dougherty Plain is a large, rolling upland area known as the Altamaha Upland. This region is mostly underlain by the Altamaha Formation of late Tertiary, Miocene age. The sediments of the Altamaha Formation consist chiefly of sand and kaolin and are very similar to some upper Cretaceous and lower Tertiary deposits of the Fall Line Hills area. However, the Altamaha Upland deposits contain more sandstone and claystone phases and are more resistant to physical erosion than sediments in the Fall Line Hills.

East of the Altamaha Upland and adjacent to the Atlantic Ocean is a band of thin, comparatively young sands and clays of late Tertiary and Quaternary age that compose the Coastal Georgia area. These sediments represent paleo-barrier island sequences that are analogous to modern deposition along the Georgia coast. These thin sands and clays are underlain by phosphatic, shallow water, marine deposits of Miocene age that may be seen in the Savannah, Altamaha, Satilla, and St. Marys river basins.

Climate

The climate of Georgia can be described generally as humid and temperate. Summers are warm to hot, with much of the annual precipitation occurring in the summer. Winters are cool to cold, and moist. Average annual precipitation varies significantly across the state, from less than 45 inches to over 70 inches. In northern Georgia, monthly precipitation totals are highest in late winter to early spring (March to April). A secondary peak in precipitation occurs in July, due to thunderstorm activity. In southeastern Georgia, maximum rainfall occurs in late summer to early fall. Southwestern Georgia locations typically experience two relatively even peaks of precipitation in March and July, with a third peak in December.

For the state as a whole, October is the month of lowest rainfall, but this monthly precipitation minimum also varies significantly across the state. For example, monthly precipitation totals are lowest in March in east-central Georgia, and in November in the extreme southeastern portion of the state.

Severe weather events occur primarily in the warmer months. Tornadoes spawned by intense thunderstorms are most likely in March, April, and May and least likely in September and October. While tornadoes have historically been recorded from nearly every county in the state, the most violent tornadoes have been concentrated in north-central Georgia. Extreme northeastern Georgia and the coastal areas of the state have the lowest incidence of tornadoes. Severe tropical storms and hurricanes are caused by development of large masses of warm, moist air over the tropical oceans. Most tropical storms affecting Georgia reach the state from the Gulf of Mexico. These storms pass over the panhandle of Florida and lose much of their energy in the process. Storms originating in the South Atlantic are more likely to provide hurricane-force winds to the coastal region of the state. The peak period of occurrence of tropical storms and hurricanes along the Atlantic coast is from August to October.

Average daily January temperatures vary from 25 to 60 degrees Fahrenheit across the state. Similarly, average daily July temperatures range from 60 to 90 degrees Fahrenheit. Locations in southcentral Georgia average 90 days per year with maximum temperatures above 90 degrees Fahrenheit, while sites in northernmost Georgia experience less than 10 such days per year. High-elevation sites in the mountains of northern Georgia average 120 days with minimum temperatures below 32 degrees Fahrenheit, while locations along the coast and the southeastern border experience less than 30 such days per year.

Ecoregions of the State

The discussion of land use trends, high priority species and habitats, and conservation objectives in this report is organized by ecological region, or ecoregion. The major divisions used in this report are as follows: 1) Southwestern Appalachians/Ridge & Valley; 2) Blue Ridge; 3) Piedmont; 4) Southeastern Plains; and 5) Southern Coastal Plain. Boundaries of the first three of these entities approximate those of corresponding physiographic provinces discussed above, while the combined boundaries of the fourth and fifth ecoregions together comprise the Coastal Plain physiographic province. Figure 4 shows the major (Level III) ecoregions used in this report as well as subunits of those ecoregions (Level IV) that reflect distinctive landscape features or regions. Although the Southwestern Appalachians and Ridge & Valley are separate Level III ecoregions, they are treated as one unit in this document because they share many topographic, geologic, soil, and biotic components.

Descriptions of Georgia ecoregions are found in the corresponding sections that follow under "Conservation Landscape Assessments and Conservation Strategies". The text is modified from Griffith et al. (2001).

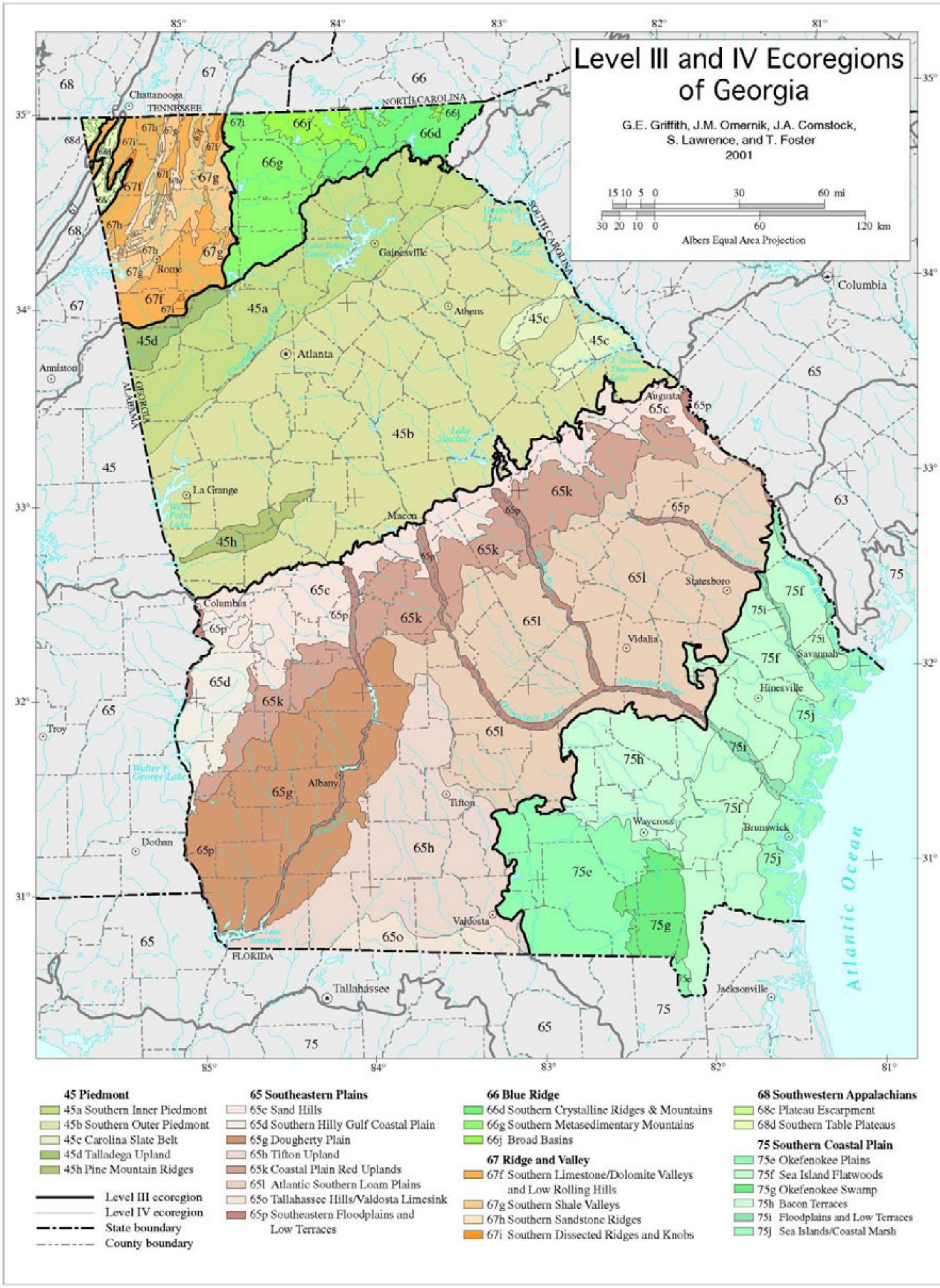

Figure 6. Level III and IV Ecoregions of Georgia

Patterns of Wildlife Diversity

Biogeographic factors such as latitude, topography and continental position are basic to an understanding of Georgia's biodiversity as compared to other areas of similar size. A well-known relationship exists between biodiversity and latitude in that species diversity generally increases from the poles to the equator, with far more species of plants and animals found in the tropics than in higher latitudes (Brown and Gibson 1983). Georgia's location within the temperate zone is associated with moderate to high levels of biodiversity. The variety in climate due to the latitudinal span of Georgia is augmented by its topography.

The effect of elevation on climate is similar to that of latitude, so that in terms of climate, Georgia effectively spans more than the four to five degrees of latitude it actually covers. Due to the elevation of the mountains in the northern part of the state, biotic elements of northern latitudes can be found within Georgia. This location has served as one of several refugia during the most recent glacial events, shaping our existing complement of life forms. Extreme variability in temperature for a given location is related to lower levels of biodiversity in that fewer life forms have adapted to such conditions. The centers of continents, distant from the moderating effects of oceans, have the greatest extremes in annual temperatures, and in general, fewer numbers of species compared to coastal areas with moderate climate.

Georgia's position on the Atlantic Slope affords a relatively moderate climate associated with a more diverse flora and fauna. Unlike the uplifted western edge of the North American continent, the Atlantic coast is submerged and highly irregular. The lower reaches of rivers that drain the Atlantic Slope transition into estuaries, and elevation and topographic diversity decline gradually toward the coast. This results in a varied physiography associated with diverse terrestrial and aquatic habitats.

Plant species diversity in Georgia is high due in part to two distinct elements of biogeography, the "rich and ancient flora covering the Southern Appalachians, and the many unusual insectivorous plants that inhabit our bogs and wetlands" (Stein et al, 2000). Both the Appalachian region and the Southern Coastal Plain have high levels of endemism. A number of narrowly endemic plant species are also associated with the granite outcrops of the Georgia Piedmont. Nationally, Georgia ranks seventh in terms of overall diversity of vascular plants.

Georgia ranks second among all states in amphibian diversity, third in freshwater fish diversity, seventh in reptile diversity, fifteenth in bird diversity, and seventeenth in mammal diversity (Stein, 2002). Based on a 2000 nationwide assessment of 21,395 species, Georgia ranks sixth in the nation in overall biological diversity based on numbers of vascular plants, vertebrate animals, and the better known invertebrate groups. Georgia also ranks twelfth in the nation in terms of endemic species, eighth in percentage of species considered globally imperiled (12.9%), and fifth in terms of number of known or suspected extinctions (Stein et al., 2000).

Species of Conservation Concern

The distribution of species of conservation concern across the state generally reflects overall patterns of wildlife diversity. However, the distributions of high priority animals and plants by ecoregions reflect diverging patterns of critical habitat distribution as well as geographic patterns of imperilment. The greatest numbers of high priority animal species can be found in the Southwestern Appalachians/Ridge & Valley ecoregions, followed by the Southeastern Plains, Southern Coastal Plain, Blue Ridge and Piedmont. For high priority plant species, the greatest numbers are found in the Southeastern Plains, followed by the Southern Coastal Plain, Piedmont, Blue Ridge, and Southwestern Appalachians/Ridge & Valley. This lack of correlation between high priority animal and plant distributions reflects divergent patterns of rarity and imperilment.

The large number of high priority animals in the Southern Appalachians/Ridge & Valley ecoregions reflects the extremely high number of rare or imperiled fish and aquatic invertebrates in this region. The Southeastern Plains region is second highest in number of high priority animals, and this total reflects a number of rare animal species distributed over several taxonomic groups. In contrast, the high number of rare plant species associated with the Southeastern Plains reflects associations with isolated wetlands, rock outcrops, wet pine savannas and seepage bogs, calcareous swamps, and several other discrete or edaphically controlled habitat types. The second-ranking ecoregion for rare or imperiled plants, the Southern Coastal Plain, is also characterized by a number of important natural habitats including sandhills, isolated wetlands, pine flatwoods, barrier island beaches and dunes, and maritime forest. Patterns of landscape and species diversity within each ecoregion will be discussed under "Conservation Landscape Assessments and Conservation Strategies".

While all of these high priority species are of conservation concern, the recommended conservation emphasis varies within the group. For one species or group of species, the most effective approach may be broad-scale habitat management over a large portion of its range, while for another species the most important goal, at least in the short term, is protection of a relatively small number of known viable populations by protecting specific sites or critical habitats. A third subset of high priority species represents the "worst case scenario" in which a species is extirpated or nearly extirpated from the state, and in which case the emphasis must be on maintenance and/or restoration of critical habitats as well as reintroduction or augmentation of populations. Unfortunately, several freshwater mussel species fall into this category. A fourth group of high priority species represents a subset for which there is evidence of rarity or decline, but for which there is currently not enough information on range, threats, or specific conservation needs to formulate a specific conservation strategy. For these species, research and survey efforts are the appropriate conservation actions.

Land Use and Human Impacts

Human Population Trends

Georgia has experienced extremely rapid population growth since the 1970s and is one of the fastest growing states in the nation. From 1980 to 2010 the population of Georgia grew from 5.46 million to 10.1 million (see below). From April 1, 2010 to July 1, 2014, the population of Georgia grew 4.2%. In comparison, the population of the United States grew 3.3% during the same period (U.S. Census Bureau 2015).

Table 2. Georgia's Population, 1980 - 2014

Georgia Population	
1980	5,462,982
1990	6,478,149
2000	8,186,453
2010	9,687,653
2014 (estimate)	10,097,343

Source: U.S. Census Bureau (http://quickfacts.census.gov/qfd/states/13000.html)

According to current projections, Georgia's population will increase 46%, from 10.1 to 14.7 million people, by 2030. The highest population density in the state will remain in the metropolitan Atlanta area, and substantial urban/suburban growth will occur in the northern and coastal counties (Georgia Office of Planning and Budget 2010). In 2010, the population density in Georgia was 168.4 individuals per square mile, while the population density of the United States was 87.4 individuals per square mile (U.S. Census Bureau 2015)

Land Cover/ Land Use Trends

Analysis of data on 13 land cover classes indicates that the largest change from 1974 to 2008 by percentage occurred in the high-density and low-density urban categories (366% and 401%, respectively) (Natural Resources Spatial Analysis Laboratory 2015). The overall percentage of these two land cover classes in the Georgia landscape increased from 0.97% in 1974 to 9.6% in 2008. While still a relatively small fraction of the total area of Georgia, the impacts related to these land uses are disproportionately high. The high rate of expansion of "sprawl zones" in Georgia represents a significant trend in terms of future impacts on wildlife species and habitats.

Habitat loss and modification attributed to increases in urban and suburban areas represent the primary threats to wildlife diversity in Georgia. These impacts include stream habitat losses due to construction of water supply reservoirs, habitat fragmentation from construction of roads and utility corridors, and conversion of natural habitats to developed areas. Other important land use factors affecting wildlife habitats and species include conversion of natural habitats for agricultural or silvicultural uses as well as activities associated with existing agricultural and forestry operations that do not meet the standards of best management practices.

Land cover trends for the period 2006 to 2011 derived from National Land Cover Database (http://www.mrlc.gov) data are provided for each ecoregion in Section IV. Though this analysis covers only half of the time period since the 2005 SWAP, it includes the time period from 2006-2008, a period of intensive development in the state. A summary of these general land cover trends is presented in the table below. Trends are expressed as percentage change per land cover class.

Table 3. Landcover Change by Ecoregion, 2006 – 2011 (n/c = no change)

	Open Water	Developed	Forest	Agriculture	Wetlands	Early Successional
SA/RV	n/c	+2.4%	-1.5%	-1.1%	n/c	+11.2%
BR	+2.9%	+1.6%	-0.8%	-1.8%	n/c	+15.3%
PD	n/c	+3.2%	-5.4%	-1.1%	+2.0%	+27.1%
SP	+2.4%	+1.2%	-5.0%	-2.7%	+0.1%	+21.2%
SCP	+6.1%	+2.1%	-6.0%	-3.0%	+0.1%	+12.1%

SA/RV=Southwestern Appalachians/Ridge & Valley Ecoregion
BR=Blue Ridge Ecoregion
PD=Piedmont Ecoregion
SP=Southeastern Plains Ecoregion
SCP=Southern Coastal Plains Ecoregion

Developed = Open space, low, medium, and high intensity urban
Forest=Deciduous, pine, and mixed forest
Agriculture=Hay/pasture and cultivated crops
Wetlands=Woody and emergent wetlands
Early Successional=Barren, herbaceous, scrub/shrub

Overall, the period 2006-2011 appears to be relatively stable from a general landcover perspective. The most notable trends for these 6 years are a substantial increase in early successional land cover in all ecoregions, increases in developed land, stable wetlands trends, stable or increasing open water, and overall losses of forest land cover. The forest loss, spread evenly across deciduous, evergreen and mixed forests types, is primarily a transition to herbaceous, scrub/shrub, and barren land cover and developed land classes. Large increases in the early successional classes during this time period could represent conversion of forest land to other land uses, or could represent the early stages of reforestation. Some of the decline in forest land could also be explained from timber revenues declining after 2007 and overall decreases in reforestation rates as silviculture became less profitable relative to other land uses. However the most likely explanation is that this trend reflects substantial timber harvest in the period 2006-2008, when timber prices were significantly higher.

Hay/pasture and cultivated crop classes appeared to be relatively stable in the state during this period. The increase in development is likely due to larger forested properties being subdivided, sold and converted to suburban type developments during the growth period (2006-2008). This loss of forest land to development has significant consequences for wildlife conservation in the state.

Importantly, stable or slightly increasing wetland land cover during this time period may signal good news statewide as the trend of wetland loss seems to have abated. Notably, wetlands in the Southeastern Plains and Southern Coastal Plain, which were significantly impacted by ditching, draining, and conversion to other land uses in previous decades, appear to be stable from 2006-2011. This may be due to lower availability of marginal and easily converted wetlands and higher costs of hydrologic modifications relative to economic gains from wetland conversion.

Altered Fire Regimes

In addition to converting natural habitats into agricultural or urban environments, humans have had a pervasive influence on regional and local natural processes in seemingly natural settings, altering the natural processes of the land. Perhaps the most obvious example is fire suppression. Fire is one of the most significant forms of disturbance in the natural landscape. It influences species composition of both plant and animal communities over a wide range of habitats. Wildfires caused by lightning or set by humans are believed to have been important factors sustaining biological diversity in the Georgia landscape for at least the last several thousand years. The timing, scale, frequency and intensity of these wildfires varied from site to site, and this variability, in combination with other local environmental gradients, influenced the diversity of natural communities and species found in this area.

During the 20th century, fire came to be viewed as detrimental to the economy and the natural environment. This perspective was reinforced by early policies of the U.S. Forest Service (Earley 2004). Human-set fires were greatly reduced, and both lightning- and human-ignited fires were suppressed. Negative opinions about prescribed fire programs are still held by a significant segment of the public today. Some are opposed to prescribed burns because of concerns about smoke hazards, air pollution, or aesthetics. Others perceive negative impacts to wildlife from prescribed burns or associate all fire with catastrophic events. Although recognition of the importance of prescribed fire for natural resource conservation has grown among land managers in recent years, there are new constraints on its use in terms of social acceptance and policy (Edwards et al. 2013).

State air quality regulations and policies have been developed to comply with air quality standards under the federal Clean Air Act standards. The Environmental Protection Agency (EPA) sets standards for air quality in the form of the National Ambient Air Quality Standards. In 2007, the EPA revised the standard by lowering permissible levels of fine particulate matter (pm2.5). This type of pollutant comes from a variety of sources, including exhaust from internal combustion engines, coal-fired power plants, agriculture, and biomass burning, including prescribed fire. While prescribed fire is a relatively minor source of pm2.5 compared to the others listed above, it is highly visible and easily targeted for restrictions. Prescribed fire is the only emission source that is managed through a permitting system that ensures that the activity occurs when atmospheric dispersion is optimal (Edwards et al. 2013).

While roughly one million acres of prescribed burning is conducted in Georgia annually, the majority of this burning is site preparation for silviculture. Nearly all of this burning is conducted outside of the parameters (i.e., timing, frequency and intensity) of natural burning regimes. Increasing human populations and continued urban sprawl prohibit the restoration of natural fire regimes on a broad scale. As a result, the Georgia landscape of today contrasts sharply with the open oak woodlands, park-like longleaf pine, extensive canebrakes and other fire-dependent habitats described by William Bartram, John Muir and other early naturalists. The maintenance of many species of plants and animals in the Georgia landscape depends on restoration and maintenance of fire-dependent communities. Implementation of these management programs remains a daunting task in the face of continued suburban sprawl, increased restrictions on prescribed burns to meet air quality standards, and concerns about smoke management along highways.

Impacts on Aquatic and Wetland Habitats

Economic growth and development in the state have also resulted in profound changes to aquatic and wetland habitats. These hydrologic alterations vary from region to region, but include construction of hydropower dams, water supply reservoirs and other types of impoundments on large and medium-sized rivers, channelization of streams, drainage of wetlands by ditches or drainage tiles, and withdrawal of groundwater and surface water. These types of activities often result in impacts to a wide variety of species in an area much larger than the footprint of the construction area. For example, construction of dams on major rivers can impact aquatic and wetland systems miles upstream and downstream of the impoundment through alteration of instream flows, changes in water quality, and physical isolation of populations of aquatic species. Similarly stream channelization affects not only the aquatic habitat in the channelized segment, but also downstream areas and adjacent floodplain habitats.

Regulated releases of water from impoundments result in downstream flow regimes in which the amplitude and seasonal variation differ from those of free-flowing streams. As a consequence, floodplains do not flood as often or extensively as they would under natural conditions; this diminished flooding reduces the overbank deposition and distribution of nutrient-rich sediments to the floodplain as well as the distribution of nutrients to downstream habitats. The cumulative effects of numerous reservoirs on natural communities and ecological services associated with free-flowing rivers are not well understood, but are of growing concern (Cowie 2002).

In regions such as southwestern Georgia, where there is significant groundwater withdrawal for irrigation, streamflow depletion can occur due to changes in regional hydrologic gradients (Rugel et al. 2011). In addition to dewatering stream segments and impacting nutrient loading to downstream communities, reduced streamflows affect channel morphology and increase stream temperatures, threatening the viability of aquatic biota (Golladay et al. 2004; Pringle and Triska 2000; Bunn and Arthington 2002). Wetlands such as seeps or geographically isolated depression wetlands that are influenced by groundwater may also be impacted by regional groundwater withdrawal.

Increases in the amount of impervious land surface associated with urbanization can result in significant impacts on water quality and quantity in streams, rivers, and wetlands, particularly in areas where riparian buffer vegetation has been removed. Similarly, disruption of riparian vegetation by cattle and other livestock results in erosion, sedimentation, and increased inputs of excess nutrients to streams. Headwater streams are particularly vulnerable to removal or destruction of riparian buffers, and changes in these upper reaches can threaten the biological integrity of entire river networks through disruptions of food webs (Hutchens and Wallace 2002) and elevated stream temperatures (Meyer et al. 2005, 2007).

Georgia's total wetland acreage is estimated to be 7.7 million acres, including 378,000 acres of coastal marshlands. Development associated with coastal marshlands has been regulated by the state since 1970 through the Coastal Marshlands Protection Act. For regulatory protection of freshwater wetlands Georgia relies on federal water quality certification under the Clean Water Act. Protection is not provided for geographically isolated wetlands in the state because they are not considered waters of the U.S. No programs exist for statewide monitoring and assessment of freshwater wetland conditions (Fowler 2008), so the degree to which these wetlands have been degraded by hydrologic alterations or pollutants is not known. A study of Carolina bays in Georgia found that the majority of the smaller wetlands had hydrologic alterations or other forms of degradation associated with agricultural uses (VandeGenachte and Cammack 2002). Similar findings were reported by Martin (2010) in sinkhole depressions in southwestern Georgia.

The percentage of streams meeting designated uses varies greatly by ecoregion, as shown in Figure 7 below. In the Blue Ridge ecoregion, some 58% of monitored streams supported designated uses, while only 27% of streams monitored in the Southern Coastal Plain were judged to fully support designated uses. The distribution of streams evaluated for support of designated uses in 2012 is shown in Figure 8.

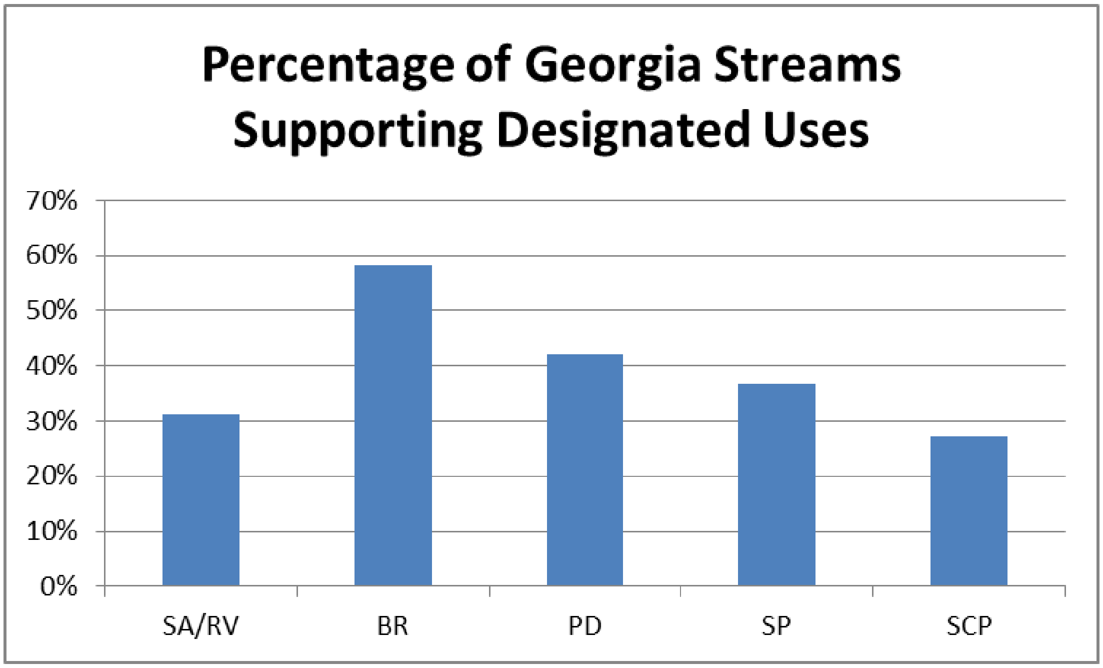

Figure 7. Percentage of Georgia Streams Supporting Designated Uses by Ecoregion, 2012

SA/RV= Southwestern Appalachians/Ridge and Valley Ecoregion
BR= Blue Ridge Ecoregion
PD=Piedmont Ecoregion
SP=Southeastern Plains Ecoregion
SCP=Southern Coastal Plain Ecoregion

Source: Georgia Environmental Protection Division

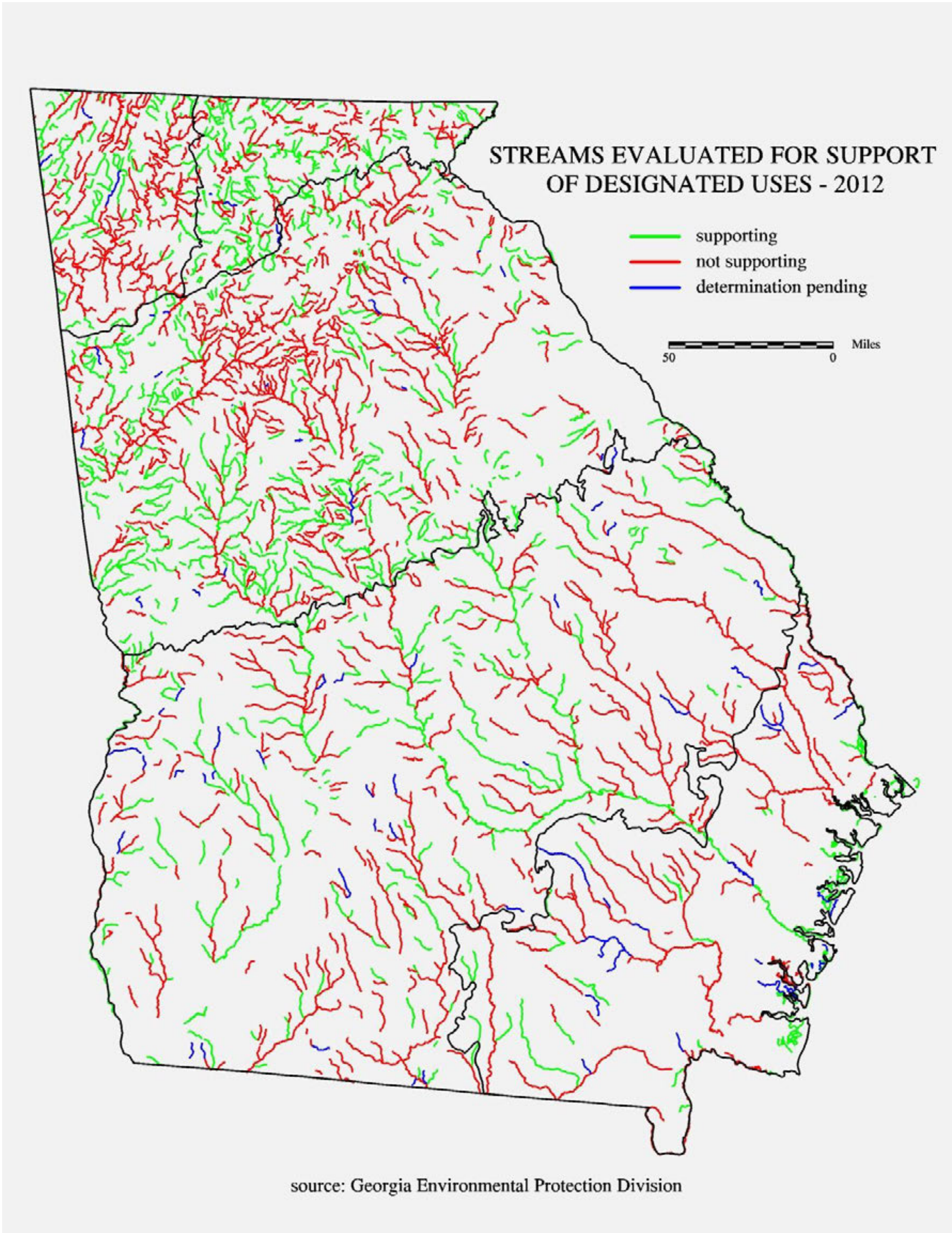

Figure 8. Streams Evaluated for Support of Designated Uses, 2012

Nonnative Invasive Species

Human activities have resulted in the introduction of many nonnative plants into the Georgia landscape. Some of these species were deliberately introduced as crop or horticultural plants, livestock, or pets and later escaped from cultivation or domestication. Others, like kudzu, autumn olive, Japanese honeysuckle, and bicolor lespedeza, were introduced to control erosion or provide food for wildlife. Still other nonnative species were accidentally introduced by importation of food and other materials. While many of these species are relatively benign or serve as pests primarily of crops, lawns, or orchards, a number of exotic species are capable of invading natural communities and causing severe negative impacts to wildlife. Chinese privet has colonized floodplain and upland habitats throughout the state, suppressing native vegetation through shading and allelopathic effects. Nepalese browntop and Japanese honeysuckle are capable of suppressing the diversity of native herbs in many forested communities. Cogon grass, an introduced species from Africa, outcompetes native grasses and burns intensely, posing a risk to human safety. Water hyacinth, hydrilla, and alligatorweed are notable exotic weeds in Georgia.

Many exotic pest plants have been identified for the Southeast (Miller 2003), and techniques for control of these pests are being explored and implemented in various habitats. Severe infestations of exotic plants exist on public conservation lands as well as on private lands, and responding to this form of "biological pollution" will be a major task for land managers in the future.

Nonnative animals cause similar impacts to high priority species and habitats. For example, the fire ant has been found to cause mortality to gopher tortoises and southern hognose snakes. The nine-banded armadillo feeds on eggs of ground-nesting birds such as northern bobwhite. Populations of eastern hemlock and Carolina hemlock are being impacted at a regional scale by the hemlock wooly adelgid, an insect that was also accidentally introduced from Asia. Other non-native insects harmful to trees include the European gypsy moth, emerald ash borer, and Asiatic oak weevil.

Millions of cave-dwelling bats in the eastern United States have been killed by "white nose syndrome," a disease caused by an introduced fungus that disrupts normal hibernation patterns, causing bats to arouse frequently from torpor and leading to debilitation and death. Feral swine impact a wide variety of habitats, wallowing in wet areas, uprooting and eating native plants, fungi, amphibians, and eggs of ground-nesting birds, removing native groundcover, and contributing to soil erosion and stream sedimentation. On barrier islands, feral swine are major predators of sea turtle and shorebird nests. Nonnative animals of concern in aquatic habitats include the flathead catfish, island apple snail, red shiner, lionfish, and Asian rice eel. Appendix I includes a detailed discussion of ongoing efforts to assess and control nonnative invasive species in Georgia.

Conservation Lands

The amount of land in permanent or long-term conservation use varies greatly from region to region. This fact influences the types of challenges faced by wildlife as well as the conservation objectives and strategies that will be emphasized in a particular region. Approximately 6.7% of the Southwestern Appalachians/Ridge and Valley and Piedmont ecoregions is in some form of public conservation ownership. Nearly 42% of the total area of the Blue Ridge ecoregion is in state or federal ownership with a large holding composed of the Chattahoochee-Oconee National Forest. Publicly owned lands in the Coastal Plain are predominantly properties of the U.S. Department of Defense or the U.S. Fish and Wildlife Service. The largest area of the state, represented by middle and southwestern Georgia, has the lowest percentage of state and federal conservation lands, approximately 3% (Figure 8).

In recent years, several large tracts of public land have been acquired in the upper Coastal Plain. The properties have been purchased through collaborative efforts by the state and federal agencies, private foundations, and nongovernmental agencies. Of the 352,000 acres of state-owned conservation lands, nearly one third were purchased since 1992 (Edwards et al. 2013). In addition, more than 250,000 acres of private lands are protected by permanent conservation easements held by private land trusts or state agencies. In addition, communities throughout the state have taken advantage of private, state, or local funding sources to purchase properties for community greenspace. Many of these county- or city-level projects focus on long-term protection of important conservation areas such as river corridors. Figure 9 shows the distribution of lands conserved by state, federal, local, and private groups.

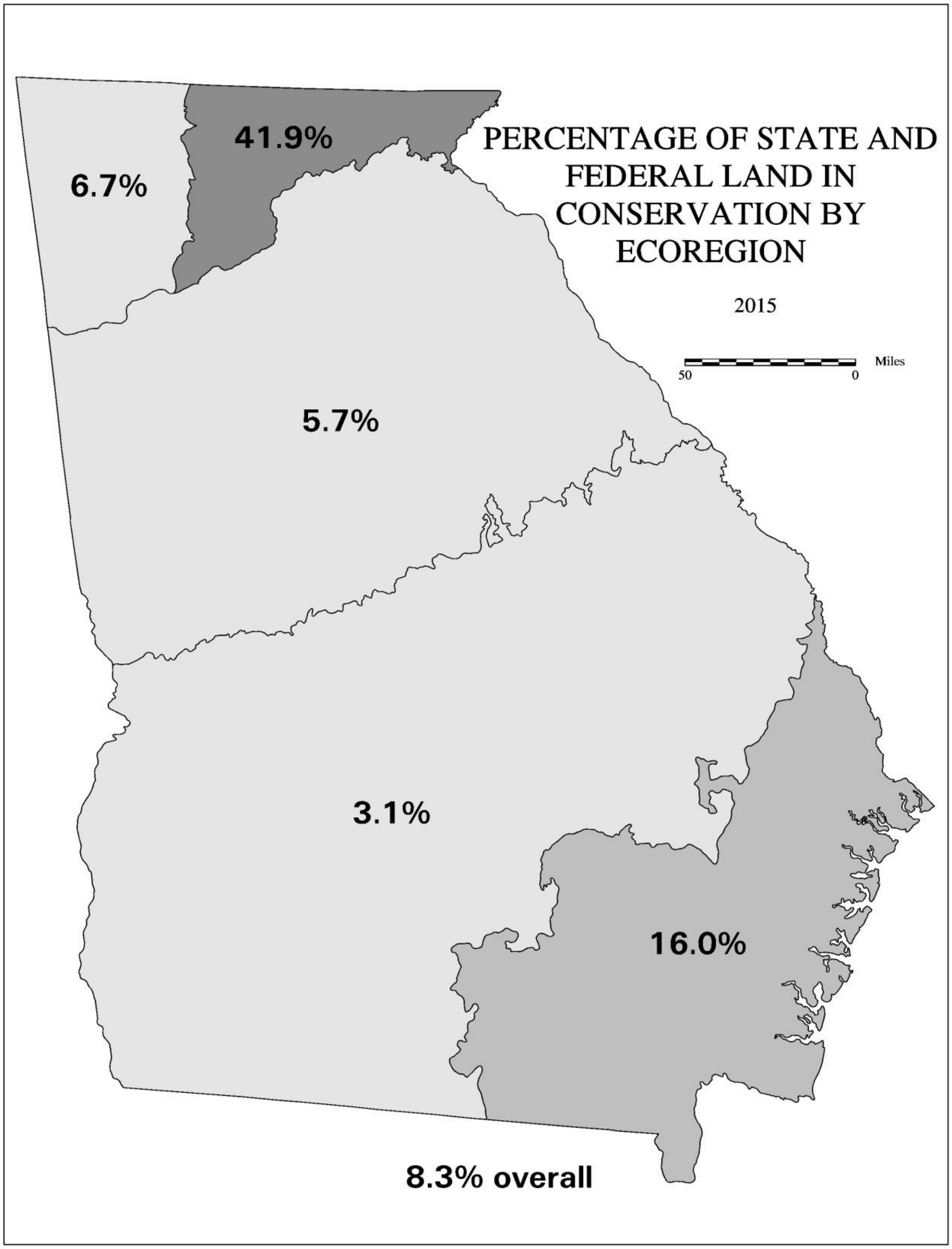

Figure 9. Percentage of state and federal land in conservation use by ecoregion, 2015

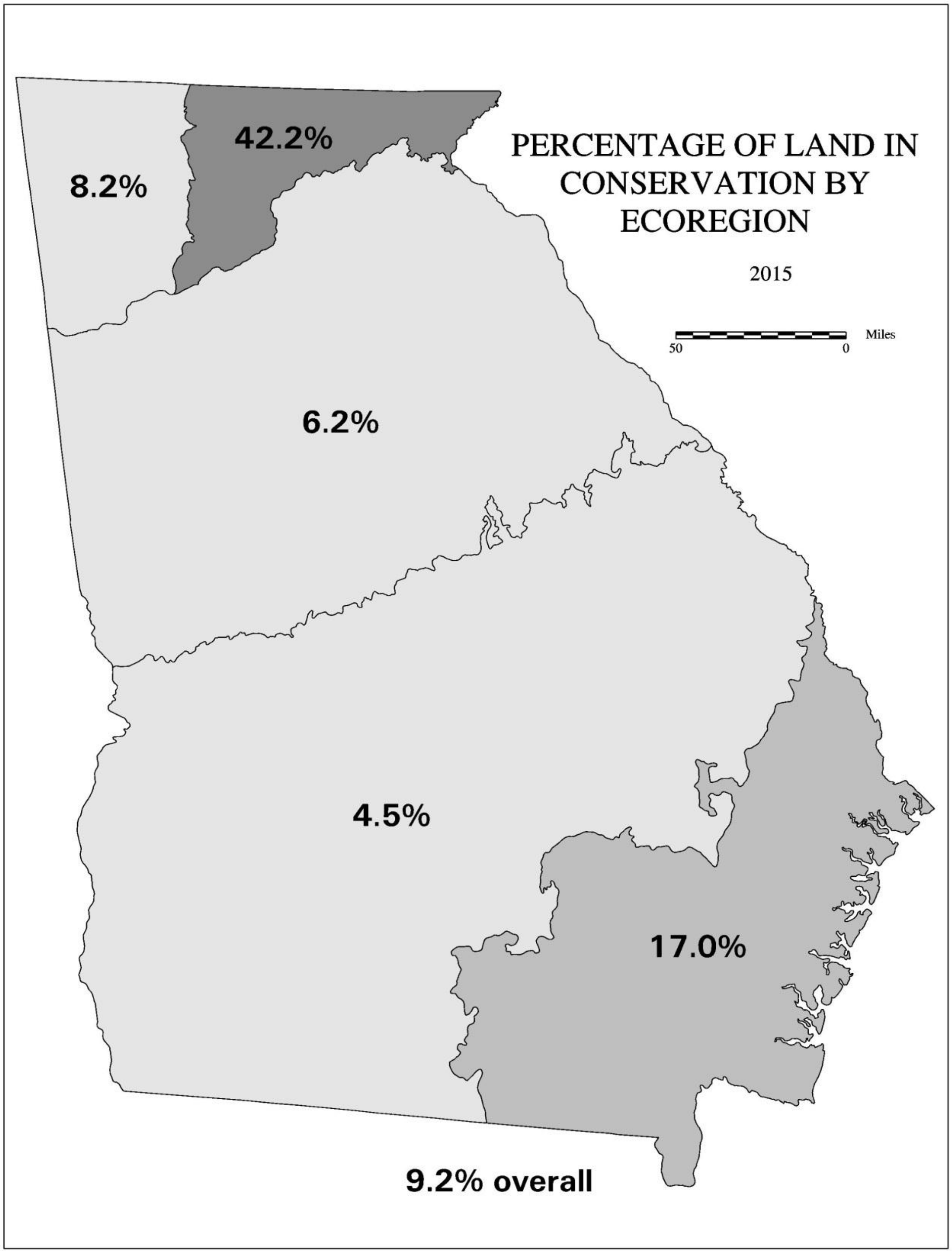

Figure 10. Percentage of land in conservation use by ecoregion, 2015

IV. Conservation Landscape Assessments and Conservation Strategies

Southwestern Appalachians/Ridge & Valley

Ecoregional Overview

The Southwestern Appalachians and Ridge & Valley ecoregions cover approximately 1,982,245 acres in northwestern Georgia. Approximately 162,544 acres (8.2 percent of the total area) are in some form of permanent conservation ownership. Georgia DNR manages approximately 28,860 acres owned in fee simple by the State of Georgia and an additional 54,830 acres in short-term leases or management agreements. Federal land ownership includes 66,160 acres managed by the U.S. Forest Service, 6,393 acres managed by the National Park Service, and 2,677 acres managed by the Department of Defense. These two ecoregions are treated as one unit in this report because they share many characteristics relating to geology, topography, soils, and vegetation.

The Southwestern Appalachian region stretches from Kentucky to Alabama and is characterized by low, flat-topped mountains containing a mosaic of forest and woodland with some cropland and pasture. The eastern boundary of this ecoregion is relatively smooth and notched by small eastward flowing streams; the western boundary has a rougher escarpment that is more deeply incised. The deeper ravines and escarpment slopes of this ecoregion contain mixed mesophytic forest, while the top of the plateau has more xeric mixed pine-oak forests and woodlands characterized by mixed oaks. Subdivisions of the Southwestern Appalachians include the Plateau Escarpment and the Southern Table Plateaus.

The Plateau Escarpment is characterized by steep, forested slopes and high gradient streams. Local relief is often 1000 feet or more. The geologic strata include Mississippian-age limestone, sandstone, shale, and siltstone, and Pennsylvanian-age shale, siltstone, sandstone, and conglomerate. Vegetation in the ravines and gorges includes mixed oak and chestnut oak forests on the upper slopes and more mesic forests on the middle and lower slopes and along streams and floodplain terraces.

The Southern Table Plateaus include Sand Mountain, Lookout Mountain, and Pigeon Mountain. While similar in some respects to the Cumberland Plateau in Tennessee, this region is lower in elevation, has a slightly warmer climate, and has more agriculture. It is mostly forested with mixed oak and oak-hickory communities. The plateau surface is less dissected with lower relief compared to the Plateau Escarpment, and it has slightly cooler temperatures and higher precipitation than the adjacent Ridge and Valley.

The Ridge & Valley is a relatively low-lying region situated between the Blue Ridge and the Southwestern Appalachians. Its roughly parallel ridges and valleys contain a variety of geologic materials, including limestone, dolomite, shale, siltstone, sandstone, chert, mudstone, and marble. Springs and caves are relatively numerous in this ecoregion. Ridges and slopes in this ecoregion are mostly forested, while pasture and row crops dominate the valleys. Subdivisions of the Ridge & Valley in Georgia include the

Southern Limestone/Dolomite Valleys and Low Rolling Hills, the Southern Shale Valleys, the Southern Sandstone Ridges, and the Southern Dissected Ridges and Knobs.

The Southern Limestone/Dolomite Valleys and Low Rolling Hills comprise a heterogeneous region underlain primarily by limestone and cherty dolomite. Landforms are mostly undulating valleys and rounded ridges and hills, with many caves and springs. Soil productivity is variable and land cover includes oak-hickory and oak-pine forests, pasture, row crops, and urban/industrial.

The Southern Shale Valleys consist of undulating to rolling valleys and low, rounded hills and knobs underlain by shale. The soils in this area formed from shale, shaly limestone, and clayey sediments, and tend to be deep, acidic, moderately well-drained, and slowly permeable. The steeper slopes are used for pasture or have reverted to brush and mixed forest. Small fields of hay and row crops are grown on the toe slopes and along streams.

The Southern Sandstone Ridges encompass the major sandstone ridges of the Ridge & Valley, but also include areas of shale, siltstone, and conglomerate. The steep, forested ridges tend to have smooth, narrow crests, and soils are typically stony, sandy, and low in fertility. The chemistry of streams flowing down the ridges varies greatly depending on underlying geologic material. Oak-hickory-pine forests are the dominant land cover.

The Southern Dissected Ridges and Knobs contain interrupted or hummocky ridges. Although shale is common, there is a mixture and interbedding of geologic materials, including cherts, siltstone, sandstone, and quartzose limestone. Oak forests and pine forests are typical for the higher elevations of the ridges, with more mesic forests on the lower slopes, knobs, and draws.

The predominant landcover types in the Southwestern Appalachian/Ridge & Valley ecoregions are deciduous forest, mixed forest and row crop/pasture (Kramer and Elliott, 2004). An analysis of land use changes from 1974 to 1998 based on satellite imagery indicated the following general trends:

- A decrease in row crop/pasture (from 32.94% of total landcover to 27.90%)
- An increase in high-intensity and low-intensity urban (from 4.41% of total landcover to 6.42%)
- An increase in deciduous and mixed forest (from 37.21% of total landcover to 44.18%)
- A decrease in evergreen forest (from 18.30% of total landcover to 14.52%)
- A decrease in clearcut/sparse vegetation (from 6.54% of total landcover to 5.82%)

These trends indicate a general decline in the total acreage devoted to active agricultural uses, an increase in hardwood and mixed forest types, an increase in residential and commercial development, and a decline in evergreen (pine and redcedar) forest types.

Analysis of land use change from 2006 to 2011 indicates a 1.5% decrease in forested land, 1.1% decrease in agricultural land, 2.4% increase in developed land, and 11.2% increase in early successional habitat. The increase in early successional classes (barren, herbaceous, and scrub/shrub) likely represents an increase in timber harvest during this period. See Appendix N for more information on land cover trends in this ecoregion.

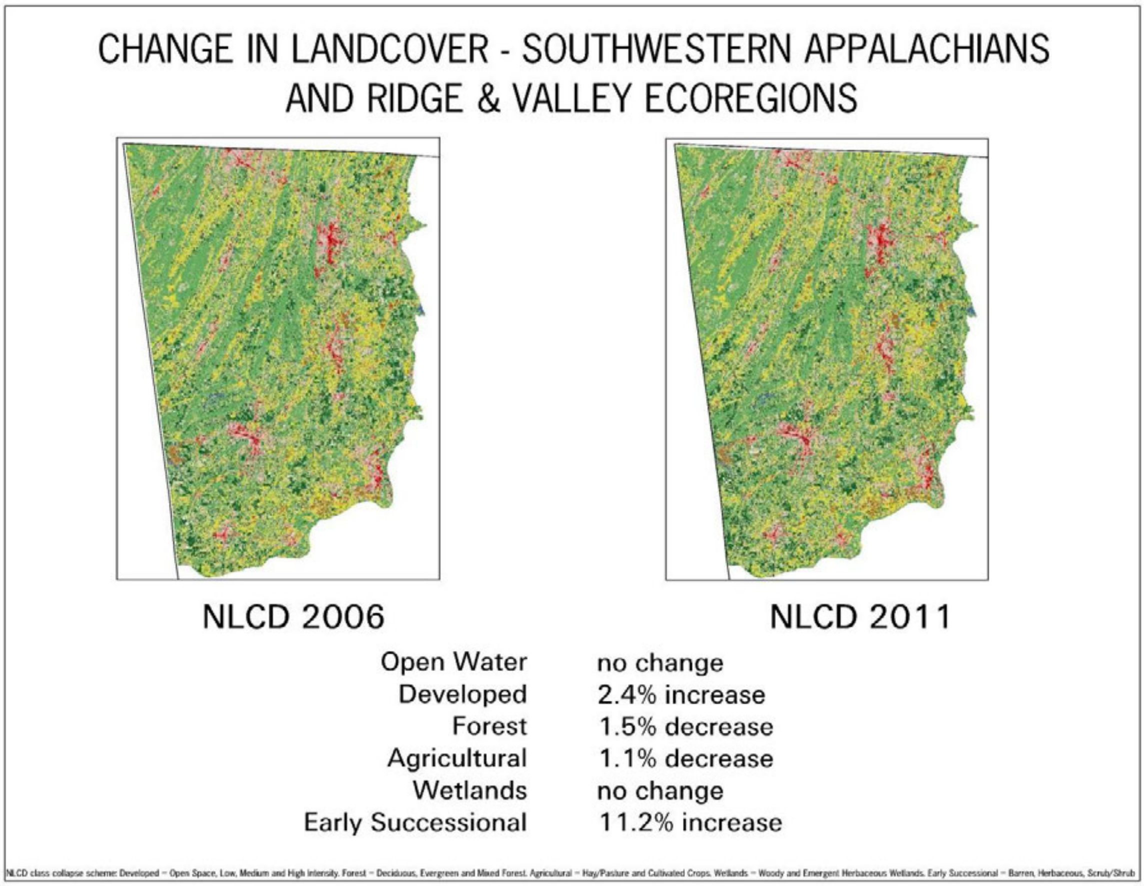

Figure 11. Change in landcover from 2006 to 2011 in the Southwestern Appalachians and Ridge & Valley ecoregions.

<u>High Priority Species and Habitats</u>

The technical teams identified 110 high priority animal species in the Southwestern Appalachians/Ridge & Valley ecoregions. These include 11 birds, 8 mammals, 2 reptiles, 6 amphibians, 35 fish, 27 mollusks, 9 aquatic arthropods, and 12 terrestrial arthropods. These species are listed in Table 4, with information on global and state rarity ranks, protected status (if any) under federal or state law, and habitat and range in Georgia. In addition, 65 species of high priority plants were identified for the Southwestern Appalachians/Ridge & Valley. These are listed in Table 5.

High priority habitats for the Southwestern Appalachians/Ridge & Valley ecoregions are described below:

1. Acidic Meadows Over Sandstone or Shale
Open, grassy habitats over shallow acidic soils; edaphic factors control species composition and diversity. May be moist or dry, depending on topographic setting. These small patch habitats are relatively rare in Georgia.

2. Calcareous Flatwoods (Hardwood Flats)
Relatively open, flat, shallowly and seasonally wet forested habitats dominated by hardwoods and including rare or uncommon species such as nutmeg hickory and Alabama leatherflower. Shrub and herb diversity is high. A small patch habitat restricted to low-lying areas with clayey calcareous soils.

3. Calcareous Prairies (Coosa Valley Prairies)
Open grass- and forb-dominated communities over clayey calcareous soils that inhibit growth of woody species. Groundlayer plant species diversity is high, and includes disjunct species known primarily from midwestern prairies. Includes wet and dry prairie subtypes. These habitats require periodic fire for maintenance.

4. Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

5. Caves, Rock Shelters, Talus Slopes
These habitats share certain structural characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. They are typically embedded in a larger matrix of forest habitats. Caves are unique in their lack of sunlight and vegetation and dependence on outside materials for energy flows. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes. This region contains the majority of Georgia's caves and provides habitat for rare species such as gray and Indiana myotis.

6. Forested Limestone Slopes and Terraces
This forest type is found at middle elevations along Lookout and Pigeon Mountain. Characterized by submesic hardwood forest, with species composition dependent on aspect and slope position. Includes partially forested limestone ledges along streams.

7. High Gradient First- and Second-Order Streams
Small, clear, cold, tumbling streams with bedrock riffles and sandy pools. Found at higher elevations and upper ends of steep ravines and slopes. These streams typically experience wide seasonal variations in flow; some receive substantial input from groundwater.

8. Limestone Glades and Barrens (Cedar Glades)
Open habitats dominated by grasses or forbs, with scattered eastern redcedars and other trees. These habitats contain a large number of endemic plant species. Glades occur on thin, rocky soils, and are typically dominated by forbs; barrens are in areas with deeper soils and are dominated by grasses. The largest and most important area of cedar glades/barrens in Georgia is centered on Chickamauga-Chattanooga National Military Park.

9. Mesic Hardwood Forests
Mesic forests of bluffs, ravines, and colluvial flats, characterized by a diverse canopy of hardwood species such as yellow poplar, black cherry, white oak, shagbark hickory, northern red oak, bigleaf magnolia, sugar maple, and American beech. Hemlock and loblolly pine may be minor components in some areas. Mature examples are characterized by a rich understory of shrubs and herbaceous plants. This large patch habitat includes a rich mesic hardwood forest subtype found on calcareous soils.

10. Medium to Large Rivers
Lower gradient streams of valley bottoms, characterized by sandy, silty, or gravelly substrates. Typically surrounded by agricultural lands on the broad, fertile floodplains. Nearly all examples of large river floodplain forest in the Ridge & Valley region have been converted to other types of land cover.

11. Montane Longleaf Pine-Hardwood Forests
Dry forests composed of longleaf pine and mixed hardwood species, including mountain chestnut oak, southern red oak, and various scrub oaks. Significant examples occur in the Ridge & Valley region near Rome. Nearly all Georgia examples are fire-suppressed and exhibit lower species diversity than corresponding habitats in Alabama.

12. Oak Woodlands
An uncommon subxeric vegetation type found at higher elevations, oak woodlands are usually surrounded by xeric pine or pine-oak forest. Canopy dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, with persimmon, blackgum, and other hardwood species. Probably maintained by a combination of infrequent fire and edaphic factors. Pigeon and Lookout Mountain contain good but narrow ecotonal examples.

13. Pine-Oak Woodlands and Forest
Relatively open subxeric to xeric forest or woodland, typically dominated by shortleaf pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. May also include chestnut oak, scarlet oak, and other dry-site hardwood species. Includes typical shortleaf pine-post oak woodlands as well as mixed pine-oak scrub and dry pine-oak forest.

14. Red Maple/Blackgum Swamps
Nonalluvial or small stream swamp forests dominated by red maple and swamp blackgum. These are often found along small low-gradient streams, in shallow

depressions, or on wet flats. Often boggy, with a layer of peat, these wetlands have been impacted by construction of drainage ditches.

15. Sagponds (Isolated Depressional Wetlands)
Depressions formed by subsidence of soil due to groundwater percolation in the underlying rock. Contain a variety of vegetation types from freshwater emergents to swamp forest, depending on hydroperiod and other factors. Forested types are usually dominated by willow oak, swamp blackgum, and red maple. These unusual wetlands may include disjunct coastal plain species.

16. Sandstone Barrens and Outcrops
This edaphic habitat type includes sandstone boulders and outcrops of the Appalachian (Cumberland) Plateau as well as scoured sandstone ledges near streams. These open, rocky habitats are typically bordered by Virginia and shortleaf pine, chestnut oak, and a variety of shrubs.

17. Springs and Spring Runs; Gravelly Seeps
Springs are highly localized points of groundwater discharge that typically feed spring runs, while seeps may be broader or less defined areas of perennial or seasonal flows. The Ridge & Valley region contains a number of high-discharge springs. The waters of springs and associated habitats can be highly variable, depending on hydrology. These perennially cool and clear waters provide important habitat to a number of animal species, particularly salamanders and fish such as the coldwater darter.

18. Streams
Moderate to low gradient streams running through lower coves and valleys. Riffle, pool, and shoal habitats may be present. Substrates include gravel, pebbles, boulders, and bedrock. Aquatic plants may also be present. Pools are often silt-bottomed. These streams become turbid after rain. These are generally more productive than headwater streams because of limestone valley bottoms.

19. Underground Streams
Includes streams of all sizes flowing through caves and other underground passages. These aquatic systems are important for rare species such as the southern cavefish and Tennessee cave salamander.

Problems Affecting Wildlife Diversity

One of the factors impacting wildlife diversity in the Southwestern Appalachians/Ridge & Valley region is an increase in residential and commercial development along major highways and on the outskirts of metropolitan areas. This has resulted in loss of both agricultural and forest land, and has resulted in habitat fragmentation as new roads and utility corridors have been constructed. Much of the development of industrial and commercial sites has occurred along Interstate Highway 75 and other major highways. Expansion of the Chattanooga metropolitan area has resulted in significant residential development in several counties in Northwest Georgia, with associated subdivisions, roads, utility corridors, and retail centers. Other metropolitan areas experiencing significant growth in this region include Rome, Dalton, Calhoun, Chatsworth and Trenton. Much of the industrial development in this region has occurred in the valleys near major streams and roads. Residential development has occurred in these same areas, but increasingly houses and subdivisions are being constructed in more remote locations, including secluded coves, steep forested slopes and along the brows of Lookout Mountain and Sand Mountain.

Past conversion of forest and woodland habitats to agricultural uses has resulted in the loss of virtually all river floodplain forest and associated habitats such as canebrakes in this region. The fertile valleys and river bottoms are employed for a wide variety of agricultural uses, including row crops, pasture, and hay fields. In several watersheds (e.g., West Chickamauga Creek) vegetated stream buffers are often too narrow to provide adequate erosion control, and in some areas livestock have unrestricted access to streams. These practices result in a general degradation of water quality and habitat for aquatic species. Expanding vegetated stream buffers and restricting livestock access to streams would provide significant benefits to some of Georgia's most imperiled aquatic species.

Based on Environmental Protection Division monitoring data for 2012, approximately 31% of monitored streams in the Southwestern Appalachians/Ridge & Valley ecoregions support designated uses (as measured by percent of total monitored stream miles); 67% did not support designated uses, and 2% were pending assessment. The percentage of monitored stream miles not supporting designated uses is the highest of all ecoregions. Point-source discharges into streams in this region include effluent from industrial facilities and treated wastewater from municipal treatment facilities. Other stressors of water quality include nutrient, pesticide or sediment inputs from roadways, cultivated fields, and pastures. Given the high number of imperiled mollusks in this ecoregion, improvements in water quality are a high priority for maintenance of wildlife diversity.

Groundwater withdrawals for industrial, municipal, and residential uses as well as contamination of groundwater represent potential impacts to sensitive karst environments such as caves. This region contains the vast majority of Georgia's 600+ caves. Most of these caves are found on private land, and only a few have been adequately surveyed for rare cave fauna. However, occurrences of several rare species have been documented from these caves, including gray myotis, Tennessee cavefish, and Tennessee cave salamander. All of these species are particularly sensitive to changes in the quantity or quality of water in underground streams.

Construction of dams or other structures altering stream flow represents another significant problem for aquatic species in this region. Most of the major river impoundments (e.g., Lake Allatoona, Carter's Lake, Weiss Lake) affecting streams in this area lie outside the Southwestern Appalachians/Ridge & Valley ecoregions, but the impacts of these impoundments extend upstream and downstream of the dams. These impacts include loss of stream habitat, creation of migration barriers, isolation of subpopulations, and degraded water quality (low dissolved oxygen, altered water temperatures).

Conversion of upland hardwood and pine-hardwood forests to pine plantations has also resulted in impacts to wildlife diversity. While not as prevalent in this region as in other areas of the state, this conversion has resulted in a decrease in habitat for a number of declining bird species. Specific problems associated with this forest conversion include loss of vegetative structure and nesting sites, decline in hard and soft mast production, loss of understory and groundcover diversity, and physical disturbance of habitat for organisms found in leaf litter or soil.

Fire suppression is a significant problem in this region. Extension of residential and commercial development from urban centers into surrounding suburbs has resulted in many fire-dependent habitats being surrounded by highways, subdivisions, or retail centers. Concerns about smoke management, air quality, and damage to structures make it difficult to implement prescribed burn plans for some of these important habitats. For example, while a fire plan has been developed for Chickamauga-Chattanooga National Military Park, concerns about smoke management problems along heavily traveled U.S. Highway 27 and potential damage to historic structures and monuments in the park represent impediments to implementation of the plan. Throughout the region, a lack of fire has resulted in the decline in the extent and quality of habitats such as limestone terrace woods, sagponds, longleaf pine-mixed hardwood forest, oak and pine-oak woodlands and forests, calcareous prairies, canebrakes, and limestone glades and barrens.

Invasive species and diseases pose significant threats to high priority species and habitats in this region. The red shiner is an introduced fish suspected of having a serious impact on several native fish in the Coosa River system through competition and hybridization. Other exotic aquatic species of concern include the Asiatic clam and the zebra mussel (the latter is currently not known from Georgia, but is a very serious aquatic pest in other states, including Tennessee). The hemlock woolly adelgid has caused serious decline in eastern hemlock stands, and the emerald ash borer is a threat to ash trees in this ecoregion. Notable examples of nonnative plant species of concern in this region include Nepalese browntop, Chinese privet, Japanese honeysuckle, oriental bittersweet, royal paulownia, silvergrass, and autumn olive. White-nose syndrome is the primary wildlife disease impacting species of conservation concern in this ecoregion.

For some high priority species and habitats, unmanaged recreational use represents a serious problem. High levels of use by rock climbers may threaten habitats such as sandstone barrens and limestone ledges and impact associated rare species. Similarly, cave exploration by careless or inexperienced cavers can result in significant impacts to cave formations and populations of rare cave fauna. Indiscriminant use of all-terrain vehicles (ATVs) and other vehicles in or adjacent to streams, springs, calcareous flatwoods, or rare edaphically controlled communities such as calcareous prairies and limestone glades can result in significant impacts to high priority species and habitats.

Incompatible road and utility corridor management pose problems for some high priority plant species such as Cumberland rose gentian, royal catchfly, and prairie purple coneflower. For these species, use of herbicides and other vegetation management tools should be planned and implemented in a way that minimizes impacts to rare plant populations occurring in the road right-of-way or utility corridor.

High Priority Sites and Landscape Features

The current assessment and previous conservation planning efforts have identified a number of important sites and landscape features in the Southwestern Appalachians and Ridge & Valley ecoregions (The Nature Conservancy 2003, Edwards et al. 2013). The following are examples of high priority conservation sites in these ecoregions.

Blacks Bluff

This steep-sloped bluff located along the Coosa River near Rome contains populations of limerock arrowwood and large flowered skullcap, as well as examples of mesic hardwood forest. The Nature Conservancy owns and manages this site as Blacks Bluff Preserve. Similar Coosa River bluff environments are found nearby and are in need of permanent protection.

Carbondale Swamp

This relatively small wetland site surrounded by residential and industrial development is notable for containing a population of least trillium and an example of calcareous flatwoods habitat. This wetland habitat is considered globally rare. A mitigation site acquired by the Georgia Department of Transportation contains the only protected example of this habitat in Georgia.

Chickamauga-Chattanooga National Military Park

This 5,100-acre tract is owned and managed by the National Park Service. Important natural communities contained in this site include examples of cedar glades and open redcedar woodlands. High priority species include least gladecress, white prairie clover, and several other rare calciphiles found in Georgia only from this area. Cedar glade habitats in this area have been impacted by decades of fire suppression, which has resulted in the encroachment of woody vegetation (redcedars and shrubs) and reduction in the extent of limestone glade and barren habitats.

Coosa Valley Prairies

These remnant patches of prairie habitat contain several globally rare species of plants. Both dry prairie and wet prairie types are present within the area; these represent very distinctive and imperiled natural communities. The best examples of these prairies known in Georgia are protected through a conservation easement donated to The Nature Conservancy by former owner Temple-Inland Forest. This property, now owned by Plum Creek Timber, has been designated Critical Habitat for the federally protected whorled sunflower. A long-term monitoring and management plan developed by The

Nature Conservancy is facilitating restoration and maintenance of these prairies as well as adjacent shortleaf pine-post oak woodland habitats.

Drummond Swamp/Sagponds

Drummond Swamp is a 700+ acre site containing a large sagpond as well as the only Georgia population of Georgia alder, a species that is state protected and petitioned for federal listing. A portion of this site is protected through a conservation easement. Other sagponds are located in scattered locations in the Southern Shale Valleys area of the Ridge and Valley region. These wetlands vary in size, depth, and species composition, but often support Coastal Plain disjunct species. Sagponds are important habitats in need of long-term protection and restoration.

Lavender Mountain/Horseleg Mountain

These low mountain ridges located west of Rome contain globally significant examples of montane longleaf pine-hardwood forest, pine-oak woodland and forest, limestone glades and barrens, and mesic hardwood forest. Rare species known from this area include flatwoods rattlesnake-root, Alabama leather-flower, large-flowered skullcap, and Tennessee yellow-eyed grass. Long-term conservation of these natural habitats requires careful application of prescribed fire.

Lookout/Sand Mountain

These two mountains make up the main portion of the Southern Table Plateaus in Georgia. Important conservation sites within this 50,000+ acre landscape include Johnson Crook, Cloudland Canyon State Park, and Zahnd Natural Area. The Johnson Crook area contains more than twenty caves as well as limestone outcrops, mesic hardwood forest, and redcedar-pine woodland. At least five rare plant species have been documented from this area and the potential for discovering other rarities is high. A portion of this site has been protected the Georgia Land Trust and Southeastern Cave Conservancy. Cloudland Canyon, owned by the State of Georgia and managed as a state park, contains many rare plants and animals. Significant natural communities include limestone outcrops, caves, mesic hardwood forest, redcedar-pine woodland, seeps and springs. Zahnd Natural Area, the largest state-owned natural area in North Georgia, contains examples of sandstone barrens/outcrop, sagponds, pine-oak woodlands and forest, and underground streams.

Pigeon Mountain

Pigeon Mountain represents the easternmost segment of the Appalachian Plateau in Georgia. This site is approximately 25,000 acres, over 20,000 acres of which is state-owned or other conservation land managed as Crockford-Pigeon Mountain Wildlife Management Area. More than two dozen rare plant species are known from this site. High priority habitats include forested limestone slopes and terraces, high gradient first- and second-order streams, mesic hardwood forests, sagponds, sandstone outcrops, underground streams, and caves. The state-protected Pigeon Mountain salamander is known only from the eastern slopes of Pigeon and Lookout Mountains. Other high priority species include green salamander, limerock arrowwood, three-flowered hawthorn, and Alabama snow-wreath.

Southern Sandstone Ridges (Armuchee Ridges)

The Southern Sandstone Ridges, also known as Armuchee Ridges, comprise the major sedimentary ridges of the Ridge & Valley; notable examples include Dick Ridge and Taylor Ridge. Much of this area is owned by the federal government and managed as the Armuchee Ranger District of the Chattahoochee National Forest. The steep, forested ridges are typically stony, sandy, and low in fertility. Oak-hickory-pine forests are the dominant land cover, with small remnant stands of montane longleaf pine. A new natural community known as shale barrens has been described from this area. High priority plants known from this area include Frasier loosestrife and large-flowered skullcap. The Armuchee Ridges Priority Amphibian and Reptile Conservation Area supports a number of species endemic to karst regions, such as the cave salamander. Green salamanders occur in the rocky outcrops and brown-backed salamanders are found in artesian springs and their outflow streams.

<u>High Priority Waters</u>

Figure 12 shows the high priority streams and watersheds identified by the Aquatic Habitat Technical Team. These streams were chosen on the basis of documented occurrences of high priority aquatic species, high water quality rankings based on Index of Biotic Integrity scores, and designation as exemplary streams in a previous study by The Nature Conservancy. Examples include Conasauga River, Coosa River, Etowah River, Oostanaula River, Chattooga River, Teloga Creek, Euharlee Creek, Cedar Creek, Chattanooga Creek, Chickamauga Creek, West Chickamauga Creek, Holly Creek, Coahulla Creek, and Cole City Creek. For more information on high priority waters in this region, refer to the Aquatic Habitat Technical Team report in Appendix F.

<u>Conservation Goals</u>

- Maintain known viable populations of all high priority species and function examples of all high priority habitats through land protection, incentive-based habitat management programs on private lands, and habitat restoration and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Encourage restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic restoration, and revegetation efforts.
- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance,

developing specific educational messages, and managing exotic species populations on public lands.

- Minimize impacts from residential and commercial development on high priority species and habitats by providing input on environmental assessments
- Continue efforts to recover federally listed species by implementation of recovery plans and restore populations of other high priority species.
- Improve water quality throughout the region, with special emphasis on high priority streams

Conasauga River

The Conasauga River watershed is home to 76 species of native fish, 26 species of freshwater mussels, 20 snails, and 20 salamanders. This river flows from its origin in the Chattahoochee National Forest in Georgia northward into the Cherokee National Forest in Tennessee, then through private lands south into Georgia, eventually merging with the Oostanaula River near Resaca.

The Nature Conservancy (TNC) has been working in the Conasauga River Watershed since 1997, focusing on restoration of key reaches of the river mainstem as well as significant tributary streams such as Holly and Sumac Creeks. Restoration projects have included working with landowners and NRCS on reestablishment of riparian buffers, bank sloping, cattle fencing, and alternative watering sources for cattle, and access controls. Land protection through acquisition is also an important focus of work in the watershed.

Ongoing research conducted by the USGS and the UGA Odum School of Ecology and Georgia Museum of Natural History in the watershed has focused on monitoring fish and mussels and identifying water quality problems, threats to imperiled species, and critical sites for conservation. Much of this research has been funded through federal grants administered by the USFWS. In 2007, analysis of survey data indicated that populations of some Conasauga fish species had declined significantly over the past 5 to 7 years.

In 2008, approximately 70 participants attended the first Conasauga Summit, organized by the USFWS and TNC. The goals of the summit were to (1) inform stakeholders of the latest research results on status of imperiled fish, mussels, and other aquatic species in the basin; (2) discuss ongoing coordination activities with landowners and industry in the basin to improve water quality and habitat for these species; and (3) develop a list of important action items to recover imperiled species. Strategic Habitat Conservation is taking place by using information gathered at the Conasauga Summit to inform biological planning and conservation design, enabling conservation delivery.

In June 2009, the USFWS developed a proposal for a Conasauga National Wildlife Refuge that would protect and restore high priority aquatic and riparian habitat to facilitate recovery of rare aquatic species, provide habitat for high priority neotropical migratory birds, provide recreational opportunities to the public, and implement environmental education and interpretation programs that focus on ecosystem management and stewardship. Information on this proposed refuge can be found at: http://www.fws.gov/athens/rivers/FactSheetConasaugaRiver.pdf

Strategies and Partnerships to Achieve Conservation Goals

- Provide financial incentives and technical expertise to encourage prescribed burns, through Interagency Burn Team and other means
- Work with NRCS staff to identify high priority habitats and sites for implementation of habitat enhancement/restoration projects through Farm Bill programs (e.g., restoration of oak and shortleaf pine-oak woodlands, longleaf pine-hardwood forest, and stream buffers.)
- Use state lands and other public lands (USFS, NPS) to showcase habitat restoration efforts.
- Control invasive exotic species populations on public lands and provide technical assistance to private landowners to discourage use of invasive exotics
- Work with GDOT and local governments to minimize direct impacts to high priority species and habitats from road construction and maintenance.
- Work with Georgia Power and private landowners to identify and conserve populations of rare species in and adjacent to utility corridors
- Develop educational materials on high priority species and habitats in the ecoregion and provide these to environmental educators at WRD facilities (e.g., Arrowhead Education Center) and other facilities
- Work with NRCS, GFC, and GFA to revise forestry BMPs for better protection of streams and wetlands and maintenance of important wildlife habitats
- Work with The Nature Conservancy, USFWS, Georgia Land Conservation Center and local land trusts to provide protection for high priority wetlands and stream corridors.

Highest Priority Conservation Actions

Highest priority conservation actions (ranked “Very High” or “High”) identified by the technical teams, advisory committee, and other stakeholders specifically for these two ecoregions include the following (see Appendix P for details):

- Continue and expand monitoring of rare species throughout the Coosa Basin and evaluate this approach for use in other basins. Continue DNR’s Stream Team surveys throughout the Coosa River Basin and UGA aquatic surveys and monitoring efforts in the Etowah and Conasauga River systems.
- Continue long-term monitoring of Pigeon Mountain salamander and other cave-inhabiting salamander populations; conduct surveys for other high priority cave and outcrop species.
- Monitor populations of gray bats in caves; conduct monitoring of caves with populations of other bats currently affected or likely to be affected by WNS. Count bats and coordinate with researchers studying the disease and potential treatment options.
- Implement occupancy sampling for freshwater mussels and snails in the under sampled reaches of the upper Coosa, including Coosawattee, Oostanaula, and Chattooga rivers.

- Continue assessment of water quality and contaminants in the Conasauga River system. Identify major toxicological stressors and the tributaries or mainstem reaches that provide the greatest concentrations of stressors. Continue evaluation of ditches as a source for nutrients and herbicides
- Protect critical reaches of the Conasauga River system through targeted acquisition and easements with willing landowners. Provide targeted outreach and technical transfer to farmers to help minimize agricultural impacts to river.

For highest priority conservation actions of statewide scope, see Section V of this report.

Bird Conservation in the Southwestern Appalachians/Ridge & Valley Ecoregions

The greatest bird conservation issue in these ecoregions is conversion of hardwood and mixed pine/hardwood forest to loblolly pine plantations, residential or commercial developments, or agricultural uses. A large percentage of natural vegetation has been converted for other uses, and mature forest and the birds dependent on mature forest are less secure here than in any other region in the Southern Appalachians. The long-term health of populations of priority birds including Acadian Flycatcher, Wood Thrush, and Yellow-throated Warbler will depend on maintenance and management of remnant forest stands as well as aggressive restoration efforts. It is recommended that at least eight upland hardwood forest patches greater than 4,000 hectares be sustained and that the number of such patches in the 4,000 to 40,000 hectare range be increased. More than 80% of the mixed mesophytic hardwood acreage within these patches should be managed for long rotation or old growth.

Existing short-rotation pine, while of less benefit to birds than mature forest, is nevertheless much more valuable than more intensive land uses, and it is recommended that the current percentage of land in this cover type be retained. All existing southern yellow pine and mixed pine hardwood habitats should be actively and appropriately managed with fire to improve habitat quality, and acreage should be increased where possible by reforestation of abandoned agricultural fields. Priority species associated with mature pine forests in the Ridge and Valley include Bachman's Sparrow and Brown-headed Nuthatch.

Table 4. Southwestern Appalachians/Ridge & Valley High Priority Animals (110 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
AA	Cambarus cymatilis	Conasauga Blue Burrower	G1	S1		E	Sandy clay burrows up to 1 mile from nearest stream
AA	Cambarus distans	Boxclaw Crayfish	G5	S1			Clear cool streams under debris or clean slab rocks; streams can dry to isolated pools
AA	Cambarus extraneus	Chickamauga Crayfish	G2	S2		T	Small to medium shallow rocky streams with moderate current
AA	Cambarus fasciatus	Etowah Crayfish	G3	S2		T	Lotic habitats under rocks in flowing water
AA	Cambarus manningi	Greensaddle Crayfish	G4	S1?			Rocky riffles in streams with moderate to swift current
AA	Cambarus scotti	Chattooga River Crayfish	G3	S2		T	Rocky riffles in streams with moderate to swift current
AA	Cambarus unestami	Blackbarred Crayfish	G2	S3		T	High elevation streams with bedrock or rocks
AA	Gomphus consanguis	Cherokee Clubtail	G3	S2		T	Spring-fed moderately-flowing forest streams, especially where they drain small ponds
AA	Ophiogomphus incurvatus	Appalachian Snaketail	G3T2T3	S2			Small to medium spring-fed streams with mud and gravel bottoms.
AM	Ambystoma tigrinum tigrinum	Eastern Tiger Salamander	G5	S3S4			isolated wetlands for breeding; variety of open, upland habitats; CP - sandhills, oldfields, dry pine savanna
AM	Aneides aeneus	Green Salamander	G3G4	S3		R	Moist rock crevices; canopies of trees; within hardwood forests
AM	Cryptobranchus alleganiensis	Hellbender	G3G4	S3		T	Clear, rocky streams within Tennessee River drainages and Cartacay River
AM	Eurycea aquatica	Brown-backed Salamander	G3	S1			springs in RV and Cumberland Plateau
AM	Gyrinophilus palleucus	Tennessee Cave Salamander	G2G3	S1		T	Streams in caves; substrates include rock, gravel, sand, and mud
AM	Plethodon petraeus	Pigeon Mountain Salamander	G2	S2		R	Moist, rocky woods; cave entrances
BI	Ammodramus savannarum pratensis	Grasshopper Sparrow	G5	S4			Breeds in grasslands, pasture lands, PD RV, rare in CP. Wintering range poorly known.
BI	Colinus virginianus	Northern Bobwhite	G5	S5			Early successional habitat, open pine savanna (frequent fire maintained in small burn unit size), fallow habitats associated with crop lands, extensive forest regen areas (area sensitive - minimal fall pop of 700 birds for viability on 3000+acres)
BI	Euphagus carolinus	Rusty Blackbird	G4	S3			Bottomland forest, pecan orchards, agricultural fields
BI	Grus americana	Whooping Crane	G1	S1	LE		Open, mostly emergent herbaceous freshwater wetlands and fields for stop-over sites
BI	Haliaeetus leucocephalus	Bald Eagle	G5	S3		T	Edges of lakes & large rivers; seacoasts
BI	Ixobrychus exilis	Least Bittern	G5	S3			Fresh and brackish water wetlands with emergent herbaceous cover including impoundments, natural freshwater marshes, and tidally influenced marshes
BI	Lanius ludovicianus	Loggerhead Shrike	G4T3Q	S3			Open woods; field edges, pastures, ball fields, industrial park, primary dunes, hammocks
BI	Limnothlypis swainsonii	Swainson's Warbler	G4	S3			Dense undergrowth or canebrakes in swamps and river floodplains, small mountain pop in rhododendron and mountain laurel thickets
BI	Peucaea aestivalis	Bachman's Sparrow	G3	S2		R	Open pine or oak woods; old fields; brushy areas, young large grassy pine regeneration areas
BI	Protonotaria citrea	Prothonotary Warbler	G5	S4			Bottomland forest, swamps, and similar forested wetlands. Nests in tree cavities.
BI	Tyto alba	Barn Owl	G5	SU			Nests in large hollow trees or old buildings (particularly cement silos) in areas with extensive pasture or grassland or other open habitats such as marsh
FI	Acipenser fulvescens	Lake Sturgeon	G3G4	S3			Large freshwater rivers & lakes over clean firm substrate
FI	Cyprinella caerulea	Blue Shiner	G2	S2	LT	E	Flowing runs and pools in streams with cool water and firm substrates

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 4. Southwestern Appalachians/Ridge & Valley High Priority Animals (110 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Erimonax monachus	Spotfin Chub	G2	SX	LT		Large creeks to medium-sized rivers; moderate to swift currents over gravel to bedrock
FI	Etheostoma cinereum	Ashy Darter	G2G3	SX			Medium to large upland streams in slackwater areas with silt-free substrate and cover such as boulders or snags
FI	Etheostoma ditrema	Coldwater Darter	G2	S1		E	Vegetated springs and spring runs or small streams with spring influence
FI	Etheostoma duryi	Blackside Snubnose Darter	G4	S1		R	Small to medium streams, gravel to cobble bottoms; riffles and pools
FI	Etheostoma etowahae	Etowah Darter	G1	S1	LE	E	moderate to high gradient streams over cobble to gravel in areas of swift current
FI	Etheostoma rufilineatum	Redline Darter	G5	S1S3			Swift shallow riffles of rocky streams
FI	Etheostoma rupestre	Rock Darter	G4	S2		R	Swift rocky riffles often associated with attached vegetation such as Podostemum
FI	Etheostoma scotti	Cherokee Darter	G2	S2	LT	T	Small to medium-sized creeks with moderate current and rocky substrates
FI	Etheostoma trisella	Trispot Darter	G1	S1		E	Breeding: vegetated spring seepage areas typical Nonbreeding: clear streams in vegetated shallow slackwater areas
FI	Fundulus catenatus	Northern Studfish	G5	S2		R	Margins of small to medium streams in areas of sluggish to moderate current
FI	Hemitremia flammea	Flame Chub	G3	S1		E	Springs and springfed streams; often associated with aquatic vegetation
FI	Hiodon tergisus	Mooneye	G5	S1			Usually found near the surface of large streams, rivers, and swift tailwaters of locks and dams
FI	Hybopsis lineapunctata	Lined Chub	G3G4	S2		R	Upland creeks over sandy substrate with gentle current
FI	Hybopsis sp. 9	Etowah Chub	G1Q	S1S2			Generally in creeks and small to medium rivers over sand-silt bottom, usually in pools adjacent to riffle areas. Tends to occupy smaller streams in east than in west.
FI	Ichthyomyzon bdellium	Ohio Lamprey	G3G4	S1		R	Medium to large rivers, mud to gravel bottoms; riffles in small tributaries
FI	Lampetra aepyptera	Least Brook Lamprey	G5	S2			ammocoetes associated with mud, silt, and macrophytes. Adults associated with sand and gravel.
FI	Lythrurus lirus	Mountain Shiner	G4	S3			Cool, clear streams in flowing water over sandy to rocky substrates
FI	Macrhybopsis sp. 1	Coosa Chub	G3G4	S1		E	Fast water in large streams and rivers
FI	Moxostoma carinatum	River Redhorse	G4	S3		R	Swift waters of medium to large rivers
FI	Notropis ariommus	Popeye Shiner	G3	S1		E	Large streams and small rivers in flowing pools areas over gravel
FI	Notropis asperifrons	Burrhead Shiner	G4	S2		T	Small streams to medium-sized rivers in pools, slow runs, and backwater areas
FI	Noturus eleutherus	Mountain Madtom	G4	S1		E	Riffle areas in medium to large rivers over coarse gravel and rubble
FI	Noturus flavipinnis	Yellowfin Madtom	G1	SX	LT		Pools and backwaters of medium-sized creeks; gravel and pebble substrate
FI	Noturus munitus	Frecklebelly Madtom	G3	S1		E	Shoals and riffles of moderate to large streams and rivers
FI	Percina antesella	Amber Darter	G1G2	S1	LE	E	Riffles & runs of medium-sized rivers, patches of sand and small gravel, riverweed
FI	Percina jenkinsi	Conasauga Logperch	G1	S1	LE	E	Fast-flowing chutes and pools over clean substrates of gravel or cobbles
FI	Percina kusha	Bridled Darter	G2	S1		E	Flowing pools and runs in large streams and small to medium sized rivers with clear water
FI	Percina lenticula	Freckled Darter	G3	S2		E	Swift deep runs of main river channels around large woody debris, possibly over a rocky substrate
FI	Percina sciera	Dusky Darter	G5	S3		R	Large creeks and rivers in moderate current associated with woody debris, undercut banks, or vegetation

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Table 4. Southwestern Appalachians/Ridge & Valley High Priority Animals (110 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Percina tanasi	Snail Darter	G2G3	S1	LT	E	Large streams to medium-sized rivers in riffle areas with sand or gravel substrate
FI	Phenacobius uranops	Stargazing Minnow	G4	S1		T	Riffle areas in small to medium rivers
FI	Phoxinus tennesseensis	Tennessee Dace	G3	S1		E	pool areas of clear headwater creeks, typically less than 2 m in width
FI	Typhlichthys subterraneus	Southern Cavefish	G4	S1		E	Underground streams
MA	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	G3G4	S3		R	Pine forests; hardwood forests; caves; abandoned buildings; bridges; bottomland hardwood forests and cypress-gum swamps
MA	Myotis grisescens	Gray Myotis	G3	S1	LE	E	Caves with flowing water or with large creeks or bodies of water nearby, also storm sewers and artificial caves in other states. Unknown summer roosts in eastern portion of GA range. Marble mines?
MA	Myotis leibii	Eastern Small-footed Myotis	G3	S2			Caves; mines; abandoned buildings, bridges, rock shelters in mountainous areas; high elevation talus fields
MA	Myotis lucifugus	Little Brown Myotis	G3	S3			Caves & mines; mixed forests, structures, bat houses
MA	Myotis septentrionalis	Northern Myotis	G2G3	S2S3			Caves & mines in winter; riparian areas, upland forests, cracks and crevices in dead and live trees in summer
MA	Myotis sodalis	Indiana Myotis	G2	S1	LE	E	Limestone caves with pools; wooded areas near streams, upland forests, large snags in open areas including ridge tops
MA	Perimyotis subflavus	Tri-colored Bat	G3	S5			Open forests with large trees and woodland edges; roost in tree foliage; hibernate in caves or mines with high humidity.
MA	Spilogale putorius	Eastern Spotted Skunk	G4	S3			brushy, rocky, wooded habitats; avoids wetlands
MO	Campeloma regulare	Cylinder campeloma	G4	S2			Large rivers to small streams along margins
MO	Elimia ornata	Ornate Elimia	G1	S1			Medium sized rivers
MO	Elimia striatula	File Elimia	G2	S1			Creeks, spring/spring brook
MO	Elliptio arca	Alabama Spike	G2G3Q	S1		E	Med creeks to Lg rivers; sand and gravel substrate
MO	Elliptio arctata	Delicate Spike	G2G3Q	S2		E	Creeks and rivers with moderate current; mainly in crevices and under large rocks in silt deposits
MO	Hamiota altilis	Finelined Pocketbook	G2G3	S2	LT	T	Small streams to large rivers; sand, gravel, and cobble substrates; usually not in swift current
MO	Lampsilis straminea	Southern Fatmucket	G5T	S2			Small creeks to rivers in slow to moderate current; sand, sandy mud and gravel substrates
MO	Lasmigona holstonia	Tennessee Heelsplitter	G3	S1			Small to large creeks; Occurs often in small creeks and medium sized rivers and spring runs. Sandy substrates, may be mixed with some gravel or mud
MO	Leptoxis foremani	Interrupted Rocksnail	G1	S1	E	E	Rocky shoals in current.
MO	Leptoxis praerosa	Onyx Rocksnail	G5	S1			Big rivers, found on algae covered rocks in strong current
MO	Medionidus acutissimus	Alabama Moccasinshell	G2	S1	LT	T	Large rivers to medium sized creeks; sand and gravel substrate; slow to swift current
MO	Medionidus conradicus	Cumberland Moccasinshell	G3G4	S1			Large creeks in TN Basin tributaries; shoal and run habitats; sand and gravel, frequently occurs under large, flat rocks
MO	Medionidus parvulus	Coosa Moccasinshell	G1Q	S1	LE	E	Shoal areas of large rivers to medium sized creeks with sand and gravel substrates.
MO	Pleurobema decisum	Southern Clubshell	G2	S1	LE	E	Large rivers to medium sized streams with flowing water; gravel with interstitial sand
MO	Pleurobema georgianum	Southern Pigtoe	G1	S1	LE	E	Large rivers to medium sized creeks in riffles, runs, and shoals; sand and gravel substrate

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Table 4. Southwestern Appalachians/Ridge & Valley High Priority Animals (110 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
MO	Pleurobema hanleyianum	Georgia Pigtoe	G1	S1	E	E	Large rivers to medium sized creeks; mainstem only, not in tribs
MO	Pleurobema hartmanianum	Cherokee Pigtoe	G1	S1			Appears to have been restricted to shoal habitats based on historical collection data.
MO	Pleurocera pyrenella	Skirted Hornsnail	G2	S2			Mountain streams
MO	Pleurocera showalteri	Upland Hornsnail	G2Q	S1			Medium sized rivers
MO	Pleurocera vestita	Brook hornsnail	G3	S2			Aquatic habitats
MO	Pleuronaia barnesiana	Tennessee Pigtoe	G2G3	S1			small streams to large rivers with flowing water in TN Basin tributaries; stable gravel with interstitial sand
MO	Ptychobranchus fasciolaris	Kidneyshell	G4G5	S1			Small creeks to large rivers with moderately strong current in substrate of coarse gravel and sand
MO	Ptychobranchus foremanianus	Rayed Kidneyshell	G1	S1		E	Medium to large rivers in moderate to swift current; sand and gravel substrate
MO	Strophitus connasaugaensis	Alabama Creekmussel	G3	S1		E	Large rivers to medium sized creeks with moderate current; sand and gravel substrate
MO	Toxolasma corvunculus	Southern Purple Lilliput	G1	S1?			Flowing waters of creeks to medium rivers
MO	Villosa nebulosa	Alabama Rainbow	G3	S2			Large rivers to small streams; flowing water with gravel and sand substrates, may be found in fine sediments among cobble and boulders
MO	Villosa umbrans	Coosa Creekshell	G2	S2			gravel and sand substrates in shoal and riffle habitats
RE	Graptemys pulchra	Alabama Map Turtle	G4	S3		R	Rivers & large streams
RE	Pituophis melanoleucus melanoleucus	Northern Pine Snake	G4T4	S2			Dry pine or pine-hardwood forests
TA	Amblyscirtes belli	Bell's Roadside-skipper	G3G4	S3			Wet hardwoods, river oats
TA	Amblyscirtes carolina	Carolina roadside-skipper	G3G4	S2S3			Wet situations with cane
TA	Amblyscirtes reversa	Reversed roadside-skipper	G3G4	S2S3			Wet hardwoods, cane, hardwood slopes with cane
TA	Autochton cellus	Golden-banded skipper	G4	S2			Hog peanut, areas of intact groundcover
TA	Bombus affinis	Rusty-patched bumblebee	G1	SH			
TA	Danaus plexippus	Monarch butterfly	G4	S4			Milkweeds
TA	Erora laeta	Early hairstreak	GU	S2S3			Hardwood, beech trees
TA	Euphydryas phaeton	Baltimore checkerspot	G4	S2			Chattahoochee River parks
TA	Pieris virginiensis	West Virginia White	G3	S3			Hardwoods
TA	Satyrium edwardsii	Edwards hairstreak	G4	S3			Blackjack oak
TA	Speyeria diana	Diana fritillary	G3G4	S3			Hardwood forests
TA	Temnothorax_GA_01	Temnothorax new species	GNR	SU			Ridge forest, Quercus monticola branches

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 5. Southwestern Appalachians/Ridge & Valley High Priority Plants (65 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Aesculus glabra	Ohio Buckeye	G5	S2			Mesic forests in circumneutral soil
Agalinis decemloba	Ten-lobed Purple Foxglove	G4Q	S1			Dry, grassy meadows.
Agastache nepetoides	Yellow Giant Hyssop	G5	S1			Openings in rich hardwoods
Alnus maritima ssp. georgiensis	Georgia Alder	G3T1	S1		T	Open, spring-fed swamps
Amelanchier sanguinea	Roundleaf Serviceberry	G5	S1?			Rocky slopes
Anemone berlandieri	Glade Windflower	G4?	S1S2			Granite outcrop ecotones; openings over basic rock
Arabis georgiana	Georgia Rockcress	G1	S1	C	T	Rocky or sandy river bluffs and banks, in circumneutral soil
Asclepias purpurascens	Purple Milkweed	G5?	S1		R	Calcareous flatwoods, wet meadows near Rome
Aureolaria patula	Spreading Yellow Foxglove	G3	S1		T	Circumneutral alluvial bottoms
Baptisia australis var. aberrans	Glade Blue Wild Indigo	G5T2	S2			Limestone glades and barrens
Berberis canadensis	American Barberry	G3	S1		E	Cherty, thinly wooded slopes
Buchnera americana	American Bluehearts	G5?	S1			Wet meadows; seasonally moist barrens and limestone glades
Calamovilfa arcuata	Cumberland Sandreed	G2G3	S1			Georgia habitat information not available
Carya laciniosa	Shellbark Hickory	G5	S2?			Bottomland forests
Carya myristiciformis	Nutmeg Hickory	G4	S1		R	Calcareous flatwoods
Chelone lyonii	Appalachian Turtlehead	G4	SNR			Wet woods, streamsides, fens of S. Appalachians
Clematis fremontii	Fremont's Leatherflower	G5	S1		E	Grassy openings in flatwoods of mostly lowland oaks and red maple
Clematis socialis	Alabama Leather Flower	G1	S1	LE	E	Grassy openings in flatwoods of mostly lowland oaks and red maple
Crataegus aemula	Rome Hawthorn	G2G3	S2?			Upland hardwood forests; creek flats
Crataegus mendosa	Albertville Hawthorn	G2G3Q	S1			Rocky woods, glades
Crataegus mollis	Downy Hawthorn	G5	SNR			Georgia habitat information not available
Crataegus triflora	Three-Flower Hawthorn	G2G3	S1		T	Hardwood forests on rocky, limestone slopes
Delphinium alabamicum	Alabama Larkspur	G2	SH			gravel hills in limestone glades
Desmodium ochroleucum	Cream-Flowered Tick-Trefoil	G1G2	S1		T	Open, calcareous woodlands, including lower slope of Pigeon Mountain
Dulichium sp. nov. (unpublished)	Coosa Prairie Threeway Sedge	GNR	S1			Coosa wet prairies
Echinacea simulata	Prairie Purple Coneflower	G4	S2S3			Remnant prairies in the Coosa flatwoods near Rome
Helianthus verticillatus	Whorled Sunflower	G1Q	S1	C	E	Remnant prairies
Hydrastis canadensis	Goldenseal	G3G4	S2		E	Rich woods in circumneutral soil
Jamesianthus alabamensis	Jamesianthus	G3	S1		E	Streambanks, in circumneutral soil
Juglans cinerea	Butternut	G4	S2			Openings in bottomland forests and in the mesophytic hardwood forests of rich mountain coves
Leavenworthia exigua var. exigua	Least Gladecress	G4T3	S2		T	Limestone glades
Lilium canadense	Canada Lily	G5	S2?			Openings in rich woods
Lilium michiganense	Michigan Lily	G5	S1		R	Remnant wet prairies andcalcareous flatwoods
Lilium philadelphicum	Wood Lily	G5	S1		E	Wet meadows over sandstone
Lysimachia fraseri	Fraser's Loosestrife	G3	S2		R	Moist, open, bouldery gravel bars and streambanks; edges of sandstone and granite outcrops
Marshallia mohrii	Coosa Barbara's-Buttons	G3	S2	LT	T	Remnant Coosa Valley prairies; maintained rights-of-way
Marshallia trinervia	Broadleaf Barbara's-Buttons	G3	S1S2			Streamsides in open, bouldery gravel bars and washed, sandy banks

Table 5. Southwestern Appalachians/Ridge & Valley High Priority Plants (65 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Neviusia alabamensis	Alabama Snow-Wreath	G2	S1		T	Along wet weather streams over limestone
Onosmodium molle ssp. occidentale	Western Marble-Seed	G4G5T4?	S1			Limestone glades and adjacent woods
Panax quinquefolius	American Ginseng	G3G4	S3			Mesic hardwood forests; cove hardwood forests
Philadelphus pubescens	Hairy Mockorange	G5?	S1			Limestone ledges and rocky banks
Platanthera integrilabia	Monkeyface Orchid	G2G3	S1S2	C	T	Red maple-gum swamps; peaty seeps and streambanks with Parnassia asarifolia and Oxypolis rigidior
Polymnia laevigata	Tennessee Leafcup	G3	S1			Bouldery slopes
Quercus similis	Swamp Post Oak	G4	S1			Bottomland swamps and other wet habitats
Rhynchospora thornei	Thorne's Beakrush	G3	S2			Margins of limesink ponds; moist limestone barrens, wet prairies
Rudbeckia heliopsidis	Little River Black-Eyed Susan	G2	S1		T	Limestone or sandstone barrens and streamsides
Sabatia capitata	Cumberland Rose Gentian	G2	S2		R	Meadows over sandstone or shale
Sagittaria secundifolia	Little River Water-Plantain	G1	S1	LT	T	Crevices in sandstone in fast flowing streams
Scutellaria montana	Large-Flower Skullcap	G4	S3	LT	T	Mesic hardwood-shortleaf pine forests; usually mature forest with open understory, sometimes without a pine component
Silene regia	Royal Catchfly	G3	S1		E	Limestone barrens; remnant prairies
Silphium mohrii	Cumberland Rosinweed	G3?Q	S1?			Rocky hardwood forests
Solidago arenicola	Black Warrier Goldenrod	G2G3	S1			Georgia habitat information not available
Spiraea virginiana	Virginia Spirea	G2	S1	LT	T	Bouldery gravel bars and ledges along major streams
Spiranthes magnicamporum	Great Plains Ladies-Tresses	G4	S1		E	Limestone glades
Symphyotrichum georgianum	Georgia Aster	G3	S2	C	T	Upland oak-hickory-pine forests and openings; sometimes with Echinacea laevigata or over amphibolite
Thalictrum debile	Trailing Meadowrue	G2	S1		T	Mesic hardwood forests over limestone
Thaspium pinnatifidum	Cutleaf Meadow-Parsnip	G2G3	S1		E	Limestone outcrops and barrens
Thermopsis fraxinifolia	Ash-Leaved Bush-Pea	G3?	S2?			Oak and oak-pine ridge forests
Thermopsis villosa	Carolina Golden Banner	G3?	S1?			Mesic forests, floodplains and roadsides; mostly in sandy soils
Trillium pusillum	Least Trillium	G3	S1		E	Red maple-blackgum swampy woods in sticky clay soils
Trillium sp. nov. (unpublished)	Lookout Mountain Toadshade	GNR	S2			Hemlock-mixed hardwood bluffs
Veratrum woodii	Ozark Bunchflower	G5	S2		R	Mesic hardwood forests over basic soils
Viburnum bracteatum	Limerock Arrowwood	G1G2	S1		E	Mesic hardwood forests over limestone
Xerophyllum asphodeloides	Eastern Turkeybeard	G4	S1		R	Xeric oak-pine forests
Xyris tennesseensis	Tennessee Yellow-Eyed Grass	G2	S1	LE	E	Seepy margins of limestone spring runs

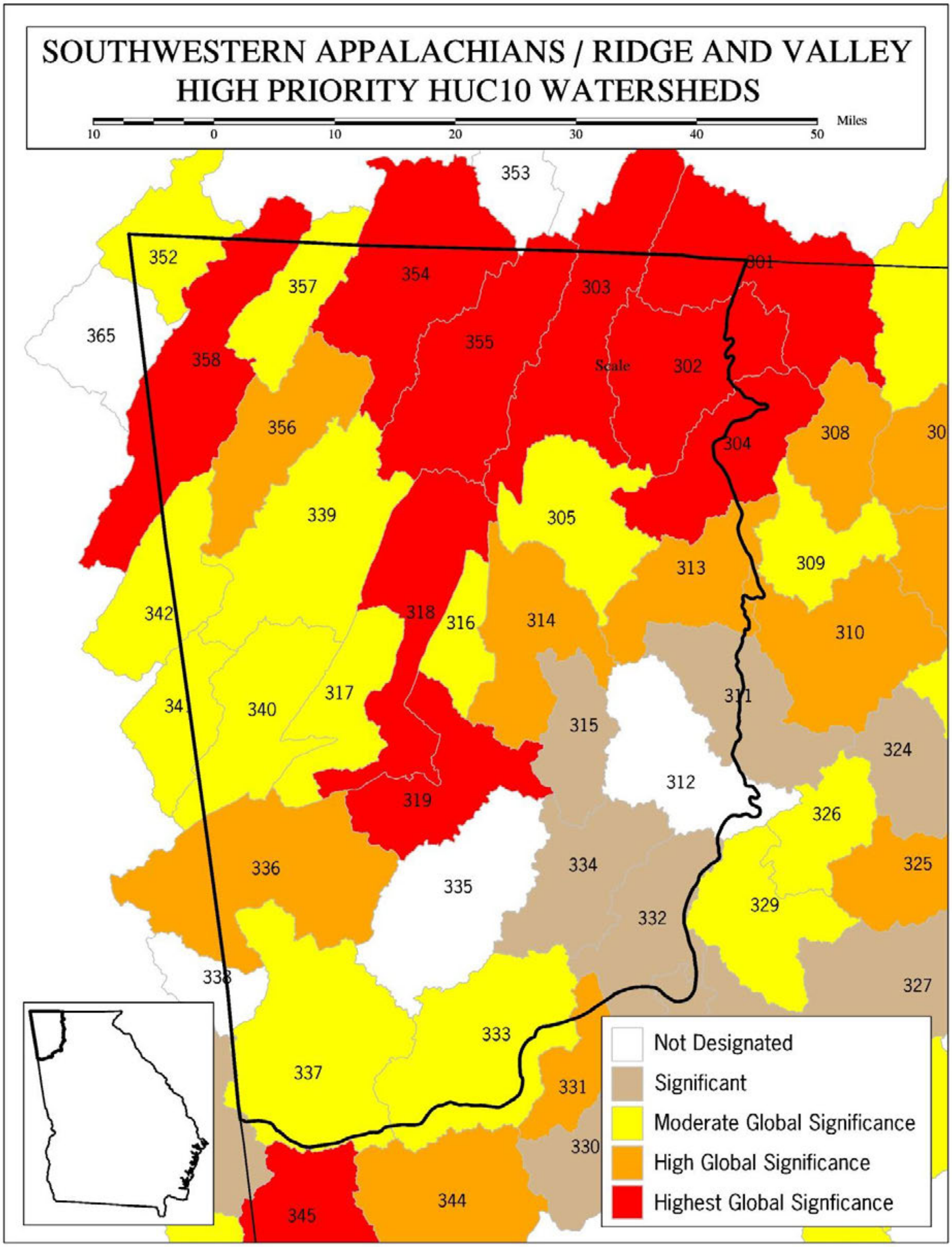

Figure 12. High Priority Waters, Southwestern Appalachians/Ridge & Valley Ecoregions

Blue Ridge Ecoregion

Ecoregional Overview

The Blue Ridge ecoregion of Georgia covers approximately 1,694,412 acres. This total includes approximately 688,528 acres in conservation ownership. Georgia DNR manages 25,217 acres owned in fee simple by the State of Georgia and an additional 34,620 acres through leases or management agreements. Most of the conservation land (approximately 613,000 acres) in the region is owned by the federal government and managed by the USDA Forest Service. Other federal land managers include the Department of Defense (8,605 acres) and the Tennessee Valley Authority (5,066 acres). This ecoregion has a higher percentage of land in conservation use (42.2%) than all of the other ecoregions.

Landforms of the Blue Ridge range from narrow ridges to hilly plateaus to more massive mountainous areas with high peaks. The mostly forested slopes, high-gradient, cool, clear streams, and rugged terrain occur on a mix of igneous, metamorphic, and sedimentary geology. High peaks in this region may have annual precipitation of over 70 inches. The southern Blue Ridge is one of the richest centers of biodiversity in North America. Characteristic vegetation includes northern hardwood forest, submesic oak forests, heath thickets, shrub balds, hemlock-hardwood-white pine forests, cove hardwood forests, and mountain bogs. The three subdivisions of the Blue Ridge ecoregion in Georgia are the Southern Crystalline Ridges and Mountains, the Southern Metasedimentary Mountains, and the Broad Basins.

The Southern Crystalline Ridges and Mountains include the highest and wettest mountains in Georgia. These occur primarily on Precambrian igneous and metamorphic rocks. The common crystalline rock types include gneiss, schist, and quartzite. Soils are well-drained, acidic, and loamy. Mafic and ultramafic rocks also occur, contributing to circumneutral soils. Elevations of this rough, dissected region range from approximately 1800 feet to over 4000 feet; Brasstown Bald, the highest point in Georgia is 4,784 feet above mean sea level. Although there are a few small areas of pasture, orchards, and other clearings, this region is mostly forested.

The Southern Metasedimentary Mountains contain rocks that are generally not as strongly metamorphosed as those in the Southern Crystalline Mountains. The geologic materials are mostly late Precambrian and include slate, conglomerate, phyllite, metagraywacke, metasiltstone, metasandstone, and quartzite, with some schist and gneiss. Although the highest peaks are lower than in the preceding region, there are some isolated rugged mountains, such as the Cohuttas, Rich Mountain, and Fort Mountain.

The Broad Basins region is drier, and has lower elevations and less relief than the two preceding regions. Soils in this region are generally deep, well-drained, and loamy to clayey. Although this rolling foothills region is mostly forested, it has more pasture than adjacent regions as well as areas of row crops and truck crops on terraces and floodplains. Much of the pasture and corn crops support local cattle, hog, or poultry operations.

The predominant landcover types in the Blue Ridge ecoregion are deciduous/mixed forest and evergreen forest (Kramer and Elliott, 2004). An analysis of land use changes from 1974 to 1998 based on satellite imagery indicated the following general trends:

- A decrease in row crop/pasture (from 7.31% of total landcover to 6.66%)
- An increase in high-intensity and low-intensity urban (from 1.26% of total landcover to 4.81%)
- An increase in clearcut/sparse vegetation (from 1.20% of total landcover to 3.16%)
- A decrease in evergreen forest (from 17.25% of total landcover to 12.12%)
- A very slight increase in deciduous/mixed forest (from 71.25% of total landcover to 71.69%)

These trends indicated a slight decline in the total acreage devoted to active agricultural uses, a significant increase in residential and commercial development, an increase in disturbance related habitats (probably representing harvest or loss of pine-dominated stands) and essentially no change in the predominant land cover type, deciduous/mixed forest during this period.

An analysis of land use change from 2006 to 2011 indicates a 2.9% increase in open water, 1.6% increase in developed land, 1.8% decrease in agricultural land, 0.8% decrease in forest land, 15.3% increase in early successional vegetation, and no change in wetland landcover. These figures confirm a continuation of decline in agricultural and forest land and an increase in developed land. The significant increase in early successional landcover classes (barren, herbaceous, and scrub/shrub) is likely a result of higher rates of timber harvest during the early portion of this six-year period, when timber prices were relatively high. See Appendix N for more information on recent landcover trends.

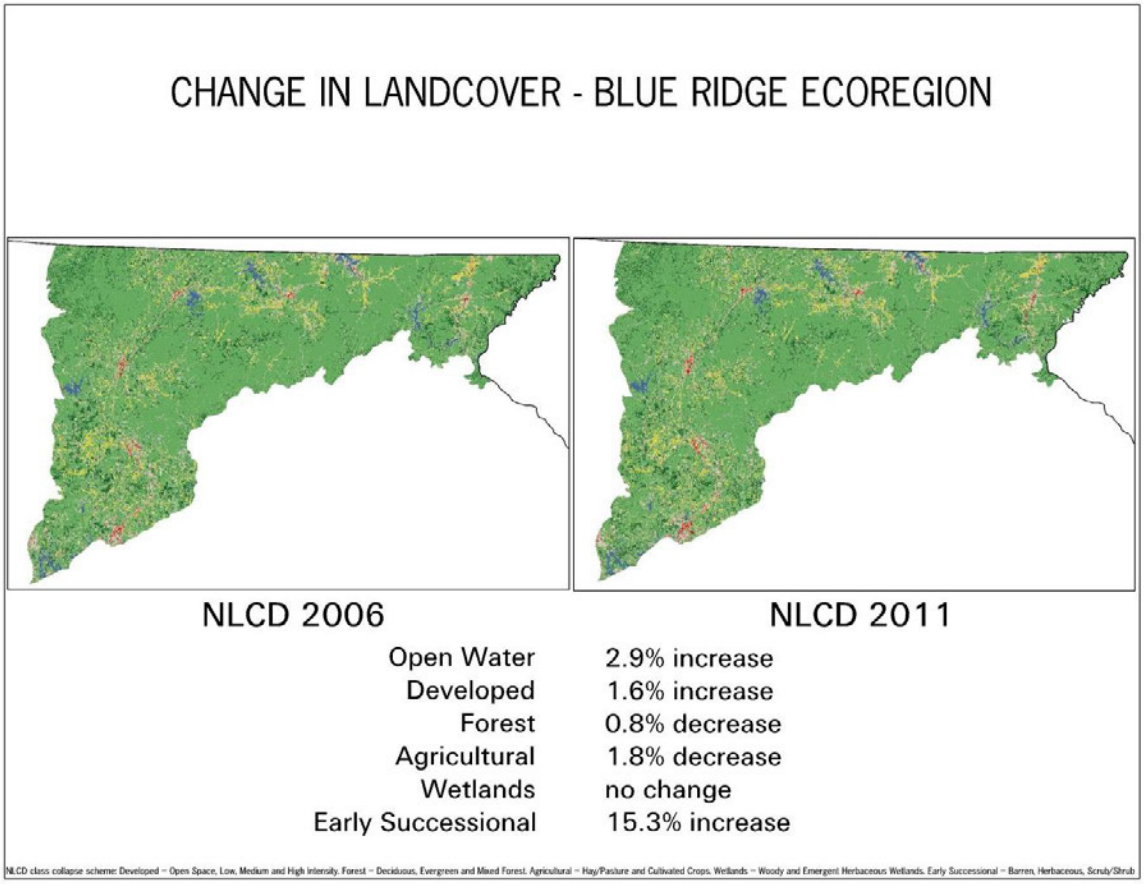

Figure 13. Change in landcover from 2006 to 2011 in the Blue Ridge ecoregion.

High Priority Species and Habitats

The technical teams identified 89 high priority animal species in the Blue Ridge ecoregion. These included 9 birds, 14 mammals, 2 reptiles, 3 amphibians, 35 fish, 3 mollusks, 9 aquatic arthropods, and 15 terrestrial arthropods. These species are listed in Table 6, with information on global and state rarity ranks, protected status (if any) under federal or state law, and habitat and range in Georgia. In addition, 66 species of high priority plants were identified for the Blue Ridge. These are listed in Table 7.

High priority habitats for the Blue Ridge ecoregion are described below:

1. Boulderfield Forests
High elevation mesic hardwood forest; dominated by broadleaf deciduous trees, occupying north-facing areas with angular rocks or blocks of rock and little visible soil. Includes rich flora with northern affinities. Typically very mesic, with trees such as yellow buckeye, sweet birch, yellow birch, rosebay rhododendron. A rare community of the Blue Ridge; only a few examples are known.

2. Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most examples in this ecoregion are small and fire-suppressed.

3. Caves, Rock Shelters, Talus Slopes
These habitats share characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. These habitats are usually embedded in a larger matrix of forest habitats. The Blue Ridge contains relatively few caves; these are typically fracture-type caves rather than solution caves. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes.

4. Floodplain Hardwood Forests
Forested wetlands characterized by a diverse association of deciduous hardwood trees, including both montane and low-elevation species. Generally lacking in the more flood-adapted oaks and hickories prevalent in Piedmont bottomland hardwood forests. Many of these floodplain forests were converted to agricultural uses early in the history of settlement of this region.

5. Hemlock-Hardwood-White Pine Forests
Mesic and submesic forests dominated by a mixed canopy of hardwoods and hemlock and/or white pine. Hemlock forests are typically found along small to medium streams, in sheltered valleys and ravines. Thickets of rhododendron and mountain laurel frequently form a dense understory, which is important for many neotropical migratory birds. White pine may share dominance with oak-dominated forests in low- to mid-elevation slopes and sheltered low ridges. A serious threat to this forest type is the hemlock wooly adelgid, which is spreading from east to west across the region. A rare subtype of this forest type containing Carolina hemlock is found in scattered locations in the lower Blue Ridge.

6. High-Elevation Early Successional Habitats
Includes a variety of vegetation types found at high elevations that are maintained by periodic natural or anthropogenic disturbance. Many high priority species are dependent on this habitat type, including the golden-winged warbler, Appalachian Bewick's wren, star-nosed mole, pygmy shrew, and fringed gentian.

7. High Elevation Forested Heath Thickets
High elevation habitats characterized by dense thickets of ericaceous shrubs under an open canopy of hardwood trees. Herbaceous layer is sparse to patchy. Typical shrubs include huckleberry, mountain laurel, and rosebay rhododendron.

8. High Elevation Rocky Summits and Shrub Balds

These are small patch habitats typically found only on the highest peaks of the Blue Ridge in association with northern hardwood forest. Characterized by a mosaic of exposed rock and patches of shrub or herb-dominated vegetation. Trees are mostly dwarfed northern red oak. Shrubs may include Catawba rhododendron, mountain laurel, huckleberry, mountain ash, viburnum, and hawthorn.

9. Low Elevation Seepy Thickets and Wet Woods

Seasonally inundated or spring-fed wetland habitats. Thickets are dominated by a variety of shrubs. Includes forested habitats along seepage slopes and at the edge of mountain bogs, some of which are maintained by the actions of beaver.

10. Medium to Large Rivers

Moderate to high gradient rivers with cold, clear riffles, pools, and runs. Substrates may include boulders, bedrock, gravel, and pebbles. Many of these rivers traverse steep gorges. These aquatic habitats are low in productivity compared to streams of the Southwestern Appalachians/Ridge & Valley.

11. Mixed Pine-Hardwood Forests

Mesic to submesic forests of hardwoods and pines, typically at middle to low elevations over a broad range of topographic conditions. A large patch habitat that comprises a major forest type of the Blue Ridge. Dominants may include yellow-poplar, sweetgum, various oaks, and loblolly, white, and/or shortleaf pine.

12. Moist Cliff Faces and Spray Cliffs

Vertical to gently sloping rock faces located adjacent to waterfalls or seepage zones. These are wetlands dominated by mosses, liverworts, vascular herbs, and sparse shrubs or scrubby trees adapted to thin soils and high humidity. These small patch habitats represent unusually stable environments, where temperatures are moderated by the constant spray or seepage. Include many bryophytes and ferns representing disjunct occurrences from tropical regions as well as Southern Appalachian endemics.

13. Mountain Bogs and Wet Meadows

A mosaic of wetland communities usually dominated by shrubs or emergent herbs, with scattered trees. May occur as elongate bands along stream valleys, or in much smaller and more compact patches on flats or slopes. Includes wetlands maintained by beaver activity as well as small, sheltered seepage areas along the headwaters of mountain creeks.

14. Northern Hardwood Forests

High elevation mesic forests found in upper coves, flats and slopes with northerly aspects, usually at elevations above 3,500 ft. Dominant canopy species include American beech, yellow birch, sugar maple, and yellow buckeye, with white basswood, northern red oak, white ash, and black cherry also present. These forests are subject to broad scale disturbances such as ice storms. Old growth examples are rare and usually restricted to steeply sloped, inaccessible areas.

15. Oak Forest and Woodlands

This vegetation type includes a wide variety of upland forests dominated by Appalachian oaks. Composition and complexity of oak forests vary with elevation, slope and moisture. In more mesic sites, canopy dominants may include red oak, white oak, and black oak, along with hickories and mesophytic hardwoods. Canopy dominants of more xeric sites may include mountain chestnut oak, scarlet oak, southern red oak, and northern red oak. Also includes subxeric or xeric oak woodlands found on ridges and upper slopes at high elevations. These oak-dominated forests and woodlands represent the most extensive natural vegetation type of the Blue Ridge.

16. Pine-Oak Woodlands and Forest

Relatively open subxeric forest to xeric woodland, typically dominated by shortleaf pine, pitch pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. A rare subtype is found on serpentine soils. Pitch pine, Virginia pine, red maple and post oak are the dominant canopy trees in this rare community; understory trees of sourwood, dogwood and sassafras are usually thinly scattered and shrubs are sparse to dense.

17. Rich Mesic Hardwood Forests (Cove Hardwoods)

The mixed mesophytic hardwood forests of the Southern Appalachians are the most biologically diverse habitats in the United States. Variations of this forest type can be found in the Blue Ridge at elevations from 1,000 to 3,800 ft. They are typically found in mesic sites on concave landforms and ravines, or on protected north and east-facing slopes at low elevations. A diverse mixture of mesophytic trees dominates the canopy, including yellow poplar, white basswood, sugar maple, yellow and sweet birch, cucumber magnolia, yellow buckeye, black cherry, eastern hemlock, white ash, blackgum, American beech, red maple, and various oaks and hickories.

18. Rocky Bluffs and Streambanks

Plant composition of these rocky streamside habitats is variable, depending on stream size, amount of rock, and extent of flooding. These periodically scoured rocky habitats typically support few trees and sparse to moderate shrubs (sometimes thickets). A diverse stratum of light-loving herbs may be present.

19. Springs and Spring Runs; Gravelly Seeps

Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. These cool clean waters provide important habitat to a number of animal species, particularly salamanders.

20. Streams

Cold, clear, high gradient streams typically containing riffles, plunge-pools, cascades, and waterfalls. Substrata dominated by bedrock and boulders, but sand and gravel may also be present in depositional areas. These streams have low productivity and aquatic vegetation is rarely present.

21. Xeric Pine Woodlands

A heterogeneous group of xeric pine-dominated woodlands found on ridges and steep slopes with southerly aspects, knobs, and low-elevation peaks. Below 2,400 ft. shortleaf pine is a dominant, with Virginia pine a common associate. From 2,400 to 2,800 ft. on the driest ridges pitch pine dominates. Above 2,800 ft. on slopes and ridges, Table Mountain pine dominates. All of these habitats require periodic fire for maintenance.

Problems Affecting Wildlife Diversity

One of the primary factors impacting habitats and species in the Blue Ridge region is the rapid pace of residential and commercial development along major highways and on the outskirts of metropolitan areas. Much of this development is occurring as a result of an influx of people from other areas of the state as well as immigrants from other states. New industrial and commercial sites have been developed along recently improved highways, including Georgia Highways 515 and U.S. Highways 19, 76, 129, 441, and 575. Metropolitan areas experiencing significant growth in this region include Clayton, Jasper, Blue Ridge, and Dawsonville.

Valleys and river bottoms in the Blue Ridge region have long been employed for a wide variety of agricultural uses, including row crops, pasture, and hay fields. In some watersheds vegetated stream buffers are too narrow to provide adequate erosion control, and in some areas livestock have unrestricted access to streams. These practices result in a general degradation of water quality and habitat for aquatic species. Expanding vegetated stream buffers and restricting livestock access to streams would provide significant benefits to imperiled aquatic species.

Point-source discharges into streams in this region include wastewater industrial facilities, and municipal treatment facilities. According to EPD stream monitoring data for 2012, 58% of streams meet designated uses (based on percentage of total monitored stream miles); 41% do not support designated uses, with 1% of stream segments pending assessment. The percentage of monitored streams meeting designated uses is the highest of all five Georgia ecoregions, due in large part to the high proportions of forest cover and conservation land.

Conversion of upland hardwood and pine-hardwood forests to pine plantations has also resulted in impacts to wildlife diversity. Specific problems associated with this forest conversion include loss of vegetative structure and nesting sites, decline in hard and soft mast production, loss of understory and groundcover diversity, and physical disturbance of habitat for organisms found in leaf litter or soil.

Fire suppression is also a significant problem in this region. Extension of residential and commercial development from urban centers into surrounding suburbs has resulted in many fire-dependent habitats being surrounded by highways, subdivisions, or retail centers. Concerns about smoke management, air quality, and damage to structures make it difficult to implement prescribed burn plans for some of these important habitats. Throughout the region, a lack of fire has resulted in the decline in the extent and quality of habitats such as canebrakes, oak woodlands, and table mountain pine woodlands. Difficulties in implementing prescribed fire programs in the interface between residential and conservation lands present obstacles for restoration of these important habitats.

Invasive nonnative species pose significant threats to high priority species and habitats in this region. Feral hogs are a particularly noxious problem, due to their fecundity and indiscriminant use of habitats. Exotic plant species of concern include Nepalese browntop, Chinese privet, Japanese honeysuckle, oriental bittersweet, royal paulownia, kudzu, and autumn olive. A particularly important nonnative forest pest is the hemlock wooly adelgid, which has spread across the Georgia Blue Ridge from east to west, causing significant losses of eastern hemlock forest. The hemlock wooly adelgid also poses a direct threat to populations of the rare Carolina hemlock. In addition to impacts on forest communities, this pest threatens adjacent stream communities by causing loss of streamside vegetation. The USDA Forest Service is currently implementing various control measures against this invasive organism. Other insect pests that threaten forests in this region include the European gypsy moth and emerald ash borer.

Non-native fungal diseases have also disrupted forest communities at landscape scales--most notably, the chestnut blight fungus, which eliminated the American chestnut as a canopy tree in Georgia and greatly altered the vegetation and ecology of forests throughout the Blue Ridge. Dogwood anthracnose, caused by a non-native fungus, is currently a threat to eastern dogwood trees, especially those in dense, mesic forests. An introduced fungus, *Pseudogymnoascus destructans* (*Pd*) is the causative agent for white-nose syndrome, which has caused bat declines of over 90% in some caves in this ecoregion. This disease threatens formerly common species such as the tricolor bat, and is the primary threat to the northern long-eared bat, recently listed under provisions of the federal Endangered Species Act.

For some high priority species and habitats, unmanaged recreational use represents a serious problem. High levels of use by rock climbers and hikers may threaten habitats such as high elevation summits and spray cliffs/gorge walls. Similarly, exploration by unethical or inexperienced cavers can result in significant impacts to caves and spread the *Pd* fungus that causes white-nose syndrome from one cave to another. Indiscriminant use of all-terrain vehicles (ATVs) and other vehicles in or adjacent to streams or wetlands or on steep side slopes can result in significant impacts to aquatic habitats.

Construction of dams or other structures altering stream flow represents another significant problem for aquatic species in this region. These impacts, from impoundments such as Rabun Lake, Hiawassee Lake, and Lake Seed, include impaired water quality, barriers to migration, and isolation of subpopulations of aquatic species. Construction of new water supply reservoirs represents a threat to high priority aquatic species in this ecoregion.

Incompatible road and utility corridor management represent problems for some high priority plants such fringed gentian, large-flowered skullcap, persistent trillium, and Carolina hemlock. For these species, use of herbicides and other vegetation management tools should be planned and implemented in a way that minimizes impacts to rare plant populations occurring in the road right-of-way or utility corridor.

High Priority Sites and Landscape Features

The current assessment and previous conservation planning efforts have identified a number of important sites and landscape features in this region of the state. An assessment of the Blue Ridge ecoregion conducted by The Nature Conservancy in cooperation with state natural heritage programs in Georgia, Tennessee, North Carolina, South Carolina, and Virginia identified 33 high priority conservation areas in Georgia representing approximately 149,300 acres (The Nature Conservancy, 2000). Recent field surveys have identified additional sites. The following are examples of important sites and landscape features in the Blue Ridge ecoregion.

Amicalola Creek Watershed/Dawson Forest WMA

This site contains a number of rare species, including the Etowah darter, holiday darter and eastern turkeybeard . Much of the immediate Amicalola Creek corridor is protected by state ownership and managed as Dawson Forest WMA, but residential development is impacting terrestrial and aquatic habitats in the watershed. This site lies on the border of the Blue Ridge and Piedmont ecoregions. A portion of Amicalola Creek has been proposed for study as a potential State Scenic River.

Blood Mountain/Coosa Bald/Sosebee Cove

This 3,200-acre site, found within the Chattahoochee National Forest, includes important examples of shrub bald, northern hardwood forest, and boulderfield forest habitats. These high-elevation habitats are rare in Georgia, and are recognized as important habitats in the Chattahoochee-Oconee National Forest Plan. Other examples of priority high-elevation habitats can be found at Tray Mountain, Brasstown Bald, and Rabun Bald. Perhaps the most significant long-term threat to these cool, moist environments and their associated species is global warming.

Chattooga Basin/Highlands Plateau

This 119,600 acre conservation landscape spans the upper Chattooga watershed in Georgia and South Carolina and the Highlands Plateau region in North Carolina. In Georgia, this area includes Cedar Cliffs, Buzzard Rock Cliffs, and the Ellicott Rock Wilderness Area. Numerous rare species and significant natural communities are contained within this landscape unit. The Upper Chattooga Basin is a designated Priority Amphibian and Reptile Conservation Area and supports high salamander diversity. It is the only place in Georgia with southern Appalachian and southern gray-cheeked salamanders. Green salamanders occur in forested areas with rock-outcroppings. While most of the area in Georgia is protected by special designation within the Chattahoochee National Forest, habitats in privately owned tracts within this area are being impacted by residential development. Another threat to this and many other conservation sites in the Blue Ridge is the hemlock wooly adelgid.

Etowah River Watershed

The Etowah River has its headwaters in the Blue Ridge Mountains. The upper portion of the Etowah River watershed provides habitat for numerous rare species, including a dozen species of imperiled fish and freshwater mussels. Several rare plants have also been documented from the Etowah River corridor. This watershed is threatened by residential and industrial development. This watershed was the subject of a grant to develop a Habitat Conservation Plan for federally listed aquatic species. In addition, a portion of the Etowah River was proposed for study as a potential State Scenic River.

Fort Mountain/Cohutta Mountains

This conservation site encompasses the western portion of the Cohutta Mountains and includes a number of important habitats including cove hardwood forest, mixed pine-hardwood forest, rock shelters, xeric pine-oak woodlands, and rocky bluffs/streambanks. Abandoned mines in the area provide suitable habitat for several species of bats. The Cohutta Mountain area is perhaps the largest contiguously forested upland region in the state, with attendant high salamander diversity. The area contains the headwaters of the Conasauga River. Most of this conservation site is under federal (USDA Forest Service) or state (Georgia DNR) management.

Hiawassee Seeps/Nantahala Mountains

This site, which straddles the Georgia-North Carolina border, includes important seep/wet meadow habitats that support the green pitcherplant and other bog species. It is threatened by residential development and associated hydrologic alterations in the landscape. While this is the only extant population of green pitcherplant in Georgia, similar low elevation seeps and bogs are found in scattered locations in the Hiawassee River drainage and elsewhere in the Blue Ridge of Georgia. The Nantahala Mountains region is a Priority Amphibian and Reptile Conservation Area. This site supports high salamander diversity as well as populations of eastern milk snakes and coal skinks.

Tallulah Gorge/Tugaloo Basin

Tallulah Gorge is a deep (600 ft.), narrow quartzitic rock gorge with sheer, almost vertical walls. The Tallulah River has been dammed to create a series of reservoirs, but much of the gorge and surrounding land is in relatively undisturbed condition. Important natural communities in this area include mesic cove hardwood forests, xeric pine-oak forests, and quartzitic cliffs. Rare species known from this area include persistent trillium, monkeyface orchid, Carolina hemlock, and green salamander. In 2015, a peregrine falcon nest was documented from the gorge walls, the first such nest in the wild in Georgia for over 80 years. Much of Tallulah Gorge is now managed as a state park, and adjacent property is managed by the USDA Forest Service. The Tugaloo Basin has the second highest salamander species richness in Georgia, and includes all but one of the known populations of the locally endemic patch-nosed salamander, as well as green salamanders.

Toms Swamp

This site located on the Chattahoochee National Forest includes mountain bog habitat containing mountain purple pitcherplant and Carolina bog-myrtle. Bog habitat at this site has been enhanced through cooperative efforts of the U.S. Forest, Georgia Department of Natural Resources, Atlanta Botanical Garden, the State Botanical Garden of Georgia, and other members of the Georgia Plant Conservation Association. Other mountain bog sites in the Blue Ridge are being actively restored by these conservation partners.

Upper Tallulah River Watershed

The headwaters of the Tallulah River contain several important habitats including hemlock-white pine-hardwood forest, rich mesic hardwood forests, and mountain streams and rivers. High priority species known from the sheltered coves and valleys of the upper Tallulah River watershed include water shrew, hairy-tailed mole, and red squirrel.

Woody Lake Bog

This small privately owned conservation site provides habitat for the state- and federally-protected bog turtle. This and other mountain bog/wet meadow habitats in the Blue Ridge are threatened by surrounding residential or commercial developments, hydrologic alterations, and encroachment by woody vegetation. Mountain bogs and wet meadows require periodic management. Under conditions prevalent in earlier times these habitats would be maintained by a combination of fire and the action of beaver.

<u>High Priority Waters</u>

Figure 14 shows the high priority streams and watersheds identified by the Aquatic Habitat Technical Team for this ecoregion. These streams were selected on the basis of documented occurrences of high priority aquatic species, the relative rarity of those species. Examples of high priority watersheds in the Blue Ridge include Holly Creek, Conasauga River, Mountaintown Creek, Cartecay River, Talking Rock Creek, Toccoa River, Amicalola Creek, Long Swamp Creek, Shoal Creek, Cochrans Creek, Chestatee River, Brasstown Creek, Chattahoochee River, Etowah River, Chattooga River, and Little Tennessee River. Refer to the Fishes and Aquatic Invertebrates Technical Team report in Appendix E for details on the factors that contribute to the global significance score of individual watersheds.

Conservation Goals

- Maintain known viable populations of all high priority species and functional examples of all high priority habitats through land protection, incentive-based habitat management programs on private lands, and habitat restoration and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Encourage restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic restoration, and revegetation efforts.
- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance, developing specific educational messages, and managing exotic species populations on public lands.
- Minimize impacts from residential and commercial development on high priority species and habitats by providing input on environmental assessments
- Continue efforts to recover federally listed species by implementation of recovery plans and restore populations of other high priority species.

Strategies and Partnerships to Achieve Conservation Goals

- Support efforts by the U.S. Forest Service to implement prescribed burns to restore high priority habitats, including oak woodlands, table mountain pine stands, and shortleaf pine-post oak woodlands.
- Provide fire training and equipment to WRD and PRHS staff and encourage participation in interagency fire teams.
- Work with NRCS staff to identify high priority habitats and sites for implementation of habitat enhancement/restoration projects through Farm Bill programs (e.g., restoration of canebrakes, xeric pine woodlands, pine-oak woodlands/forest, and oak forest/woodlands)
- Prioritize control efforts for exotic species on public lands and provide technical assistance to private landowners to discourage use of invasive exotics
- Use state parks, wildlife management areas, and national forest lands to showcase habitat restoration efforts.
- Work with GDOT and local governments to minimize direct impacts to high priority species and habitats from road development projects
- Work with Georgia Power and private landowners to identify and conserve populations of rare species in and adjacent to utility corridors
- Develop educational materials on high priority species and habitats in the ecoregion and provide these to environmental educators at WRD facilities (e.g., Smithgall-Dukes Creek Conservation Area) and other facilities
- Work with the U.S. Forest Service, The Nature Conservancy, Georgia Land Conservation Center and local land trusts to provide protection for high priority wetlands and stream corridors.

- Share data on rare species and significant natural communities with staff of the Chattahoochee National Forest and provide input into forest management plans and biological evaluations.
- Provide enforcement to limit illegal ATV use. Work with ATV groups and ATV manufacturers to promote responsible use.
- Continue efforts to monitor ginseng trade through the Ginseng Management Program, and investigate illegal trade in nongame plants and animals.

Highest Priority Conservation Actions

Highest priority conservation actions (actions ranked "Very High" or "High") identified by the technical teams, Steering Committee, and other stakeholders specifically for this ecoregion include the following (see Appendix P for details):

- Conduct monitoring of caves with populations of bats currently affected or likely to be affected by white nose syndrome. Count bats and coordinate with researchers studying the disease and potential treatment options.
- Continue Conasauga River mainstem monitoring of fishes and water quality. Expand project to include mussels and other rare aquatic species as appropriate. Integrate results with ongoing water quality and contaminant studies.
- Implement occupancy sampling for freshwater mussels and snails in under-sampled reaches of the upper Coosa, including Coosawattee, Oostanaula, and Chattooga rivers.
- Develop Little Tennessee River System Watershed Plan. Work with USFWS and other partners to identify on-the-ground conservation projects that will improve water quality for people and aquatic species.
- Protect critical reaches of the Conasauga River system through targeted acquisition and easements with willing landowners. Provide targeted outreach and technical transfer to farmers to help minimize agricultural impacts to river.
- Restore mountain bogs. Restore or enhance populations of rare bog plants and continue bog turtle headstart and population establishment efforts. Monitor bog turtle populations.
- Develop a Sicklefin Redhorse Conservation Agreement. Support development and actively participate in a multi-partner effort to conserve the Sicklefin Redhorse.

For highest priority conservation actions of statewide scope, see Section V.

Oak Woodland Restoration on Chattahoochee-Oconee National Forests

Restoring oak woodlands is the largest single restoration acreage objective of the Land and Resource Management Plan for Chattahoochee-Oconee National Forests. The 2004 revised plan has an objective to restore 10,000 acres of open oak woodland on the Chattahoochee and 1,000 acres on the Oconee within the first 10 years of Plan implementation. Other objectives call for additional acreage for restoration of pine, pine-oak, or oak-pine forests that share ecological characteristics with oak woodland.

Bartram (1791) and Brewster (1885) described extensive open oak and pine woodlands in their travels through the southern Appalachians, which supported a unique assemblage of plant and wildlife species. The presence of significant grass and herbaceous cover in these forests has been documented for the past 10,000 years in the pollen record (Delcourt and Delcourt 1997). Some of the wildlife species, such as northern bobwhite and golden-winged warbler, that have been recorded as common in these forest types (Brewster 1885, 1886) have decline significantly in the region (Sauer et al. 2001). Since the end of annual woods burning and the end of free-ranging herbivores in the late 1920's to early 1930's, there has been a precipitous decline in this habitat type as forest succession first closed the canopy then provided conditions for the development of dense shade tolerant but fire intolerant mid-story. Current forests are typically densely stocked, closed-canopied stands with little or no herbaceous understories.

Woodland restoration is envisioned as recreating complexes of open habitat with tree densities varying irregularly from grassland to woodland condition, often grading into surrounding open forest conditions. This irregular density is meant to mimic historical conditions created and maintained by variation in fire intensities due to slope, aspect, landform, and soil type. In general, the most open parts of these complexes would occur on drier upper slopes and ridges and on south and west aspects. Using a single upslope fire run as a 'template,' intensity is lowest at the base of the slope, builds rapidly with progress upslope, and reaches its peak at the 'shoulder' of the ridgeline at the top of the slope. Similarly, top kill of woody vegetation shows a gradient with larger stems being killed as one ascends the slope. Ridge crest fires are variable in intensity with greatest intensity occurring on narrow crests. Fire intensity drops off rapidly with increasing distance away from the point of maximum intensity, changing into a backing fire of relatively low intensity on the lee slopes. Where fires burned at large scales of thousands to tens of thousands of acres, a mosaic of conditions resulting from variable fire behavior resulted.

There are four primary treatment types needed for woodland restoration: (1) thinning (reduction) of overstory canopy, (2) largely eliminating the midstory canopy, (3) reducing the sprouting of hardwood rootstocks, especially of the fire intolerant species, and (4) reduction in the litter and duff layer depth. This will involve a combination of selective timber removal, prescribed fire, and the use of herbicides to control vigorous re-sprouting of fire intolerant hardwoods. The Chattahoochee-Oconee National Forests is currently implementing several large-scale oak woodland projects with a goal of restoring this important community to the landscape.

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Brewster, W. 1886. An ornithological reconnaissance of western North Carolina. Aug 3:94-113, 173-179.

Delcourt, H. R., and P. A. Delcourt. 1997. Pre-Columbian Native American use of fire on southern Appalachian landscapes. Conservation Biology 11:10-14.

Table 6. Blue Ridge High Priority Animals (89 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
AA	Cambarus coosawattae	Coosawattee Crayfish	G2	S2		E	Riffle habitats in the Coosawattee River system
AA	Cambarus fasciatus	Etowah Crayfish	G3	S2		T	Lotic habitats under rocks in flowing water
AA	Cambarus georgiae	Little Tennessee Crayfish	G2G3	S1		E	Flowing parts of medium size rivers with sandy-clay substrate
AA	Cambarus parrishi	Hiwassee Headwaters Crayfish	G2	S1		E	Rocky areas between riffles and in flowing runs in clear cold headwater streams
AA	Cambarus speciosus	Beautiful Crayfish	G2	S2		E	Medium-sized streams with clear water and moderate to swift current with rock-littered substrate
AA	Macromia margarita	Mountain River Cruiser	G3	S1S2			Rocky mountain streams and rivers with good current
AA	Ophiogomphus edmundo	Edmund's Snaketail	G1G2	S1		E	Clear, moderately flowing streams and rivers with riffles.
AA	Ophiogomphus incurvatus	Appalachian Snaketail	G3T2T3	S2			Small to medium spring-fed streams with mud and gravel bottoms.
AM	Aneides aeneus	Green Salamander	G3G4	S3		R	Moist rock crevices; canopies of trees; within hardwood forests
AM	Cryptobranchus alleganiensis	Hellbender	G3G4	S3		T	Clear, rocky streams within Tennessee River drainages and Cartacay River
AM	Urspelerpes brucei	Patch-nosed Salamander	G1	S1			headwater streams
BI	Colinus virginianus	Northern Bobwhite	G5	S5			Early successional habitat, open pine savanna (frequent fire maintained in small burn unit size), fallow habitats associated with crop lands, extensive forest regen areas (area sensitive - minimal fall pop of 700 birds for viability on 3000+acres)
BI	Euphagus carolinus	Rusty Blackbird	G4	S3			Bottomland forest, pecan orchards, agricultural fields
BI	Haliaeetus leucocephalus	Bald Eagle	G5	S3		T	Edges of lakes & large rivers; seacoasts
BI	Limnothlypis swainsonii	Swainson's Warbler	G4	S3			Dense undergrowth or canebrakes in swamps and river floodplains, small mountain pop in rhododendron and mountain laurel thickets
BI	Setophaga cerulea	Cerulean Warbler	G4	S1B,S2M		T	Mature deciduous forest; floodplains or other mesic conditions
BI	Setophaga kirtlandii	Kirtland's Warbler	G3G4	SNRN	LE	E	Transient; varying habitats during late spring and fall
BI	Sphyrapicus varius appalachiensis	Appalachian Yellow-bellied Sapsucker	G5	S1B,S5M			Georgia habitat information not available
BI	Tyto alba	Barn Owl	G5	SU			Nests in large hollow trees or old buildings (particularly cement silos) in areas with extensive pasture or grassland or other open habitats such as marsh
BI	Vermivora chrysoptera	Golden-winged Warbler	G4	S1B,S2M		E	Regenerating clearcuts and burned areas; overgrown pastures, open oak forest, beaver pond regeneration
FI	Acipenser fulvescens	Lake Sturgeon	G3G4	S3			Large freshwater rivers & lakes over clean firm substrate
FI	Cyprinella caerulea	Blue Shiner	G2	S2	LT	E	Flowing runs and pools in streams with cool water and firm substrates
FI	Cyprinella callitaenia	Bluestripe Shiner	G2G3	S2		R	Flowing areas in large creeks and medium-sized rivers over rocky substrates
FI	Erimystax insignis	Blotched Chub	G4	S2		E	Medium to large clear streams in moderate current with substrate of gravel to cobble
FI	Etheostoma brevirostrum	Holiday Darter	G2	S1		E	Small creeks to moderate sized rivers in gravel and bedrock pools
FI	Etheostoma chlorobranchium	Greenfin Darter	G4	S2		T	Cool to cold high elevation creeks and rivers in swift current with boulder to bedrock substrate

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 6. Blue Ridge High Priority Animals (89 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Etheostoma etowahae	Etowah Darter	G1	S1	LE	E	moderate to high gradient streams over cobble to gravel in areas of swift current
FI	Etheostoma gutselli	Tuckasegee Darter	G3G4	S2			High gradient creeks and medium-sized rivers
FI	Etheostoma rufilineatum	Redline Darter	G5	S1S3			Swift shallow riffles of rocky streams
FI	Etheostoma rupestre	Rock Darter	G4	S2		R	Swift rocky riffles often associated with attached vegetation such as Podostemum
FI	Etheostoma scotti	Cherokee Darter	G2	S2	LT	T	Small to medium-sized creeks with moderate current and rocky substrates
FI	Etheostoma vulneratum	Wounded Darter	G3	S1		E	Fast rocky riffles of small to medium rivers
FI	Hybopsis lineapunctata	Lined Chub	G3G4	S2		R	Upland creeks over sandy substrate with gentle current
FI	Lampetra aepyptera	Least Brook Lamprey	G5	S2			ammocoetes associated with mud, silt, and macrophytes. Adults associated with sand and gravel.
FI	Lythrurus lirus	Mountain Shiner	G4	S3			Cool, clear streams in flowing water over sandy to rocky substrates
FI	Macrhybopsis sp. 1	Coosa Chub	G3G4	S1		E	Fast water in large streams and rivers
FI	Micropterus chattahoochee	Chattahoochee Bass	GNR	S1			flowing sections of streams and rivers, including river shoals
FI	Micropterus sp. cf coosae "Savannah"	Bartrams Bass	GNR	S3			upland streams and rivers
FI	Moxostoma carinatum	River Redhorse	G4	S3		R	Swift waters of medium to large rivers
FI	Moxostoma sp. 2	Sicklefin Redhorse	G2Q	S1	C	E	Riffles, runs and pools in large creeks and small to medium-sized rivers. Juveniles may also occur in reservoirs downstream of spawning sites
FI	Notropis asperifrons	Burrhead Shiner	G4	S2		T	Small streams to medium-sized rivers in pools, slow runs, and backwater areas
FI	Notropis hypsilepis	Highscale Shiner	G3	S3		R	Flowing areas of small to large streams over sand or bedrock substrates
FI	Notropis photogenis	Silver Shiner	G5	S1		E	Large creeks to small rivers in riffles to flowing pools over firm substrates
FI	Notropis scepticus	Sandbar Shiner	G4	S2		R	Large streams to medium-sized rivers in flowing pools over sandy to rocky substrates
FI	Noturus munitus	Frecklebelly Madtom	G3	S1		E	Shoals and riffles of moderate to large streams and rivers
FI	Percina antesella	Amber Darter	G1G2	S1	LE	E	Riffles & runs of medium-sized rivers, patches of sand and small gravel, riverweed
FI	Percina aurantiaca	Tangerine Darter	G4	S2		E	Deep riffles and runs with boulders, cobble, or bedrock in large to moderate headwaters of Tennessee River
FI	Percina aurolineata	Goldline Darter	G2	S2	LT	E	Shallow rocky riffles with swift current in medium-sized rivers
FI	Percina crypta	Halloween Darter	G2	S2		T	larger streams in riffle/shoal habitat
FI	Percina jenkinsi	Conasauga Logperch	G1	S1	LE	E	Fast-flowing chutes and pools over clean substrates of gravel or cobbles
FI	Percina kusha	Bridled Darter	G2	S1		E	Flowing pools and runs in large streams and small to medium sized rivers with clear water
FI	Percina lenticula	Freckled Darter	G3	S2		E	Swift deep runs of main river channels around large woody debris, possibly over a rocky substrate
FI	Percina sciera	Dusky Darter	G5	S3		R	Large creeks and rivers in moderate current associated with woody debris, undercut banks, or vegetation

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 6. Blue Ridge High Priority Animals (89 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Percina squamata	Olive Darter	G3	S1		E	High gradient upland rivers with large rocky substrate in moderate to swift current
FI	Phenacobius crassilabrum	Fatlips Minnow	G3G4	S2		E	Riffle areas in small to medium rivers
MA	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	G3G4	S3		R	Pine forests; hardwood forests; caves; abandoned buildings; bridges; bottomland hardwood forests and cypress-gum swamps
MA	Mustela nivalis	Least Weasel	G5	S1			Extreme northern Georgia, meadows, fields, brushy areas, open woods
MA	Myotis leibii	Eastern Small-footed Myotis	G3	S2			Caves; mines; abandoned buildings, bridges, rock shelters in mountainous areas; high elevation talus fields
MA	Myotis lucifugus	Little Brown Myotis	G3	S3			Caves & mines; mixed forests, structures, bat houses
MA	Myotis septentrionalis	Northern Myotis	G2G3	S2S3			Caves & mines in winter; riparian areas, upland forests, cracks and crevices in dead and live trees in summer
MA	Myotis sodalis	Indiana Myotis	G2	S1	LE	E	Limestone caves with pools; wooded areas near streams, upland forests, large snags in open areas including ridge tops
MA	Parascalops breweri	Hairy-tailed Mole	G5	S1			Deciduous woodlands with thick humus; prefers well-drained light moist soil
MA	Perimyotis subflavus	Tri-colored Bat	G3	S5			Open forests with large trees and woodland edges; roost in tree foliage; hibernate in caves or mines with high humidity.
MA	Sorex dispar	Long-tailed or Rock Shrew	G4	S1			Mountainous, forested areas (deciduous or evergreen) with boulderfields, cliffline breakdown, loose talus - may also occur in and along high-gradient mtn streams
MA	Sorex palustris	Water Shrew	G5	S1			Mountainous, along small cold streams with thick overhanging riparian growth
MA	Spilogale putorius	Eastern Spotted Skunk	G4	S3			brushy, rocky, wooded habitats; avoids wetlands
MA	Sylvilagus obscurus	Appalachian Cottontail	G4	S1S2		R	heath (Vaccinium, Kalmia) thickets within high elevation forests
MA	Synaptomys cooperi	Southern Bog Lemming	G5	S1			Bogs, marshes, meadows, and upland forests with thick humus layer
MA	Tamiasciurus hudsonicus	Red Squirrel	G5	S3			Northern hardwood - Cove hardwood - Hemlock forests
MO	Elimia striatula	File Elimia	G2	S1			Creeks, spring/spring brook
MO	Strophitus connasaugaensis	Alabama Creekmussel	G3	S1		E	Large rivers to medium sized creeks with moderate current; sand and gravel substrate
MO	Villosa nebulosa	Alabama Rainbow	G3	S2			Large rivers to small streams; flowing water with gravel and sand substrates, may be found in fine sediments among cobble and boulders
RE	Glyptemys muhlenbergii	Bog Turtle	G3	S2	LT	E	Mountain bogs; wet meadows; edges of mountain streams
RE	Pituophis melanoleucus melanoleucus	Northern Pine Snake	G4T4	S2			Dry pine or pine-hardwood forests
TA	Amblyscirtes carolina	Carolina roadside-skipper	G3G4	S2S3			Wet situations with cane
TA	Amblyscirtes reversa	Reversed roadside-skipper	G3G4	S2S3			Wet hardwoods, cane, hardwood slopes with cane
TA	Autochton cellus	Golden-banded skipper	G4	S2			Hog peanut, areas of intact groundcover
TA	Bombus affinis	Rusty-patched bumblebee	G1	SH			
TA	Bombus borealis	Northern amber bumble	G4G5	S1			Northern hardwoods
TA	Danaus plexippus	Monarch butterfly	G4	S4			Milkweeds

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 6. Blue Ridge High Priority Animals (89 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
TA	Erora laeta	Early hairstreak	GU	S2S3			Hardwood, beech trees
TA	Erynnis martialis	Mottled duskywing	G3	S2			New Jersey tea, longleaf-wiregrass, mountain hardwoods
TA	Euphydryas phaeton	Baltimore checkerspot	G4	S2			Chattahoochee River parks
TA	Phyciodes batesii maconensis	Tawny crescent	G4T2T3	S2			Higher mountains in BR, wavy-leaved aster, dry banks
TA	Pieris virginiensis	West Virginia White	G3	S3			Hardwoods
TA	Polygonia faunus	Green comma	G5T3T4	S3			Hardwoods, higher elevations
TA	Satyrium edwardsii	Edwards hairstreak	G4	S3			Blackjack oak
TA	Speyeria diana	Diana fritillary	G3G4	S3			Hardwood forests
TA	Temnothorax_GA_01	Temnothorax new species	GNR	SU			Mixed open forest

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 7. Blue Ridge High Priority Plants (66 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Agalinis decemloba	Ten-lobed Purple Foxglove	G4Q	S1			Dry, grassy meadows.
Agastache scrophulariifolia	Purple Giant Hyssop	G4	SH			Forested floodplains; river terraces
Amelanchier sanguinea	Roundleaf Serviceberry	G5	S1?			Rocky slopes
Berberis canadensis	American Barberry	G3	S1		E	Cherty, thinly wooded slopes
Buchnera americana	American Bluehearts	G5?	S1			Wet meadows; seasonally moist barrens and limestone glades
Carex acidicola	Acid-Loving Sedge	G2G3	S2?			Granite outcrop woodlands
Carex biltmoreana	Biltmore Sedge	G3	S1		T	High elevation ledges and rock faces
Chelone cuthbertii	Cuthbert's Turtlehead	G3	S1		T	Bogs and wet meadows
Coreopsis rosea	Pink Tickseed	G3	S1			Banks of blackwater rivers; pond shores
Cymophyllus fraserianus	Fraser's Sedge	G4	S1		T	Mixed hardwood-hemlock forests
Danthonia epilis	Bog Oat-Grass	G3G4	S1?			Mountain bogs
Diplophyllum andrewsii	Andrews' Diplophyllum (Liverwort)	G3	SNR			Occurs as a pioneer on partly or strongly shaded (rarely quite sunny) open mineral soil, especially on loamy soil of roadside banks, or on eroding banks along streams, more rarely on soil and the accumulating detritus at the foot of ledges, where it may invade rock crevices.
Euphorbia purpurea	Glade Spurge	G3	S1			Seeps over amphibolite
Fothergilla major	Large Witch-Alder	G3	S1		T	Rocky (sandstone, granite) woods; bouldery stream margins
Frullania appalachiana	Appalachian Frullania	G1?	S1?			On tree trunks and decaying wood above 3800 ft.
Gentianopsis crinita	Fringed Gentian	G5	S1		T	Wet meadows and grassy roadsides over circumneutral soils
Gymnoderma lineare	Rock Gnome Lichen	G3	S1	LE	E	Moist cliff faces
Helianthus glaucophyllus	Whiteleaf Sunflower	G3G4	S1			Open, oak-hickory woods above 2500 ft.
Helianthus smithii	Smith's Sunflower	G2Q	S1			Dry open woods and thickets
Helodium blandowii	Blandow's Feather Moss	G5	S1?			On tree bases, hummocks in montane seeps
Helonias bullata	Swamp-Pink	G3	S1	LT	T	Open swamps
Hydrastis canadensis	Goldenseal	G3G4	S2		E	Rich woods in circumneutral soil
Hypnum cupressiforme var. filiforme	Filiform Cypress-Moss	G5TNR	S2?			Hanging as green threads from rocks or bark, perhaps above 3800 ft.
Isotria medeoloides	Small Whorled Pogonia	G2	S2	LT	T	Mixed hardwood- pine forests with open understory; history of nearby heavy logging, homesite or road clearing activity
Juglans cinerea	Butternut	G4	S2			Openings in bottomland forests and in the mesophytic hardwood forests of rich mountain coves
Kalmia carolina	Carolina Bog Myrtle	G4	S1		T	Open swamps and wet meadows; mountain bogs and Atlantic white-cedar swamps
Leiophyllum buxifolium	Sand-Myrtle	G4	S1		T	High altitude rocky ledges
Lejeunea blomquistii	Blomquist's Lejeunea	G1G2	SH			Waterfall spray zones
Lilium canadense	Canada Lily	G5	S2?			Openings in rich woods
Liparis loeselii	Fen Orchid	G5	S1			Ultramafic fens
Lysimachia fraseri	Fraser's Loosestrife	G3	S2		R	Moist, open, bouldery gravel bars and streambanks; edges of sandstone and granite outcrops
Megaceros aenigmaticus	Headwaters Hornwort	G3	S1		T	Shaded rocks in small streams, springs or waterfall spray zones
Monotropsis odorata	Sweet Pinesap	G3	S1		T	Upland forests

Table 7. Blue Ridge High Priority Plants (66 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Oncophorus raui	Rau's Oncophorus Moss	G3	SNR			Moist acidic rocks or cliffs near streams and waterfalls
Packera millefolia	Blue Ridge Golden Ragwort	G2	S1		T	High elevation rock outcrops
Panax quinquefolius	American Ginseng	G3G4	S3			Mesic hardwood forests; cove hardwood forests
Panax trifolius	Dwarf Ginseng	G5	S1			Mesic hardwood-coniferous forests
Pedicularis lanceolata	Swamp Lousewort	G5	S1		E	Bogs and wet woods
Plagiochila caduciloba	Brittle-Lobed Leafy Liverwort	G2	S1?			Moist cliff faces
Plagiochila sharpii	Sharp's Leafy Liverwort	G2G4	S1?			Moist cliff faces and spray zones
Plagiomnium carolinianum	Carolina Wavy-Leaf Moss	G3	S2?			Moist cliff faces
Platanthera flava var. herbiola	Pale Green Orchid	G4?T4Q	SH			Red maple-gum swamps
Platanthera grandiflora	Large Purple Fringed Orchid	G5	S1			Wet thickets; seepy open northern hardwood forests
Platanthera integrilabia	Monkeyface Orchid	G2G3	S1S2	C	T	Red maple-gum swamps; peaty seeps and streambanks with Parnassia asarifolia and Oxypolis rigidior
Platanthera peramoena	Purple Fringeless Orchid	G5	S1			Wet meadows, openings among bottomland hardwoods
Platyhypnidium pringlei	Pringle's Platyhypnidium	G2G3	S1			Seepy rock cliffs
Pohlia rabunbaldensis	Rabun Bald Feather-Moss	G1	S1?			Rocky moist openings, select high balds
Quercus similis	Swamp Post Oak	G4	S1			Bottomland swamps and other wet habitats
Sanguisorba canadensis	Canada Burnet	G5	S1		T	Seepy meadows and thickets
Sarracenia oreophila	Green Pitcherplant	G2	S1	LE	E	Wet meadows; upland bogs
Sarracenia purpurea var. montana	Mountain Purple Pitcherplant	G5T1T3	S1		E	Mountain bogs
Shortia galacifolia	Oconee Bells	G2G3	S1		E	Mesic forests with mountain laurel and rhododendron
Sibbaldiopsis tridentata	Three-Toothed Cinquefoil	G5	S1		E	Rocky summits
Silene ovata	Mountain Catchfly	G3	S1S2		R	Mesic deciduous or beech-magnolia forests over limestone; bouldery, high elevation oak forests
Solidago simulans	Cliffside Goldenrod	G2	S1		E	Seepy summits of granite domes; moist, steep, rocky slopesand cliffs
Spiraea latifolia	Broadleaf Bog Meadowsweet	G5T5	S1			Mountain bogs; roadside seepage slopes
Streptopus lanceolatus var. lanceolatus	Rosy Twisted-Stalk	G5T5	S1		T	High elevations boulderfields
Symphyotrichum georgianum	Georgia Aster	G3	S2	C	T	Upland oak-hickory-pine forests and openings; sometimes with Echinacea laevigata or over amphibolite
Thalictrum coriaceum	Appalachian Meadowrue	G4	S1?			Rich woods
Thermopsis fraxinifolia	Ash-Leaved Bush-Pea	G3?	S2?			Oak and oak-pine ridge forests
Thermopsis villosa	Carolina Golden Banner	G3?	S1?			Mesic forests, floodplains and roadsides; mostly in sandy soils
Trillium persistens	Persistent Trillium	G1	S1	LE	E	Mesic hardwood forests, upland forests
Trillium sp. nov. (unpublished)	Amicalola Trillium	GNR	S1			Mixed hardwood bluffs
Triphora trianthophora	Three-Birds Orchid	G3G4	S2?			Loamy soils of rhododendron thickets; hardwood forests
Tsuga caroliniana	Carolina Hemlock	G3	S1		E	Rocky bluffs
Waldsteinia lobata	Piedmont Barren Strawberry	G2G3	S2		R	Stream terraces and adjacent gneiss outcrops

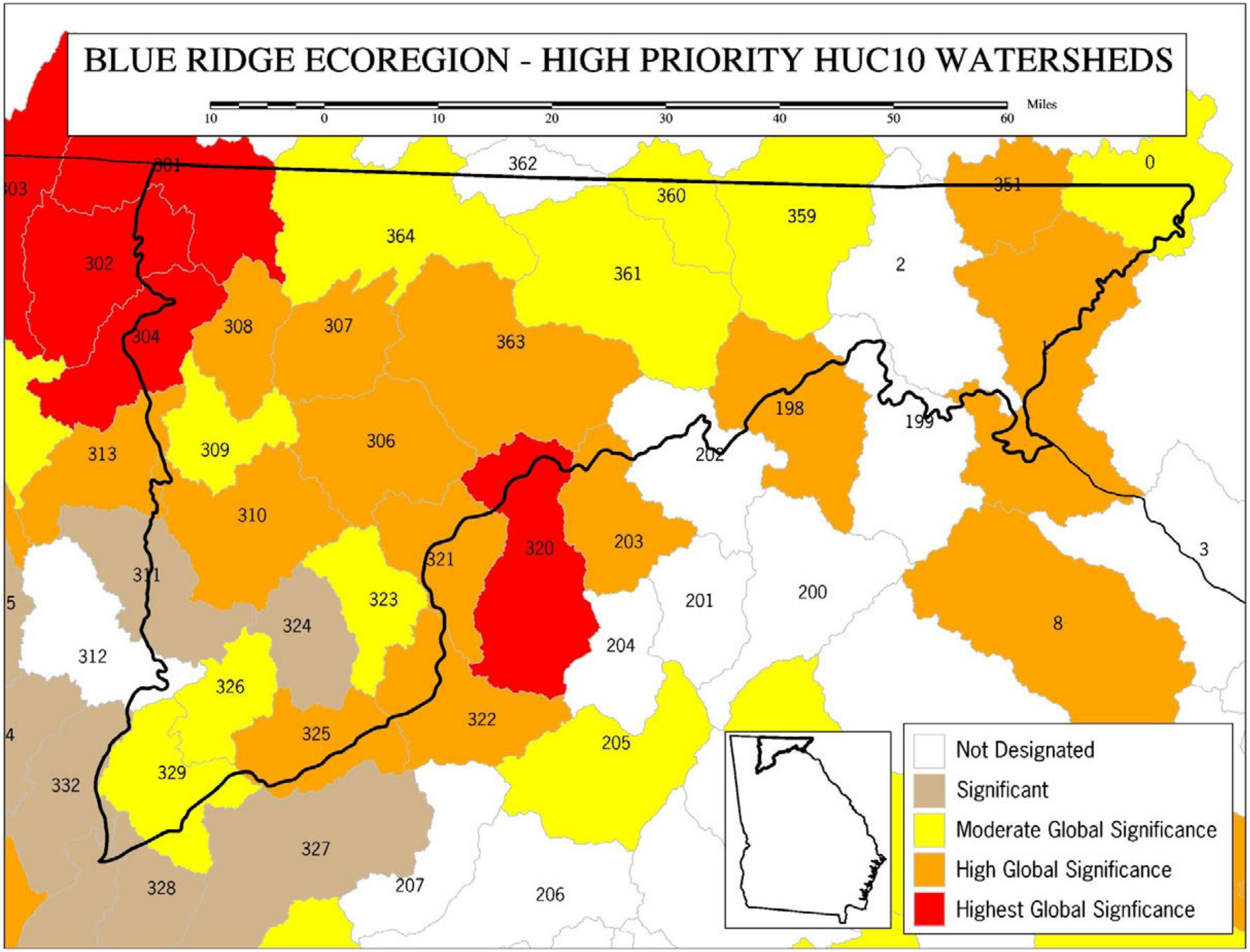

Figure 14. High Priority Waters, Blue Ridge Ecoregion

Piedmont Ecoregion

Ecoregional Overview

The Piedmont ecoregion encompasses about 11,003,500 acres, or about 29% of the state. Approximately 634,620 acres of this ecoregion are in permanent or long-term conservation ownership. Georgia DNR manages 81,655 acres owned in fee simple by the State of Georgia and an additional 181,643 acres through short-term leases or management agreements. Federal land ownership includes 180,221 acres managed by the USDA Forest Service, 168,755 acres managed by the U.S. Department of Defense (including the Army Corps of Engineers), 35,711 acres managed by the U.S. Fish & Wildlife Service, and 11,525 acres managed by the National Park Service. The Piedmont has the second lowest percentage of lands in permanent conservation status (6.2%) of all ecoregions in Georgia.

The Piedmont comprises a transitional area between the mountainous ecoregions to the northwest and the relatively flat Coastal Plain to the southeast. Geologically, it is a complex mosaic of Precambrian and Paleozoic metamorphic and igneous rocks with moderately dissected plains and isolated monadnocks (rounded hills). The soils tend to be finer-textured than in the coastal plain ecoregions. Once largely cultivated, much of this region has reverted to pine and hardwood woodlands, and, more recently, to sprawling urban and suburban areas. Subdivisions of the Piedmont ecoregion in Georgia include the Southern Inner Piedmont, the Southern Outer Piedmont, the Carolina Slate Belt, the Talladega Upland, and the Pine Mountain Ridges.

The rolling to hilly, well-dissected upland of the Southern Inner Piedmont contains mostly schist, gneiss, and granite bedrock. West of Atlanta and into Alabama, mica schist and micaceous saprolite are typical. To the east, biotite gneiss is more common. The region is now mostly forested with oak-pine, oak-hickory, and loblolly-shortleaf pine forests. Open areas are mostly in pasture, although there are some small areas of cropland. Hay, cattle, and poultry are the main agricultural products. Urban/suburban land cover has increased greatly within this ecoregion over the past twenty years.

The Southern Outer Piedmont ecoregion has lower elevations, less relief, and less precipitation than the Southern Inner Piedmont. Loblolly-shortleaf pine is the major forest type, with less oak-hickory and oak-pine than in the Southern Inner Piedmont. Gneiss, schist and granite are the dominant rock types, covered with deep saprolite and mostly red, clayey subsoils. The southern boundary of the ecoregion occurs at the Fall Line, where unconsolidated coastal plain sediments overlay the metamorphic and igneous rocks of the Piedmont.

As its name suggests, the Carolina Slate Belt is found primarily in the Carolinas, although a small portion extends into Georgia. The region's mineral-rich metavolcanic and metasedimentary rocks with slatey cleavage are finer-grained and less metamorphosed than most Piedmont regions. This area tends to be less rugged and dissected, with wider valleys than other Piedmont areas, and with more silty and silty clay soils.

The Talladega Upland contains dissected hills and tablelands that are mostly forested and at generally higher elevations than the Southern Inner and Southern Outer Piedmont. The geology is distinctive, consisting of mostly phyllite, quartzite, slate, metasiltstone, and metaconglomerate, in contrast to the metamorphic and intrusive igneous rocks of the Southern Inner and Southern Outer Piedmont. The climate of the Talladega Upland is slightly cooler and wetter than the other ecoregions of the Georgia Piedmont. Oak-hickory-pine forest is the dominant natural vegetation type.

The Pine Mountain Ridges, a narrow region in the southwest portion of the Georgia Piedmont, contains quartzite-capped, steep-sloped ridges that rise 300-400 feet to elevations over 1300 feet. Pine Mountain and Oak Mountain are the primary linear ridges trending southwest to northeast, and several other smaller ridges and mountains between these, including Bull Trail Mountain, Indian Grave Mountain, Salter Mountain, and Huckleberry Pinnacle, add to the region's more mountainous appearance. The Flint River has cut narrow, steep gorges through the ridges. Streams in this region are generally of higher gradient than surrounding areas of the Southern Outer Piedmont and contain more rocky or gravelly substrates.

The predominant landcover types in the Piedmont are deciduous/mixed forest and evergreen forest (Kramer and Elliott, 2004). An analysis of land use changes from 1974 to 1998 based on satellite imagery indicated the following general trends:

- A decrease in row crop/pasture (from 19.47% of total landcover to 15.51%)
- An increase in high-intensity and low-intensity urban (from 4.86% of total landcover to 9.57%)
- An increase in clearcut/sparse vegetation (from 3.82% of total landcover to 7.38%)
- A decrease in deciduous/mixed forest (from 38.23% of total landcover to 33.98%)
- A slight decrease in evergreen forest (from 28.86% of total landcover to 28.17%)

These trends indicate a general decline in the total acreage devoted to active agricultural uses, a significant increase in residential and commercial development, an increase in cleared or sparsely vegetated habitats (likely from a wide range of activities, including construction, timber harvest, and abandonment of agricultural fields), a decline in deciduous/mixed forest, and little change in the total acreage of pine forest (represented primarily by loblolly pine plantations in this ecoregion).

An analysis of land use change from 2006 to 2011 indicates a 27% increase in early successional vegetation, a 5.4% decrease in forest cover, a 3.2% increase in developed land, a 2.0% increase in wetland landcover, and slight decrease in agricultural land. These figures demonstrate a combination of increasing development and loss of forest land in the Piedmont ecoregion in recent years. See Appendix N for more information.

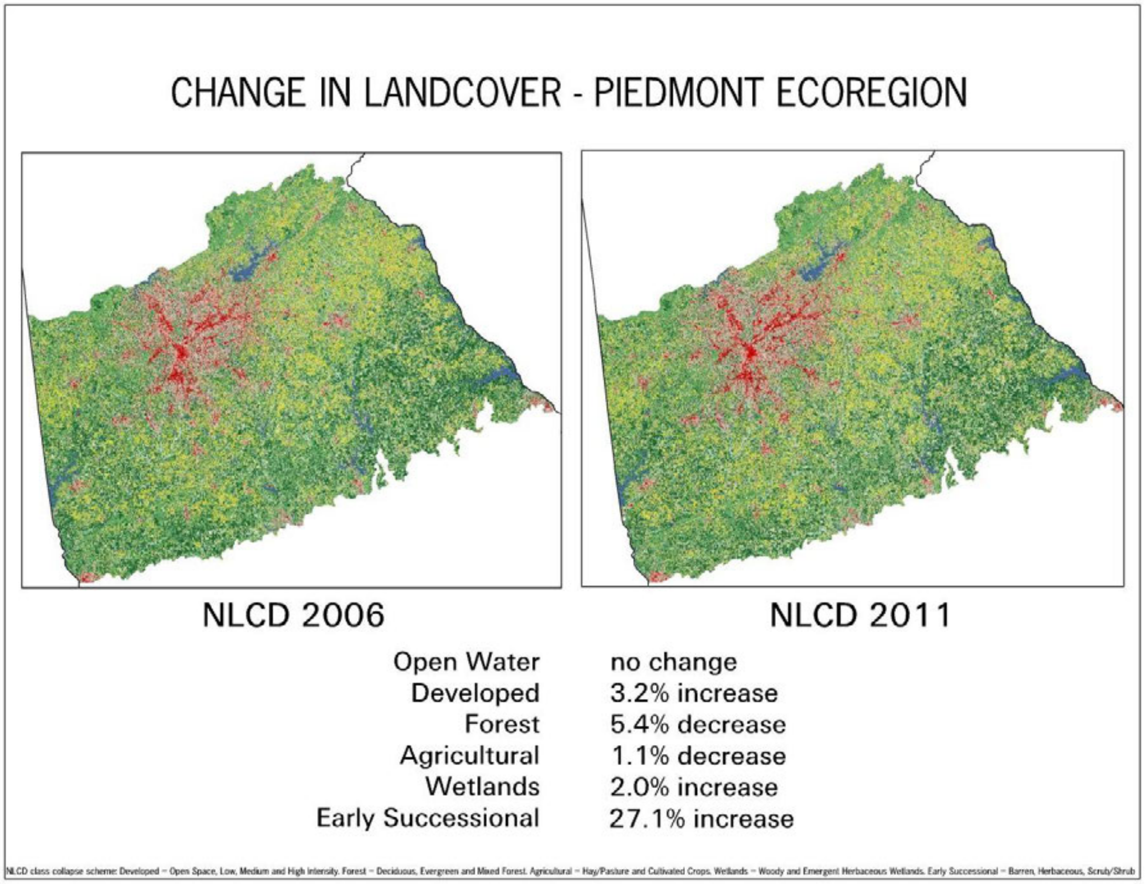

Figure 15. Change in landcover from 2006 to 2011 in the Piedmont ecoregion.

High Priority Species and Habitats

The technical teams identified 87 high priority animal species in the Piedmont ecoregion. These included 17 birds, 3 reptiles, 5 mammals, 3 amphibians, 11 mollusks, 29 fish, 8 aquatic arthropods, and 14 terrestrial arthropods. These species are listed in Table 8, with information on global and state rarity ranks, protected status (if any) under federal or state law, and habitat and range in Georgia. In addition, 66 species of high priority plants were identified for the Piedmont. These are listed in Table 9.

High priority habitats for the Piedmont ecoregion are listed and briefly described below:

1. Beaver Ponds; Freshwater Marsh

Beaver ponds are temporary impoundments created by beaver on small to medium sized streams. Freshwater marshes develop in shallow beaver ponds and along the edges of larger lakes and ponds. Dominants include a variety of sedges, rushes, grasses, and forbs, with scattered buttonbush, red maple, swamp dogwood, and tag alder. Few Georgia examples exist that are not invaded by the exotic weed, Murdannia. These wetlands provide habitat for a wide variety of wildlife species.

2. Bottomland Hardwood Forests

Forested wetlands of alluvial river floodplains, characterized by a diverse association of deciduous hardwood trees. Canopy dominants vary, but may include water oak, willow oak, overcup oak, cherrybark oak, swamp chestnut oak, green ash, sweetgum, bitternut hickory, and pignut hickory. Shrub layer may be dense or relatively sparse, containing a variety of mesophytic or hydrrophytic woody plants and often a significant woody vine component. Many of these habitats have been impacted by invasive exotic species such as Chinese privet and Nepalese browntop.

3. Canebrakes

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most canebrakes in this region are relatively small and fire-suppressed, often occurring along the edges of fields and other clearings.

4. Granite Outcrops

Diverse mosaics of exposed granitic rock, herb and shrub dominated patches, and wetland microhabitats. Most have shallow solution pits that collect soil and support various stages of plant succession. These environments support rare or endemic species of plants and animals. The most important of these habitats contain a variety of solution pits, seepage zones, and bare rock exposures. Some outcrops are monadnocks (isolated rock domes or low mountains) while others are flat rock exposures. The Georgia Piedmont is the center of granite outcrop species diversity.

5. Medium to Large Rivers

Low to moderate gradient meandering rivers, typically with heavy sediment loads. Floodplains are relatively narrow compared to similar rivers in the Coastal Plain. Extensive shoal habitats may occur, especially along the Fall Line. Dominant habitats include runs, pools, and shoals. Substrate is variable, but is dominated by sand in runs and pools and by bedrock in shoals. Aquatic vegetation may be present.

6. Mesic Hardwood Forests

Non-wetland forests of floodplains, ravines, and north-facing slopes in the Piedmont. These may include species such as American beech, white oak, northern red oak, bitternut hickory, pignut hickory, shagbark hickory, bigleaf magnolia, yellow poplar, blackgum, dogwood, black cherry, and loblolly pine. Typical shrubs include spicebush, sweetshrub, pawpaw, Oconee azalea, rusty viburnum, and pinxter-flower.

7. Montane Longleaf Pine-Hardwood Forest

A subxeric or xeric mixed forest with longleaf pine, oaks, and hickories. Georgia examples are typically fire-suppressed. Pine Mountain contains many globally significant examples; other occurrences of this rare forest type can be found along Dugdown and Hightower Mountains and in Paulding Forest and Sheffield WMAs. Includes a rare longleaf pine/Georgia oak subtype found on Hollis quartzite along the main Pine Mountain ridge.

8. Oak Woodlands and Savannas

Rare upland hardwood habitats found in scattered locations in the Piedmont. These xeric or subxeric oak-dominated woodland are influenced by edaphic conditions (i.e. thin soils, mafic rocks) and periodic fire. Dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, sometimes with shortleaf pine. Sparkleberry and hawbushes are common shrub components. A particularly rare type, the post oak-blackjack oak savanna, was apparently much more common in pre-settlement times; only small, fire-suppressed remnants of these habitats exist today.

9. Oak-Hickory-Pine Forest

Considered the climax forest of the Piedmont, this forest type formerly covered 50% to 75% of the region; most examples on fertile soils were eliminated by conversion to agricultural uses. Remaining examples are often found in rocky areas that were difficult to convert to agricultural fields. Typically include a variety of hardwood species such as white oak, black oak, southern red oak, pignut hickory, shagbark hickory, mockernut hickory, red maple, blackgum, shortleaf pine, and loblolly pine, with dogwood, rusty viburnum, hog plum, dwarf pawpaw, and various hawbushes in the understory. American chestnut was formerly a major component of the canopy. Examples over circumneutral soils influenced by mafic or ultramafic bedrock are often floristically richer, and may contain species such as Oglethorpe oak, basswood, red mulberry, redbud, and fringetree.

10. Rocky or Cobbly River Shoals

Shallow, high gradient reaches with swift water and rocky substrates. These habitats are important spawning areas for fish, including darters, shiners, and suckers (such as the extremely rare robust redhorse). In addition, shoals provide foraging areas for wading birds, and sunning areas for turtles. May contain dense growths of riverweed (*Podostemum ceratophyllum*). The shoals spiderlily (*Hymenocallis coronaria*), a State-protected plant, is found on rocky shoals in the middle reaches of the Savannah, Flint, and Chattahoochee rivers. Many shoals have been degraded by stream impoundments, altered water quality, and excessive silt deposition.

11. Rocky/Sandy River Bluffs

Exposed rocky or sandy bluffs along rivers in the Piedmont are often characterized by mixed pine-oak vegetation with shortleaf pine, loblolly pine post oak, eastern redcedar, southern red oak, blackjack oak, and white oak. Small trees and shrubs may include hornbeam, winged elm, sparkleberry, winged sumac, yucca, and century plant. More sheltered or east-facing bluffs may have mountain laurel and rosebay rhododendron.

12. Serpentine Outcrops/Woodland/Savanna

This globally rare habitat represents a complex mosaic of woodlands and savannas with scattered outcropping of serpentine rocks. The pine-mixed hardwood vegetation includes longleaf pine as a dominant. This type is maintained by fire and edaphic conditions. The only known Georgia examples are fire-suppressed. These habitats include disjunct coastal plain species such as pineland Barbara-buttons and Georgia plume.

13. Springs and Spring Runs

Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. Springs of the Piedmont have varying mineral content, chemical properties, and temperatures. Includes spring pools and first order streams immediately below springs where rare fish and invertebrates may occur.

14. Streams

In the upper Piedmont, streams are low to moderate gradient and typically contain well-defined riffles and pools. Substrate consists of gravel, pebble, sand, and silt; some bedrock may also be present. Lower Piedmont streams are lower gradient, have fewer riffles and pools, and their substrates have a higher proportion of silt, clay, and detritus than upper Piedmont streams. Turbidity is highly variable, but most of these streams become highly turbid after rain.

15. Upland Depression Swamp

A non-alluvial open swamp with water oak, southern shagbark hickory, Oglethorpe oak, and loblolly and shortleaf pine. Coastal plain elements in the understory include swamp palmetto and parsley haw. Usually found on Iredell or Enon soils in the lower Piedmont. These sticky, plastic soils pond water in the spring, resulting in swampy conditions for a portion of the year.

16. Xeric Pine Woodlands

Pine-dominated habitats of dry, rocky ridgetops and granitic outcrops. Dominants are loblolly, shortleaf, and Virginia pine. These woodland habitats are maintained by a combination of edaphic factors and periodic fire.

<u>Problems Affecting Wildlife Diversity</u>

One of the primary factors impacting habitats and species in the Piedmont is the rapid pace of residential and commercial development. These development pressures have resulted in the loss or fragmentation of a number of habitats, including bottomland hardwood forest, oak-hickory-pine forest, granite outcrops, and mesic hardwood forest. Much of this is due to the development of new industrial and commercial sites along interstate highways and other major highways.

Metropolitan Atlanta is the ninth-largest metropolitan statistical area in the United States, with an estimated 2013 population of 5.49 million. Continued expansion of the Atlanta metropolitan area has resulted in development of subdivisions, roads, utility corridors, and retail centers. Other metropolitan areas experiencing significant growth in this region include Augusta, Gainesville, Columbus, and Athens.

Point-source discharges into streams in this region include wastewater industrial facilities, and municipal treatment facilities. According to EPD stream monitoring data for 2012, 42% of streams meet designated uses (based on percentage of total monitored stream miles); 57% do not support designated uses, with 1% pending assessment. The percentage of streams supporting designated uses in the Piedmont is second highest of the five ecoregions.

Former conversion of forest and woodland habitats to agricultural uses resulted in the loss of most of the original upland forest (generally described as oak-hickory-pine forest, but containing a wide variety of subtypes) in this region. In addition, erosional soil losses buried many floodplains and river shoals in up to 12 feet of silt. Many of these habitats have recovered partially in the intervening decades. For example, reductions in the rates of sedimentation have resulted in reemergence of shoals in several areas of the Piedmont. However, reductions in streamflow fluctuations by upstream dams have resulted in isolation and dewatering of floodplains in many areas of this ecoregion. Restoration of more natural hydrologic conditions, maintenance of vegetated stream buffers, and continued improvements in erosion and sedimentation control are essential to the protection of aquatic diversity in this ecoregion.

Conversion of remaining upland hardwood and pine-hardwood forests to pine plantations also presents problems for wildlife. Specific problems associated with this forest conversion include loss of vegetative structural diversity and nesting sites, decline in hard and soft mast production, loss of understory and groundcover species diversity, and physical disturbance of habitat for organisms found in leaf litter or soil. The Pine Mountain region has experienced a decline in montane longleaf pine-hardwood forest as a result of conversion to loblolly pine plantations over several decades. However, some harvested loblolly pine stands have been replanted in longleaf pine in recent years.

Fire suppression is also a significant problem in this region. The remarkable expansion of residential and commercial development zones from urban centers into surrounding suburbs has resulted in many fire-dependent habitats being surrounded by highways, subdivisions, or retail centers. Concerns about smoke management, air quality, and damage to structures make it difficult to implement prescribed burn plans for these habitats. For example, while a fire plan has been developed for Kennesaw Mountain National Military Park, concerns about smoke management problems and potential damage to historic structures and monuments in the park represent major impediments to implementation of the plan. Throughout the region, a lack of fire has resulted in the decline in the extent and quality of habitats such as oak-pine-hickory forest, oak woodlands and savannas, montane longleaf pine-hardwood forest, serpentine outcrops/woodland/savanna, and canebrakes.

Invasive nonnative species pose significant problems to habitats in this region. The Asiatic clam and feral hogs are examples of exotic animal species. Most river floodplains and valleys in the Piedmont are overrun with exotic plants such Chinese privet and Nepalese browntop. Japanese honeysuckle, kudzu, and autumn olive are major components of the understory in many upland forest stands.

For some high priority species and habitats, unmanaged recreational use represents a serious problem. In the Piedmont, river shoals have traditionally been sites of concentrated recreational use (e.g., fishing, picnicking). Today, many of these shoal areas are being heavily impacted by ATV and ORV traffic as well as littering. Use of motorized vehicles or horses on granite outcrops can result in significant impacts to plant communities, substrates, and rare species associates.

Granite Rock Outcrops

Georgia contains nearly 90% of all known Piedmont granitic outcrops. Granite rock outcrops host unique microhabitats that are characterized by a granitic substrate with pockets of acidic, nutrient-poor mineral soil. These harsh environments can fluctuate between hydric and xeric several times a year. Vernal pools, or solution pits, are shallow, flat-bottomed depressions where water collects after a rain. These pools are formed naturally by erosion over millions of years and are home to several high priority species that are severely restricted in their range, including mat-forming quillwort, black-spored quillwort, and snorkelwort. Unfortunately, these species are in steady decline where populations are not protected.

Specific threats to these habitats include destruction of habitat from quarrying activities, recreational use (trail bicycles, ORV traffic, littering, vandalism, fire building, overuse for education), eutrophication resulting from conversion of habitat to pasture (cattle waste adds nutrients that favor competing vegetation), pollution (dumping of trash and airborne deposition), invasive exotic species, and shading due to tree growth.

The highest priority for management of granite outcrops is to preserve habitat and avoid disturbance. Efforts should be made to bring these important habitats into some kind of protection. Currently, only six granite rock outcrop sites are protected in Georgia.

Construction of dams or other structures altering stream flow represents another significant problem for aquatic species in this region. The Piedmont is the primary region of water supply reservoir construction in Georgia. These impoundments threaten the viability of populations of native aquatic species, including rare species such as the Cherokee darter, Etowah darter, and bluestripe shiner. The various impacts to these aquatic fauna from impoundments include direct loss of lotic habitat, barriers to dispersal, alteration of instream flows, and impaired water quality (altered temperature and dissolved oxygen regimes).

Incompatible road and utility corridor management represent potential threats for some high priority plants of open areas, such as Georgia rockcress, Georgia aster, harperella, and pool sprite. Indiscriminant use of herbicides or excessive ground disturbance along roads and in utility corridors may impact adjacent terrestrial and aquatic habitats. Vegetation management programs should be planned and implemented in a way that minimizes impacts to rare plant populations occurring in the road right-of-way or utility corridor.

Encroachment of vegetated stream buffers and general loss of permeable watershed surfaces are particularly significant problems in this ecoregion, due to intense development pressures and the resulting rapid increase in density of roads, utility corridors, lawns, and parking areas near streams. In many areas, the amount of impermeable surface in the local watershed provides very little capacity for amelioration of nonpoint source pollution, leads to flash flooding and streambank scouring, and greatly diminishes groundwater recharge capacity.

High Priority Sites and Landscape Features

The current assessment and previous conservation planning efforts have identified a number of important sites and landscape features in this region. An assessment of the Piedmont ecoregion in the Southeast conducted by The Nature Conservancy in cooperation with state natural heritage programs in Alabama, Georgia, South Carolina, North Carolina, and Virginia identified a number of high priority terrestrial and aquatic conservation areas. Recent surveys by Georgia DNR and other organizations have resulted in the identification of additional priority sites. The following are examples of important sites and landscape features in Georgia's Piedmont.

Burks Mountain/Dixie Mountain

This site is highly significant, both geologically and ecologically. The ridge comprising Burks Mountain and Dixie Mountain is underlain with magnesium rich (ultramafic) rock known as "serpentine". This landform is reportedly the largest serpentine ridge east of the Appalachian Mountains and south of Maryland. Vegetation types on the upper slopes of the ridge include open woodland with scattered rock outcrops ("serpentine barrens"), as well as xeric hardwood-pine forest with longleaf pine. This area contains the only Piedmont populations of two State-protected plants: Georgia plume (*Elliottia racemosa*) and pineland Barbara buttons (*Marshallia ramosa*) as well as a population of the endemic Dixie Mountain breadroot (*Pediomelum piedmontanum*).

Currahee Mountain/Lake Russell WMA

This site, located in the upper Piedmont on the Chattahoochee National Forest, is an important area for restoration of shortleaf pine-post oak woodland habitat. This high priority habitat, formerly common in the upper Piedmont and Blue Ridge, was greatly reduced in extent and condition due to decades of forest conversion and fire suppression. Restoration of shortleaf pine-post oak woodland habitat at this site has greatly benefited the federally protected smooth purple coneflower (*Echinacea laevigata*) and associated species.

Granite Outcrops (numerous sites)

These small "islands" of biological diversity are found scattered across the Piedmont of Georgia, and contain some of the most imperiled species in the state. Granite outcrop habitats are threatened by quarrying, grazing, off-road vehicles and sedimentation. Protected examples of these habitats can be found at Panola Mountain State Park, Davison-Arabia Mountain Preserve, Stone Mountain, Rock and Shoals Outcrop Natural Area, Camp Meeting Rock Preserve, and Heggies Rock Preserve. Several other granite outcrop sites should be protected in order to preserve a representative portion of the native flora and fauna of these important ecosystems.

Oconee National Forest/Piedmont National Wildlife Refuge

These two federal properties comprise the largest block of publicly owned land in the lower Piedmont. Much of the habitat in Oconee National Forest and Piedmont National Wildlife Refuge consists of loblolly pine stands on upland sites that have been severely impacted by previous agricultural practices. However, these federal lands also contain significant examples of oak-hickory-pine forest, mesic hardwood forest, bottomland hardwood forest, upland depression swamp, and other high priority habitats. High priority species known from this conservation landscape include red-cockaded woodpecker (*Picoides borealis*) Bachman's sparrow (*Aimophila aestivalis*), American ginseng (*Panax quinquefolius*), and Oglethorpe oak (*Quercus oglethorpensis*).

Pine Mountain/Flint River

Pine Mountain is a series of linear ridges extending from Auburn, Alabama northeastward to Barnesville, Georgia. This mountain is composed largely of Hollis quartzite, an extremely hard rock of almost pure silica that is highly resistant to erosion. Pine Mountain rises 300 to 500 feet above the surrounding lands of the lower Piedmont. Toward its eastern end, Pine Mountain is cut by the Flint River in a series of twisting, narrow gorges approximately 400 feet deep. This mountainous area includes several examples of globally rare natural communities associated with the greater longleaf pine ecosystem. The biota of the Pine Mountain/Flint River region represents a diverse mixture of montane, piedmont and coastal plain elements. High priority plants known from the Pine Mountain/Flint River region include shoals spiderlily, Schwerin's indigo-bush, fringed campion, and relict trillium. Several coastal plain fishes, amphibians and reptiles have northward range extensions in this region. High priority vertebrates reported from the Pine Mountain/Flint River region include Barbour's map turtle, alligator snapping turtle, Webster's salamander, seepage salamander, and bluestripe shiner. Several rare freshwater mollusks have also been documented from the Flint River.

Pool Mountain

This conservation site in the eastern Piedmont contains a rich mesic hardwood forest more typical of the Blue Ridge, with several rare or uncommon plants, including state protected species such as Wood's false hellebore (*Veratrum woodii*). Pool Mountain has archaeological, historical, and geological significance. This exemplary site is surrounded by residential and commercial development in eastern Gwinnett County, but a portion of the site was acquired by Gwinnett County for use as a park. Similar sites with rich mesic hardwood forests can be found in ravines along the Chattahoochee, Oconee, Flint, and Ocmulgee rivers.

Sheffield Tract WMA/Paulding Forest WMA

This important conservation site includes globally significant examples of montane longleaf pine-hardwood forest, mesic hardwood forest, oak-hickory-pine forest, and high priority streams (e.g., Raccoon Creek) that support rare species such as the Cherokee darter and Etowah darter. Recent land acquisition projects supported by a combination of state, federal, local, and private funds have added significantly to the amount of public conservation land in this area. Other high priority landscape features with montane longleaf pine-hardwood forest communities in this portion of the western Piedmont include Dugdown Mountain and Hightower Mountain.

<u>High Priority Waters</u>

Figure 16 shows the high priority watersheds identified by the Aquatic Habitat Team for this ecoregion. These streams were chosen on the basis of documented occurrences of high priority aquatic species and the relative rarity of these species. Examples of high priority stream in the Piedmont include Amicalola Creek, Etowah River, Raccoon Creek, Chestatee River, Chattahoochee River, Tallapoosa River, Little Tallapoosa River, Potato Creek, Flint River, Yellowjacket Creek, House Creek, North Oconee River, Middle Oconee River Little River, Broad River, South Fork Broad River, Long Creek, and Savannah River. Refer to the Aquatic Habitat Technical Team report in Appendix F for details on the factors contributing to the significance of these and other high priority streams.

<u>Conservation Goals</u>

- Maintain known viable populations of all high priority species and functional examples of all high priority habitats through land protection, incentive-based habitat management programs on private lands, and habitat restoration and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Encourage restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic restoration, and revegetation efforts.

- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance, developing specific educational messages, and managing exotic species populations on public lands.
- Minimize impacts from residential and commercial development on high priority species and habitats by providing input on environmental assessments and sharing information from DNR biodiversity databases.
- Continue efforts to recover federally listed species by implementation of recovery plans

Mature Pine and Upland Hardwood Forests

Public lands are an important component of the Piedmont landscape and may serve as core areas from which to manage or expand wildlife habitat. Forest products companies are the largest private landowners in the Piedmont and provide tremendous opportunities for increased cooperative management strategies to accomplish wildlife conservation objectives. Private, non-industrial landowner incentive programs can be increased in key areas as well, further adding to core habitat for high priority Piedmont species.

Land tenure in this ecoregion is changing rapidly, however. Recent land divestitures by corporate landowners point to the need for conservation organizations to act quickly when properties containing high priority habitats and species are placed on the market. Partnerships with corporate landowners that involve technical and field assistance can facilitate identification of these habitats and development of specific proposals for long-term protection. A particularly high priority in this ecoregion is protection, restoration and maintenance of montane longleaf pine communities in areas such as Pine Mountain, the Sheffield/Paulding Forest WMA area, and the Dugdown Mountain/Hightower Mountain area.

Strategies and Partnerships to Achieve Conservation Goals

- Provide financial incentives and technical expertise to encourage prescribed burns for high priority fire-maintained habitats (e.g., serpentine woodlands/savannas, montane longleaf pine-hardwood forest) through participation in the Interagency Burn Team and other means.
- Work with NRCS staff to identify high priority habitats and sites for implementation of habitat enhancement/restoration projects through Farm Bill programs (e.g., thinning and burning pine stands, restoration of oak and shortleaf pine-oak woodlands)
- Establish partnerships to assess and combat exotic species populations on public lands and provide technical assistance to private landowners to discourage use of invasive exotics.

- Use state parks, wildlife management areas, natural areas, and other public lands to showcase habitat restoration efforts (removal of exotic species, prescribed fires, reduction of deer populations, restoration of streams and stream buffers).
- Work with GDOT and local governments to minimize direct impacts to high priority species and habitats from road development projects
- Work with Georgia Power and private landowners to identify and conserve populations of rare species in and adjacent to utility corridors
- Develop educational materials on high priority species and habitats in the ecoregion and provide these to environmental educators at WRD educational facilities (e.g., Charlie Elliott Wildlife Center) and other facilities
- Work with EPD and local governments to assess potential impacts of stream buffer variances, with special emphasis on high priority streams and watersheds.
- Work with GFC and SIC to facilitate revision of forestry BMPs for better protection of streams and wetlands and maintenance of important wildlife habitats
- Work with The Nature Conservancy, USFWS, Georgia Land Conservation Center and local land trusts to provide protection for high priority wetlands and stream corridors.

Highest Priority Conservation Actions

Highest priority conservation actions (actions ranked "Very High" or "High") identified by the technical teams, advisory committee, and other stakeholders specifically for this ecoregion include the following (see Appendix P for details):

- Develop a baseline database of stream geomorphic characteristics in high quality Cherokee Darter streams. Use these data to revise stream restoration methods used in the Etowah basin.
- Conduct surveys for Black Rails in high marsh areas of saltmarsh and possibly other shallowly flooded freshwater habitats.
- Implement diadromous fish restoration projects in Piedmont streams. Evaluate existing population status, commercial and recreational fisheries, and habitat limitations. Look for opportunities to enhance habitat through a suite of alternatives.
- Implement Shoal Creek, Smithwick Creek, and Raccoon Creek watershed projects to benefit high priority aquatic species.
- Maintain Robust Redhorse Conservation Committee to assure restoration of robust redhorse populations. Conduct research and management efforts to develop six self-sustaining populations of robust redhorse throughout its historic range.
- Work with private landowners to restore and manage high priority upland habitats, including montane longleaf pine communities.

For high priority conservation actions of statewide scope, see Section V.

Table 8. Piedmont High Priority Animals (90 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
AA	Cambarus englishi	Tallapoosa Crayfish	G3	S2		R	Cobble-rubble riffles of medium size rivers.
AA	Cambarus fasciatus	Etowah Crayfish	G3	S2		T	Lotic habitats under rocks in flowing water
AA	Cambarus harti	Piedmont Blue Burrower	G1	S1		E	Complex burrows in floodplain areas with sandy-organic soil
AA	Cambarus howardi	Chattahoochee Crayfish	G3Q	S2		T	Riffle areas of streams; in rocks with swift-flowing water
AA	Cambarus strigosus	Lean Crayfish	G2	S2		T	Complex burrows in sandy clay soil, often among roots; Savannah R. drainage
AA	Distocambarus devexus	Broad River Burrowing Crayfish	G1	S1		T	Sandy-clay burrows in Broad River drainage.
AA	Ophiogomphus incurvatus	Appalachian Snaketail	G3T2T3	S2			Small to medium spring-fed streams with mud and gravel bottoms.
AA	Procambarus acutissimus	Sharpnose Crayfish	G5	S2			Temporary fluctuating pools or ponds to permanent lotic habitats (not typical of GA populations); sometimes in simple burrows
AM	Eurycea chamberlaini	Chamberlain's Dwarf Salamander	G4	S2			Seepage ravines/stream sides; bogs, sphagnum beds, marshes
AM	Necturus punctatus	Dwarf Waterdog	G5	S2S3			Sluggish streams with substrate of leaf litter or woody debris
AM	Urspelerpes brucei	Patch-nosed Salamander	G1	S1			headwater streams
BI	Ammodramus savannarum pratensis	Grasshopper Sparrow	G5	S4			Breeds in grasslands, pasture lands, PD RV, rare in CP. Wintering range poorly known.
BI	Colinus virginianus	Northern Bobwhite	G5	S5			Early successional habitat, open pine savanna (frequent fire maintained in small burn unit size), fallow habitats associated with crop lands, extensive forest regen areas (area sensitive - minimal fall pop of 700 birds for viability on 3000+acres)
BI	Elanoides forficatus	Swallow-tailed Kite	G5	S2		R	River swamps; marshes, forages over pastures and ag fields - post breeding. Forage in well burned open pine woodlands where exist. Open pine and bottomland forest with super canopy pines preferred nest sites. Will nest in non-emergent hardwoods and thinned pine plantations as well - typically several years before final harvest.
BI	Euphagus carolinus	Rusty Blackbird	G4	S3			Bottomland forest, pecan orchards, agricultural fields
BI	Falco peregrinus	Peregrine Falcon	G4	S1		R	Rocky cliffs & ledges; seacoasts - migration; skyscrapers
BI	Grus americana	Whooping Crane	G1	S1	LE		Open, mostly emergent herbaceous freshwater wetlands and fields for stop-over sites
BI	Haliaeetus leucocephalus	Bald Eagle	G5	S3		T	Edges of lakes & large rivers; seacoasts
BI	Ixobrychus exilis	Least Bittern	G5	S3			Fresh and brackish water wetlands with emergent herbaceous cover including impoundments, natural freshwater marshes, and tidally influenced marshes
BI	Lanius ludovicianus	Loggerhead Shrike	G4T3Q	S3			Open woods; field edges, pastures, ball fields, industrial park, primary dunes, hammocks
BI	Laterallus jamaicensis	Black Rail	G3G4	S1			Very shallowly flooded freshwater marshes, brackish marshes, and saltmarshes. Some high marsh areas of the saltmarsh may have breeding pairs
BI	Limnothlypis swainsonii	Swainson's Warbler	G4	S3			Dense undergrowth or canebrakes in swamps and river floodplains, small mountain pop in rhododendron and mountain laurel thickets
BI	Peucaea aestivalis	Bachman's Sparrow	G3	S2		R	Open pine or oak woods; old fields; brushy areas, young large grassy pine regeneration areas
BI	Picoides borealis	Red-cockaded Woodpecker	G3	S2	LE	E	Open pine woods; pine savannas
BI	Protonotaria citrea	Prothonotary Warbler	G5	S4			Bottomland forest, swamps, and similar forested wetlands. Nests in tree cavities.
BI	Rallus elegans	King Rail	G4	S3			Freshwater to brackish emergent herbaceous wetlands of grasses, sedges, cattails, wild rice; herbaceous portions of forested wetlands.

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 8. Piedmont High Priority Animals (90 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
BI	Setophaga kirtlandii	Kirtland's Warbler	G3G4	SNR N	LE	E	Transient; varying habitats during late spring and fall
BI	Tyto alba	Barn Owl	G5	SU			Nests in large hollow trees or old buildings (particularly cement silos) in areas with extensive pasture or grassland or other open habitats such as marsh
FI	Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	G3T3	S3	LE	E	Estuaries; lower end of large rivers in deep pools with soft substrates; spawn as far inland as Macon, GA on the Ocmulgee
FI	Alosa sapidissima	American Shad	G5	S5			large rivers between coast and fall zone are used for spawning and early life history stages
FI	Ameiurus serracanthus	Spotted Bullhead	G3	S3		R	Large streams and rivers with moderate current and rock-sand substrate
FI	Carpiodes velifer	Highfin Carpsucker	G4G5	S2S3			swift sandy areas associated with sandbars, yoy found in backwaters and on margins of sandbars
FI	Cyprinella callitaenia	Bluestripe Shiner	G2G3	S2		R	Flowing areas in large creeks and medium-sized rivers over rocky substrates
FI	Cyprinella gibbsi	Tallapoosa Shiner	G4	S3			Medium-sized creeks in moderate to swift current over sand, gravel, or bedrock substrates
FI	Cyprinella xaenura	Altamaha Shiner	G2G3	S2S3		T	Medium-sized to large streams in runs or pools over sand to rocky substrates
FI	Etheostoma brevirostrum	Holiday Darter	G2	S1		E	Small creeks to moderate sized rivers in gravel and bedrock pools
FI	Etheostoma chuckwachatte	Lipstick Darter	G3	S2		E	Medium to large streams with moderate to swift current over gravel, cobble, and boulder substrate
FI	Etheostoma etowahae	Etowah Darter	G1	S1	LE	E	moderate to high gradient streams over cobble to gravel in areas of swift current
FI	Etheostoma parvipinne	Goldstripe Darter	G4G5	S2S3		R	Small sluggish streams and spring seepage areas in vegetated habitat
FI	Etheostoma rupestre	Rock Darter	G4	S2		R	Swift rocky riffles often associated with attached vegetation such as Podostemum
FI	Etheostoma scotti	Cherokee Darter	G2	S2	LT	T	Small to medium-sized creeks with moderate current and rocky substrates
FI	Fundulus bifax	Stippled Studfish	G2G3	S1		E	Slow eddies over sand or gravel along the margins of riffles and runs in medium-sized streams to small rivers
FI	Hybopsis lineapunctata	Lined Chub	G3G4	S2		R	Upland creeks over sandy substrate with gentle current
FI	Hybopsis sp. 9	Etowah Chub	G1Q	S1S2			Generally in creeks and small to medium rivers over sand-silt bottom, usually in pools adjacent to riffle areas. Tends to occupy smaller streams in east than in west.
FI	Macrhybopsis sp. 1	Coosa Chub	G3G4	S1		E	Fast water in large streams and rivers
FI	Micropterus cataractae	Shoal Bass	G3	S2			large river, shoal and fluvial specialist
FI	Micropterus chattahoochee	Chattahoochee Bass	GNR	S1			flowing sections of streams and rivers, including river shoals
FI	Micropterus sp. cf coosae "Altamaha/Ogeechee"	Undescribed Redeye Bass	GNR	S3			believed to be headwater species but patterns altered by non-native species
FI	Micropterus sp. cf coosae "Savannah"	Bartrams Bass	GNR	S3			upland streams and rivers
FI	Moxostoma robustum	Robust Redhorse	G1	S1		E	Med to large rivers, shallow riffles to deep flowing water; moderately swift current
FI	Notropis hypsilepis	Highscale Shiner	G3	S3		R	Flowing areas of small to large streams over sand or bedrock substrates
FI	Notropis scepticus	Sandbar Shiner	G4	S2		R	Large streams to medium-sized rivers in flowing pools over sandy to rocky substrates
FI	Noturus munitus	Frecklebelly Madtom	G3	S1		E	Shoals and riffles of moderate to large streams and rivers
FI	Percina antesella	Amber Darter	G1G2	S1	LE	E	Riffles & runs of medium-sized rivers, patches of sand and small gravel, riverweed

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 8. Piedmont High Priority Animals (90 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Percina crypta	Halloween Darter	G2	S2		T	larger streams in riffle/shoal habitat
FI	Percina kusha	Bridled Darter	G2	S1		E	Flowing pools and runs in large streams and small to medium sized rivers with clear water
FI	Percina smithvanizi	Muscadine Darter	G3	S3		R	Flowing pool areas with substrate of sand, detritus, or bedrock in small rivers
MA	Myotis austroriparius	Southeastern Myotis	G3G4	S3			Caves & buildings near water; large hollow trees in bottomland hardwood swamps
MA	Myotis grisescens	Gray Myotis	G3	S1	LE	E	Caves with flowing water or with large creeks or bodies of water nearby, also storm sewers and artificial caves in other states. Unknown summer roosts in eastern portion of GA range. Marble mines?
MA	Myotis septentrionalis	Northern Myotis	G2G3	S2S3			Caves & mines in winter; riparian areas, upland forests, cracks and crevices in dead and live trees in summer
MA	Perimyotis subflavus	Tri-colored Bat	G3	S5			Open forests with large trees and woodland edges; roost in tree foliage; hibernate in caves or mines with high humidity.
MA	Spilogale putorius	Eastern Spotted Skunk	G4	S3			brushy, rocky, wooded habitats; avoids wetlands
MO	Alasmidonta arcula	Altamaha Arcmussel	G2	S3		T	Large rivers and reservoirs on gently sloping banks with soft and fine sediments. Often under overhanging willows.
MO	Anodontoides radiatus	Rayed Creekshell	G3	S2		T	Small creeks to large rivers with moderate current in mud, sand, and gravel
MO	Elimia mutabilis	Oak Elimia	G2Q	S2			shoals in medium sized rivers
MO	Elliptio nigella	Winged Spike	G1	S2			Large rivers in swift and shallow shoals. Often times associated with large crevices and cavities in and around limestone boulders.
MO	Hamiota altilis	Finelined Pocketbook	G2G3	S2	LT	T	Small streams to large rivers; sand, gravel, and cobble substrates; usually not in swift current
MO	Hamiota subangulata	Shinyrayed Pocketbook	G2	S2	LE	E	Medium sized creeks to large rivers in sand substrates in slow to swift flowing water.
MO	Lampsilis straminea	Southern Fatmucket	G5T	S2			Small creeks to rivers in slow to moderate current; sand, sandy mud and gravel substrates
MO	Medionidus penicillatus	Gulf Moccasinshell	G2	S1	LE	E	Large rivers to small creeks; found in a variety of substrates
MO	Pleurobema pyriforme	Oval Pigtoe	G2	S1	LE	E	Large rivers to small creeks with slow to moderate current in pool, run, and riffle habitats; combinations of clay, sand, and gravel substrate
MO	Somatogyrus alcoviensis	Reverse Pebblesnail	G1Q	S1			Medium to small rivers with moderate gradient in riffle habitat; found on bedrock, cobble, and boulders
MO	Somatogyrus tenax	Savannah Pebblesnail	G2G3 Q	S2S3			Medium rivers, undersides of cobbles and boulders in shallow rocky rapids; also found in association with aquatic vegetation
RE	Graptemys barbouri	Barbour's Map Turtle	G2	S3		T	Rivers & large creeks of Apalachicola River drainage; possible in Ochlockonee
RE	Macrochelys temminckii	Alligator Snapping Turtle	G3G4	S3		T	Streams and rivers; impoundments; river swamps
RE	Pituophis melanoleucus melanoleucus	Northern Pine Snake	G4T4	S2			Dry pine or pine-hardwood forests
TA	Amblyscirtes alternata	Dusky roadside-skipper	G2G3	S3			Sunny patches in pine forests
TA	Amblyscirtes belli	Bell's Roadside-skipper	G3G4	S3			Wet hardwoods, river oats
TA	Amblyscirtes carolina	Carolina roadside-skipper	G3G4	S2S3			Wet situations with cane
TA	Bombus affinis	Rusty-patched bumblebee	G1	SH			
TA	Bryophaenocladius chrissichuckorum	Midge (Heggie's Rock)		S1			Heggie's Rock pools, adjacent outcrops?
TA	Danaus plexippus	Monarch butterfly	G4	S4			Milkweeds
TA	Euphydryas phaeton	Baltimore checkerspot	G4	S2			Chattahoochee River parks

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 8. Piedmont High Priority Animals (90 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
TA	Habronattus sabulosus	Jumping spider (Heggie's Rock)	GNR	S1S2			Granite flatrock outcrops
TA	Melanoplus longicornis	A spur-throat grasshopper	G1G2	S2			Hardwoods
TA	Neonympha helicta	Helicta satyr	G3G4	S2			Dry fields
TA	Pieris virginiensis	West Virginia White	G3	S3			Hardwoods
TA	Satyrium edwardsii	Edwards hairstreak	G4	S3			Blackjack oak
TA	Speyeria diana	Diana fritillary	G3G4	S3			Hardwood forests
TA	Trimerotropis saxatalis	Lichen or rock grasshopper	G3	S3			Granite flatrock outcrops

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 9. Piedmont High Priority Plants (66 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Acmispon helleri	Carolina Trefoil	G5T3	S1		E	Clayey soil over ultramafic rock; post oak-blackjack oak savannas
Aesculus glabra	Ohio Buckeye	G5	S2			Mesic forests in circumneutral soil
Allium speculae	Flatrock Onion	G2	S2		T	Granite outcrops (limited to Lithonia Gneiss types)
Amorpha nitens	Shining Indigo-Bush	G3?	S1?			Rocky, wooded slopes; alluvial woods
Amorpha schwerinii	Schwerin's Indigo-Bush	G3G4	S2			Rocky upland woods
Amphianthus pusillus	Pool Sprite, Snorkelwort	G2	S2	LT	T	Vernal pools on granite outcrops
Amsonia ludoviciana	Louisiana Blue Star	G3	S2			Open woods near granite outcrops (limited to Lithonia Gneiss types)
Anemone berlandieri	Glade Windflower	G4?	S1S2			Granite outcrop ecotones; openings over basic rock
Anemone caroliniana	Carolina Windflower	G5	S1?			Upland seepage swamp openings over Iredell soils; wet meadows
Arabis georgiana	Georgia Rockcress	G1	S1	C	T	Rocky or sandy river bluffs and banks, in circumneutral soil
Baptisia megacarpa	Bigpod Wild Indigo	G2	S1			Floodplain forests
Berberis canadensis	American Barberry	G3	S1		E	Cherty, thinly wooded slopes
Boechera missouriensis	Missouri Rockcress	G5	S2			Granite and amphibolite outcrops
Calamintha sp. nov. (undescribed)	Indian Grave Mountain Wild Savory	GNR	S1			Montane longleaf woodlands
Carex biltmoreana	Biltmore Sedge	G3	S1		T	High elevation ledges and rock faces
Carex radfordii	Radford's Sedge	G2	S1?		T	Rich woods of marble ravines
Cirsium virginianum	Virginia Thistle	G3	S2?			Moist pinelands; moist longleaf pine/wiregrass savannas
Crataegus aemula	Rome Hawthorn	G2G3	S2?			Upland hardwood forests; creek flats
Crataegus aprica	Sunny Hawthorn	GNR	S1			Open, sandy, rocky dry sites in lower elevation mountains and perhaps Piedmont.
Croomia pauciflora	Croomia	G3	S2		T	Mesic hardwood forests, usually with Fagus and Tilia
Cuscuta harperi	Harper's Dodder	G2G3	S1		E	Altamaha Grit outcrops; granite outcrops; often with Liatris microcephala as host
Danthonia epilis	Bog Oat-Grass	G3G4	S1?			Mountain bogs
Draba aprica	Open-Ground Whitlow-Grass	G3	S1S2		E	Granite and amphibolite outcrops, usually in redcedar litter
Echinacea laevigata	Smooth Purple Coneflower	G2G3	S2	LE	E	Upland forests over amphibolite
Eleocharis wolfii	Spikerush	G3G5	S1			Shallow pools on granite outcrops
Eriocaulon koernickianum	Dwarf Pipewort	G2	S1		E	Granite outcrops
Eurybia jonesiae	Piedmont Bigleaf Aster	G3?	S2			Mixed oak-hickory forests
Fimbristylis brevivaginata	Flatrock Fimbry	G2	S2			Granite outcrops
Fothergilla gardenii	Dwarf Witch-Alder	G3G4	S2		T	Openings in low woods; swamps
Helianthus smithii	Smith's Sunflower	G2Q	S1			Dry open woods and thickets
Hydrastis canadensis	Goldenseal	G3G4	S2		E	Rich woods in circumneutral soil
Hymenocallis coronaria	Shoals Spiderlily	G2Q	S2		T	Rocky shoals of broad, open rivers
Isoetes melanospora	Black-Spored Quillwort	G1	S1	LE	E	Vernal pools on granite outcrops
Isoetes tegetiformans	Mat-Forming Quillwort	G1	S1	LE	E	Vernal pools on granite outcrops
Juglans cinerea	Butternut	G4	S2			Openings in bottomland forests and in the mesophytic hardwood forests of rich mountain coves
Juniperus communis var. depressa	Ground Juniper	G5T5	S1			Gneiss ledges

Table 9. Piedmont High Priority Plants (66 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Lilium canadense	Canada Lily	G5	S2?			Openings in rich woods
Lysimachia fraseri	Fraser's Loosestrife	G3	S2		R	Moist, open, bouldery gravel bars and streambanks; edges of sandstone and granite outcrops
Monotropsis odorata	Sweet Pinesap	G3	S1		T	Upland forests
Nestronia umbellula	Indian Olive	G4	S3		R	Mixed with dwarf shrubby heaths in oak-hickory-pine woods; often in transition areas between flatwoods and uplands
Panax quinquefolius	American Ginseng	G3G4	S3			Mesic hardwood forests; cove hardwood forests
Paronychia virginica	Yellow Nailwort	G4	S1		E	Serpentine outcrops
Pediomelum piedmontanum	Dixie Mountain Breadroot	G1	S1		E	Shallow soils over mafic (serpentine) rock, upland longleaf pine-mixed oak savanna and powerline rights-of-way
Platanthera integrilabia	Monkeyface Orchid	G2G3	S1S2	C	T	Red maple-gum swamps; peaty seeps and streambanks with Parnassia asarifolia and Oxypolis rigidior
Portulaca umbraticola ssp. coronata	Wingpod Purslane	G5T2	S2			Granite outcrops; Altamaha Grit outcrops
Ptilimnium nodosum	Harperella	G2	S1	LE	E	Granite outcrop seeps; shallow seasonal ponds in limesink depressions
Quercus oglethorpensis	Oglethorpe Oak	G3	S2		T	Broad River bottomlands; upland seepage swamps over Iredell and Enon soils with seasonally wet clay beds
Rhus michauxii	Dwarf Sumac	G2G3	S1	LE	E	Open forests over ultramafic rock
Sabatia capitata	Cumberland Rose Gentian	G2	S2		R	Meadows over sandstone or shale
Schisandra glabra	Bay Starvine	G3	S2		T	Rich woods on stream terraces and lower slopes
Schwalbea americana	Chaffseed	G2G3	S1	LE	E	Open pinelands, as in well-managed, somewhat moist longleaf pine-wiregrass forests seeps
Sedum nevii	Nevius' Stonecrop	G3	S1		T	Gneiss ledges on river bluffs
Sedum pusillum	Granite Stonecrop, Puck's Orpine	G3	S3		T	Granite outcrops, often in mats of Hedwigia moss under Juniperus virginiana
Silene polypetala	Fringed Campion	G2	S2	LE	E	Mesic deciduous forests
Stewartia malacodendron	Silky Camellia	G4	S2		R	Along streams on lower slopes of beech-magnolia or beech-basswood-Florida maple forests
Symphyotrichum georgianum	Georgia Aster	G3	S2	C	T	Upland oak-hickory-pine forests and openings; sometimes with Echinacea laevigata or over amphibolite
Trillium persistens	Persistent Trillium	G1	S1	LE	E	Mesic hardwood forests, upland forests
Trillium reliquum	Relict Trillium	G3	S3	LE	E	Mesic hardwood forests; limesink forests; usually with Fagus and Tilia
Trillium sp. nov. (unpublished)	Southern Decumbent Trillium	GNR	S1			Mesic hardwoods
Triphora trianthophora	Three-Birds Orchid	G3G4	S2?			Loamy soils of rhododendron thickets; hardwood forests
Veratrum woodii	Ozark Bunchflower	G5	S2		R	Mesic hardwood forests over basic soils
Viburnum rafinesquianum var. affine	Downy Arrowwood	G5TNR	S1			Limestone bluffs along major rivers
Waldsteinia lobata	Piedmont Barren Strawberry	G2G3	S2		R	Stream terraces and adjacent gneiss outcrops
Xerophyllum asphodeloides	Eastern Turkeybeard	G4	S1		R	Xeric oak-pine forests
Xyris scabrifolia	Harper's Yellow-Eyed Grass	G3	S1			Sedge bogs; pitcherplant bogs; pine flatwoods
Xyris tennesseensis	Tennessee Yellow-Eyed Grass	G2	S1	LE	E	Seepy margins of limestone spring runs

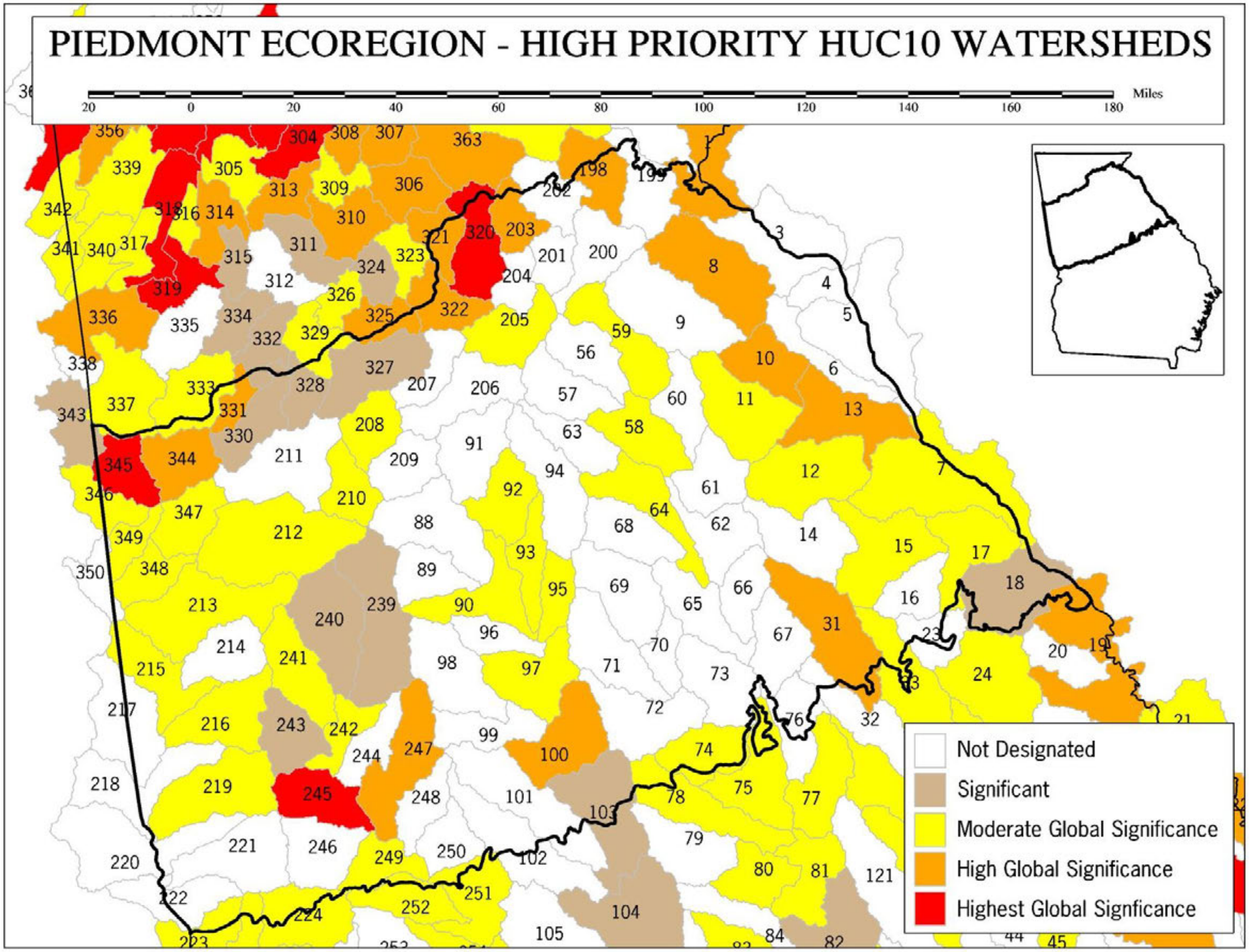

Figure 16. High Priority Waters, Piedmont Ecoregion

Southeastern Plains Ecoregion

Ecoregional Overview

The Southeastern Plains ecoregion stretches across middle and southwestern Georgia, covering approximately 16,252,663 acres. It is bordered on the northwest by the Piedmont and on the southeast by the Southern Coastal Plain. The northwestern edge of this ecoregion is known as the Fall Line, a distinctive zone of transition between the topographically varied Piedmont and the relatively flat Coastal Plain. Approximately 675,000 acres are in permanent or long-term conservation ownership. Georgia DNR manages approximately 133,500 acres owned in fee simple by the State of Georgia and an additional 62,700 acres in leases or management agreements. Federal land ownership includes approximately 258,300 acres managed by the U.S. Department of Defense, 14,050 acres managed by the U.S. Fish & Wildlife Service, 4,619 acres managed by the Natural Resources Conservation Service, and 1,157 acres managed by the National Park Service. While this ecoregion is the largest in the state, it has the lowest percentage of lands in permanent conservation status (4.5%).

This expansive ecoregion of irregular plains and broad interstream areas contains a mosaic of cropland, pasture, woodland, and forest. Natural vegetation is mostly longleaf pine-wiregrass, longleaf pine-scrub oak, oak-hickory-pine and southern mixed forest. Geologic strata of this region are of Cretaceous or Tertiary age. Elevations and relief are generally less than in the Piedmont and greater than in the Southern Coastal Plain. Streams in this region have relatively low gradients and sandy substrates. Subdivisions of the Southeastern Plains in Georgia include the Sand Hills, the Southern Hilly Gulf Coastal Plain, the Dougherty Plain, the Tifton Upland, the Sand Hills, the Tallahassee Hill/Valdosta Limesink, and the Southeastern Floodplains and Low Terraces.

The Sand Hills are a narrow, rolling to hilly, highly dissected belt stretching across the state from Augusta to Columbus. The region is composed primarily of Cretaceous and Eocene marine sands and clays deposited over the crystalline and metamorphic rocks of the Piedmont. Soils are mostly excessively well drained and low in nutrients, although soils in some areas contain more loamy and clayey horizons. The driest sites have typical sandhill vegetation characterized by longleaf pine and turkey oak. Other areas have shortleaf-loblolly pine forests or mixed oak-pine forests. Atlantic white-cedar swamps can be found in a few areas in the western portion of the Sand Hills region.

The Southern Hilly Gulf Coastal Plain is characterized by irregular plains and gently rolling hills developed over bands of sand, clay, and marl formations. This heterogeneous region, which stretches west across Alabama and into Mississippi, has a variety of clayey, loamy, and sandy soils. The natural vegetation is mostly oak-hickory-pine forest, transitioning to southern mixed forest at its southern border. Land cover is mostly mixed forest and woodland, pine plantations, and small areas of pasture and cropland.

The Dougherty Plain is mostly flat to gently rolling and influenced by limestone near the surface of the soil. The karst topography contains numerous sinkholes and springs, and relatively few streams in the flatter part of the plain. Predominant landcover types are row crop and pasture, with some small areas of upland mixed forest. Crops such as cotton, peanuts and pecans are common. Many shallow, flat-bottomed depressions (Grady ponds and limesink ponds) are scattered throughout the region.

The Tifton Upland has rolling, hilly topography with a mosaic of agriculture, pasture, and some mixed pine/hardwood forests. Soils are well-drained, brownish, and loamy, often with iron-rich or plinthic layers. They support crops of cotton, peanuts, soybeans, and corn. On the western edge of the region the Pelham Escarpment has bluffs, caves, and deep ravines that support mesic hardwood forest and several rare plants.

The Coastal Plain Red Uplands formed on reddish Eocene sand and clay formations. Soils are mostly well-drained with a brown or reddish brown loamy or sandy surface layer and red subsoils. The majority of the area is in cropland or pasture, with some woodland on steeper slopes. The Fort Valley Plateau falls within this ecoregion, a relatively small agricultural area characterized by flat terrain.

The Atlantic Southern Loam Plains, also known as the Vidalia Upland, is generally lower, flatter, and more gently rolling than the Coastal Plain Red Uplands and has more cropland and finer-textured soils than the adjacent Sea Island Flatwoods. It has an abundance of agriculturally important soils in active cultivation, but also contains forests in areas that are more sloping or are low, flat and poorly drained. Parallel to some of the major streams in this region (e.g., Ohoopee, Little Ohoopee, Canoochee, and Little Ocmulgee) are deep wind-derived sand ridges with xeric vegetation such as longleaf pine-turkey oak forests as well as evergreen shrubs such as sandhills rosemary and woody mints.

The Tallahassee Hills/Valdosta Limesink region includes two topographically different areas, both influenced by underlying limestone. The Floridan aquifer is thinly confined in this region and streams may be intermittent or flow underground in the karst landscape. The Tallahassee Hills portion has rolling, hilly topography that is mostly covered in pine forest. Clayey sands weathered to a thick red residual soil are typical. The Valdosta Limesink area has lower relief and more solution basins containing ponds, lakes, and swamps, as well as more cropland. Major natural vegetation types include pine-mixed oak forest on clay-based upland soils, bayswamp and pondcypress swamp in depressions, and longleaf pine-scrub oak on sandy, well-drained areas.

Southeastern Floodplains and Low Terraces comprise a region of large sluggish rivers and backwaters with ponds, swamps, and oxbow lakes. Swamp forests of bald cypress and water tupelo and oak-dominated bottomland hardwood forests provide important wildlife corridors and habitat. This region includes the major alluvial river corridors, such as the Chattahoochee, Flint, Ocmulgee, Oconee, Ogeechee, and Savannah.

The predominant landcover types in the Southeastern Plains are row crop/pasture, evergreen forest, and forested wetland (Kramer and Elliott, 2004). An analysis of land use changes from 1974 to 1998 based on satellite imagery indicated the following general trends:

- A slight decrease in row crop/pasture (from 38.47% of total landcover to 32.73%)
- A slight increase in high-intensity and low-intensity urban (from 1.83% of total landcover to 2.85%)
- An increase in clearcut/sparse vegetation (from 4.66% of total landcover to 7.32%)
- An increase in evergreen forest (from 22.97% of total landcover to 27.19%)
- A decrease in forested wetlands (from 16.39% of total landcover to 14.52%)
- A decrease in deciduous/mixed forest (from 14.55% of total landcover to 13.70%)

These trends indicate a decline in the total acreage devoted to active agricultural uses and a corresponding increase in evergreen forest. This change likely reflects the trend toward enrollment of agricultural lands in the Conservation Reserve Program during this time period. The decrease in deciduous/mixed forest and forested wetlands and the increase in clearcut/sparse vegetation reflect, in part, the harvest of hardwood and hardwood-pine forests. Some of these forests were likely converted to pine plantations. Overall, this ecoregion has undergone a relatively modest urban/suburban expansion which has been limited primarily to the outlying areas of large metropolitan areas and major highway corridors.

An analysis of land use change from 2006 to 2011 indicates a 21.2% increase in early successional vegetation, a 2.4% increase in open water and 1.2% in developed land, a 5% decrease in forest land, a 2.7% decrease in agricultural land, and little change in wetland acreage. These figures demonstrate an overall decline in forest cover and a continuation of the increase in early successional classes (barren, herbaceous, and scrub/shrub) and decrease in acreage devoted to agricultural uses. The large increase in early successional habitat may represent increased timber harvest during this period, when timber prices were relatively high. See Appendix N for more information on landcover trends.

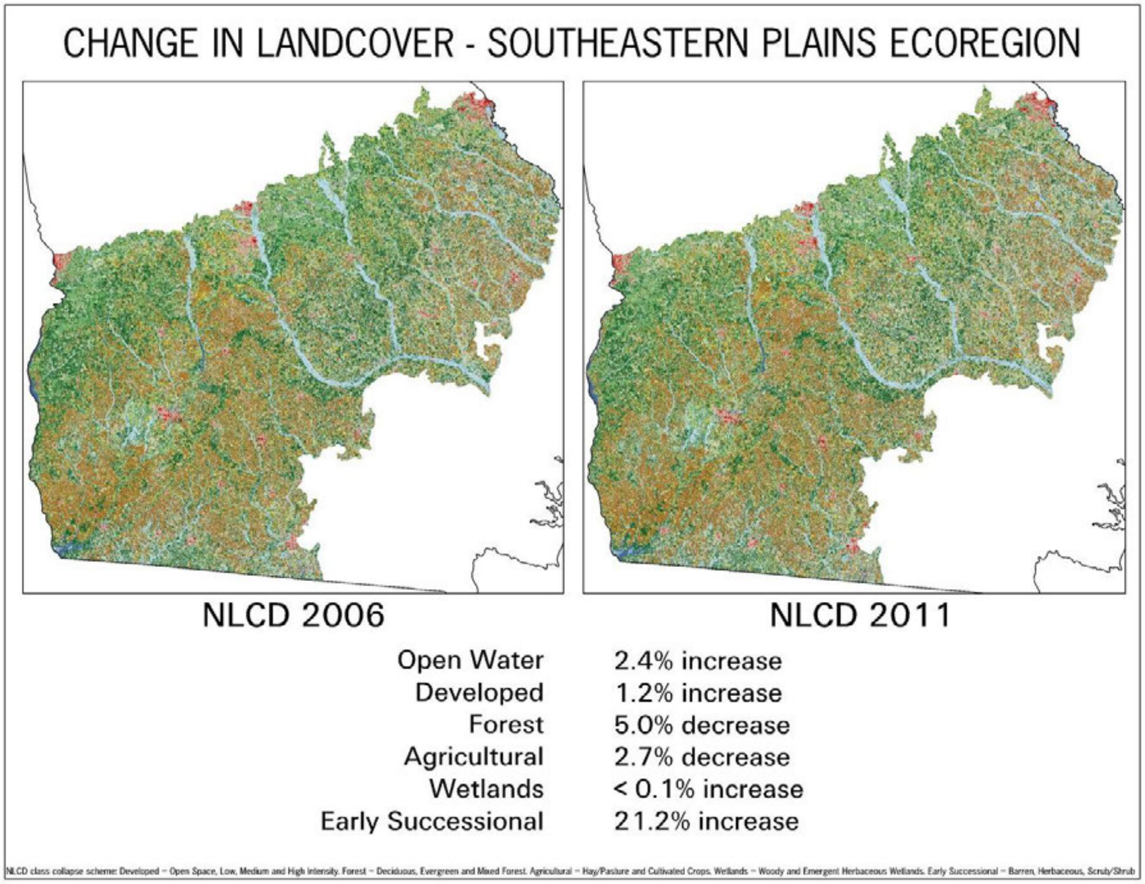

Figure 17. Change in landcover from 2006 to 2011 in the Blue Ridge ecoregion.

According to EPD stream monitoring data for 2012, 37% of streams in this region support designated uses (based on percentage of total monitored stream miles); 59% do not support designated uses, with 4% pending assessment. The percentage of monitored streams supporting designated uses in the Southeastern Plains is second lowest of the five ecoregions.

High Priority Species and Habitats

The technical teams identified 145 high priority animal species in the Southeastern Plains ecoregion. These included 22 birds, 7 mammals, 11 reptiles, 10 amphibians, 13 mollusks, 22 fishes, 9 aquatic arthropods, and 57 terrestrial arthropods. These species are listed in Table 7, with information on global and state rarity ranks, protected status (if any) under federal or state law, and habitat and range in Georgia. In addition, 118 species of high priority plants were identified for the Southeastern Plains. These are listed in Table 8.

High priority habitats for the Southeastern Plains are listed and briefly described below:

1. Alluvial (Brownwater) Rivers and Swamps

Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the dominant substrata and these rivers typically carry heavy sediment loads. Extensive cypress-gum swamps can be found on all major alluvial rivers in the upper portion of the Southeastern Plains. These systems have been impacted by altered flows from upstream dams.

2. Altamaha Grit Outcrops

These small patch habitats represent mosaics of indurated sandstone outcrops (vertical and horizontal surfaces) interpersed with rock-influenced pine woodland, bogs, and bottomlands. Characterized by several endemic species and plant associations.

3. Atlantic Whitecedar Swamps; Clearwater Stream Swamps

Narrow, linear forested systems along cold, clear streams of the Fall Line sandhills. Characterized by a fairly dense canopy of Atlantic whitecedar, with pond pine, red maple, sweetbay, and other mesic-hydric site species. Clearwater stream swamps are similar but without Atlantic whitecedar in the canopy. The shrub layer is usually well developed and diverse, while the groundlayer herbaceous vegetation is often sparse. These systems are thought to be maintained by periodic fire, beaver activity, and possibly other forms of disturbance.

4. Bayheads and Titi Swamps

Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). Considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain.

5. Beech-Magnolia Slope Forests

These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

6. Black Belt Prairies

Small-patch prairie habitats occurring over alkaline Oktibbeha soils. These soils are adhesive when wet and hard when dry, limiting the growth of woody plants. Black Belt prairies consist of herb-dominated patches interspersed with woody scrub component. These rare habitats are maintained by a combination of soil conditions and periodic fire.

7. Bottomland Hardwood Forests
Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

8. Calcareous Swamps
Hardwood dominated swamp forests that are influenced by calcareous soils. Examples include Spring Creek in the Dougherty Plain. These spring-fed swamps may contain rare plants such as variable-leaved water plantain. Similar habitats are found along tributaries of the Ocmulgee and Ogeechee rivers (e.g., Limestone Creek, Williamson Swamp Creek)

9. Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

10. Caves
Found primarily along the Pelham Escarpment in the southwestern portion of the ecoregion. A few caves are also found in karst environments near Cochran and Sandersville. These Coastal Plain caves provide habitat for high priority species such as the southeastern myotis and Georgia blind salamander.

11. Evergreen Hammocks and Mesic Hardwood Forests
Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

12. Flint Kaolin Outcrops
Rare and unusual rock outcrops composed of flint kaolin, a hard, flinty conglomerate of metamorphosed sediments. The outcrops are surrounded by xeric mixed oak/pine forest. Plant communities of these habitats resemble those of Altamaha Grit outcrops. Known only from Columbia County in the northeastern portion of this ecoregion.

13. Forested Depressional Wetlands
Seasonally or semi-permanently flooded forests of depressional features, including Carolina bays, limesinks, and Grady ponds. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish

populations are very important breeding habitats for amphibians such as the flatwoods salamander.

14. Freshwater "Prairies"
Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is Grand Bay, possibly the largest Carolina bay known. Other examples can be found in the Tallahassee Hills/Valdosta Limesink region. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

15. Hillside Seeps
Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

16. Limestone and Marl Outcrops; Calcareous Bluffs
Rich riparian or ravine habitats influenced by limestone substrate. Marl gorges and bluffs are restricted to tributaries of the Chattahoochee River (Town Creek, Kolomoki Creek) near Fort Gaines. These "blue marl gorges" have diverse mesic hardwood forests and unusual seepage cliffs. Mesic calcareous bluffs are also found along the Savannah River and contain plant species of northern affinities.

17. Longleaf Pine-Scrub Oak Woodlands
Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

18. Longleaf Pine-Wiregrass Savannas
Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. These can range from mesic to dry, depending on topographic position and soils. Transition downslope into wet pine savanna. These habitats are heavily dependent on frequent fire for maintenance.

19. Nonalluvial (Blackwater) Rivers and Swamps
Large, meandering rivers with darkly stained but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form bars in larger systems. In contrast to smaller blackwater streams, the forest canopy may only shade a portion of the stream width. Runs and pools are dominant habitats. Large snags represent a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers. These systems are vulnerable to negative impacts from nutrient loadings and hydrologic disruptions resulting from a wide variety of human activities.

20. Open-Water Ponds and Lakes
Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. Many wildlife species are dependent on these habitats. Limesinks are generally round, formed by the collapse of underground caverns, and are found primarily in the Dougherty Plain. Carolina bays are characterized by an elliptical shape, NW-SE axis, and a deep sandy rim on the east and south edges. Beaver activity along small branches may semi-permanently inundate areas, creating open wetlands.

21. Pine Flatwoods
Seasonally wet forests with open to closed pine canopy, often with an ericaceous shrub understory. Canopy dominants may include slash, longleaf, and occasionally pond pine. These habitats generally occur on nonalluvial flats and low terraces, and have a strong herbaceous component (although not as diverse as the longleaf pine savanna). Maintained by periodic fire.

22. Rocky/Sandy River Bluffs
Subxeric mixed pine-hardwood forest on river bluffs that are sandy, or rarely, rocky. May contain species such as white oak, southern red oak, post oak, laurel oak, mockernut hickory, shortleaf pine, loblolly pine and spruce pine. The woody understory may include red buckeye, blueberry, and possumhaw. The herb layer is typically sparse, but may include rare species such as Alabama milkvine.

23. Springs and Spring Runs
Clear, flowing systems with circumneutral pH and stable temperature and flow regimes. Limestone, detritus, and woody debris are dominant substrata. Floodplains of these systems are poorly developed. Mostly confined to the Dougherty Plain. Many of the larger springs in this ecoregion serve as important cool-water refuges for species such as striped bass.

24. Steephead Ravines
Rich mesic ravine forests characterized by a diverse canopy of hardwood trees, including American beech, southern sugar maple, southern magnolia, pyramid magnolia, basswood, and sugarberry. The most significant examples are the "Torreya Ravines" of the lower Pelham Escarpment near Lake Seminole. Similar habitats are found in the upper ends of narrow ravines in the Fall Line Sandhills and along the edges of deep limesinks in the Dougherty Plain.

25. Streams (Blackwater)
Meandering acidic streams with tea-stained, translucent waters and small to moderate-sized floodplains. Blackwater streams are highly acidic, high in dissolved organic materials, and low in suspended materials. Streambeds are characterized by sandy substrates, often with extensive woody debris and live plant roots are often interspersed. Pools and runs are the dominant microhabitats, but these are occasionally interspersed with beaver ponds and limestone outcroppings. Many of these aquatic systems have been

impacted by channelization, impoundment, and encroachment by agricultural and silvicultural uses.

26. Wet Pine Savannas, Herb and Shrub Bogs
Open pine savanna dominated by longleaf or slash pine, with interspersed bogs. Herb bogs are found in low swales or depressions. Herb bogs are often characterized by pitcherplants and a high diversity of forbs. Shrub bogs occur in the ecotones of Carolina bays or cypress ponds and along the drier edges of bay swamps. Dominated by shrubs with a few (usually stunted) scattered pines and a sparse herb layer.

27. Xeric Aeolian Dunes
Wind-formed deep and well-drained dunes found mostly along the eastern side of rivers such as the Ohoopee, Little Ohoopee, Canoochee, and Little Ocmulgee. These unusual xeric habitats are dominated by deciduous or evergreen scrub oaks and scattered pines, with little groundcover other than patches of wiregrass and lichens. A number of rare plants are associated with these habitats, including sandhills rosemary and Ashe's savory.

The Longleaf Pine Ecosystem

Longleaf pine forests and savannas once covered approximately 92 million acres across the Southeast. Today, less than 3 percent of this habitat remains, and what is left is being lost at an estimated rate of 100,000 acres per year. In the last 30 years alone, longleaf pine acreage in North Florida has declined by 84 percent. Rangewide, longleaf pine-dominated ecosystems support more than 300 globally imperiled species; the steady decline in abundance and health of this habitat is thus linked with increasing imperilment of these species. Longleaf pine-wiregrass savannas and embedded wetlands comprise some of the most biologically diverse natural communities in North America. In Georgia, most of the remaining longleaf pine habitat is found on military bases or on quail plantations and other large privately owned tracts in the Red Hills and lower Dougherty Plain. Throughout its former range, the longleaf pine ecosystem is being impacted by forest conversion, fire suppression, habitat fragmentation, and invasive exotics species.

Several organizations, including the Longleaf Alliance, The Nature Conservancy, the Georgia Wildlife Federation, Tall Timbers Research Station, Georgia Forestry Commission, Joseph Jones Ecological Research Center and Georgia DNR have focused research, education, and conservation efforts on this globally significant ecosystem. In addition to protecting high priority sites through fee-simple ownership or conservation easements, ongoing efforts include promotion of prescribed burning, providing technical guidance to private landowners wanting to reforest with longleaf pine, developing educational materials explaining the significance of this habitat, and conducting field research on ecosystem functions and restoration techniques. A number of private landowners and forestry consultants have been instrumental in efforts to restore and maintain habitat quality in the longleaf pine ecosystem.

Problems Affecting Wildlife Diversity

Past conversion of forest and woodland habitats to agricultural uses has resulted in the loss of much of the natural upland vegetation in this area. In particular, the more mesic subtypes of longleaf pine-dominated forest/savanna, a predominant vegetation type in pre-settlement times, have been greatly reduced in the landscape. Remaining examples can be found in the Tallahassee Hills region and a few sites elsewhere in the region (e.g., Ichauway Plantation in the Dougherty Plain). More xeric sites (e.g., Fall Line sandhills and xeric aeolian dunes) that are generally unsuitable for agricultural uses still contain intact examples of longleaf pine-scrub oak woodlands and associated habitats. Wetland habitats adjacent to or surrounded by cultivated fields may be impacted by encroachment of soil-disturbing activities or by construction of drainage ditches. Other habitat types impacted by conversion to agricultural uses include forested depression wetlands, canebrakes, and beech-magnolia slope forests.

The uplands of this region are currently employed for a wide variety of agricultural uses, including row crops, orchards, pastures, and hayfields. In some watersheds, particularly in the Dougherty Plain, vegetated stream buffers are often too narrow to provide adequate erosion control. In other areas, intermittent or seasonal headwater streams and seeps have been impacted by encroachment of soil-disturbing practices. These activities result in a general degradation of water quality and habitat for aquatic and wetland species. Expanding vegetated stream buffers and protecting headwater streams would provide significant benefits to some of Georgia's most imperiled aquatic species as well as species associated with streamside bogs and seeps.

Conversion of upland pine and pine-hardwood forests to pine plantations has also resulted in impacts to wildlife diversity. In some cases, this conversion has resulted in replacement of the original longleaf pine canopy with slash or loblolly pine, while the groundlayer vegetation retains much of the original diversity due to frequent prescribed burns and less intensive site preparation techniques. Where intensive site preparation techniques have been utilized and/or burning has been eliminated as a management tool, much of this native groundlayer diversity has been lost, and habitat suitability for many high priority animals (e.g., red-cockaded woodpecker, Bachman's sparrow, northern bobwhite quail, gopher tortoise, indigo snake, flatwoods salamander) has been greatly reduced.

Although many landowners within this ecoregion utilize prescribed fire as a management tool, there are some areas in which altered fire regimes constitute a significant problem for wildlife. Expansion of residential and commercial development from urban centers into surrounding suburbs has resulted in many fire-dependent habitats being surrounded by highways, subdivisions, or retail centers. In these areas, concerns about smoke management, air quality, and damage to structures make it difficult to implement prescribed burn plans. In other areas, existing agricultural fields, roads, or utility corridors may isolate fire-dependent wetland communities from forested upland areas that would normally serve as fire source areas.

Extensive peat-bottomed wetland habitats that are difficult to burn are often excluded from prescribed burn plans. Historically, fires in the larger Carolina bays occurred at approximately 25-year intervals. Today, fire exclusion and altered hydrologic conditions have greatly reduced the variety of habitat types represented within depression wetlands. Grand Bay, one of the most extensive wetlands in the state, is maintained primarily by fluctuating water levels along with periodic prescribed fires. This type of management is critical for maintenance of freshwater marsh habitat for the Florida water rat, Florida sandhill crane, and other associated species.

Groundwater and surface water withdrawals for agricultural uses represent significant impacts to wetlands, streams and sensitive karst environments, particularly in the Dougherty Plain. These withdrawals are capable of greatly reducing the hydroperiod of depression wetlands and reducing flows substantially in streams, affecting habitat for a wide variety of rare or declining birds, mussels, fishes, amphibians, reptiles, and plants. In addition, these withdrawals can remove water that would normally from sensitive environments such as caves, springs, and underground streams.

While less prevalent than in other ecoregions, residential and commercial development has resulted in loss of habitats on the periphery of metropolitan areas and along major highways. This is most noticeable in metropolitan areas of Columbus, Albany, Tifton, Valdosta, Warner-Robins, Statesboro, and Augusta. Development pressures have resulted in the loss or fragmentation of a number of upland habitats, alteration of fire regimes, increased sedimentation of streams, and filling or draining of isolated wetlands.

Invasive exotic species pose significant problems to habitats and species in this region. Notable examples include feral hogs, Chinese privet, hydrilla, Japanese climbing fern, cogon grass, and Asian clam. Feral hogs are particularly damaging to understory vegetation in mesic upland hardwood forests, where they feed on roots, tubers, and fruits of a wide variety of herbs, including rare species such as relict trillium. They are also capable of impacting a wide variety of plant species associated with wet pine savannas and herb bogs. Hydrilla is a noxious aquatic weed that has infested shallow water habitats in Lake Seminole, reducing aquatic habitat quality. Japanese climbing fern, a well-known pest in Florida, has gained a foothold in this ecoregion, and cogon grass, a very serious exotic pest plant has recently been documented.

For some high priority species and habitats, unmanaged recreational use represents a serious problem. For example, ATV use in and adjacent to the Ohoopee River may represent a threat to populations of rare mussels such as the Altamaha spinymussel. The potential impacts from this type of recreational use include destabilization of streambanks, excessive sedimentation, pollution from fuel spills, and direct mortality from vehicular impacts. Unmanaged vehicular traffic on xeric aeolian dunes, sandhills, and rock outcrops (e.g., Altamaha Grit) results in damage to the sparse xerophytic vegetation, destabilization of substrates, and direct mortality to rare or declining species such as the gopher tortoise, indigo snake, and eastern diamondback rattlesnake.

Construction of dams or other structures altering stream flow represents a significant problem for high priority species and habitats in this region. Most of the major river impoundments affecting streams and associated wetlands in this area are in the Piedmont (e.g., Lake Sinclair, Lake Oconee, Lake Jackson, West Point Lake, Lake Lanier, Clarks Hill Lake, Jackson Lake), but the regulation of flows on these alluvial river systems results in altered hydroperiods and sediment transport regimes for riverine swamps and bottomland hardwood forests, which in turn affects species composition, structure, and function of these ecosystems. Woodruff Dam at Lake Seminole serves as a barrier for passage of species such as the gulf sturgeon.

Nonalluvial (blackwater) rivers and streams are particularly vulnerable to nutrient loadings and hydrologic disruptions from groundwater and surface water withdrawals, draining of adjacent wetlands, insufficient stream buffers, and other factors. Impacts on these nonalluvial systems include increased flow variability, low dissolved oxygen conditions, increased silt loadings, and resulting stresses to aquatic organisms.

Throughout this ecoregion, depressional wetlands have been impacted by construction of impoundments or drainage ditches. These alterations of natural hydrologic conditions, along with the elimination of fire as a management tool, result in a decline in the number and variety of depression wetland communities.

High Priority Sites and Landscape Features

The current assessment and previous conservation planning efforts have identified a number of ecologically important sites and landscape features in this region of the state. An assessment of the East Gulf Coastal Plain conducted by The Nature Conservancy in cooperation with state natural heritage programs in Alabama, Georgia, Florida, Mississippi, and Louisiana identified 15 high priority areas of conservation interest in Georgia (The Nature Conservancy, 1999). A similar assessment conducted for the South Atlantic Coastal Plain in cooperation with state natural heritage programs in Georgia, Florida, and South Carolina identified 38 high priority conservation areas in Georgia (The Nature Conservancy, 2002). Field surveys conducted by Georgia DNR staff and others have brought additional areas of conservation interest to light in recent years (Edwards et al. 2013). The following list includes examples of significant sites and landscape features in the Southeastern Plains ecoregion.

Alapaha River Corridor

The Alapaha River is a nonalluvial (blackwater) river in the Gulf Coastal Plain of Georgia. The Alapaha River corridor includes significant upland habitats associated with sandhill environments. This system includes longleaf pine-scrub oak woodlands, old-growth dwarf pondcypress swamps, mesic hardwood bluffs, and depression ponds. High priority species associated with these habitats include striped newt, gopher frog, gopher tortoise, spotted turtle, eastern indigo snake, eastern diamondbacked rattlesnake, tiger salamander, silky camellia, and pondspice. The Alapaha River is inhabited by the

Suwannee River alligator snapping turtle, a distinct, newly described species that is rarer in Georgia than the species found in other drainages. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Altamaha River Corridor

The Altamaha basin drains a total of 14,400 square miles, more than one-fourth of Georgia's land surface. Natural communities associated with this immense river system include oxbow lakes, sandbars, evergreen hammocks, sand ridge scrub forests, hardwood levee forests, cypress-gum swamps, pine flatwoods, limestone shoals, coastal marshes, and open-water estuaries. Important habitats located adjacent to the river floodplain include springs, bogs, Carolina bays and cypress/gum ponds.

Numerous high priority plants and animals are known from the Altamaha River corridor. Examples include green fly orchid, pondspice, Georgia plume, Franklinia, red-cockaded woodpecker, gopher tortoise, indigo snake, Bachman's sparrow, and swallow-tailed kite. Several rare and/or endemic bivalves have been reported from the Altamaha River, including the Altamaha spinymussel and Altamaha arcmussel. Ongoing efforts to provide long-term protection for the Altamaha River corridor involve a number of agencies and organizations, including Georgia DNR, U.S. Department of Defense, The Nature Conservancy, The Conservation Fund, the U.S. Fish & Wildlife Service, Plum Creek Timber Company, The Longleaf Alliance, International Paper, and Rayonier, Inc. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Broxton Rocks/Altamaha Grit Outcrops

Altamaha Grit outcrops can be considered a high priority habitat type endemic to Georgia. These outcrops, composed of indurated sandy clay often commonly called "sandstone", are typically associated with longleaf pine-scrub oak woodlands or longleaf pine-wiregrass savannas. They occur in scattered locations in the Tifton Upland and Vidalia Upland regions of the Southeastern Plains. Perhaps the most significant examples of this habitat type can be found at Broxton Rocks Preserve, owned and managed by The Nature Conservancy in Coffee County, as well as the nearby Flat Tub Landing WMA. Other significant examples of Altamaha Grit outcrops can be found in Turner, Laurens, Treutlen and Washington counties. Several additional examples of this habitat type should be protected and managed in a landscape context of fire-maintained upland and wetland communities.

Caves of Southwest Georgia

Caves in the Pelham Escarpment area of southwestern Georgia represent significant natural communities. Several of these caves also provide habitat for rare species such as the southeastern bat, Georgia blind salamander, and Dougherty Plain cave crayfish. Associated natural communities of significance include limesinks, springs and mesic ravine forests. No caves in this region of the state are in public ownership, though some are protected through conservation easements. These sensitive habitats are threatened by point and nonpoint pollution, sedimentation and vandalism.

Chickasawhatchee Swamp/Ichauway Plantation

Chickasawhatchee Swamp is an extensive habitat complex that represents the second-largest nonalluvial swamp system in Georgia. This area contains a number of important habitats, including springs, pondcypress ponds, and bottomland hardwood forest. The State of Georgia owns and manages a large portion of this site as Chickasawhatchee Wildlife Management Area. Ichauway Plantation is a privately owned conservation and research site that contains a variety of high priority riverine, wetland, and upland habitats. The Chickasawhatchee/Ichauway Plantation PARCA supports populations of Florida green watersnakes and alligator snapping turtles, and larger streams in this region have Barbour's map turtles in abundance. Upland communities of longleaf pine support gopher tortoises, eastern diamond-backed rattlesnakes, pine snakes, southern hognose snakes, and non-breeding habitat for reticulated flatwoods salamanders, gopher frogs, tiger salamanders, and striped newts, all of which breed in nearby isolated wetlands. This site serves as important groundwater/surface water exchange area; its protection is critical for the maintenance of groundwater and surface water quality in this region.

Fort Benning/Western Fall Line Sandhills

Fort Benning and surrounding areas in the upper Coastal Plain of West Georgia include significant examples of longleaf pine-scrub oak woodland, blackwater streams, alluvial river and swamp, mesic hardwood forest, and sandy bluffs. Over 40 species of conservation concern are known from this conservation area, including red cockaded woodpecker, Bachman's sparrow, Georgia rockcress, bay starvine, and relict trillium. High priority reptiles and amphibians in this area include gopher tortoise, Barbour's map turtle, alligator snapping turtle, eastern diamond-backed rattlesnake, pine snake, southern hognose snake, southern coal skink, gopher frog, tiger salamander, Chamberlain's dwarf salamander, and striped newt. Biologists from The Nature Conservancy and Georgia DNR have worked with Fort Benning staff to identify and develop management recommendations for significant natural communities and rare species populations on the base. Significant land acquisitions in this area of the western Fall Line Sandhills region have been made possible by funding from the U.S. Department of Defense, U.S. Fish and Wildlife Service, The Nature Conservancy, and the State of Georgia.

Fort Gordon

Located in the upper portion of the Southeastern Plains southwest of Augusta, this military facility contains significant examples of longleaf pine-scrub oak woodland, longleaf pine-wiregrass savannas, Atlantic whitecedar swamps, mesic hardwood forest, and blackwater streams. Rare species known from this conservation area include sandhills rosemary, Pickering's morning glory, Carolina redtop, sweet pitcherplant, red cockaded woodpecker, bluebarred pygmy sunfish, dwarf waterdog, southern hognose snake, gopher tortoise, Barbour's map turtle, alligator snapping turtle, eastern diamond-backed rattlesnake, pine snake, southern coal skink, gopher frog, tiger salamander, Chamberlain's dwarf salamander, and striped newt. The Nature Conservancy and the

State of Georgia have collaborated with the U.S. Department of Defense on vegetation monitoring and rare species management on this military base.

Grand Bay/Banks Lake

This high priority conservation landscape includes approximately 20,000 acres in south-central Georgia. Major landowners are the U.S. Fish and Wildlife Service (Banks Lake NWR), the U.S. Air Force (Moody AFB) and Georgia DNR (Grand Bay WMA). This area includes several large, shallow depressions similar to Carolina bays, but which may actually be solution sinks. If Grand Bay is actually a Carolina bay, it would be one of the largest known. Natural communities of interest include cypress-gum swamps, broadleaf evergreen hammocks, pine flatwoods, and open-water lakes. High priority species known from this area include greenfly orchid and Florida water rat.

Kinchafoonee and Muckalee Creeks

These blackwater (nonalluvial) streams are found in southwestern Georgia. Kinchafoonee and Muckalee creeks provide habitat for a wide variety of aquatic species, including more than a dozen species of imperiled fish and mussels. Protection of these and other high priority blackwater stream systems through enhancement of stream buffers, regulation of groundwater and surface water withdrawals, and reduction of pollution sources is critical for maintenance of high priority aquatic species in this ecoregion.

Lake Seminole/Spring Creek

This site generally encompasses the area surrounding Lake Seminole (managed by the U.S. Army Corps of Engineers) at the confluence of the Flint and Chattahoochee rivers. It also includes the lower portion of Spring Creek, a tributary of the Flint River Important natural communities include lacustrine habitats, clay-based sandhills, steephead ravines, springs, and limesink ponds. Longleaf pine communities and embedded isolated wetlands provide habitat for gopher tortoises and eastern diamond-backed rattlesnakes. A small, remnant population of eastern indigo snakes also is found here, the only known remaining population in SW Georgia. Other high priority species in this area include Florida torreya, gulf sturgeon, Barbour's map turtle, Chamberlain's dwarf salamander, Georgia blind salamander, and alligator snapping turtle. Protected state lands surrounding Lake Seminole include Silver Lake WMA and Lake Seminole State Park

Lower Flint River Corridor

The lower Flint River corridor includes many significant aquatic and terrestrial habitats, including springs, limestone shoals, mesic bluff forest, sinkholes, longleaf pine forest, and large riverine habitat. A large number of imperiled mussels can be found in the lower Flint River and tributary streams. Conserved lands in this area include Elmodel WMA, Flint River WMA. Radium Springs, Ichauwaynochaway Creek, and Spring Creek are notable tributaries to the Flint River. The lower Flint River has populations of Barbour's map and alligator snapping turtles. Chamberlain's dwarf salamanders are found in seepages in this region. This area is underlain by the Floridan Aquifer which is home to the Georgia blind salamander.

Ocmulgee River Corridor/Oaky Woods WMA

The Ocmulgee River corridor south of Warner Robins contains a number of high priority habitats, including bottomland hardwood forest, mesic hardwood forest, alluvial river and swamp, Black Belt prairies, limesinks, and caves. This area supports the only black bear population in central Georgia, as well as several other high priority species such as Ocmulgee skullcap and relict trillium. Acquisition of a large portion of the property formerly leased from Weyerhaeuser has increased protection for these habitats. A recent multi-agency effort to expand Ocmulgee National Monument and Bond Swamp National Wildlife Refuge has focused on the need to conserve natural and cultural resources and provide additional opportunities for outdoor recreation.

Ogeechee River Corridor

The Ogeechee River originates in the lower Georgia Piedmont and flows 245 miles to the Atlantic Ocean at Ossabaw Sound. Natural communities of the Ogeechee River corridor include limestone shoals, sandbars, cypress-gum swamps, springs, bottomland hardwood forests and coastal salt marshes. Important habitats adjacent to the river floodplain include Carolina bays, springs, limesinks, sandhills and Altamaha Grit outcrops. Examples of high priority species associated with the Ogeechee River floodplain and adjacent habitats include Georgia plume, wood stork, and swallow-tailed kite. Numerous springs provide cool-water refuges for striped bass and other game fish.

The Ogeechee is relatively free from significant development, except in the lower portions. This river has been considered for inclusion as a component of the Georgia Scenic River system and was nominated as a potential National Wild and Scenic River. Impacts to the river corridor include residential and industrial development (especially along the coast), conversion of bottomland hardwood forests, and drainage of adjacent wetland habitats. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Ohoopee/Little Ohoopee Rivers and Dunes

The Ohoopee and Little Ohoopee rivers of east-central Georgia represent important examples of non-alluvial (blackwater) stream ecosystems. These rivers flow southeastward for a total of approximately 110 miles from their headwaters to the Altamaha River. The Ohoopee/Little Ohoopee rivers contain a variety of natural communities, including cypress-gum swamps, bottomland hardwood forests and white sandbars. The "Ohoopee Dunes" consist of a series of high undulating sand ridges lying east of, and parallel to, the Ohoopee and Little Ohoopee rivers. These deep, coarse sand dunes were formed by wind action during the late Pleistocene.

Natural communities of the xeric upper dunes include dwarf oak-evergreen scrub, evergreen scrub-lichen vegetation and longleaf pine-scrub oak woodlands. The lower slopes of the dunes, near the edge of the river floodplains, contain diverse "bayhead" forests, seeps, and bogs. Numerous rare plant and animal species have been documented from these ecosystems; examples include sandhills rosemary, Ashe's savory, Indian olive, eastern indigo snake, gopher tortoise, striped newt, and Altamaha spinymussel. Approximately 2,500 acres of this habitat is owned by the State of Georgia and managed as Ohoopee Dunes State Natural Area. The Nature Conservancy owns and manages an adjacent 267-acre tract as Ohoopee Dunes Preserve, and the U.S. Fish and Wildlife Service owns a tract that is managed by Georgia DNR as part of the natural area.

Red Hills Region

The Red Hills region of southwestern Georgia contains impressive examples of longleaf pine/wiregrass savannas, pitcherplant bogs, blackwater creek swamps, blackwater rivers, wet pine flatwoods and other natural communities. Most of this area is in private ownership and managed as quail plantations. Many high priority plants and animals have been documented from this region, and efforts are ongoing to provide permanent protection for the most important sites and habitats through fee-simple acquisition, conservation easements, and long-term management agreements such as Safe Harbor. High priority reptiles and amphibians in this area include gopher tortoise, eastern diamond-backed rattlesnake, pine snake, alligator snapping turtle, one-toed amphiuma, and tiger salamander.

Yuchi WMA/Plant Vogtle

This site along the Savannah River south of Augusta contains Pleistocene beach dune-origin sandhills that are a stronghold for southern hognose and pine snakes. Gopher tortoises are also present, though depleted from past human collection for food. Dwarf waterdogs, Chamberlain's dwarf salamanders, and spotted turtles are likely in the blackwater streams and riparian zones. The Savannah slimy salamander, a Georgia endemic, may occur in the uplands.

High Priority Waters

Figure 18 shows the high priority streams and watersheds identified by the Aquatic Habitat Technical Team for this ecoregion. These streams were chosen on the basis of documented occurrences of high priority aquatic species and relative rarity of these species. Examples of high priority streams in the Southeastern Plains include Spring Creek, Pataula Creek, Patsiliga Creek, Chickasawhatchee Creek, Kinchafoonee Creek, Kiokee Creek, Ichawaynochaway Creek, Hannahatchee Creek, Buckhead Creek, Flint River, Savannah River, Brier Creek, Ogeechee River, Withlacoochee River, Ochlockonee River, Alapaha River, Williamson Swamp Creek, Suwannee River, Aucilla River, Little Ohoopee River, Oconee River, Ocmulgee River, and Altamaha River. Refer to the Aquatic Habitat Technical Team report in Appendix F for details on the identification of high priority watersheds.

Conservation Goals

- Maintain known viable populations of all high priority species and functional examples of all high priority habitats through land protection, incentive-based habitat management programs on private lands, and habitat restoration and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Encourage restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic restoration, and revegetation efforts.
- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance, developing specific educational messages, and managing exotic species populations on public lands.
- Minimize impacts from residential and commercial development on high priority species and habitats by providing input on environmental assessments
- Continue efforts to recover federally listed species by implementation of recovery plans

Strategies and Partnerships to Achieve Conservation Goals

- Provide financial incentives and technical expertise to encourage prescribed burns, through Interagency Burn Team and other means
- Work with NRCS staff to identify high priority habitats and sites for implementation of habitat enhancement/restoration projects through Farm Bill programs (e.g., restoration of longleaf pine-dominated forests and savannas)
- Use state lands (e.g., Doerun Pitcherplant Bog Natural Area, Big Dukes Pond Natural Area, Mayhaw WMA) and other public lands to showcase habitat restoration efforts. Complete management plans for all state lands and incorporate management objectives for populations of high priority species.
- Assess nonnative invasive species populations on public lands and provide technical assistance to private landowners to discourage use of invasive plants
- Work with GDOT and local governments to minimize direct impacts to high priority species and habitats from development projects
- Work with Georgia Power and private landowners to identify and conserve populations of rare species in and adjacent to utility corridors
- Develop educational materials on high priority species and habitats in the ecoregion and provide these to environmental educators at WRD facilities (e.g., GoFish Center, Grand Bay Education Center) and other facilities
- Work with GFC and SFI-SIC to facilitate development of forestry BMPs for maintenance of important wildlife habitats
- Work with The Nature Conservancy, USFWS, Georgia Land Conservation Center and local land trusts to provide protection for high priority wetlands and stream corridors.

Highest Priority Conservation Actions

High priority conservation actions (actions rated “Very High” or “High”) identified by the technical teams, advisory committee, and other stakeholders specifically for this ecoregion include the following (see Appendix P for details):

- Assess Middle Georgia black bear population and habitat conservation needs; develop conservation plan for the Ocmulgee River corridor.
- Conduct surveys for Black Rails in high marsh areas of saltmarsh and possibly other shallowly flooded freshwater habitats.
- Continue monitoring freshwater mussel populations in key sites in the lower Flint River Basin and Sawhatchee Creek (lower Chattahoochee).
- Survey mussels in poorly sampled stream reaches in the Ochlockonee, Withlacoochee and Suwanee basins. Species of interest include Suwanee Moccasinshell, Ochlockonee Mocassinshell, Suwanee Pigtoe, Oval Pigtoe, and Shinyrayed Pocketbook.
- Continue Line Transect Distance Sampling (LTDS) of gopher tortoise populations to maintain gopher tortoise Candidate Conservation Agreement.
- Continue monitoring hellbender and eastern indigo snake occupancy.
- Monitor reproductive activity at known, recently extant ponds used by pond-breeding amphibians.
- Maintain Robust Redhorse Conservation Committee to assure restoration of robust redhorse populations. Conduct research and management efforts to develop six self-sustaining populations of robust redhorse throughout its historic range.
- Incorporate Henslow's Sparrow habitat management into management plans on all WMAs that have confirmed wintering sites
- Monitor populations of southeastern bats in Southwest Georgia caves; conduct monitoring of caves with populations of other bats currently affected or likely to be affected by WNS. Count bats and coordinate with researchers studying the disease and potential treatment options.
- Implement restoration projects for Gulf striped bass and other diadromous fish. Evaluate existing population status, commercial and recreational fisheries, and habitat limitations. Look for opportunities to enhance habitat.
- Implement red-cockaded woodpecker conservation on private lands, through safe harbor agreements and mitigated take from small, isolated populations. Administer landowner incentive program for safe harbor participants.
- Conduct surveys of southwest Georgia isolated wetlands. Assess sites for potential suitable habitat for high priority species of conservation concern. Obtain landowner contacts and conduct rare species survey at sites with high potential.

Other high priority conservation actions that are statewide in scope are addressed in Section V of this report.

Table 10. Southeastern Plains High Priority Animals (151 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
AA	Cambarus cryptodytes	Dougherty Plain Cave Crayfish	G2	S2		T	Pool areas of subterranean systems
AA	Cambarus doughertyensis	Dougherty Burrowing Crayfish	G1	S1		E	Primary burrower in wooded wetlands; black sticky clay soil.
AA	Cambarus truncatus	Oconee Burrowing Crayfish	G2	S2		T	Complex burrows in sandy clay soil
AA	Cordulegaster sayi	Say's Spiketail	G2	S2		T	Trickling hillside seepages in deciduous forest with scrub-oak sandhills nearby
AA	Ophiogomphus australis	Southern Snaketail	G1G2	S1			Small streams in woodland with some gravely substrate
AA	Procambarus acutissimus	Sharpnose Crayfish	G5	S2			Temporary fluctuating pools or ponds to permanent lotic habitats (not typical of GA populations); sometimes in simple burrows
AA	Procambarus gibbus	Muckalee Crayfish	G3Q	S2		T	Found in flowing streams with good oxygen supply
AA	Procambarus verrucosus	Grainy Crayfish	G4	S2		R	Marshes and standing water (often temporary) adjacent to small, coastal plain creeks.
AA	Procambarus versutus	Sly Crayfish	G5	S1		R	Found in debris in moderately swift streams. Found in root masses and plants.
AM	Ambystoma bishopi	Reticulated Flatwoods Salamander	G2	S1	LE		Pine flatwoods; moist savannas; isolated cypress/gum ponds
AM	Ambystoma cingulatum	Frosted Flatwoods Salamander	G2	S1	LT	T	Pine flatwoods; moist savannas; isolated cypress/gum ponds
AM	Ambystoma tigrinum tigrinum	Eastern Tiger Salamander	G5	S3S4			isolated wetlands for breeding; variety of open, upland habitats; CP - sandhills, oldfields, dry pine savanna
AM	Amphiuma pholeter	One-toed Amphiuma	G3	S1		R	Organic muck beds in floodplains and seepage bogs
AM	Desmognathus auriculatus	Southern Dusky Salamander	G5	S2			Mucky areas usually in or near moving water
AM	Eurycea chamberlaini	Chamberlain's Dwarf Salamander	G4	S2			Seepage ravines/stream sides; bogs, sphagnum beds, marshes
AM	Haideotriton wallacei	Georgia Blind Salamander	G2	S1		T	Cave pools; aquifer
AM	Lithobates capito	Gopher Frog	G3	S2S3		R	Sandhills; dry pine flatwoods; breed in isolated wetlands
AM	Necturus punctatus	Dwarf Waterdog	G5	S2S3			Sluggish streams with substrate of leaf litter or woody debris
AM	Notophthalmus perstriatus	Striped Newt	G2G3	S2	C	T	Pine flatwoods, sandhills; isolated wetlands
BI	Ammodramus henslowii	Henslow's Sparrow	G4	S2		R	Grassy areas, especially wet grasslands, pitcher plant bogs, pine flatwoods, power-line corridors in CP. Require open veg at ground level with grass canopy above
BI	Ammodramus savannarum pratensis	Grasshopper Sparrow	G5	S4			Breeds in grasslands, pasture lands, PD RV, rare in CP. Wintering range poorly known.
BI	Colinus virginianus	Northern Bobwhite	G5	S5			Early successional habitat, open pine savanna (frequent fire maintained in small burn unit size), fallow habitats associated with crop lands, extensive forest regen areas (area sensitive - minimal fall pop of 700 birds for viability on 3000+acres)
BI	Coturnicops noveboracensis	Yellow Rail	G4	SU			
BI	Egretta caerulea	Little Blue Heron	G5	S4			Nest in single species and mixed species colonies in various inland forested fresh-water wetlands, including impounded wetlands, cypress swamps, and similar habitats
BI	Egretta tricolor	Tricolored Heron	G5	S4			Nests in colonies (often with other wading bird species) in wetlands and on isolated islands. Feeds in shallow wetlands, creeks and rivers. The most coastal of all our waders.
BI	Elanoides forficatus	Swallow-tailed Kite	G5	S2		R	River swamps; marshes, forages over pastures and ag fields - post breeding. Forage in well burned open pine woodlands where exist. Open pine and bottomland forest with super canopy pines preferred nest sites. Will nest in non-emergent hardwoods and thinned pine plantations as well - typically several years before final harvest.
BI	Euphagus carolinus	Rusty Blackbird	G4	S3			Bottomland forest, pecan orchards, agricultural fields

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 10. Southeastern Plains High Priority Animals (151 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
BI	Falco sparverius paulus	Southeastern American Kestrel	G5T4	S2		R	Open pine grasslands with snags in Coastal Plain, also hayfields and pasture lands
BI	Grus americana	Whooping Crane	G1	S1	LE		Open, mostly emergent herbaceous freshwater wetlands and fields for stop-over sites
BI	Haliaeetus leucocephalus	Bald Eagle	G5	S3		T	Edges of lakes & large rivers; seacoasts
BI	Ixobrychus exilis	Least Bittern	G5	S3			Fresh and brackish water wetlands with emergent herbaceous cover including impoundments, natural freshwater marshes, and tidally influenced marshes
BI	Lanius ludovicianus	Loggerhead Shrike	G4T3Q	S3			Open woods; field edges, pastures, ball fields, industrial park, primary dunes, hammocks
BI	Laterallus jamaicensis	Black Rail	G3G4	S1			Very shallowly flooded freshwater marshes, brackish marshes, and saltmarshes. Some high marsh areas of the saltmarsh may have breeding pairs
BI	Limnothlypis swainsonii	Swainson's Warbler	G4	S3			Dense undergrowth or canebrakes in swamps and river floodplains, small mountain pop in rhododendron and mountain laurel thickets
BI	Mycteria americana	Wood Stork	G4	S3	LT	E	Breeding Cypress/gum ponds; impounded wetlands with islands or emergent cypress, river swamps; Foraging - marshes (fresh and intertidal); river swamps; bays; farm ponds,
BI	Passerina ciris	Painted Bunting	G5	S2S3			Most in Lower Coastal Plain in thickets, woodland borders, marsh edges, and brushy areas. Smaller numbers in Upper Coastal Plain, particularly the eastern half, agricultural habitat
BI	Peucaea aestivalis	Bachman's Sparrow	G3	S2		R	Open pine or oak woods; old fields; brushy areas, young large grassy pine regeneration areas
BI	Picoides borealis	Red-cockaded Woodpecker	G3	S2	LE	E	Open pine woods; pine savannas
BI	Protonotaria citrea	Prothonotary Warbler	G5	S4			Bottomland forest, swamps, and similar forested wetlands. Nests in tree cavities.
BI	Rallus elegans	King Rail	G4	S3			Freshwater to brackish emergent herbaceous wetlands of grasses, sedges, cattails, wild rice; herbaceous portions of forested wetlands.
BI	Tyto alba	Barn Owl	G5	SU			Nests in large hollow trees or old buildings (particularly cement silos) in areas with extensive pasture or grassland or other open habitats such as marsh
FI	Acipenser brevirostrum	Shortnose Sturgeon	G3	S2	LE	E	Estuaries; lower end of large rivers in deep pools with soft substrates
FI	Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	SX			Estuaries; deep pools at lower end of large rivers
FI	Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	G3T3	S3	LE	E	Estuaries; lower end of large rivers in deep pools with soft substrates; spawn as far inland as Macon, GA on the Ocmulgee
FI	Alosa alabamae	Alabama Shad	G2G3	S1		T	Migrates into Gulf coastal rivers for reproduction
FI	Alosa sapidissima	American Shad	G5	S5			large rivers between coast and fall zone are used for spawning and early life history stages
FI	Ameiurus serracanthus	Spotted Bullhead	G3	S3		R	Large streams and rivers with moderate current and rock-sand substrate
FI	Carpiodes velifer	Highfin Carpsucker	G4G5	S2S3			swift sandy areas associated with sandbars, yoy found in backwaters and on margins of sandbars
FI	Chologaster cornuta	Swampfish	G5	S2S3			near vegetation and debris in swamps, ponds, ditches, and slow moving streams, pools backwaters
FI	Cyprinella callitaenia	Bluestripe Shiner	G2G3	S2		R	Flowing areas in large creeks and medium-sized rivers over rocky substrates
FI	Elassoma gilberti	Gulf Coast Pygmy Sunfish	G4G5	S2S3			vegeated habitats with no or slow flow in the Coastal Plain
FI	Elassoma okatie	Bluebarred Pygmy Sunfish	G2G3	S1		E	Temporary ponds and stream backwaters with dense aquatic vegetation
FI	Enneacanthus chaetodon	Blackbanded Sunfish	G3G4	S1		E	Blackwater streams; bays; cypress/gum ponds
FI	Etheostoma parvipinne	Goldstripe Darter	G4G5	S2S3		R	Small sluggish streams and spring seepage areas in vegetated habitat

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 10. Southeastern Plains High Priority Animals (151 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Lucania goodei	Bluefin Killifish	G5	S1		R	Heavily vegetated ponds and streams with little or no current; frequently associated with springs
FI	Micropterus notius	Suwannee Bass	G3	S2		R	Flowing water over rocky shoals or large springs and spring runs
FI	Micropterus sp. cf coosae "Altamaha/Ogeechee"	Undescribed Redeye Bass	GNR	S3			believed to be headwater species but patterns altered by non-native species
FI	Micropterus sp. cf coosae "Savannah"	Bartrams Bass	GNR	S3			upland streams and rivers
FI	Moxostoma robustum	Robust Redhorse	G1	S1		E	Med to large rivers, shallow riffles to deep flowing water; moderately swift current
FI	Notropis hypsilepis	Highscale Shiner	G3	S3		R	Flowing areas of small to large streams over sand or bedrock substrates
FI	Percina crypta	Halloween Darter	G2	S2		T	larger streams in riffle/shoal habitat
FI	Pteronotropis euryzonus	Broadstripe Shiner	G3	S3		R	Flowing areas of medium sized streams associated with sandy substrate and woody debris or vegetation
FI	Pteronotropis welaka	Bluenose Shiner	G3G4	S1		T	Quiet backwaters and vegetated pools of streams and rivers
MA	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	G3G4	S3		R	Pine forests; hardwood forests; caves; abandoned buildings; bridges; bottomland hardwood forests and cypress-gum swamps
MA	Geomys pinetis	Southeastern Pocket Gopher	G5	S3S4		T	sandy well-drained soils in open pine woodlands with grassy or herbaceous groundcover, fields, grassy roadsides
MA	Lasiurus intermedius	Northern Yellow Bat	G4G5	S3			Wooded areas near open water or fields, hardwoods - live oaks preferred, large trees
MA	Myotis austroriparius	Southeastern Myotis	G3G4	S3			Caves & buildings near water; large hollow trees in bottomland hardwood swamps
MA	Neofiber alleni	Round-tailed Muskrat	G3	S3		T	Freshwater marshes; bogs
MA	Perimyotis subflavus	Tri-colored Bat	G3	S5			Open forests with large trees and woodland edges; roost in tree foliage; hibernate in caves or mines with high humidity.
MA	Spilogale putorius	Eastern Spotted Skunk	G4	S3			brushy, rocky, wooded habitats; avoids wetlands
MO	Alasmidonta triangulata	Southern Elktoe	G1Q	S1		E	Gently sloping banks with soft substrate. Often in slackwater areas and possibly in reservoirs. Mixtures of mud, sand, and gravel substrate
MO	Anodontoides radiatus	Rayed Creekshell	G3	S2		T	Small creeks to large rivers with moderate current in mud, sand, and gravel
MO	Elimia darwini	Pup Elimia	G1	S1			small streams and springs
MO	Elimia inclinans	Slanted Elimia	G1G2	S1S2			Creeks and medium-sized rivers in the Flint River basin
MO	Elimia induta	Gem Elimia	G2	S2			Flint River tributaries in SW GA
MO	Elimia timida	Timid Elimia	G1	S1			small streams and springs on the right side of the Ocmulgee River.
MO	Elliptio spinosa	Altamaha Spinymussel	G1G2	S1	LE	E	Large Rivers in firm sand substrate; good flow
MO	Fusconaia masoni	Atlantic Pigtoe	G2	S1		E	Medium sized streams to large rivers from the Ogeechee River northward; coarse sand and gravel at downstream edge of riffles; fast flowing and well oxygenated water
MO	Lampsilis straminea	Southern Fatmucket	G5T	S2			Small creeks to rivers in slow to moderate current; sand, sandy mud and gravel substrates
MO	Marstonia agarhecta	Ocmulgee Marstonia	G1	S1			Submerged logs in clear water with slight current; occasionally individuals found in silt that contained large amounts of diatoms (Thompson, 1977)
MO	Marstonia gaddisorum	Emily's Marstonia	G1	S1			Springs/small stream in Oconee basin
MO	Quadrula kleiniana	Suwannee Pigtoe	G2G3	S2			Georgia habitat information not available
MO	Somatogyrus rheophilus	Flint Pebblesnail	G1	S1			Mainstem of medium to large rivers
RE	Clemmys guttata	Spotted Turtle	G5	S3		U	Heavily vegetated swamps, marshes, bogs, small ponds, tidally influenced freshwater wetlands; nest and possibly hibernate in surrounding uplands

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 10. Southeastern Plains High Priority Animals (151 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
RE	Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	G4	S4			Early successional habitats on barrier islands and mainland; pine flatwoods; sandhills; maritime forests/hammocks; ruderal habitats
RE	Drymarchon couperi	Eastern Indigo Snake	G3	S2	LT	T	Sandhills; pine flatwoods; dry hammocks; summer habitat includes wetlands
RE	Eumeces anthracinus	Coal Skink	G5	S2			Mesic forests; often near streams, springs or bogs
RE	Gopherus polyphemus	Gopher Tortoise	G3	S3	C	T	Sandhills; dry hammocks; longleaf pine-turkey oak woods; old fields
RE	Graptemys barbouri	Barbour's Map Turtle	G2	S3		T	Rivers & large creeks of Apalachicola River drainage; possible in Ochlockonee
RE	Heterodon simus	Southern Hognose Snake	G2	S1S2		T	Sandhills; fallow fields; longleaf pine-turkey oak
RE	Macrochelys temminckii	Alligator Snapping Turtle	G3G4	S3		T	Streams and rivers; impoundments; river swamps
RE	Ophisaurus compressus	Island Glass Lizard	G3G4	S2			Pine savannas, pine flatwoods, secondary dunes/interdunal swales on islands
RE	Ophisaurus mimicus	Mimic Glass Lizard	G3	S1		R	Pine flatwoods; savannas; seepage bogs
RE	Pituophis melanoleucus mugitus	Florida Pine Snake	G4T3	S3			Sandhills; scrub; pine savanna; old fields
TA	Acronicta albarufa	Albarufan dagger moth	G3G4	S2			Ohoopee dunes
TA	Alloblackburneus troglodytes	Little gopher tortoise scarab beetle	GNR	SU			Gopher tortoise burrows
TA	Amblyomma tuberculatum	Gopher tortoise tick	G2G3	S2			Sandhills, longleaf pine woodlands, other sandy open habitats
TA	Amblyscirtes alternata	Dusky roadside-skipper	G2G3	S3			Sunny patches in pine forests
TA	Aphodius aegrotus	A dung beetle	G3G4	S3			Pocket gopher mounds
TA	Aphodius alabama	A dung beetle	G2	S2			Pocket gopher mounds
TA	Aphodius baileyi	A dung beetle	G2G3	S2S3			Pocket gopher mounds
TA	Aphodius bakeri	A dung beetle	G2G3	S2S3			Pocket gopher mounds
TA	Aphodius dyspistus	A dung beetle	G3G4	S3			Pocket gopher mounds
TA	Aphodius gambrinus	Amber pocket gopher Aphodius beetle	G2	S2			Pocket gopher mounds
TA	Aphodius hubbelli	A dung beetle	GNR	S3			Pocket gopher mounds
TA	Aphodius laevigatus	Large pocket gopher Aphodius beetle	G3G4	S3			Pocket gopher mounds
TA	Aphodius pholetus	Rare pocket gopher Aphodius beetle	G1G2	S1			Pocket gopher mounds
TA	Aphodius platypleurus	Broad-sided pocket gopher Aphodius beetle	G2G3	S2			Pocket gopher mounds
TA	Aphodius tanytarsus	Long-clawed pocket gopher Aphodius beetle	G2G3	S2			Pocket gopher mounds
TA	Aptenopedes apalachee	Apalachee linear-winged grasshopper	GU	S2			Longleaf pine savannas
TA	Atrytone arogos arogos	Eastern Aragos Skipper	G3T1T2	SH			Sandhills/longleaf: opsided indiangrass or big bluestem
TA	Bombus affinis	Rusty-patched bumblebee	G1	SH			
TA	Callophrys hesselli	Hessell's hairstreak	G3G4	S2			Atlantic white cedar
TA	Callophrys irus	Frosted elfin	G3	SH			Lupinus perennis, sandhills
TA	Catocala grisatra	Grisatra underwing moth	G1G3	SU			Sandhills with hawthorns
TA	Caupolicana electa	Plasterer bee	GNR	S1S2			Sandhills
TA	Chelyoxenus xerobatis	Gopher tortoise hister beetle	G2G3s2	S2			Gopher tortoise burrows
TA	Chlosyne gorgone gorgone	Gorgone checkerspot	G5T2T3Q	S2			Sandhills
TA	Cicindela nigrior	Autumn tiger beetle	G2G3	S2			Sandhills
TA	Crossidius grahami	Ohoopee dunes Crossidius beetle	GNR	S2			Sandhills with Chrysoma pauciflosculosa

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 10. Southeastern Plains High Priority Animals (151 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
TA	Cyclocosmia torreya	Torreya trap-door spider	GNR	SU			Hardwood ravines
TA	Danaus plexippus	Monarch butterfly	G4	S4			Milkweeds
TA	Dorymyrmex bossutus	Sandhills cone ant	G?	S2			Sandhills
TA	Eotettix palustris	Longleaf spur-throated grasshopper	GU	S3			Longleaf pine savannas
TA	Erynnis martialis	Mottled duskywing	G3	S2			New Jersey tea, longleaf-wiregrass, mountain hardwoods
TA	Euphoria aeusutosa	Pocket gopher flower beetle	G2	S2			Pocket gopher mounds
TA	Fernaldella georgiana	Ohoopee Geometer	G1G3	S2S3			Woody goldenrod, sandy dune systems
TA	Floritettix borealis	A grasshopper	G5TU	S2			Longleaf pine savannas
TA	Geopsammodius ohoopee	Ohoopee dunes scarab beetle	GNR	S2			Sandhills
TA	Hesperia attalus slossonae	Dotted skipper	G3G4T3	S1			Sandhills, buckwheat
TA	Hesperia meskei	Meske's skipper	G3G4	S2S3			Sandhills
TA	Hesperotettix floridensis	A grasshopper	GU	S2			Longleaf pine savannas
TA	Hypothyce osburni	Osburn's hypothyce	GNR	S1			Sandhills
TA	Idia gopheri	Gopher tortoise burrow noctuid moth	G2G3	S1S2			Sandhills, open longleaf pine uplands; gopher tortoise commensal occurring at some subset of tortoise sites
TA	Machimus polyphemi	Gopher tortoise robber fly	G2	S1?			Gopher tortoise burrows
TA	Melanoplus acidocercus	A spur-throat grasshopper	GU	S3			Sandhills
TA	Melanoplus clypeatus	Shield-tailed spur-throat Grasshopper	GU	S3			Mesic longleaf
TA	Melanoplus nossi	Noss' spur-throat grasshopper	G3 (rec)	S2/S3			Hardwoods
TA	Melanoplus sp nov 1	A spur-throat grasshopper	G2 (rec)	S2			Fall Line Sandhills; GA endemic
TA	Melanoplus sp nov 2	A spur-throat grasshopper	G1 (rec)	S1			Fall Line Sandhills; GA endemic
TA	Melanoplus stegocercus	A spur-throat grasshopper	G1G3	S2			Georgia endemic; Ohoopee Dunes sandhills
TA	Melanoplus tumidicercus	A spur-throat grasshopper	GU	S2			Pine woods
TA	Mycotrupes cartwrighti	Cartwright's burrowing beetle	G3	S2			Longleaf pine savannas
TA	Mycotrupes lethroides	Large Mycotrupes	GU	S1S2			Sandhills
TA	Onthophagus polyphemi polyphemi	Onthophagus tortoise commensal scarab beetle	G2G3	S2			In association with Gopherus polyphemus burrows
TA	Pheidole davisi	Pine barrens Pheidole	GNR	S3			Sandhills
TA	Polites baracoa	Baracoa skipper	G4	SH			Sandhill habitats, grassy areas
TA	Polyphylla donaldsoni	Donaldson's lined june beetle	GNR	S2			Sandhills
TA	Satyrium edwardsii	Edwards hairstreak	G4	S3			Blackjack oak
TA	Sphodros abbotii	Purse-web spider	G4G5	S2			Hardwoods
TA	Zale perculta	Okefenokee zale moth	G2	S2			Cypress swamps

Group Codes: AA = aquatic arthropod; AM = amphibian; BI = bird; FI = fish; MA = mammal; MO = mollusk; RE = reptile; TA = terrestrial arthropod

Table 11. Southeastern Plains High Priority Plants (118 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Agalinis georgiana	Georgia Purple Foxglove	G1Q	S1			Mesic to submesic wiregrass pinelands
Arnoglossum sulcatum	Grooved-Stem Indian-Plantain	G3	S1			Bottomland forests
Asclepias rubra	Red Milkweed	G4G5	S1			Bogs, wet savannas
Asplenium heteroresiliens	Morzenti's Spleenwort	G2	S1		T	Limestone and marl outcrops; tabby ruins
Astragalus michauxii	Sandhill Milkvetch	G3	S2		T	Longleaf pine-wiregrass savannas; turkey oak scrub
Balduina atropurpurea	Purple Honeycomb Head	G2	S2S3		R	Wet savannas, pitcherplant bogs
Baptisia megacarpa	Bigpod Wild Indigo	G2	S1			Floodplain forests
Brickellia cordifolia	Heartleaf Brickellia	G2G3	S2		T	Mesic hardwood forests
Calystegia catesbiana ssp. Sericata	Catesby's Bindweed	G3T2?Q	S1?			Longleaf pine- wiregrass savannas
Carex baltzellii	Baltzell's Sedge	G3	S1		E	Beech-magnolia slope forests
Carex decomposita	Cypress-Knee Sedge	G3G4	S2?			Swamps and lake margins on floating logs
Carex exilis	Meager Sedge	G5	S1			Atlantic white-cedar swamps
Carex thornei	Thorne's Sedge	G2G3	S2?			Floodplain low terraces, sw. GA.
Ceratiola ericoides	Rosemary	G4	S2		T	Ohoopee Dunes; deep sandridges
Chamaecrista deeringiana	Florida Senna	G2G4Q	S1?			Sandhill scrub; longleaf pine-wiregrass savannas
Chamaecyparis thyoides	Atlantic White-Cedar	G4	S2		R	Clearwater stream swamps in fall line sandhills
Coreopsis integrifolia	Ciliate-Leaf Tickseed	G1G2	S1S2		T	Floodplain forests, streambanks
Crataegus aprica	Sunny Hawthorn	GNR	S1			Open, sandy, rocky dry sites in lower elevation mountains and perhaps Piedmont.
Crataegus mendosa	Albertville Hawthorn	G2G3Q	S1			Rocky woods, glades
Crataegus triflora	Three-Flower Hawthorn	G2G3	S1		T	Hardwood forests on rocky, limestone slopes
Croomia pauciflora	Croomia	G3	S2		T	Mesic hardwood forests, usually with Fagus and Tilia
Croton elliottii	Pondshore Croton	G2G3	S2S3			Pond margins and wet savannas
Cuscuta harperi	Harper's Dodder	G2G3	S1		E	Altamaha Grit outcrops; granite outcrops; often with Liatris microcephala as host
Cypripedium kentuckiense	Kentucky Ladyslipper	G3	S1		E	Forested, springhead seeps in sandy soils
Desmodium ochroleucum	Cream-Flowered Tick-Trefoil	G1G2	S1		T	Open, calcareous woodlands, including lower slope of Pigeon Mountain
Elliottia racemosa	Georgia Plume	G2G3	S2S3		T	Scrub forests; Altamaha Grit outcrops; open forests over ultramafic rock
Eriophorum virginicum	Tawny Cottongrass	G5	S1			Mountain bogs; peaty wet meadows in alluvial flats in Fall Line sandills; also in Okefenokee Swamp
Eustachys floridana	Florida Finger Grass	G2?	S1?			Sandhills and flatwoods
Fimbristylis perpusilla	Harper's Fimbry	G2	S1		E	Exposed muddy margins of pineland ponds
Fothergilla gardenii	Dwarf Witch-Alder	G3G4	S2		T	Openings in low woods; swamps
Glandularia bipinnatifida var. bipinnatifida	Dakota Vervain	G5T5	S1			Georgia habitat information not available
Habenaria quinqueseta	Michaux's Orchid	G4G5	S1?		T	Rich, moist hardwood hammocks, pine flatwoods, roadside ditches
Hamamelis ovalis	Bigleaf Witch-Hazel	GNR	S1			Ecotone between bay swamp and Slash Pine woodland
Helenium brevifolium	Bog Sneezeweed	G4	S1			Seepage bogs, sometimes with Sarracenia rubra near the Fall Line
Hypericum adpressum	Bog St. Johnswort	G3	S1			Swamps

Table 11. Southeastern Plains High Priority Plants (118 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Hypericum erythraeae	Georgia St.-John's-Wort	G2	S2			Seepage bogs; roadside ditches
Illicium floridanum	Florida Anise-Tree	G5	S1		E	Steepheads, floodplain forests
Isoetes boomii	Boom's Quillwort	G1	S1S2			Shallow water (one foot deep) of slow moving streams
Isoetes flaccida	Florida Quillwort	G3	S2?			Shaded pond margins, cypress swamps, open miry places; margins of sluggish pineland streams often with cypress
Isoetes hyemalis	Winter Quillwort	G2G3	S1?			Sandy blackwater creek banks; deciduous swamps
Isoetes junciformis	Rush Quillwort	G1?Q	S1?			Low, seasonally flooded swales
Justicia angusta	Narrowleaf Water-Willow	G3Q	S1			Roadside ditches; perhaps with Hartwrightia in shallow sloughs and wet savannas
Kalmia carolina	Carolina Bog Myrtle	G4	S1		T	Open swamps and wet meadows; mountain bogs and Atlantic white-cedar swamps
Lachnocaulon beyrichianum	Southern Bog-Button	G4	S1?			Flatwoods
Leitneria floridana	Corkwood	G3	S1		T	Swamps; sawgrass-cabbage palmetto marshes
Liatris tenuifolia var. quadriflora	Florida Narrowleaf Blazing Star	G4G5T4T5	S1?			Open oak or pine woods
Lilium pyrophilum	Pineland Lily	G2	S1			Altamaha grit, open low woods
Lindera melissifolia	Pondberry	G2G3	S2	LE	E	Pond margins and wet savannas
Lindera subcoriacea	Bog Spicebush	G2G3	S1?			Bayheads; seepy forested slopes
Litsea aestivalis	Pondspice	G3?	S2		R	Cypress ponds; swamp margins
Lythrum curtissii	Curtiss' Loosestrife	G1	S1		T	Openings in calcareous swamps
Macbridea caroliniana	Carolina Bogmint	G2G3	S1		R	Bogs; marshes; alluvial woods
Macranthera flammea	Bog Flameflower	G3	S1?		T	Wet, sandy thickets; pitcherplant bogs
Malaxis spicata	Florida Adders-Mouth Orchid	G4?	S1			Low hammocks; spring-fed river swamps
Matelea alabamensis	Alabama Milkvine	G2	S1		T	Open bluff forests; mesic margins of longleaf pine sandridges
Matelea floridana	Florida Milkvine	G2	S1			Open bluff forests
Morella inodora	Odorless Bayberry	G4	S1?		T	Bayheads, titi swamps; forests with pond pine
Najas filifolia	Narrowleaf Naiad	G1	S1		E	Lakes
Nestronia umbellula	Indian Olive	G4	S3		R	Mixed with dwarf shrubby heaths in oak-hickory-pine woods; often in transition areas between flatwoods and uplands
Oxypolis canbyi	Canby's Dropwort	G2	S2	LE	E	Cypress ponds and sloughs; wet savannas
Oxypolis ternata	Savanna Cowbane	G3	S2			Wet pine savannas and bogs
Panax quinquefolius	American Ginseng	G3G4	S3			Mesic hardwood forests; cove hardwood forests
Pinguicula primuliflora	Clearwater Butterwort	G3G4	S1		T	In shallow, sandy, clearwater streams and seeps; Atlantic whitecedar swamps
Pityopsis oligantha	Few-Flowered Golden-Aster	G2G4	S1S2			Flatwoods, bogs and seeps of Southwest Georgia
Plagiochila floridana	Florida Leafy Liverwort	G2?	SNR			Deep, partially evergreen swamp forests and rich hammock forests, where most often at tree bases and on exposed roots, sometimes on exposed knees of Taxodium distichum
Plantago sparsiflora	Pineland Plantain	G3	S2			Open, wet pine savannas; shallow ditches and seeps, especially in mowed rights-of-way
Platanthera conspicua	Large White Fringed Orchid	G4G5T3T4	S1			Bogs, seeps, roadsides, wet savannas

Table 11. Southeastern Plains High Priority Plants (118 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Platanthera integra	Yellow Fringeless Orchid	G3G4	S1			Wet savannas, pitcherplant bogs
Portulaca biloba	Grit Portulaca	G1G2	S1			Altamaha Grit outcrops
Pteroglossaspis ecristata	Wild Coco	G2G3	S2		T	Grassy saw palmetto barrens; longleaf pine grasslands, sometimes with Schwalbea americana
Ptilimnium nodosum	Harperella	G2	S1	LE	E	Granite outcrop seeps; shallow seasonal ponds in limesink depressions
Rhexia aristosa	Awned Meadowbeauty	G3G4	S2			Pond margins and wet savannas
Rhexia salicifolia	Willowleaf Meadowbeauty	G2	S1			Georgia habitat information not available
Rhododendron eastmanii	May Pink Azalea	G2	S1S2			Deciduous forest streamsides
Rhododendron prunifolium	Plumleaf Azalea	G3	S3		T	Mesic hardwood forests in ravines and on sandy, seepy streambanks
Rhynchospora breviseta	Short-Bristle Beakrush	G3G4	SU			Bogs; flatwoods
Rhynchospora crinipes	Bearded Beakrush	G2	S1			Streambanks and shallow streambeds
Rhynchospora culixa	Georgia Beakrush	G1Q	S1			Pine savannas; flatwoods
Rhynchospora decurrens	Decurrent Beakrush	G3G4	S2?			Swamps
Rhynchospora pleiantha	Clonal Thread-Leaved Beakrush	G2G3	SH			Margins of limesink depression ponds (dolines)
Rhynchospora punctata	Spotted Beakrush	G1?	S1?			Wet savannas, pitcherplant bogs
Rhynchospora solitaria	Solitary Beakrush	G1	S1		E	Wet, sandy, peaty depressions
Rhynchospora thornei	Thorne's Beakrush	G3	S2			Margins of limesink ponds; moist limestone barrens, wet prairies
Sageretia minutiflora	Climbing Buckthorn	G4	S2		T	Calcareous bluff forests; maritime forests over shell mounds
Salix floridana	Florida Willow	G2	S1		E	Spring runs; seepy, sphagnous wetlands with Eleocharis tortilis, Itea, Alnus, Orontium, Arnoglossum sulcatum
Sarracenia leucophylla	Whitetop Pitcherplant	G3	S1		E	Wet savannas, pitcherplant bogs
Sarracenia psittacina	Parrot Pitcherplant	G4	S2S3		T	Wet savannas, pitcherplant bogs
Sarracenia purpurea var. venosa	Lowland Purple Pitcherplant	GNR	S1		E	Pitcherplant bogs of S. Atlantic Coastal Plain and rarely Piedmont
Sarracenia rubra aff. gulfensis	Sweet Pitcherplant	GNR	S1		T	Atlantic white-cedar swamps
Schisandra glabra	Bay Starvine	G3	S2		T	Rich woods on stream terraces and lower slopes
Schoenoplectus erectus ssp. raynalii	Raynal's Bulrush	G4G5T4T5	S1			Margins of seasonal ponds
Schoenoplectus etuberculatus	Clearwater Bulrush	G3G4	S2			Marshes; shallow ponds; peaty swamps, as Okefenokee Swamp and Atlantic whitecedar swamps
Schwalbea americana	Chaffseed	G2G3	S1	LE	E	Open pinelands, as in well-managed, somewhat moist longleaf pine-wiregrass forests seeps
Scutellaria altamaha	Altamaha Skullcap	G2G3	S2?			Sandy, deciduous woods
Scutellaria mellichampii	Mellichamp's Skullcap	GNR	S2?			Sandy deciduous woods
Sideroxylon macrocarpum	Ohoopee Bumelia	G3Q	S3		R	Dry longleaf pine woods with oak understory; often hidden in wiregrass
Silene ovata	Mountain Catchfly	G3	S1S2		R	Mesic deciduous or beech-magnolia forests over limestone; bouldery, high elevation oak forests
Silene polypetala	Fringed Campion	G2	S2	LE	E	Mesic deciduous forests
Sium floridanum	Florida Water-Parsnip	G1Q	S1?			Calcareous swamps; floodplains
Spiranthes longilabris	Giant Spiral Ladies-Tresses	G3	S1			Pine flatwoods, wet savannas, low hammocks with saw palmetto
Sporobolus teretifolius	Wire-Leaf Dropseed	G2	S2?			Longleaf pine-wiregrass savannas, pitcherplant bogs
Stachys hyssopifolia var. lythroides	Tallahassee Hedge-Nettle	G5T1Q	S1			Moist longleaf pine savannas; roadside ditches

Table 11. Southeastern Plains High Priority Plants (118 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Stewartia malacodendron	Silky Camellia	G4	S2		R	Along streams on lower slopes of beech-magnolia or beech-basswood-Florida maple forests
Stokesia laevis	Stokes Aster	G4	S1			Pitcherplant bogs
Symphyotrichum georgianum	Georgia Aster	G3	S2	C	T	Upland oak-hickory-pine forests and openings; sometimes with Echinacea laevigata or over amphibolite
Teloschistes exilis	Slender Orange Bush Lichen	G3G5	S1?			Relict Blackland prairies; on bark, especially on stunted Campsis radicans and in Cornus asperifolia thickets
Tephrosia mohrii	Dwarf Goat's-Rue	G3	S1?			Scrub; longleaf pine-wiregrass savannas
Thalictrum cooleyi	Cooley's Meadowrue	G2	S1	LE	E	Pond margins and wet savannas
Torreya taxifolia	Florida Torreya	G1	S1	LE	E	Rich ravines in extreme Southwest Georgia
Tridens carolinianus	Carolina Redtop	G3G4	S2?			Dry, open mixed oak-pine forests of the Fall Line Sandhills
Trillium decipiens	Mimic Trillium	G3	S3?			Mesic hardwood forests; limesink forests
Trillium reliquum	Relict Trillium	G3	S3	LE	E	Mesic hardwood forests; limesink forests; usually with Fagus and Tilia
Trillium sp. nov. (unpublished)	Southern Decumbent Trillium	GNR	S1			Mesic hardwoods
Veratrum woodii	Ozark Bunchflower	G5	S2		R	Mesic hardwood forests over basic soils
Verbesina walteri	Carolina Crownbeard	G4	S1?			Moist slopes of hardwood bluffs and edges of colluvial swamps with calcareous substrate; along Savannah River
Waldsteinia lobata	Piedmont Barren Strawberry	G2G3	S2		R	Stream terraces and adjacent gneiss outcrops
Xyris drummondii	Drummond's Yellow-Eyed Grass	G3	S1			Pine flatwoods
Xyris scabrifolia	Harper's Yellow-Eyed Grass	G3	S1			Sedge bogs; pitcherplant bogs; pine flatwoods

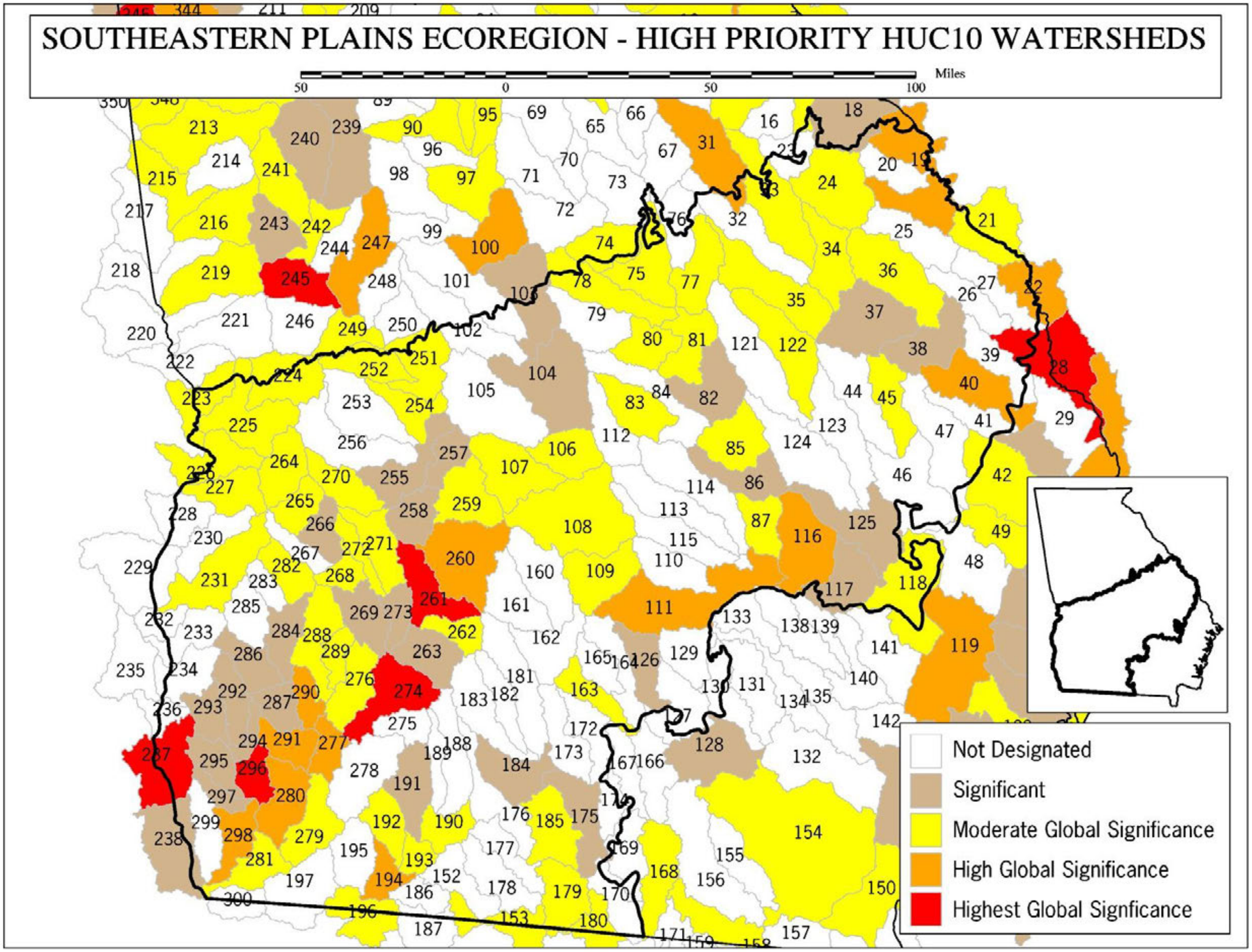

Figure 18. High Priority Waters, Southeastern Plains Ecoregion

Southern Coastal Plain Ecoregion

Ecoregional Overview

The Southern Coastal Plain ecoregion covers approximately 6,634,517 acres in Georgia. Approximately 1,121,120 acres (17% of the ecoregion) are in some form of permanent or long-term conservation ownership. Georgia DNR manages approximately 159,790 acres owned in fee simple by the State of Georgia and an additional 108,500 in leases or management agreements. Federal land ownership includes approximately 431,446 acres managed by the U.S. Fish & Wildlife Service, 294,658 acres managed by the Department of Defense, 34,420 acres managed by the National Park Service, and 6,613 acres managed by the Natural Resources Conservation Service. The vast majority of federal land is found in two properties - Okefenokee National Wildlife Refuge and Fort Stewart Military Reservation.

Regionally, the Southern Coastal Plain extends from South Carolina and Georgia through much of central Florida, and along the Gulf coast lowlands of the Florida Panhandle, Alabama, and Mississippi. This ecoregion is lower in elevation with less relief and wetter soils than the Southeastern Plains. Once covered by a variety of forest communities that included longleaf pine, slash pine, pond pine, beech-magnolia, and mixed upland hardwoods, land cover in the region is now predominantly slash and loblolly pine plantations with cypress-gum, bay swamp, and bottomland hardwoods in low lying areas. Ecoregional subdivisions of the Southern Coastal Plain include the Okefenokee Plains, Sea Island Flatwoods, Okefenokee Swamp, Bacon Terraces, Floodplains and Low Terraces, and Sea Islands/Coastal Marsh.

The Okefenokee Plains consist of flat plains and low terraces developed on Pleistocene-Pliocene sands and gravels, and contain pine stands interspersed with numerous swamps and bays. There are some highly acidic natural lakes with low clarity and darkly colored water. Soils in the region are somewhat poorly drained to poorly drained. The region has mostly coniferous forest and young pine plantation land cover, with areas of forested wetlands.

The Sea Island Flatwoods are poorly drained flat plains with Pleistocene terraces and shoreline deposits. Poorly drained soils are common in this region; small areas of better-drained soils contribute to ecological diversity. Trail Ridge forms the eastern boundary of the Okefenokee Swamp. Loblolly and slash pine plantations cover much of the region.

The Okefenokee Swamp is a mixture of forested swamp and freshwater marsh with some pine-dominated uplands. The swamp drains to the south and southwest and contains the headwaters for the St. Marys and Suwannee Rivers as well as numerous islands, lakes, and thick beds of peat. The slow-moving waters are darkly colored and acidic. Cypress, swamp blackgum, and bay forests are common, with scattered areas of prairie, which are comprised of grasses, sedges, and various aquatic plants. Cycles of drought and fire affect both its vegetation and wildlife.

The Bacon Terraces include several relatively flat, moderately dissected terraces with subtle east-facing scarps. The terraces, developed on Pliocene to Pleistocene sands and gravels, are dissected in a dendritic pattern by much of the upper Satilla River basin. Cropland is mostly on well-drained soils on the long, narrow, flat to gently sloping ridges paralleling the stream courses. The broad flats of the interfluves are typically poorly drained pine stands, while bottomland hardwood forests are found in the wet, narrow floodplains.

Floodplains and Low Terraces are a continuation of the region of the same name in the Southeastern Plains, and consist of the broad floodplains and terraces of major rivers, such as the Savannah, Ogeechee, and Altamaha. Soils consist of stream alluvium and terrace deposits of sand, silt, clay, and gravel, along with some organic muck and swamp deposits. Swamp forests of bald cypress and water tupelo and oak-dominated bottomland hardwood forests provide important wildlife habitat.

The Sea Islands/Coastal Marsh region contains the lowest elevations in Georgia and is a highly dynamic environment affected by ocean wave, wind, and river action. Mostly sandy soils occur on the barrier islands, while organic and clayey soils occur in the freshwater, brackish, and salt marshes. Maritime forests of live oak, redcedar, slash pine, and cabbage palmetto grow on parts of the barrier islands, and various species of cordgrass, saltgrass, and rushes are dominant in the marshes. The coastal marshes, tidal creeks, and estuaries represent important nursery areas for fish, crabs, shrimp, and other marine or estuarine organisms.

The predominant landcover types in the Southern Coastal Plain are evergreen forest and forested wetlands. These two types combined account for approximately 62% of the total land area in the ecoregion. (Kramer and Elliott, 2004) An analysis of land use changes from 1974 to 1998 based on satellite imagery indicated the following general trends:

- A decrease in row crop/pasture (from 9.74% of total landcover to 8.52%)
- An increase in high-intensity and low-intensity urban (from 1.52% of total landcover to 2.63%)
- An increase in clearcut/sparse vegetation landcover types (from 8.54% of total landcover to 11.70%)
- A decrease in forested wetlands (from 30.57% of total landcover to 26.11%)
- Little apparent change in evergreen forest (from 35.28% of total landcover to 35.97%)

These trends indicate a general decline in the total acreage devoted to active agricultural uses, an increase in residential and commercial development, an increase in clearcuts, fallow fields, and other sparsely vegetated landcover resulting from a variety of land use practices, and a decline in forested wetlands.

Analysis of land use changes from 2006 to 2011 indicates a 12.1% increase in early successional vegetation, a 6.1% increase in open water and 2.1% increase in developed land, a 6% decrease in forest land, and a 3% decrease in agricultural land. These figures confirm a continuation of the overall decline in agricultural uses, a decrease in overall forest cover, and an increase in early successional habitats resulting from timber harvest, development, and other activities. The increase in open water may represent more open conditions following significant fires and salvage logging in the Okefenokee Swamp region. See Appendix N for more information on landcover trends in this ecoregion.

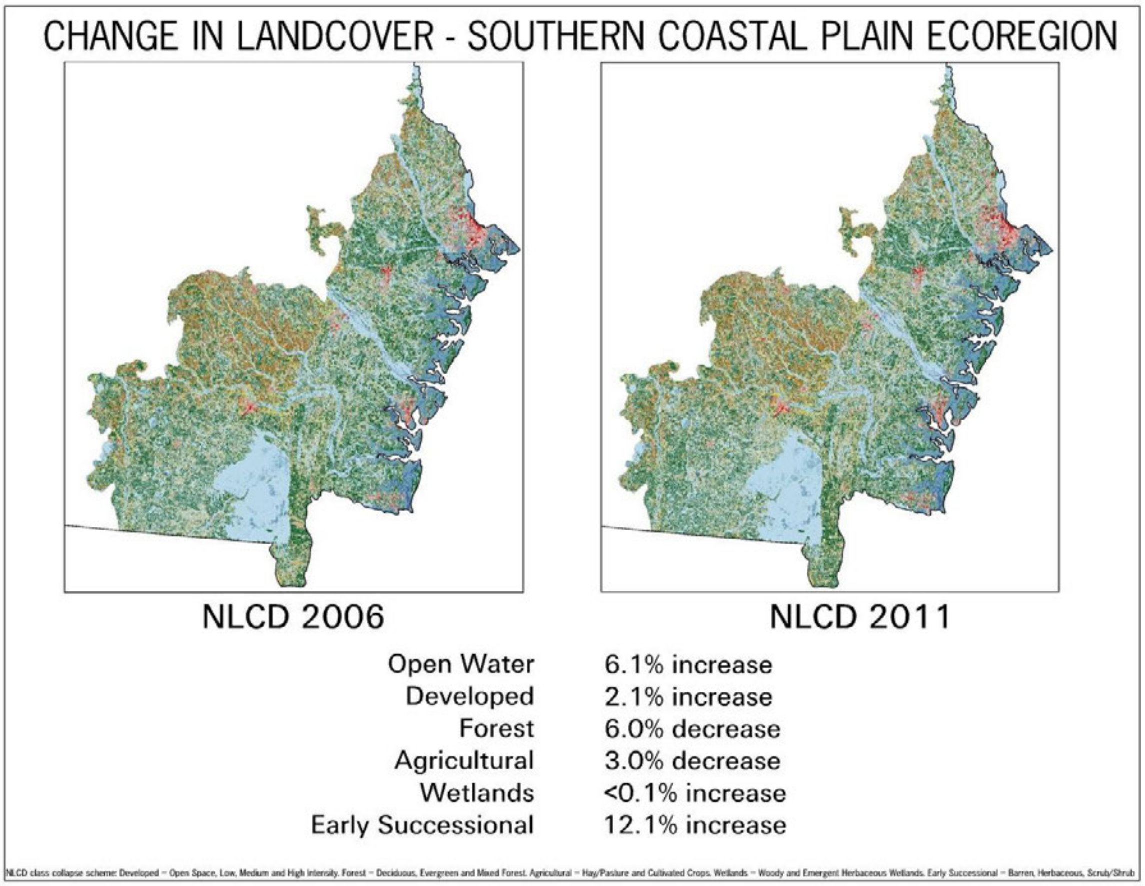

Figure 19. Change in landcover from 2006 to 2011 in the Blue Ridge ecoregion.

According to EPD stream monitoring data for 2012, 27% of streams in this region support designated uses (based on percentage of total monitored stream miles); 61% do not support designated uses, with 12% pending assessment. The percentage of monitored streams supporting designated uses in the Southern Coastal Plain is lowest of the five ecoregions.

High Priority Species and Habitats

The technical teams identified 120 high priority animal species in the Southern Coastal Plain. These included 35 birds, 14 reptiles, 11 mammals, 7 amphibians, 15 mollusks, 12 fish, 4 aquatic arthropods, and 22 terrestrial arthropods. These species are listed in Table 9, with information on global and state rarity ranks, protected status (if any) under federal or state law, and habitat and range in Georgia. In addition, 68 species of high priority plants were identified for the Southern Coastal Plain. These are listed in Table 10.

High priority habitats for the Southern Coastal Plain are listed and briefly described below:

1. Alluvial (Brownwater) Rivers and Swamps
Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the dominant substrata and these rivers typically carry heavy sediment loads. Dominant canopy trees are baldcypress and tupelo gum; the understory tree/shrub vegetation may be patchy, often consisting of swamp privet, water elm, swamp dogwood, red maple, and Carolina ash. Cypress and gum-dominated swamps can be found along the Altamaha, Savannah, and Ogeechee rivers. These systems have been impacted by altered flows from upstream dams.

2. Barrier Island Freshwater Wetlands and Ponds
Usually found in broad flats or in elliptical to linear interdune depressions on Georgia's coastal barrier islands. These wetland habitats are variable in physiognomy and species composition; deeper, more permanently flooded ponds often have a large extent of open water; shallower ponds are usually dominated by a combination of submergent, emergent and/or floating macrophytes. Trees or shrubs are present mainly along the edges of the ponds. These habitats have been impacted by groundwater withdrawals, fire suppression, and invasive exotic plants such as Chinese tallow tree.

3. Bayheads and Titi Swamps
Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). These are considered late successional communities in a variety of hydrogeomorphic settings in the Coastal Plain.

4. Beech-Magnolia Slope Forests
These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

5. Bottomland Hardwood Forests
Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

6. Brackish Marsh and Salt Marsh
Salt marshes are salt-tolerant grasslands, dominated by cordgrasses and rushes, over soils with circumneutral pH. These are extremely productive habitats. Brackish marshes occupy a wide ecotonal zone in the vicinity of river mouths.

7. Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

8. Coastal Beaches and Sand Bars
Beaches and sand bars are dynamic, high-energy intertidal systems that represent important habitat for shorebirds and sea turtles. Longshore movement of sand on barrier islands results in erosion at the north end and building up at the south end. These unvegetated habitats are important foraging areas for coastal shorebirds; sea turtles nest in the foredunes at the upper ends of sandy beaches.

9. Coastal Dunes and Bluffs
These habitats consist of sparsely vegetated sandy interdunes, rear dunes, and bluffs. They constitute important habitats for a number of high priority species adapted to harsh temperatures and salt spray. Coastal dune habitats include a number of important microhabitats such as interdune meadows and depressions, shrub thickets, and dune scrub forests. Similar vegetation can be found along eroded or exposed coastal bluffs.

10. Coastal Scrub-Shrub Wetlands
Shrub dominated estuarine communities found along the upper border of salt marsh or brackish marsh. These habitats are infrequently flooded by tidal action and form ecotones between wetland and terrestrial environments. Typical shrubs include groundsel tree, marsh elder, yaupon holly, wax myrtle, Florida privet, and false willow. Wind-pruned redcedar may also be present.

11. Estuarine and Inshore Marine Waters
Estuaries (brackish waters between barrier islands and mainland) and near-shore ocean waters. Estuaries serve as nurseries for many species of fish and shellfish as well as habitats for manatees and other marine mammals. Species composition in these aquatic communities is influenced by tidal regime and salinity.

12. Evergreen Hammocks and Mesic Hardwood Forests

Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

13. Forested Depressional Wetlands

Seasonally or semi-permanently flooded forests of depressional features in broad interstream flats. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish populations are very important breeding habitats for amphibians such as the flatwoods salamander.

14. Freshwater "Prairies"

Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is the Okefenokee Swamp. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

15. Hillside Seeps

Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

16. Longleaf Pine-Scrub Oak Woodlands

Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

17. Longleaf Pine-Wiregrass Savannas

Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. Can range from mesic to dry, depending on topographic position and soils. Transition downslope into wet pine savannas, pine flatwoods, or other wetlands. These habitats are heavily dependent on frequent fire for maintenance.

18. Maritime Forest and Coastal Hammocks

Coastal forests dominated by live oak and palmetto; hammocks are small islands of maritime forest usually surrounded by brackish water and/or salt marsh. These are restricted to a narrow band of shoreline and barrier islands. Characterized by sandy soils and wind-pruned canopy trees. Provide important habitat for neotropical migrant birds.

19. Mud and Sand Flats
Periodically inundated mud and sand deposits located in estuarine or inshore marine waters. These unvegetated habitats are generally covered at high tide and exposed at low tide. They serve as important feeding areas for a number of coastal shorebirds such as plovers, sandpipers, and dowitchers.

20. Nonalluvial (Blackwater) Rivers and Swamps
Large, meandering rivers with tea-stained, but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form bars in larger systems. In contrast to blackwater streams, forest canopy may only shade a portion of the stream width. Runs and pools are dominant habitats. Large snags are a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers.

21. Offshore Marine Waters
Georgia's offshore marine waters provide habitat for a number of high priority species, including loggerhead, green, Kemp's ridley, and leatherback turtles, North Atlantic right whales, and bottlenose dolphins. Hard-bottom areas are especially important habitats for marine fish and sessile organisms.

22. Open-Water Ponds and Lakes
Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. These habitats are relatively uncommon in this region, and are maintained by periodic fire and fluctuating water levels.

23. Pine Flatwoods
Mesic or wet forests on flat, poorly-drained areas of the lower Coastal Plain. Dominated formerly by longleaf pine, now typically by slash pine, occasionally with loblolly or pond pine. Contains a well-developed shrub layer consisting of saw palmetto, gallberry, lowbush blueberry, and other ericaceous species. One of the most extensive and prevalent habitats of this ecoregion.

24. Tidal Rivers and Freshwater Tidal Marsh
Includes tidally influenced portions of rivers and creeks and associated wetlands. Freshwater tidal marshes are wetlands found along the margins of tidal rivers and creeks above the brackish water zone, typically dominated by giant cutgrass, sawgrass, pickerel weed, wild rice, cattail, rushes, and a variety of other herbs

25. Wet Pine Savannas, Herb and Shrub Bogs
Wet pine savannas are poorly drained wetlands with open to sparse canopies dominated by longleaf, slash, and/or pond pine. The shrub layer may be sparse, consisting mainly of gallberry, wax myrtle, and blueberries. The herbaceous layer is often diverse and dense,

dominated by grasses, sedges, composites, orchids, and lilies. May include small peat-filled depressions dominated by titi and other shrubs or by herbaceous bog plants.

Problems Affecting Wildlife Diversity

One of the primary stressors of wildlife diversity in the Southern Coastal Plain is the rapid pace of development in the coastal counties. Intense development pressures have resulted in the loss or fragmentation of a number of habitats, including maritime forest, pine flatwoods, coastal bluffs, and forested depression wetlands. In fact, the pace of commercial and residential development appears to be increasing as new residents flock to the Georgia coast to metropolitan areas such as Brunswick, St. Simons, Jekyll Island, Kings Bay, and Savannah. Development of subdivisions, roads, utility corridors, and commercial facilities has burgeoned in this area of the state. Non-coastal metropolitan areas experiencing significant growth include Waycross and Valdosta. Examples of species affected by this development pressure include Bachman's sparrow, painted bunting, gopher tortoise, and southeastern pocket gopher.

Past conversion of natural pine-dominated stands to commercial pine plantations with intensive site preparation and drainage of wetland habitats has resulted in an overall decline in species diversity. While many of the biotic components of the original forests are still extant, the simplified canopy composition and understory structure has resulted in lower overall wildlife habitat quality. Examples of priority species impacted by forest conversion include Bachman's sparrow, eastern indigo snake, flatwoods salamander, and southern hognose snake.

Fire suppression can also be a significant problem, as many fire-dependent habitats lie adjacent to residential areas, highways, or commercial/industrial zones. Throughout the region, a lack of fire has resulted in the decline in the extent and quality of habitats such as herb and shrub bogs, wet pine flatwoods, freshwater "prairies", longleaf pine-wiregrass savannas, and longleaf pine-scrub oak woodlands. Fire suppression in sites containing isolated depression wetlands impacts populations of gopher frogs, striped newts, and flatwoods salamanders; other examples of species affected by fire suppression include gopher tortoise, Florida pine snake, eastern indigo snake, purple honeycomb head, hairy rattleweed, and all seven species of pitcherplants native to Georgia.

Groundwater withdrawals for industrial and municipal uses have resulted in dewatering of many of the small but significant depression wetlands, especially along the coast. This impact presents significant problems for rare wading birds, including the wood stork and tricolored heron, as well as species such as striped newt, gopher frog, dwarf siren, and dwarf waterdog.

Construction of dams or other structures altering stream flow represents a significant problem for some high priority species and habitats in this region. Most of the major river impoundments affecting streams and associated wetlands in this area are in the Piedmont, but the regulation of flows on these alluvial river systems results in altered hydroperiods for riverine swamps and bottomland hardwood forests, which in turn affects species composition and function of these ecosystems. For example, there is evidence that diminished flow variability in the Savannah River produced by upstream dams impacts the periodic flushing of tributary streams such as Ebenezer Creek, which may contribute to problems with low dissolved oxygen in this old-growth cypress-gum swamp. Alteration of sediment transport regimes in these alluvial river systems impacts the productivity of estuarine areas as well as the coastal sand-sharing system.

Nonalluvial (blackwater) rivers and streams are vulnerable to nutrient loadings and hydrologic disruptions from groundwater and surface water withdrawals, draining of adjacent wetlands, insufficient stream buffers, and other factors. Impacts on these systems from human activities include increased flow variability, reduced dissolved oxygen, and increased silt loads.

Invasive exotic species pose significant problems to habitats in this region. Examples of exotic animals causing significant negative impacts in this region include flathead catfish and feral hogs. Other nonnative species that are of concern include island apple snails, and feral grazers such as cattle and horses. Examples of invasive exotic plants in this ecoregion include Chinese tallow tree, water hyacinth, alligatorweed, parrotfeather, giant reed, tropical soda apple, and coastal bermudagrass. The channeled apple snail, a South American species that is a well-known pest in Florida, has been recently found in the Satilla River watershed.

For rare marine species such as the North Atlantic right whale, West Indian manatee and loggerhead, collisions with boats and/or incidental take by fishing operations (capture or entanglement in nets or other fishing gear) can cause significant negative population impacts. Unmanaged recreational use of beach and dune environments represents a significant threat to nesting sea turtles as well as a variety of coastal shorebirds, including American oystercatcher, black skimmer, least tern, and piping plover.

Vehicle induced mortality is a significant problem for several high priority species in this area. Examples include eastern diamondback rattlesnake, eastern indigo snake, gopher tortoise, diamondback terrapin, Sherman's fox squirrel, and Florida pine snake. For these and other species, construction of new roads results in increased risk of direct mortality as well as fragmentation of habitat.

While climate change will undoubtedly affect habitats throughout Georgia, the impacts will likely be most obvious and significant in this ecoregion. Conservation plans in this region must acknowledge the need to protect coastal uplands as well as wetlands, and provide opportunities for migration of habitats and species as sea levels and coastlines change. Restoration of more natural hydrology in alluvial rivers that feed the coastal sand-sharing system may help mitigate the impacts of coastline changes. In addition, development plans must include setbacks and buffers to provide protection for both wildlife and humans as sea levels and storm surge levels rise in the coming decades.

High Priority Sites and Landscape Features

The current assessment and previous conservation planning efforts have identified a number of ecologically important sites and landscape features in this region of the state. An assessment of the South Atlantic Coastal Plain in cooperation with state natural heritage programs in Georgia, Florida, and South Carolina identified 38 high priority conservation areas in Georgia (The Nature Conservancy, 2002). Additional surveys conducted by Georgia DNR staff and others have brought additional areas of conservation interest to light in recent years. The following list includes examples of some of the most significant sites and landscape features identified to date for the Southern Coastal Plain ecoregion.

Alapaha River Corridor

The Alapaha River is a blackwater (nonalluvial) river in the Gulf Coastal Plain of Georgia. The Alapaha River corridor includes significant upland habitats associated with sandhill environments. This system includes longleaf pine-scrub oak woodlands, old-growth dwarf pondcypress swamps, mesic hardwood bluffs, and depression ponds. High priority species associated with these habitats include striped newt, gopher frog, gopher tortoise, spotted turtle, eastern indigo snake, eastern diamondbacked rattlesnake, tiger salamander, silky camellia, and pondspice. The Alapaha River is inhabited by the Suwannee River alligator snapping turtle, a distinct, newly described species that is rarer in Georgia than the species found in other drainages. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Altamaha River Corridor

The Altamaha basin drains a total of 14,400 square miles, more than one-fourth of Georgia's land surface. Natural communities associated with this immense river system include oxbow lakes, sandbars, evergreen hammocks, sand ridge scrub forests, hardwood levee forests, cypress-gum swamps, pine flatwoods, limestone shoals, coastal marshes, and open-water estuaries. Important habitats located adjacent to the river floodplain include springs, bogs, Carolina bays and cypress/gum ponds.

Numerous high priority plants and animals are known from the Altamaha River corridor. Examples include green fly orchid, pondspice, Georgia plume, Franklinia, red-cockaded woodpecker, gopher tortoise, indigo snake, Bachman’s sparrow, and swallow-tailed kite. Several rare and/or endemic bivalves have been reported from the Altamaha River, including the Altamaha spinymussel and Altamaha arcmussel. Ongoing efforts to provide long-term protection for the Altamaha River corridor involve a number of agencies and organizations. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Crooked River State Park/Kings Bay Naval Base

These two adjacent public lands contain several high priority habitats, including estuarine waters, maritime forest, coastal river bluffs, wet pine flatwoods, and pine-oak coastal scrub. Rare species known from these sites include pondspice, Florida wild privet, climbing buckthorn, Florida orange-grass, Bartram's air-plant, gopher tortoise, and West Indian manatee. Estuaries and embedded marsh islands are habitat for diamondback terrapins. Other high priority species found in upland areas in this region include island glass lizards and eastern diamond-backed rattlesnakes.

Ebenezer Creek/Savannah River

Ebenezer Creek, a non-alluvial tributary of the Savannah River, is a "backwater swamp", whose hydrology is influenced significantly by water levels in the lower Savannah River. The lower portion of Ebenezer Creek contains an old growth baldcypress-water tupelo swamp. Other high priority habitats include bottomland hardwoods, shrub bog, pine flatwoods, mesic river bluff forests, hillside seeps, titi swamp, and alluvial river swamp. Rare species known from this area include silky camellia, sweet pitcherplant, Rafinesque's big-eared bat, swallowtailed kite, and painted bunting.

Fort Stewart

This military base contains some of the best examples of natural habitats in Georgia's Southern Coastal Plain, including extensive longleaf pine-dominated uplands, isolated depression wetlands, wet pine flatwoods, and nonalluvial river swamp. High priority species known from this site include frosted flatwoods salamander, striped newt, gopher frog, pine snake, southern hognose snake, mimic glass lizard, tiger salamander, southern dusky salamander, striped newt, red-cockaded woodpecker, Sherman's fox squirrel, purple honeycomb head, and pondspice. The U.S. Department of Defense collaborates with Georgia DNR and other agencies and organizations to ensure the viability of priority species and their habitats on the base and in surrounding lands.

Ogeechee River Corridor

The Ogeechee River originates in the lower Georgia Piedmont and flows 245 miles to the Atlantic Ocean at Ossabaw Sound. Natural communities of the Ogeechee River corridor include limestone shoals, sandbars, cypress-gum swamps, springs, bottomland hardwood forests and coastal salt marshes. Important habitats adjacent to the river floodplain include Carolina bays, springs, limesinks, sandhills and Altamaha Grit outcrops. Examples of high priority species associated with the Ogeechee River floodplain and adjacent habitats include Georgia plume, wood stork, and swallow-tailed kite. Numerous springs provide cool-water refuges for striped bass and other game fish.

The Ogeechee is relatively free from significant development, except in the lower portions. This river has been considered for inclusion as a component of the Georgia Scenic River system and was nominated as a potential National Wild and Scenic River. Impacts to the river corridor include residential and industrial development (especially along the coast), conversion of bottomland hardwood forests, and drainage of adjacent wetland habitats. (Note: this conservation landscape spans the Southeastern Plains and Southern Coastal Plain).

Okefenokee Swamp

This remarkable, extensive nonalluvial wetland system has been described as a "bog swamp" (Wharton, 1978) due to the fact that it is a huge, peat-filled basin with measurable sheet flow. High priority habitats associated with this ecosystem complex include freshwater "prairies", pine flatwoods, pondcypress savanna, wet pine savannas, titi swamp, herb and shrub bogs. Examples of rare species known from the Okefenokee Swamp include Florida sandhill crane, Sherman's fox squirrel, flatwoods salamander, Florida water rat, striped newt, wood stork, Florida black bear, Rafinesque's big-eared bat, Florida orange grass, and Okefenokee giant pitcherplant.

Ossabaw Island

Third largest of Georgia's barrier islands, Ossabaw consists of approximately 12,000 acres of upland and at least twice that acreage of marsh. Ossabaw is owned by the State of Georgia and managed as a WMA and natural area. Development on the island is restricted to five houses and some outbuildings. Habitats present include beach, dunes, maritime forest, salt marsh and tidal creeks, and freshwater ponds. Understory vegetation is sparse due to past grazing by deer and feral livestock, but is recovering due to recent efforts to control populations of grazers. Two mixed-species wading bird rookeries occur on the island. Ossabaw's beaches support nesting by loggerhead turtles and several species of coastal shorebirds. High priority plant species include soapberry and climbing buckthorn.

Sapelo Island

Sapelo Island is a barrier island mostly owned by the State of Georgia and accessible only by boat or plane. It consists of approximately 11,000 acres of upland and several thousand acres of marsh. The island is managed as a Wildlife Management Area and a National Estuarine Research Reserve. The University of Georgia Marine Institute operates a research facility on the island. Development on the island is restricted to buildings constructed by some of the original plantation owners, now used to house staff of the Marine Institute and DNR, and houses associated with a 500-acre private community. Habitats present include salt marsh, maritime forest, second-growth pine, dunes and approximately 6 miles of beach. One small freshwater pond supports a small wading bird rookery. Beaches are used as nesting areas by loggerhead turtles and four species of rare or uncommon shorebirds. Plants of conservation interest on the island include Chapman's oak, soapberry, and other species of plants restricted to shell mounds.

St. Simons/Little St. Simons

This site consists of Little St. Simon's Island and the undeveloped northern ends of St. Simon's Island and Sea Island, including Pelican Spit, an accreting sandbar in the Hampton River on the north end of Sea Island. St. Simon's and Sea Island are almost entirely privately owned and connected to the mainland by causeway. Habitat types are similar to those described for Sapelo and Ossabaw. There is a mixed-species wading bird rookery on the north end of St. Simon's Island that includes nesting wood storks.

Cannons Point Preserve on the north end of the island is a significant conservation tract owned by the St. Simons Land Trust. Little St. Simons Island supports a small egret rookery and a small great blue heron rookery. The seven miles of beach on Little St. Simons support limited nesting by loggerhead turtles and significant nesting populations of five shorebirds. This privately owned property has recently received permanent protection through a conservation easement granted to The Nature Conservancy

St. Marys and Suwannee Rivers

From its headwaters in the Okefenokee Swamp to its outlet on the Atlantic Ocean, the St. Marys meanders over 120 miles in a straight-line distance of only 40 miles. Tidal influence extends as far upstream as the Folkston area. The Suwannee also originates in the Okefenokee, flowing southwestward 18 miles to the Georgia-Florida state line. From there it continues approximately 265 miles to its outlet on the eastern Gulf of Mexico. Like the St. Marys, the upper Suwannee is characterized by slow stream flow and numerous meanders. Further south, the Suwannee flows swiftly over limestone shoals, then enters a region in which numerous springs contribute to its discharge. Other important natural features of these blackwater stream corridors include sandbars, clay or limestone banks, sandy bluffs, cypress-gum swamps, bottomland hardwood forests, pine flatwoods, tidal swamps, sawgrass flats and coastal marshes. Protection of these river floodplains will help maintain important wildlife migration corridors between the Okefenokee Swamp, the lower Suwannee delta and estuaries, Georgia's coastal wetlands, and lands of the Osceola National Forest.

High Priority Waters

Figure 20 shows high priority streams and watersheds identified for the Southern Coastal Plain by the Aquatic Habitat Technical Team. These streams were chosen on the basis of documented occurrences of high priority aquatic species and the relative rarity of these species. Examples of high priority streams in this ecoregion include the Savannah River, Altamaha River, Brunswick River, Alapaha River, St. Marys River, Suwannee River, Doboy Ogeechee River, Satilla River, and Turtle River. Refer to the Aquatic Habitat Technical Team report in Appendix F for more information on the methods used to identify high priority waters.

Coastal Beaches and Dunes

Georgia's coastal beaches and dunes represent critical habitats for rare turtles and shorebirds. Intertidal sand beaches provide foraging habitat for a great number of shorebirds, including sandpipers, plovers, sanderlings, turnstones, terns, and dowitchers. These birds feed on the abundant invertebrate fauna of intertidal areas and nest among the sparsely vegetated dunes and beach wrack. Loggerhead sea turtles nest in the foredunes at the upper edge of the beach, and several rare plants are found in interdune or rear dune/bluff habitats. Beachfront property is also perhaps the most highly prized real estate in Georgia for residential development and recreation.

Human activities have resulted in a wide variety of direct and indirect impacts to these important habitats. Impoundment of Georgia's major rivers has reduced sediment input to the coastal sand-sharing system. In addition, construction of sea walls and jetties and dredging of tidal river channels have altered natural sand movement patterns along the coast, resulting in increased erosion of some beaches. Other activities impacting coastal beach and dune habitats include residential and commercial development, vehicular traffic, excessive herbivory (e.g., by feral horses), excessive predation (e.g., from feral hogs, raccoons, dogs, or cats), littering, artificial lighting and unmanaged recreational use. Protection of these important habitats will require a concerted effort involving state, federal, and local governments as well as local residents, educational groups, and civic organizations.

<u>Conservation Goals</u>

- Maintain known viable populations of all high priority species and functional examples of all high priority habitats through land protection, incentive-based habitat management programs on private lands, and habitat restoration and management on public lands.
- Increase public awareness of high priority species and habitats by developing educational messages and lesson plans for use in environmental education facilities, local schools, and other facilities.
- Encourage restoration of important wildlife habitats through reintroduction of prescribed fire, hydrologic restoration, and revegetation efforts.
- Combat the spread of invasive/noxious species in high priority natural habitats by identifying problem areas, providing technical and financial assistance, developing specific educational messages, and managing exotic species populations on public lands.
- Minimize impacts from residential and commercial development on high priority species and habitats by providing input on environmental assessments
- Continue efforts to recover federally listed species by implementation of recovery plans

Strategies and Partnerships to Achieve Conservation Goals

- Provide financial incentives and technical expertise to encourage prescribed burns, through Interagency Burn Team and other means
- Work with NRCS staff to identify high priority habitats and sites for implementation of habitat enhancement/restoration projects through Farm Bill programs (e.g., restoration of longleaf pine-dominated forests and savannas)
- Use state lands (e.g., Crooked River State Park, Sapelo Island, Ossabaw Island) and other public lands to showcase habitat restoration and management efforts. Complete management plans for all state lands and incorporate management objectives for populations of high priority species.
- Assess exotic plant populations on public lands and provide technical assistance to private landowners to discourage use of invasive plants
- Work with GDOT and local governments to minimize direct impacts to high priority species and habitats from development projects
- Work with Georgia Power and private landowners to identify and conserve populations of rare species in and adjacent to utility corridors
- Develop educational materials on high priority species and habitats in the ecoregion and provide these to environmental educators at WRD regional education centers (e.g., Sapelo Island) and other facilities
- Work with GFC and SFI-SIC to facilitate development of forestry BMPs for maintenance of important wildlife habitats
- Work with The Nature Conservancy, USFWS, Georgia Land Conservation Center and local land trusts to provide protection for high priority wetlands and stream corridors.
- Continue collaborative efforts to protect sea turtle nests and minimize impacts from shrimp fisheries
- Continue North Atlantic right whale and manatee recovery and monitoring efforts

Highest Priority Conservation Actions

Highest priority conservation actions (actions rated “Very High” or “High”) identified by the technical teams, Steering Committee, and other stakeholders specifically for this ecoregion include the following (see Appendix P for details):

- Conduct midwinter waterbird survey and piping plover winter survey; conduct research and surveys on southeastern red knot and whimbrels; investigate American oystercatcher ecology and demographics.
- Determine population demographics (size, nesting success, productivity, etc.) for MacGillivray's Seaside Sparrows .
- Assess populations of high priority terrestrial birds in the Coastal Plain (e.g. swallow-tailed kite, southeastern American kestrel, painted bunting, Henslow's sparrow).
- Conduct surveys for Black Rails in high marsh areas of saltmarsh and possibly other shallowly flooded freshwater habitats.

- Conduct surveys for Yellow Rail in pine flatwoods and similar sites as well as other shallowly flooded habitats.
- Continue Line Transect Distance Sampling (LTDS) of gopher tortoise populations to maintain gopher tortoise Candidate Conservation Agreement.
- Monitor reproductive activity at known, recently extant ponds used by pond-breeding amphibians.
- Continue monitoring eastern indigo snake occupancy.
- Conserve key Swallow-tailed Kite nesting habitat along the Satilla River.
- Resolve the current difficulty in protecting newly created or emerging beach nest bird habitat. Educate beachgoers and boaters about the plight of beach nesting birds and passage migrants that use Georgia beaches and offshore bars. Experiment with sand fencing to increase elevation on key offshore bars.
- Manage coyote populations on barrier islands to reduce impacts to beach nesting birds
- Continue restoring and enhancing oyster reef communities along the coast through targeted restoration efforts outside of shellfish harvest areas, enhancements within shellfish harvest areas, and living shoreline implementation to restore oyster communities as well as salt marsh plant species.
- Conduct field inventory and landowner outreach to conserve coastal plain seepage bogs.
- Implement right whale recovery plan in the Southeast U.S.
- Determine the demographic patterns and habitat use of juvenile sea turtles in coastal waters.
- Continue sea turtle stranding and salvage network. Enforce and monitor trawl fisheries for impacts to sea turtles
- Monitor effects of climate change on sea turtles and their nesting habitat. Monitor trends in adult female sea turtle abundance through nest monitoring programs and genetic mark-recapture sampling.
- Continue the Waterbird Conservation Initiative. Identify population trends, stresses, nesting areas, staging sites, and wintering habitat. Work within North American Waterbird Conservation Plan and U.S. Shorebird Conservation Plan recommendations to promote recovery and maintain waterbird populations.
- Implement diadromous fish restoration projects. Evaluate existing population status, commercial and recreational fisheries, and habitat limitations. Look for opportunities to enhance habitat.
- Implement red-cockaded woodpecker conservation on private lands, through safe harbor agreements and mitigated take from small, isolated populations. Administer landowner incentive program for safe harbor participants.

For high priority conservation actions of statewide scope, see Section V of this report.

Table 12. Southern Coastal Plain High Priority Animals (120 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
AA	Callinectes sapidus	Blue Crab	GNR	S4			estuarine habitats: marshes, tidal creeks, estuaries, and coastal rivers
AA	Cambarus truncatus	Oconee Burrowing Crayfish	G2	S2		T	Complex burrows in sandy clay soil
AA	Cordulegaster sayi	Say's Spiketail	G2	S2		T	Trickling hillside seepages in deciduous forest with scrub-oak sandhills nearby
AA	Procambarus petersi	Ogeechee Crayfish	G3	S2			burrows in lotic waters without appreciable silt deposits
AM	Ambystoma cingulatum	Frosted Flatwoods Salamander	G2	S1	LT	T	Pine flatwoods; moist savannas; isolated cypress/gum ponds
AM	Ambystoma tigrinum tigrinum	Eastern Tiger Salamander	G5	S3S4			isolated wetlands for breeding; variety of open, upland habitats; CP - sandhills, oldfields, dry pine savanna
AM	Desmognathus auriculatus	Southern Dusky Salamander	G5	S2			Mucky areas usually in or near moving water
AM	Lithobates capito	Gopher Frog	G3	S2S3		R	Sandhills; dry pine flatwoods; breed in isolated wetlands
AM	Necturus punctatus	Dwarf Waterdog	G5	S2S3			Sluggish streams with substrate of leaf litter or woody debris
AM	Notophthalmus perstriatus	Striped Newt	G2G3	S2	C	T	Pine flatwoods, sandhills; isolated wetlands
AM	Plethodon savannah	Savannah Slimy Salamander	G2G3	S2?			Hardwood forest, mixed forest
BI	Ammodramus caudacutus	Saltmarsh Sparrow	G4	S3			Tidal brackish and salt marsh (low marsh)
BI	Ammodramus henslowii	Henslow's Sparrow	G4	S2		R	Grassy areas, especially wet grasslands, pitcher plant bogs, pine flatwoods, power-line corridors in CP. Require open veg at ground level with grass canopy above
BI	Ammodramus maritimus macgillvraii	Seaside Sparrow (Macgillivray's)	G4T2	S3			Tidal low marsh on or adjacent to creek levees
BI	Ammodramus nelsoni	Nelson's Sparrow	G5	S3			Tidal brackish and salt marsh (low marsh)
BI	Calidris canutus	Red Knot	G4	S3	C	R	Beaches and exposed mudflats
BI	Charadrius melodus	Piping Plover	G3	S2	LT	T	Sandy beaches; tidal flats, inlets
BI	Charadrius wilsonia	Wilson's Plover	G5	S2		T	Sandy beaches; tidal flats
BI	Colinus virginianus	Northern Bobwhite	G5	S5			Early successional habitat, open pine savanna (frequent fire maintained in small burn unit size), fallow habitats associated with crop lands, extensive forest regen areas (area sensitive - minimal fall pop of 700 birds for viability on 3000+acres)
BI	Coturnicops noveboracensis	Yellow Rail	G4	SU			
BI	Egretta caerulea	Little Blue Heron	G5	S4			Nest in single species and mixed species colonies in various inland forested fresh-water wetlands, including impounded wetlands, cypress swamps, and similar habitats
BI	Egretta tricolor	Tricolored Heron	G5	S4			Nests in colonies (often with other wading bird species) in wetlands and on isolated islands. Feeds in shallow wetlands, creeks and rivers. The most coastal of all our waders.
BI	Elanoides forficatus	Swallow-tailed Kite	G5	S2		R	River swamps; marshes, forages over pastures and ag fields - post breeding. Forage in well burned open pine woodlands where exist. Open pine and bottomland forest with super canopy pines preferred nest sites. Will nest in non-emergent hardwoods and thinned pine plantations as well - typically several years before final harvest.
BI	Euphagus carolinus	Rusty Blackbird	G4	S3			Bottomland forest, pecan orchards, agricultural fields
BI	Falco peregrinus	Peregrine Falcon	G4	S1		R	Rocky cliffs & ledges; seacoasts - migration; skyscrapers
BI	Falco sparverius paulus	Southeastern American Kestrel	G5T4	S2		R	Open pine grasslands with snags in Coastal Plain, also hayfields and pasture lands
BI	Gelochelidon nilotica	Gull-billed Tern	G5	S1		T	Salt marshes; fields; sandy beaches, interdune, dredge islands
BI	Grus canadensis pratensis	Florida Sandhill Crane	G5T2T3	S1			Freshwater marshes; bays; fields. Only known from Okefenokee NWR (recent surveys outside swamp detected no birds)
BI	Haematopus palliatus	American Oystercatcher	G5	S2		R	Sandy beaches; tidal flats; salt marshes, shell rakes, sand bars

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Table 12. Southern Coastal Plain High Priority Animals (120 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
BI	Haliaeetus leucocephalus	Bald Eagle	G5	S3		T	Edges of lakes & large rivers; seacoasts
BI	Himantopus mexicanus	Black-necked Stilt	G5	S2			Shallow ponds; lagoons, beach, managed impoundments, dredge spoil island/impoundments
BI	Ixobrychus exilis	Least Bittern	G5	S3			Fresh and brackish water wetlands with emergent herbaceous cover including impoundments, natural freshwater marshes, and tidally influenced marshes
BI	Lanius ludovicianus	Loggerhead Shrike	G4T3Q	S3			Open woods; field edges, pastures, ball fields, industrial park, primary dunes, hammocks
BI	Laterallus jamaicensis	Black Rail	G3G4	S1			Very shallowly flooded freshwater marshes, brackish marshes, and saltmarshes. Some high marsh areas of the saltmarsh may have breeding pairs
BI	Limnothlypis swainsonii	Swainson's Warbler	G4	S3			Dense undergrowth or canebrakes in swamps and river floodplains, small mountain pop in rhododendron and mountain laurel thickets
BI	Mycteria americana	Wood Stork	G4	S3	LT	E	Breeding Cypress/gum ponds; impounded wetlands with islands or emergent cypress, river swamps; Foraging - marshes (fresh and intertidal); river swamps; bays; farm ponds,
BI	Numenius phaeopus	Whimbrel	G5	S3			Saltmarsh habitat and outer bars
BI	Passerina ciris	Painted Bunting	G5	S2S3			Most in Lower Coastal Plain in thickets, woodland borders, marsh edges, and brushy areas. Smaller numbers in Upper Coastal Plain, particularly the eastern half, agricultural habitat
BI	Peucaea aestivalis	Bachman's Sparrow	G3	S2		R	Open pine or oak woods; old fields; brushy areas, young large grassy pine regeneration areas
BI	Picoides borealis	Red-cockaded Woodpecker	G3	S2	LE	E	Open pine woods; pine savannas
BI	Protonotaria citrea	Prothonotary Warbler	G5	S4			Bottomland forest, swamps, and similar forested wetlands. Nests in tree cavities.
BI	Rallus elegans	King Rail	G4	S3			Freshwater to brackish emergent herbaceous wetlands of grasses, sedges, cattails, wild rice; herbaceous portions of forested wetlands.
BI	Rynchops niger	Black Skimmer	G5	S1		R	Foraging tidal creeks and Tidal ponds; Nesting sandy beaches, spits and dredge islands
BI	Setophaga kirtlandii	Kirtland's Warbler	G3G4	SNRN	LE	E	Transient; varying habitats during late spring and fall
BI	Sternula antillarum	Least Tern	G4	S2		R	Sandy beaches; sandbars, dredge islands
BI	Tyto alba	Barn Owl	G5	SU			Nests in large hollow trees or old buildings (particularly cement silos) in areas with extensive pasture or grassland or other open habitats such as marsh
FI	Acipenser brevirostrum	Shortnose Sturgeon	G3	S2	LE	E	Estuaries; lower end of large rivers in deep pools with soft substrates
FI	Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	G3T3	S3	LE	E	Estuaries; lower end of large rivers in deep pools with soft substrates; spawn as far inland as Macon, GA on the Ocmulgee
FI	Alosa sapidissima	American Shad	G5	S5			large rivers between coast and fall zone are used for spawning and early life history stages
FI	Carpiodes velifer	Highfin Carpsucker	G4G5	S2S3			swift sandy areas associated with sandbars, yoy found in backwaters and on margins of sandbars
FI	Chologaster cornuta	Swampfish	G5	S2S3			near vegetation and debris in swamps, ponds, ditches, and slow moving streams, pools backwaters
FI	Cynoscion nebulosus	Spotted Seatrout	G5	S5			estuarine habitats: oyster bed, salt marshes, tidal creeks
FI	Elassoma okatie	Bluebarred Pygmy Sunfish	G2G3	S1		E	Temporary ponds and stream backwaters with dense aquatic vegetation
FI	Enneacanthus chaetodon	Blackbanded Sunfish	G3G4	S1		E	Blackwater streams; bays; cypress/gum ponds
FI	Lucania goodei	Bluefin Killifish	G5	S1		R	Heavily vegetated ponds and streams with little or no current; frequently associated with springs
FI	Micropterus cataractae	Shoal Bass	G3	S2			large river, shoal and fluvial specialist

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Table 12. Southern Coastal Plain High Priority Animals (120 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
FI	Moxostoma robustum	Robust Redhorse	G1	S1		E	Med to large rivers, shallow riffles to deep flowing water; moderately swift current
FI	Sphryna lewini	Scalloped Hammerhead	GNR	S2S3			estuarine and marine: subadults are in estuaries, adults in ocean
MA	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	G3G4	S3		R	Pine forests; hardwood forests; caves; abandoned buildings; bridges; bottomland hardwood forests and cypress-gum swamps
MA	Eubalaena glacialis	Northern Atlantic Right Whale	G1	S1	LE	E	Inshore and offshore ocean waters
MA	Geomys pinetis	Southeastern Pocket Gopher	G5	S3S4		T	sandy well-drained soils in open pine woodlands with grassy or herbaceous groundcover, fields, grassy roadsides
MA	Lasiurus intermedius	Northern Yellow Bat	G4G5	S3			Wooded areas near open water or fields, hardwoods - live oaks preferred, large trees
MA	Megaptera novaeangliae	Humpback Whale	G4	SNR	LE	E	Inshore and offshore ocean waters
MA	Myotis austroriparius	Southeastern Myotis	G3G4	S3			Caves & buildings near water; large hollow trees in bottomland hardwood swamps
MA	Neofiber alleni	Round-tailed Muskrat	G3	S3		T	Freshwater marshes; bogs
MA	Perimyotis subflavus	Tri-colored Bat	G3	S5			Open forests with large trees and woodland edges; roost in tree foliage; hibernate in caves or mines with high humidity.
MA	Sciurus niger shermani	Sherman's Fox Squirrel	G5T2	SNR?			Pine forests; pine savannas
MA	Trichechus manatus	Manatee	G2	S2	LE	E	Estuaries, tidal rivers, nearshore ocean waters
MA	Tursiops truncatus	Atlantic Bottle-nose Dolphin	G5	S4			Estuaries, tidal rivers, ocean waters
MO	Alasmidonta arcula	Altamaha Arcmussel	G2	S3		T	Large rivers and reservoirs on gently sloping banks with soft and fine sediments. Often under overhanging willows.
MO	Amblema neislerii	Fat Threeridge	G1	S1	LE	E	Sm-Lg rivers with fine sediments with low-moderate gradient & slow-moderate current; pools and riffles; subtrate gravel/cobble to sand and sandy mud
MO	Crassostrea virginica	American Oyster	G5	S4			estuarine habitats: intertidal
MO	Elliptio fraterna	Brother Spike	G1	S1			Large Rivers with sand substrates, little info available.
MO	Elliptio nigella	Winged Spike	G1	S2			Large rivers in swift and shallow shoals. Often times associated with large crevices and cavities in and around limestone boulders.
MO	Elliptio purpurella	Inflated Spike	G2	S2		T	Medium creeks to small rivers; clay, sand, and cravel substrate; moderate current
MO	Elliptoideus sloatianus	Purple Bankclimber	G2	S2	LT	T	Medium to large rivers in the ACF and Ochlockonee basins; all substrates except bedrock. Species was 20 times more likely to occur in cobble substrates (Wisniewski et al. 2013)
MO	Hamiota subangulata	Shinyrayed Pocketbook	G2	S2	LE	E	Medium sized creeks to large rivers in sand substrates in slow to swift flowing water.
MO	Lampsilis cariosa	Yellow Lampmussel	G3G4	S3			Large streams and rivers with good current, sand and gravel
MO	Marstonia castor	Beaverpond Marstonia	G1	S1			Found on aquatic macrophytes in clear flowing water of low gradient creeks
MO	Medionidus penicillatus	Gulf Moccasinshell	G2	S1	LE	E	Large rivers to small creeks; found in a variety of substrates
MO	Medionidus simpsonianus	Ochlockonee Moccasinshell	G1	SH	LE	E	Medium sized river to large creeks with moderate current; muddy sand, sand, and gravel substrates
MO	Medionidus walkeri	Suwannee Moccasinshell	GNR	SX			medium creeks and rivers in slow to moderate current; muddy sand, sand, and gravel.
MO	Pleurobema pyriforme	Oval Pigtoe	G2	S1	LE	E	Large rivers to small creeks with slow to moderate current in pool, run, and riffle habitats; combinations of clay, sand, and gravel substrate
MO	Toxolasma pullus	Savannah Lilliput	G2	S2		T	Large rivers to small creeks, oxbows, and sloughs; found in silty sand and sand in shallow water along banks to about 1 foot deep in some lakes, ponds, streams, and big rivers
RE	Caretta caretta	Loggerhead Sea Turtle	G3	S3	LT	E	Open ocean; sounds; coastal rivers; beaches

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Table 12. Southern Coastal Plain High Priority Animals (120 Records)

Group	Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
RE	Chelonia mydas	Green Sea Turtle	G3	S1	LE	T	Open ocean; sounds; coastal rivers; beaches
RE	Clemmys guttata	Spotted Turtle	G5	S3		U	Heavily vegetated swamps, marshes, bogs, small ponds, tidally influenced freshwater wetlands; nest and possibly hibernate in surrounding uplands
RE	Crotalus adamanteus	Eastern Diamond-backed Rattlesnake	G4	S4			Early successional habitats on barrier islands and mainland; pine flatwoods; sandhills; maritime forests/hammocks; ruderal habitats
RE	Dermochelys coriacea	Leatherback Sea Turtle	G2	S1	LE	E	Open ocean; sounds; coastal beaches
RE	Drymarchon couperi	Eastern Indigo Snake	G3	S2	LT	T	Sandhills; pine flatwoods; dry hammocks; summer habitat includes wetlands
RE	Gopherus polyphemus	Gopher Tortoise	G3	S3	C	T	Sandhills; dry hammocks; longleaf pine-turkey oak woods; old fields
RE	Heterodon simus	Southern Hognose Snake	G2	S1S2		T	Sandhills; fallow fields; longleaf pine-turkey oak
RE	Lepidochelys kempii	Kemp's or Atlantic Ridley	G1	S1	LE	E	Open ocean; sounds; coastal rivers; beaches
RE	Macrochelys temminckii	Alligator Snapping Turtle	G3G4	S3		T	Streams and rivers; impoundments; river swamps
RE	Malaclemys terrapin	Diamondback Terrapin	G4	S4		U	Entire coast, estuarine and marine edge; All saltmarsh, beaches
RE	Ophisaurus compressus	Island Glass Lizard	G3G4	S2			Pine savannas, pine flatwoods, secondary dunes/interdunal swales on islands
RE	Ophisaurus mimicus	Mimic Glass Lizard	G3	S1		R	Pine flatwoods; savannas; seepage bogs
RE	Pituophis melanoleucus mugitus	Florida Pine Snake	G4T3	S3			Sandhills; scrub; pine savanna; old fields
TA	Alloblackburneus troglodytes	Little gopher tortoise scarab beetle	GNR	SU			Gopher tortoise burrows
TA	Amblyomma tuberculatum	Gopher tortoise tick	G2G3	S2			Sandhills, longleaf pine woodlands, other sandy open habitats
TA	Aphodius aegrotus	A dung beetle	G3G4	S3			Pocket gopher mounds
TA	Aphodius dyspistus	A dung beetle	G3G4	S3			Pocket gopher mounds
TA	Aphodius hubbelli	A dung beetle	GNR	S3			Pocket gopher mounds
TA	Aphodius laevigatus	Large pocket gopher Aphodius beetle	G3G4	S3			Pocket gopher mounds
TA	Bombus affinis	Rusty-patched bumblebee	G1	SH			
TA	Callophrys irus	Frosted elfin	G3	SH			Lupinus perennis, sandhills
TA	Caupolicana electa	Plasterer bee	GNR	S1S2			Sandhills
TA	Chelyoxenus xerobatis	Gopher tortoise hister beetle	G2G3s2	S2			Gopher tortoise burrows
TA	Danaus plexippus	Monarch butterfly	G4	S4			Milkweeds
TA	Euphyes berryi	Berry's Skipper	G1G3	S2S3			Freshwater marshes, boggy areas, swamps, utility easements
TA	Euphyes bimacula arbogastii	Two-spotted Skipper	G4	S2S3			Freshwater marshes, sedges
TA	Euphyes dukesi	Duke's Skipper	G3	S2S3			Tidal shrub/swamp, brackish water
TA	Euphyes pilatka	Palatka Skipper	G3G4	S2S3			Sawgrass, brackish water
TA	Machimus polyphemi	Gopher tortoise robber fly	G2	S1?			Gopher tortoise burrows
TA	Neonympha areolatus	Georgia Satyr	G3G4	S3			Freshwater marsh, powerlines
TA	Onthophagus polyphemi polyphemi	Onthophagus tortoise commensal scarab beetle	G2G3	S2			In association with Gopherus polyphemus burrows
TA	Poanes aaroni howardi	Aaron's skipper	G4T4	S2S3			Freshwater marshes
TA	Problema bulenta	Rare Skipper	G2G3	S2S3			Brackish marshes
TA	Satyrium kingi	King's hairstreak	G3G4	S3			Wormsloe, sweetleaf
TA	Sphodros abbotii	Purse-web spider	G4G5	S2			Hardwoods

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Table 13. Southern Coastal Plain High Priority Plants (68 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Amorpha georgiana	Georgia Indigo-Bush	G3	S1		E	Longleaf pine flatwoods; stream terraces
Amorpha herbacea var. floridana	Florida Leadbush	G4TNRQ	S1			River terraces along the Alapaha River
Arabis georgiana	Georgia Rockcress	G1	S1	C	T	Rocky or sandy river bluffs and banks, in circumneutral soil
Arnoglossum diversifolium	Variable-Leaf Indian-Plantain	G2	S2		T	Calcareous swamps
Arnoglossum sulcatum	Grooved-Stem Indian-Plantain	G3	S1			Bottomland forests
Asplenium heteroresiliens	Morzenti's Spleenwort	G2	S1		T	Limestone and marl outcrops; tabby ruins
Astragalus michauxii	Sandhill Milkvetch	G3	S2		T	Longleaf pine-wiregrass savannas; turkey oak scrub
Balduina atropurpurea	Purple Honeycomb Head	G2	S2S3		R	Wet savannas, pitcherplant bogs
Baptisia arachnifera	Hairy Rattleweed	G1	S1	LE	E	Pine flatwoods
Brickellia cordifolia	Heartleaf Brickellia	G2G3	S2		T	Mesic hardwood forests
Carex calcifugens	Lime-Fleeing Sedge	G2G4	S2?			Rich bluff forests; evergreen maritime forests
Carex decomposita	Cypress-Knee Sedge	G3G4	S2?			Swamps and lake margins on floating logs
Coreopsis integrifolia	Ciliate-Leaf Tickseed	G1G2	S1S2		T	Floodplain forests, streambanks
Coreopsis rosea	Pink Tickseed	G3	S1			Banks of blackwater rivers; pond shores
Crocanthemum nashii	Florida Scrub Sunrose	G3?	S1			Sand dunes
Ctenium floridanum	Florida Orange-Grass	G2	S1			Moist pine barrens
Dicerandra radfordiana	Radford's Dicerandra	G1Q	S1		E	Sandridges
Eccremidium floridanum	Florida Pygmy Moss	G1?	SNR			Sandy (or clay) dry, open, disturbed sites, thin soil over exposed rocks arouind Taxodium swamp margins
Elliottia racemosa	Georgia Plume	G2G3	S2S3		T	Scrub forests; Altamaha Grit outcrops; open forests over ultramafic rock
Eriochloa michauxii var. michauxii	Michaux's Longleaf Cupgrass	G3G4T3T4	S2?			Coastal freshwater and brackish marshes; flatwoods
Eriophorum virginicum	Tawny Cottongrass	G5	S1			Mountain bogs; peaty wet meadows in alluvial flats in Fall Line sandills; also in Okefenokee Swamp
Evolvulus sericeus var. sericeus	Creeping Morning-Glory	G5T3T5	S1			Altamaha Grit outcrops; open calcareous uplands
Forestiera godfreyi	Godfrey's Wild Privet	G2	S1		E	Mesic, maritime forests over shell mounds
Forestiera segregata var. segregata	Florida Wild Privet	G4T4?	S2			Georgia habitat information not available
Fothergilla gardenii	Dwarf Witch-Alder	G3G4	S2		T	Openings in low woods; swamps
Habenaria quinqueseta	Michaux's Orchid	G4G5	S1?		T	Rich, moist hardwood hammocks, pine flatwoods, roadside ditches
Hartwrightia floridana	Hartwrightia	G2	S1		T	Wet savannas; ditches, sloughs and flatwood seeps
Hypericum erythraeae	Georgia St.-John's-Wort	G2	S2			Seepage bogs; roadside ditches
Justicia angusta	Narrowleaf Water-Willow	G3Q	S1			Roadside ditches; perhaps with Hartwrightia in shallow sloughs and wet savannas
Lachnocaulon beyrichianum	Southern Bog-Button	G4	S1?			Flatwoods
Leitneria floridana	Corkwood	G3	S1		T	Swamps; sawgrass-cabbage palmetto marshes
Lindera melissifolia	Pondberry	G2G3	S2	LE	E	Pond margins and wet savannas
Litsea aestivalis	Pondspice	G3?	S2		R	Cypress ponds; swamp margins
Lycium carolinianum	Carolina Wolfberry	G4	S1			Coastal sand spits
Malaxis spicata	Florida Adders-Mouth Orchid	G4?	S1			Low hammocks; spring-fed river swamps
Matelea alabamensis	Alabama Milkvine	G2	S1		T	Open bluff forests; mesic margins of longleaf pine sandridges
Oxypolis ternata	Savanna Cowbane	G3	S2			Wet pine savannas and bogs

Table 13. Southern Coastal Plain High Priority Plants (68 Records)

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Habitat in Georgia
Plantago sparsiflora	Pineland Plantain	G3	S2			Open, wet pine savannas; shallow ditches and seeps, especially in mowed rights-of-way
Platanthera blephariglottis	Small White Fringed Orchid	G4G5	S1?			Pine flatwoods, roadside ditches, seeps and wet savannas
Platanthera chapmanii	Chapman's Fringed Orchid	G2	S1			Open, wet meadows; pine flatwoods
Platanthera conspicua	Large White Fringed Orchid	G4G5T3T4	S1			Bogs, seeps, roadsides, wet savannas
Platanthera integra	Yellow Fringeless Orchid	G3G4	S1			Wet savannas, pitcherplant bogs
Portulaca biloba	Grit Portulaca	G1G2	S1			Altamaha Grit outcrops
Pteroglossaspis ecristata	Wild Coco	G2G3	S2		T	Grassy saw palmetto barrens; longleaf pine grasslands, sometimes with Schwalbea americana
Ptilimnium ahlesii	Coastal Bishopweed	G1	SH			Tidal freshwater marshes
Quercus similis	Swamp Post Oak	G4	S1			Bottomland swamps and other wet habitats
Rhynchospora breviseta	Short-Bristle Beakrush	G3G4	SU			Bogs; flatwoods
Rhynchospora decurrens	Decurrent Beakrush	G3G4	S2?			Swamps
Rhynchospora fernaldii	Fernald's Beakrush	G3G4	S2?			Sandy, peaty pond margins and depressions
Rhynchospora macra	Many-Bristled Beakrush	G3	S1?			Peaty, sandhill seepage slopes; streamhead pocosins
Rhynchospora pleiantha	Clonal Thread-Leaved Beakrush	G2G3	SH			Margins of limesink depression ponds (dolines)
Rhynchospora punctata	Spotted Beakrush	G1?	S1?			Wet savannas, pitcherplant bogs
Ruellia noctiflora	Night-Blooming Wild Petunia	G2	S1			Open, slash pine flatwoods
Sageretia minutiflora	Climbing Buckthorn	G4	S2		T	Calcareous bluff forests; maritime forests over shell mounds
Sapindus saponaria var. marginatus	Soapberry	G5TNR	SNR			Georgia habitat information not available
Sarracenia psittacina	Parrot Pitcherplant	G4	S2S3		T	Wet savannas, pitcherplant bogs
Sarracenia rubra ssp. rubra	Sweet Pitcherplant	G4T3T4	S2		E	Georgia habitat information not available
Schoenolirion albiflorum	White Sunnybell	G3	S1?			Wet savannas
Scutellaria altamaha	Altamaha Skullcap	G2G3	S2?			Sandy, deciduous woods
Scutellaria mellichampii	Mellichamp's Skullcap	GNR	S2?			Sandy deciduous woods
Sideroxylon macrocarpum	Ohoopee Bumelia	G3Q	S3		R	Dry longleaf pine woods with oak understory; often hidden in wiregrass
Sideroxylon thornei	Swamp Buckthorn	G2	S2		R	Forested limesink depressions; calcareous swamps
Spiranthes floridana	Florida Ladies-Tresses	G1	S1?			Wet savannas; mowed grassy openings in Okefenokee area
Sporobolus pinetorum	Pineland Dropseed	G3	S2?			Wet savannas with wiregrass
Sporobolus teretifolius	Wire-Leaf Dropseed	G2	S2?			Longleaf pine-wiregrass savannas, pitcherplant bogs
Stewartia malacodendron	Silky Camellia	G4	S2		R	Along streams on lower slopes of beech-magnolia or beech-basswood-Florida maple forests
Xyris drummondii	Drummond's Yellow-Eyed Grass	G3	S1			Pine flatwoods
Xyris scabrifolia	Harper's Yellow-Eyed Grass	G3	S1			Sedge bogs; pitcherplant bogs; pine flatwoods

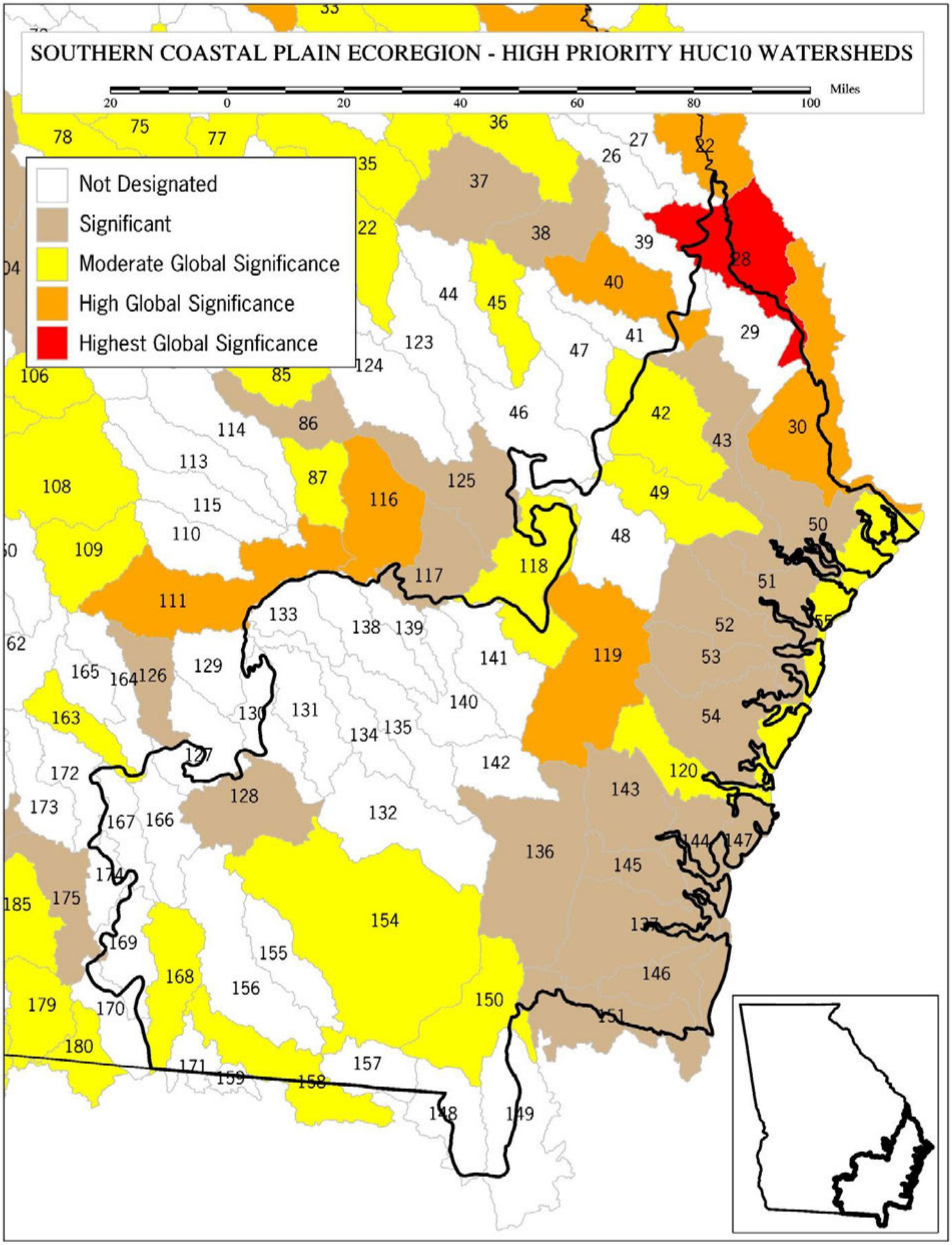


Figure 20. High Priority Waters, Southern Coastal Plain Ecoregion

V. Statewide Wildlife Conservation Themes and Strategies

During the process of outlining and evaluating objectives for wildlife conservation in Georgia, several issues or themes pertaining to high priority species and habitats across the state or in multiple ecoregions were identified. These conservation themes are described below, and the highest priority specific conservation actions associated with each of these themes are listed.

State Wildlife Action Plans (SWAPs) are intended to be living documents subject to revision based on new science and changing conditions. Since 2005 when the Georgia SWAP was developed, the conservation landscape has changed. The state, region and nation are experiencing changes in climate, wildlife diseases, and energy development. These changes represent emerging issues that impact the status and distribution of species and habitats. Therefore, as part of the 2015 revision, Georgia's SWAP describes these emerging issues and proposes conservation actions to address them.

Climate Change

Climate change is consistent, directed change in climatic conditions at regional scales. Climate change is impacting species and habitats, and these effects are projected to increase substantially over time. These climate-driven changes will profoundly affect our ability to conserve fish and wildlife and their habitats.

Climate change has become a central and defining wildlife conservation issue since the development of the original 2005 SWAP. An emerging approach to addressing climate change is called climate change adaptation, or preparing for and coping with climate change impacts on fish and wildlife. The Intergovernmental Panel on Climate Change defines climate change adaptation as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

The impact of climate change reaches beyond state boundaries, exacerbates existing threats to wildlife, and affects each species differently. Consequently, climate change warrants being addressed in the 2015 revision of the Georgia SWAP as an emerging issue. The intent is not to develop a stand-alone "Climate Change Action Plan." Rather, this subsection is an acknowledgement that climate change is an important issue to be dealt with as part of the implementation of the SWAP, but that it is still a threat inherent with uncertainty that requires a great deal more work with researchers and other agencies and conservation organizations to elucidate potential impacts and implement Climate-Smart Conservation.

This subsection identifies the highest priority conservation actions for climate change adaptation over the next 10 years. Other emerging issues, including wildlife diseases and renewable energy development, are addressed in the following subsection. Climate change is also addressed in the Climate Change Adaptation Technical Team Report in Appendix O.

Georgia's Revision Process in the Context of Climate Change

This 2015 revised version of the SWAP incorporates climate change into the selection of high priority species, habitats, and conservation actions. It contains information on current climate change impacts, predictions for future climate change impacts, and a plan for researching and adapting to the impacts. While conservation goals focus on future conditions, this 10-year plan accounts for near-term challenges and transition needs.

The impacts of climate change do not exist in isolation, but combine with and exacerbate existing threats to fish, wildlife, and habitat. As such, the 2015 Georgia SWAP uses a new lens to reconsider conservation actions. This revisioning is a result of compiling information from regional conservation partnerships, expert opinion, vulnerability assessments, published studies regarding current and potential climate change impacts, and other resources. These interactions were the underpinning for the technical teams to identify high priority species, habitats, and conservation actions. This revised plan acknowledges and addresses the problems of the past and anticipates and attempts to prepare for those of an uncertain future.

Furthermore, physical changes on the landscape impact human elements such as agriculture, water use, and land use. The human element will need to be considered when implementing climate change adaptation. Partners such as the University of Georgia and the State Climatologist can help inform this process.

Tools and Resources

Climate change presents unprecedented challenges, but new tools and regional partnerships offer new opportunities. Regional conservation partnerships provide resources to address the landscape level impacts of climate change on fish and wildlife. The local effects of climate change are often difficult to quantify. A regional issue warrants a regional approach. The following are examples of tools and resources that can facilitate implementation and future revisions of the SWAP to address climate change.

Analysis of Vegetation Type Change. The U.S. Forest Service (USFS) conducted an analysis of vegetation type change for every state. The analysis shows a map of historical vegetation and then the future changes for a single emission scenario and three climate models, and a composite of the changes based on three emissions scenarios and three climate models under no suppression of wildfire. Climate stress index results are shown at the state level. Each projection is accompanied by a description of associated climate changes. Also under consideration is partnering with the National Wildlife Federation (NWF) to create a map of Georgia that overlays the USFS map with terrestrial climate vulnerability index maps with priority habitat areas. NWF is currently developing this resource for the Tennessee Wildlife Resources Agency.

Best Practices for State Wildlife Action Plans. Developed by a working group of the Teaming With Wildlife Committee of the Association of Fish and Wildlife Agencies (AFWA), the best practices recommends incorporating climate change into the revision of SWAPs (AFWA 2012). Best practices include:

- Include climate change and its impacts as one of the criteria used in selecting and prioritizing species of greatest conservation need (SGCN).
- Follow recommendations outlined in AFWA's *Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans and Other Management Plans* (AFWA 2009)—specifically as described in "Chapter 3: SWAP Revision Process."
- Conduct vulnerability assessments to inform the selection of SGCN and conservation actions. Use *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment* (Glick et al. 2011) to determine the best approach for conducting a vulnerability assessment for habitats and species at an appropriate level (as determined by each state). Use an approach that is more quantitative and spatially-explicit than a ranking system. Be specific about the aspect of climate change addressed (e.g., increased precipitation, prolonged drought, increased fire, sea-level rise, etc.), and take advantage of information from assessments already available (e.g., regional vulnerability assessments, university- or nongovernmental organization- led vulnerability assessments).
- Link climate impact to priority actions. Using the best available climate data, specify which impact (e.g., sea-level rise, prolonged drought, increased precipitation, increased fire, etc.) will result in which threat, and which action will address that impact. Avoid unspecified generalities such as "will create corridors" or "eliminate invasive species." To determine which conservation actions will maximize investments, consider both current and projected future conditions and trends.
- Integrate key characteristics of Climate-Smart Conservation.
- Consider key adaptation approaches when developing conservation actions as described in West et al., (2009). Examples include: reduce nonclimate stresses, protect key ecosystem features, and ensure connectivity.
- Work with regional partners such as Landscape Conservation Cooperatives (LCCs) and U.S. Department of Interior (DOI) Climate Science Centers (CSCs) to use climate information and resources as well as ensure that they incorporate state-based information into their programs and resources. Develop a regional adaptation plan to better coordinate individual SWAPs.
- Reach out to diverse partners who work on adaptation to ensure coordination and avoid maladaptation (e.g., hardened structures that would prevent marsh migration as sea levels rise). Key sectors might include coastal interests, transportation, agriculture, forestry, etc.

Climate-Smart Conservation. The 2015 Georgia SWAP incorporates the National Wildlife Federation's (NWF) *Climate-Smart Conservation* (Stein et al., 2014), which recommends paying attention to the following overarching themes:

- Act with intentionality
- Manage for change, not just persistence
- Reconsider goals, not just strategies
- Integrate adaptation into existing work

Key characteristics of climate-smart conservation include:

- Link actions to climate impacts
- Embrace forward-looking goals
- Consider broader landscape context
- Adopt strategies robust in an uncertain future
- Employ agile and informed management
- Minimize carbon footprint
- Account for climate influence on project success
- Safeguard people and wildlife
- Avoid maladaptation

Coastal Datasets. Important coastal datasets for understanding potential sea level rise include the Coastal Habitat Map (Georgia Department of Natural Resources, Sea Level Affecting Marshes Model (SLAMM 6) (Chris Craft, Indiana University), the Analyzing Moving Boundaries Using R (AMBUR) software package, which assists with analyzing and visualizing historical shoreline change, Historical Shoreline Change (Chester Jackson, Georgia Southern University), Hardened Shoreline dataset (Clark Alexander, Skidaway Institute of Oceanography), coastal LiDAR data, FEMA Flood Risk Maps, 2006 National Wetlands Inventory (NWI), and the NOAA tidal gauge historical data at Fort Pulaski.

National Fish, Wildlife, and Plants Climate Adaptation Strategy. In October 2014, the Obama Administration released its Priority Agenda for Enhancing the Climate Resilience of America's Natural Resources, which provides policy guidance for shaping the priorities and actions of seven federal natural resource management agencies (DOI, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Federal Emergency Management Agency, and U.S. Department of Defense). It envisions an important role for the 2013 National Fish, Wildlife, and Plant Climate Adaptation Strategy (Strategy).

The Landscape Conservation Cooperatives (LCCs) may facilitate the development of action plans for regional implementation of the Strategy that would include specific objectives, actions, and commitments of resources appropriate to their geographic areas. The 2015 Georgia SWAP includes many of the strategies and specific actions to reach the goals of the Strategy, such as identifying resilient areas and protecting genetic material. The Strategy includes seven goals:

1. Conserve and connect habitat
2. Manage species and habitats
3. Enhance management capacity
4. Support adaptive management
5. Increase knowledge and information
6. Increase awareness and motivate action
7. Reduce non-climate stressors

Scanning the Conservation Horizon. Developed by NWF, this document assists fish and wildlife managers in planning, executing, and interpreting climate change vulnerability assessments (VAs). VAs help in identifying which species are likely to be the most strongly affected, and in understanding why these resources are likely vulnerable. Vulnerability to climate change has three components: sensitivity, exposure, and adaptive capacity (Glick et al., 2011).

South Atlantic Landscape Conservation Cooperative Conservation Blueprint. The South Atlantic Landscape Conservation Cooperative has developed the Conservation Blueprint, a spatially-explicit, living plan that describes the places and actions needed to meet conservation objectives in the face of future change. Incorporating information from different partner organizations operating in the South Atlantic ecoregion, the blueprint is the consistent, cross-boundary, cross-organization plan for how the conservation community can respond to change. When used appropriately, regional coarse scale datasets provide a relevant context for finer scale local datasets and conservation actions.

Southeast Conservation Adaptation Strategy. The Southeast Conservation Adaptation Strategy (SECAS) is a shared, long-term vision for lands and waters that sustain fish and wildlife populations that unifies the delivery of conservation action and supports innovation that can be applied across the region. The goal of SECAS is to knit together the conservation blueprints of all of the Landscape Conservation Cooperatives (LCCs) in the southeast U.S. to collaboratively define the conservation landscape of the future. SECAS is a regional initiative led by members of the Southeastern Association of Fish and Wildlife Agencies, supported by federal leaders in the Southeast Natural Resources Leadership Group, and developed through a partnership of all of the LCCs in the southeast U.S. Southeastern LCCs include South Atlantic, Peninsular Florida, Appalachians, Gulf Coastal Plains and Ozarks, and Caribbean and Gulf Coast Prairies LCCs. Through a grant from the Southeast Climate Science Center, the Georgia Department of Natural Resources intends to work with partners on a SECAS effort to summarize key values and goals of SWAPs and other conservation plans in terms of change drivers that may affect the feasibility of achieving those values and goals.

Southeast Resilient Landscapes Model. While not explicitly defined as a climate change adaptation model, the Southeast Resilient Landscapes Model developed by the Nature Conservancy (TNC) identifies key places for conservation in the face of climate change and other factors. The model is based on conserving complex landscapes that increase diversity and resilience. An estimated resilience score is assigned based on scores of landscape diversity and local connectedness, and ranked relative to the geophysical setting and ecoregion. Landscape diversity refers to the number of landforms, elevation range, and wetland density. Topographic diversity buffers against the impacts of climate change by providing a variety of microclimates. Local connectedness refers to the number of barriers and the degree of fragmentation within a landscape. A highly permeable landscape promotes resilience by facilitating or accommodating range shifts and the reorganization of communities.

Using Doris Duke Charitable Foundation funds, TNC plans to implement Resilience 2015: Southeast Resilient Landscapes Model with the purpose of identifying a network of resilient sites and linkages for the eastern U.S. and communicating the results to agencies and partners. The Georgia Department of Natural Resources (GADNR) has been invited to join the Steering Committee for this project to refine the model and identify resilient coastal areas in the southeast U.S. The longer term goal is to use this and other tools to integrate consideration of a regional context and uncertain futures into conservation management.

Information from TNC's Southeast Resilience Project has been incorporated into the South Atlantic Landscape Conservation Cooperative's datasets. Some of the data from this model has also been incorporated into the draft "Georgia Greenway Opportunities" map in this document. The current and revised products of the Southeast Resilient Landscapes project will continue to inform climate change adaptation efforts going forward. GADNR and others will work with TNC to evaluate the model outputs and recommend improvements.

Also funded by the Doris Duke Charitable Foundation, a land conservation initiative coordinated by the Open Space Institute incorporates information from the Southeast Resilient Landscapes model. The initiative is designed to help land trusts and public agencies focus their conservation efforts on climate change adaptation priorities. The initiative includes several priority areas in Georgia (Open Space Institute, 2015).

<u>Highest Priority Conservation Actions</u>

Conservation actions include research, survey, management, habitat protection, education, outreach, database enhancements, monitoring, regulation/policy, funding, database development, administrative actions, and communication efforts. All involve working with a large number of partners. Some of the following conservation actions are drawn from the technical team reports found in the appendices. Actions that are not drawn from the technical team reports can be found in the Conservation Actions table in Appendix P under the goal of Implement Climate Change Adaptation.

Birds

- Add species to the 2015 list of high priority species, including seaside sparrow, saltmarsh sparrow, and Nelson's sparrow. Primary threats to these species include climate change scenarios with predicted increases in the variability of rainfall, leading to increased drought conditions punctuated with more extreme rainfall events. This altered rainfall pattern may present new challenges at both ends of the rainfall spectrum, from drought conditions where nesting is not possible, to flood conditions where nests are lost and foraging areas are flooded making them unsuitable for feeding.

A warming climate will likely cause the ranges of many species to shift northward, possibly leading to negative interactions with other species or less favorable environmental conditions that affect reproduction and survival. Some species will likely lose a significant amount of habitat because there are spatial and temporal impediments to habitat migration. This may result in dramatic population declines, extirpations, or even extinctions of species.

Climate change can also cause trophic asynchrony when many species of migratory songbirds have been documented returning to their breeding grounds and nesting earlier in the season as the climate continues to warm. The timing of peak bird nesting, and the flush of insects that feed their young, could become asynchronous, leading to lower productivity rates. Trophic asynchrony is likely much more of a problem in the Arctic, where climate change has been occurring more rapidly than in temperate regions. This would potentially influence several arctic nesting shorebirds, including high priority species in Georgia such as red knot and whimbrel. Arctic warming may influence breeding habitat, prey availability, quality, and timing, and potentially shift or alter other ecological interactions.

- Enhance habitat in utility corridors for use by migratory birds and pollinators. For some migratory bird and pollinator species (e.g., painted bunting and ruby-throated hummingbird), Georgia may be their first significant landfall during spring migration. Georgia may contribute to rebuilding populations of the monarch butterfly, which is being considered for federal listing under the Endangered Species Act at the time of this writing. Conduct research and habitat management for transmission rights-of-way (ROW), which can provide a corridor of habitat that could accommodate major shifts in climate. Conduct pilot projects in partnership with the University of Georgia (UGA) and Georgia Power Company to assess the feasibility of low-cost, low-maintenance Safe Passage management on ROWs. Two identified pilot projects include creating detention ponds and plantings in ROWs on the UGA campus. Habitat would be managed and wildlife use would be monitored by students. If the pilot projects are successful and effective, this action could be expanded to include other ROWs owned by Georgia Power Company.

Mammals

- Continue implementing the North Atlantic Right Whale Recovery Plan. This project is implemented in cooperation with Florida Fish and Wildlife Conservation Commission, National Marine Fisheries Service, and other partners. North Atlantic right whales are among the most endangered whale species with a population numbering approximately 450 whales. Right whales are the highest priority marine mammal species in Georgia because of their small population size and the importance of Georgia waters to the population's recovery. Waters along the South Carolina, Georgia, and northeast Florida coast are an important wintering ground and the only known calving ground for this species. Climate change may negatively impact forage availability in Northeast U.S. and Canada, and the suitability of wintering habitat in Southeast U.S. Whale distribution in the Southeast U.S. is strongly correlated with water temperature.

- Work with the U.S. Forest Service (USFS) and private landowners to conserve habitat for high priority mammal species. The mountains of northeastern Georgia represent the extreme southern limits of the ranges of several species of mammals, including the long-tailed shrew, water shrew, hairy-tailed mole, Appalachian cottontail, red squirrel, southern bog lemming, and least weasel. Many of these probably represent relict populations left isolated in high elevation sites as the boreal forests retreated northward following the last Ice Age. Though Georgia provides only a very small amount of the total occupied habitat and supports only a very small portion of the entire population for these species, maintenance of these range extremes could conserve a disproportionate amount of the species' genetic diversity because of isolation and adaptation. In general, these species need high quality forested habitat, with accompanying clean streams, rich soils, and rocky outcrops. In Georgia, much of this habitat occurs on national forest land and is under no immediate threat. However, the Georgia Department of Natural Resources should work with the USFS and private landowners to conserve these important high elevation habitats. The ranges of these species might be particularly vulnerable to climate change. A small increase in average temperature would likely result in a northward retreat, reducing or eliminating occupied habitat in Georgia.

Reptiles and Amphibians

- Address and monitor climate change impacts to reptiles and amphibians. Climate change is likely to have adverse effects on herpetofauna. Effects on habitat suitability are the most wide-ranging, but in the case of most of Georgia's turtle species and the American alligator, species that exhibit temperature-dependent sex determination, warming temperatures may skew sex ratios adversely. Georgia Department of Natural Resources (GADNR) cooperators will continue to monitor the length of incubation for all sea turtle nests in the state, which is significantly correlated with incubation temperature and sex ratio.

  Additionally, GADNR will continue periodic qualitative surveys of sea turtle nesting habitat on all barrier island beaches, categorizing each 100 m section as erosional or depositional based on beach and dune morphological characteristics. Annual surveys are compared to determine changes in the erosional state of sea turtle nesting habitat.

  Researchers at UGA conducted an "Amphibian and Reptile Climate Change Vulnerability Assessment" for select southeastern species, including ten that are considered high priority in Georgia, including flatwoods salamander, tiger salamander, one-toed amphiuma, green salamander, hellbender, striped newt, gopher frog, eastern indigo snake, bog turtle, and gopher tortoise. The predictions are dire for all high priority Georgia species in showing significant reductions in climatically suitable habitat. The assessment maps indicate where climatically suitable habitat is predicted to remain in 2050, and for the striped newt and flatwoods salamander, no habitat is predicted to remain.

- Continue monitoring populations of high priority species. Species include striped newt, flatwoods salamander, hellbender, eastern indigo snake, gopher tortoise. Monitoring will enable comparisons between field observations and predictive models.

- Create permanent fishless wetlands for pond-breeding amphibians. Species of concern include striped newts, tiger salamanders, and gopher frogs. Installing flexible plastic liners in natural or excavated depressions may help maintain breeding habitat in years with low rainfall.

Fishes and Aquatic Invertebrates

- Protect riparian buffers and maintain forest cover in North Georgia watersheds. Georgia occurs within one of the most diverse regions for aquatic species richness in the temperate world. Georgia is among the top five states in the number of native species of mussels (127 species), fishes (265 species), and crayfishes (70 species). Unfortunately, Georgia is also ranked among the top states in the number of imperiled aquatic species. Climate change is a threat to Georgia's aquatic diversity, and habitats are representative of the threats contributing to the global freshwater biodiversity crisis. Species such as brook trout that are restricted to higher elevation, cold water streams may be particularly susceptible to climatic shifts. Efforts to protect riparian buffers and maintain forest cover in North Georgia watersheds are particularly important for these species.

Terrestrial Invertebrates

- For high elevation species that will lose habitat in Georgia, work with neighboring states, Landscape Conservation Cooperatives, and other regional conservation partnerships to ensure that suitable habitat exists in the region. Although legally protected under the Clean Water Act, freshwater marshes are still threatened by sea level rise due to climate change. This threat has the potential to affect species found in freshwater marsh ecosystems, primarily butterflies. In addition, some species found in the Blue Ridge Mountains, especially those near the southern end of their range, may be impacted. Similar to the situation along the coast, communities or host plants may not be able to migrate upslope quickly enough as their current habitat/elevation range becomes unsuitable, or there may simply be no higher elevation place for them to move.

Plants

- Participate in the Safeguarding Database to conserve rare plants. The Georgia Plant Conservation Alliance (GPCA) Safeguarding Database is a centralized, standardized, and updated repository for data pertaining to collaborative plant conservation projects. The database is a tool for tracking rare species in safeguarding and landscape management, and for communicating successes, methods, threats, and needs. Safeguarding can help conserve and restore rare plants species from the effects of landscape change. The database provides details relevant to habitats across the landscape that can serve as indicators for responses to climate change. Sharing this information supplies a broad range of important factors to consider in analyses assessing climate change. The GPCA keeps genetic material for rare plants should assisted migration become necessary. The database was developed by Atlanta Botanical Garden in conjunction with the Georgia Department of Natural Resources, the State Botanical Garden of Georgia, and the Chattahoochee-Oconee National Forest. The GPCA has been successfully coordinating safeguarding efforts since 1995, and restores and introduces rare species into native habitat. Member organizations establish and maintain collections for rare plant species that represent invaluable genetic resources.

Habitat Restoration

- Manage invasive species. Another challenge facing Georgia is the potential expansion of invasive species infestations due to climate change. Some climate change models predict an increase in July heat indexes across the Southeast U.S. from 8-15° F to as high as 20° F. Higher average temperatures may enable invasive species to take advantage of weakened ecosystems and further out-compete native species. It is estimated that global warming will allow 48 percent of currently established invasive plants and animals to expand their ranges northward if current warming trends continue. This effect can already be seen as warming winter temperatures permit species such as kudzu and garlic mustard to survive in areas much farther north than in the past. In addition, it is expected that climate change will contribute to more severe infestations and habitat damage from invasive insect species, including the gypsy moth. Studies have also shown that increased carbon dioxide levels appear to stimulate the growth of invasive plants, and may render herbicides less effective.
- Prioritize management practices on those lands most resilient to change to minimize risk. Management actions that maintain and enhance connectivity in priority areas, and avoid fragmenting habitats would be prioritized.

Ecosystems/Habitat Mapping

- Build a comprehensive, dynamic modeling process. Changes can be incorporated into the model as modeling assumptions shift, land cover and climate changes, and conservation lands are added. This would create a future habitat component to habitat models that will be beneficial for long term planning. Final prioritization inputs will include sea level rise and climate change impacts.

- Incorporate climate change into distribution models for all high priority species. These models will develop future habitat spatial representation of multiple climate scenarios.
- Complete a statewide map of priority habitats and landscape features for a detailed picture of the status of habitats around the states. The current map of 11 counties took three years to complete so the approach needs to be modified in order to meet objectives in a reasonable timeframe. Over the longer term, this map will facilitate strategic conservation, and partners would apply for grants to do some of the work. One recommended area of emphasis is mapping isolated wetlands and monitoring inundation levels to identify variation and responses to precipitation patterns.
- Acquire statewide LiDAR coverage to facilitate habitat mapping. LiDAR, Light Detection and Ranging, is a remote sensing method used to examine the surface of the Earth. Use the statewide LiDAR coverage to show topography and delineate wetlands. Because the results could inform the work of state and federal agencies as well as local governments, the return on investment would be great. Use LiDAR data to develop strategies for protection and management of coastal plain wetlands.
- Create a map to help guide land acquisition and identification of greenways and wildlife corridors. The land trust community could use it to prioritize local protection projects and grant programs. Include some priorities on the map that were identified by The Nature Conservancy. Coordinate with the Oconee Rivers Greenway Commission and other local planning groups to incorporate conservation of wildlife corridors in local greenspace efforts. This is also a strategy of the National Fish, Wildlife, and Plants Climate Adaptation Strategy.
- Consider changes in sea level rise in conservation planning. The past 80 years have seen 10 inches of recorded sea level rise per the National Oceanic and Atmospheric Administration Fort Pulaski tidal gauge near Savannah. Most sea level rise models predict this to accelerate sharply over the next decade. Use the Sea Level Rise Affecting Marshes Model (SLAMM) based on high accuracy, LiDAR-derived elevations when considering coastal habitat response to sea level rise. This dataset projects various scenarios of sea level rise over the coming 100 years. Much of the coast of Georgia is well situated for the next 30 years due to the predominance of high elevations, but the vast expanses of saltmarsh will begin fragmenting substantially over that period, and will be followed by marsh drowning on a large scale.
- Prioritize the conservation of diverse topographical areas on the coast. Account for sea level rise. Bias this approach towards land with substantial areas above 13 Foot Mean Sea Level, which is the initial zone of elevation, which enjoys the least amount of protection.

Understanding and adapting to the impacts of climate change is a process inherent with uncertainty and many questions remain before the path forward is clear. Fortunately, a large number of agencies, organizations, and academic institutions are working collaboratively to conduct climate change adaptation. Many of these institutions have overlapping responsibilities and geographic scopes, but each group plays a unique and vital role. One of the great challenges is coordinating efforts among groups so that limited resources are utilized in the most effective manner possible. While there have been substantial individual and group efforts to coordinate adaptation actions, there is no established framework for regular fish and wildlife conservation planning in Georgia. Continue to meet with other states to discuss climate change adaptation, using existing agency committees and initiatives (e.g., Association of Fish and Wildlife Agencies Climate Change Committee, Southeastern Association of Fish and Wildlife Agencies, Landscape Conservation Cooperatives).

Other Emerging Issues

In addition to climate change, several other issues have emerged since the original version of the SWAP. Emerging issues addressed in this subsection include wildlife diseases and energy development. This subsection describes those issues and lists high priority conservation actions to address them. Renewable energy sources addressed include solar power, wind power, and bioenergy.

Wildlife Diseases

Several wildlife diseases have emerged or worsened since the 2005 version of the Georgia SWAP. Emerging wildlife diseases are often linked with global trade, climate shifts, habitat changes, and introductions of invasive species (e.g., introduced Ambrosia beetles spreading laurel wilt disease). Diseases caused by or carried by invasive species present a special case because wildlife may not have a natural immunity to them. Many of these invasive species are covered in the habitat restoration technical team report (see Appendix I).

Wildlife disease ecology is a rapidly growing field that is critical to the conservation of wildlife. In 1957, the Southeastern Cooperative Wildlife Disease Study (SCWDS) was founded by the Southeastern Association of Fish and Wildlife Agencies as the first diagnostic and research service to be established for the specific purpose of investigating wildlife diseases. SCWDS is a state-federal cooperative that provides expertise to the state and federal agencies responsible for managing the nation’s wildlife and domestic livestock. Guidance on preventing or minimizing the spread of wildlife diseases has also been developed by organizations such as the Association of Fish and Wildlife Agencies and Partners in Amphibian and Reptile Conservation. Through collaboration with government agencies, non-governmental organizations, universities, and the public, research needs and conduct management actions related to emerging wildlife diseases will be identified.

Many wildlife diseases also present a threat to human health. Recent outbreaks of West Nile virus and avian influenza illustrate the link between wildlife disease and human health. As humans increase their contact with wildlife and their habitat, the risk of disease transmission increases. Healthy ecosystems are essentially for reducing the threat of wildlife disease for both human and wildlife health. For more information, visit http://vet.uga.edu/scwds.

White Nose Syndrome. White nose syndrome (WNS) is a disease that is devastating hibernating bat species in the U.S. The disease is linked to the fungus, *Pseudogymnaoascus destructans*, which manifests itself on the muzzles and wings of bats and thrives in the cold, humid conditions of caves. First documented in New York in 2006, the disease spread rapidly and was documented in Georgia in 2013. Bats at hibernacula in the northeastern U.S. have experienced 90 to 100 percent mortality, although mortality differs by site and species. As of 2014, at least 5.7 million bats have been killed by WNS since the disease was first documented in the U.S. Seven bat species have been confirmed with WNS, and the northern long-eared bat was federally listed as threatened in 2015 primarily due to the threat of WNS. Bat species that occur in Georgia and are known to be impacted by WNS include the northern long-eared bat, little brown bat, big brown bat, tricolored bat, Southeastern myotis, small-footed myotis, and the federally endangered Indiana bat. However, the only ones with documented cases of WNS in Georgia include the northern long-eared bat and tri-colored bat (Georgia Department of Natural Resources, n.d.).

Partners such as the U.S. Fish and Wildlife Service (USFWS) and Bat Conservation International (BCI) are assisting state fish and wildlife agencies with coping with the impacts of WNS. The USFWS developed the 2011 White Nose Syndrome National Plan. BCI provides funds for research, surveillance, and monitoring, as well as provides information to managers and decision-makers. The 2013 Georgia White Nose Syndrome Response Plan outlines steps for raising awareness, preventing or slowing the spread of the disease, reporting and analyzing bats, and managing related natural resources such as caves (Georgia Department of Natural Resources, 2013).

Avian Vacuolar Myelinopathy. Avian Vacuolar Myelinopathy (AVM) is a neurological disease that causes mortality in waterbirds in the southern U.S. Since it was discovered in 1994, the disease has killed at least 80 bald eagles and possibly thousands of American coots. The disease has also been confirmed as the cause of death of mallards, buffleheads, ring-necked ducks, Canada geese, killdeer, and a great horned owl. AVM causes a lesion in the myelin of the brain and spinal cord, which is linked to a lack of muscle coordination and difficulty flying and swimming. Cyanobacteria growing on submerged aquatic vegetation (primarily invasive hydrilla) are suspected to be the cause of AVM. Waterbirds consume the vegetation, and eagles consume the sick or dead waterbirds. According to the U.S. Army Corps of Engineers (USACE) Aquatic Nuisance Species Research Program, "AVM is the most significant unknown cause of eagle mortality in the history of the United States" (Warnell School of Forestry and Natural Resources, 2014).

In Georgia, the impacts of AVM are localized but significant in those areas where it occurs. AVM has likely resulted in the loss of at least eight bald eagle nesting territories in Georgia, and several dozen eagles, most at Lake Thurmond. The USACE is developing a hydrilla management strategy for Lake Thurmond with input from federal and state agencies and stakeholders (J. Ozier, personal communication, April 24, 2015).

Chytridiomycosis. Chytridiomycosis has been implicated in the decline and extinction of numerous amphibians. A species of chytrid fungus, *Batrachochytrium dendrobatidis*, or *Bd*, is linked to the disease. Chytrid is a type of fungus that lives in water or moist habitats worldwide. The fungus thickens the skin of amphibians with keratin, interfering with their ability to breathe or take up water through their skin. *Bd* is infecting and decimating populations of frogs and other amphibians around the world. The rapid speed at which populations can decline has disproportionately eliminated rare, specialized, and endemic species. In a study from 1999 to 2006, more than 1200 amphibians were sampled for *Bd* at 30 sites across the southeastern USA. Chytrid infection was confirmed in 10 species of aquatic-breeding amphibians. While no evidence was found of chytrid-associated declines in the region, the presence of the fungus is cause for concern and further study given global climate change and other stressors (Rothermel, 2008).

Another species of chytrid, *Batrachochytrium salamandrivorans,* is impacting salamanders overseas. This presents cause for concern: a) the disease is likely not yet present in the U.S., b) more salamander species occur in the U.S. than in any other country, and c) lessons learned from the impact of *Bd* (Martel et al., 2014). Results from Martel and colleagues demonstrate that native U.S. salamanders will be highly vulnerable to this new disease if it arrives. The Lacey Act can be implemented to impose an injurious listing for the import of salamanders until more information can be determined.

Snake Fungal Disease. Snake fungal disease (SFD) is a severe dermatitis that causes scabs and other abnormalities on a snake's skin. The disease is associated with the fungus, *Ophidiomyces ophiodiicola*. SFD was first documented in Georgia in 2014. Two clinical reports of SFD have been confirmed in wild Georgia snakes, including the federally threatened eastern indigo snake (J. Jensen, personal communication, April 24, 2015). At least eight species of snake have been infected but it is potentially harmful to all species of snake. The impact to snake populations is unclear but the disease has been implicated in declines in rattlesnake populations in Illinois and New Hampshire (Georgia Department of Natural Resources, 2014).

Ranavirus. Ranaviruses are emerging pathogens of amphibians, reptiles, and fish. They have been linked to die-offs in amphibians in the Americas, Europe, and Asia. Ranaviruses can be transmitted across amphibians, reptiles, and fish, and are moved regionally and internationally in the animal trade. In Georgia, they impact many amphibian species and some turtle species, including box turtles (J. Jensen, personal communication, April 24, 2015). Ranavirus has been found in Georgia's mountain streams, which poses a risk to salamanders. Gopher frogs are highly vulnerable based on laboratory trails. Ranaviruses pose a growing risk to global biodiversity (Global Ranavirus Consortium, n.d.).

Upper Respiratory Tract Disease. Upper respiratory tract disease (URTD) is characterized by a mild to severe nasal discharge. While the causative agent has not been identified, predisposing factors such as poor nutrition from habitat degradation, drought, and release of captive turtles and tortoises are likely involved (Jacobson, 1992). In

Georgia, the disease impacts gopher tortoise, which is a candidate species for federal listing, and box turtle. A population of gopher tortoise in Georgia with a historically high prevalence of antibodies to *Mycoplasma agassizii* was studied to assess long-term effects of URTD on tortoise behavior. The study showed that emigration of tortoises with severe clinical disease may play an important role in dispersal and persistence of pathogens (McGuire, 2014).

Chronic Wasting Disease. Chronic wasting disease (CWD) is a highly contagious, fatal neurological disease found in deer and elk. CWD has been confirmed in 18 states but has not been confirmed in the southeast U.S. Preventing the transmission of CWD into Georgia is a high priority. The first line of defense is to halt importation of all deer species. In Georgia, it is illegal to import any member of the deer family. Other preventative action includes continuing to prohibit canned hunting operations; prohibiting baiting of deer for hunting, which facilitates the transmission of wildlife disease agents by concentrating sick deer with healthy deer; and, discouraging management practices that result in high concentrations of deer over small areas (Georgia Department of Natural Resources, n.d.).

Highest Priority Conservation Actions

Highest priority conservation actions for wildlife diseases can be found in the Conservation Actions table in Appendix P under the goal of "Conserve high priority species."

- Implement the 2013 Georgia White Nose Syndrome Response Plan.
- Assess the need and feasibility of disease testing of potential or known-to-be vulnerable high priority species for emerging infectious diseases as a component of ongoing population surveys and monitoring efforts.
- Conduct outreach to decision-makers and the public about the impact, transmission, management, and prevention of wildlife diseases.
- Propose updates to legislation to address wildlife diseases.

Energy Development

Since the development of the Georgia SWAP, several national laws and initiatives have resulted in the scaling up of renewable energy development. In 2007, President Bush signed the Energy Independence and Security Act to, among other things, increase the production of clean renewable fuels. In 2011, Secretary of the Interior Ken Salazar announced initiatives to encourage rapid and responsible development of renewable energy on public lands. In 2014, Georgia was responsible for nearly three percent of new clean energy capacity installed in the U.S., ranking ninth in the country. That same year, private industry invested $477 million in Georgia's clean energy sector, the eighth-highest figure in the nation (Pew Charitable Trusts 2014). Renewable energy holds promise for reducing greenhouse gas emissions that contribute to climate change.

However, the development of renewable energy resources should be done with proactive plans in place to prevent unintended consequences and costs to native fish, wildlife, habitat, and public and private landowners and managers. Often, sites that are ideal for energy development are the same sites critical to high priority species, including federally listed and candidate species. The first step in energy project siting should be consultation with the Georgia Department of Natural Resources Nongame Conservation Section. Voluntary best practices and early coordination can help conserve fish and wildlife and ensure regulatory certainty. America's fish and wildlife are a public trust resource, and for more than 100 years state fish and wildlife agencies have upheld the primary responsibility for conserving those resources on public and private lands and waters within their borders.

Solar Power

Georgia is the fastest growing solar market in the nation (Solar Energy Industries Association [SEIA], 2015). In 2013, the Georgia Public Service Commission directed Georgia Power Company, the largest utility in Georgia, to add 525 megawatts (MW) of solar power between 2013 and 2016 (Pew Charitable Trusts 2014). This new requirement prompted an increase in solar development initiatives across the state. Now, Georgia has 161 MW of solar energy installed, ranking it 15th in the country, with more than 167 solar companies at work (SEIA, 2015).

Because of the speed of the development and lack of established regulatory procedures, development of large solar energy facilities has sometimes proceeded without implementation of proper precautions to minimize impacts to fish, wildlife, and habitat. Often, rural sites that are ideal for large solar power "farms" are the same sites critical to species of conservation concern, including federally endangered and candidate species, such as the gopher tortoise. The gopher tortoise is a keystone species that provides shelter for other high priority species. Some solar power developers in Georgia recognize that in keeping with the environmental benefits inherent to solar energy, the solar industry should consider impacts to fish, wildlife, and habitat when moving forward with projects. Coordination between the solar industry and fish and wildlife agencies to develop and implement voluntary best practices and early coordination can help conserve fish and wildlife habitat and maintain biological diversity.

Solar power plants are typically built with private funds, and therefore not subject to regulation under the National Environmental Policy Act. Without a federal nexus, no formal process for engaging solar power developers exists. At the time of this writing, the Association of Fish and Wildlife Agencies is planning to identify a process to engage solar power developers in the absence of a regulatory pathway. Furthermore, lessons learned on federal land in the southwestern U.S. may be applicable. In 2012, the Approved Resource Management Plan Amendments/Record of Decision for Solar Energy Development in Six Southwestern States was completed, which evaluates solar energy development, develops agency-specific programs or guidance that would establish environmental policies and mitigation strategies for solar energy projects, and establishes a new Bureau of Land Management Solar Energy Program (K. Boydston, personal communication, April 22, 2015).

Highest Priority Conservation Actions

Highest priority conservation actions for solar power can be found in Appendix P under the goal of "Reduce impacts from development and other activities."

- Develop procedures for engaging with solar developers in the siting, permitting, mitigation, and implementation stages of solar energy development. Promote early consultation with the Nongame Conservation Section of Georgia Department of Natural Resources as the first step during the site selection process to avoid impacts to known species/habitats of conservation concern. Participate in meetings and workshops with solar industry and wildlife agency representatives to identify ways to engage in all stages of the solar development process.
- Develop a "Risk Map" with summarized information for rare species and sensitive habitats to be used as an early planning tool for energy project siting.
- Conduct studies on the impacts to wildlife and the effectiveness of mitigation efforts for solar power. Use standard protocols to improve comparability to other studies, enhance coordination among states, and provide a consistent message to managers, decision makers, and the public.
- Identify and apply applicable lessons from other states and regions, including siting and mitigating lessons from the desert tortoise.
- Participate in regional efforts to understand impacts to wildlife and develop strategies to minimize the impact of solar power development.
- Conduct outreach to the public and decision makers about the impacts to wildlife of solar power development and potential solutions.

Wind Power

The scaling up of wind power development preceded the scaling up of solar power development so more research is available on how to minimize the impact of wind energy production on wildlife. However, a lack of information on wildlife mortality and the effectiveness of mitigation measures still leave wildlife at risk. Potential risks to wildlife include collisions with wind turbines and associated infrastructure, habitat loss, degradation, and fragmentation from turbines and infrastructure, displacement and behavioral changes, and impacts from increased predator populations or introduction of invasive plant species. In the U.S., wind energy development increased by 27% in 2006 and 45% in 2007. Fatalities of birds and bats have been reported at wind energy facilities worldwide, with large numbers of raptor kills in California and bat kills in the eastern U.S. (The Wildlife Society, 2008). Surveys at wind facilities demonstrate that across the states over half a million bats are killed per year. For more information, visit http://pubs.usgs.gov/of/2012/1110/OF12-1110.pdf

Developers and wildlife agencies worked together to develop guidance for siting and mitigating for wind energy projects. In 2012, the U.S. Fish and Wildlife Service (USFWS) developed two relevant guidance documents. The Land-based Wind Energy Guidelines provide a voluntary, scientific process for conserving wildlife at all stages of land-based wind energy development (USFWS, 2012a). The Eagle Conservation Plan Guidance provides guidance for conserving bald and golden eagles at the siting, constructing, and operating stages of wind energy facilities (USFWS, 2012b).

The guidelines provide a tiered approach to turbine construction, starting with preconstruction monitoring of the site to quantify the potential wildlife impacts of the project, and continuing with post-construction monitoring to determine the actual impact. This adaptive, iterative process incorporates lessons learned to generate new operating procedures to reduce mortality. Premonitoring can assist with determining whether a proposed site has a high risk of wildlife mortality. After premonitoring, if turbines are constructed, every effort should be made to minimize the chance of collision and monitor whether any wildlife mortality is occurring (USFWS, 2012a).

In 2013, the first offshore wind turbine on the east coast of the U.S. was constructed off the coast of Maine. The Association of Fish and Wildlife Agencies is monitoring offshore wind power development on the east coast and will provide any updates and recommendations to affected state fish and wildlife agencies. Potential impacts to wildlife from offshore wind development include impairing the ability of marine mammals to process and use sound due to anthropogenic sound, and collisions with turbines of marine, coastal, pelagic, and migratory birds and bats. Furthermore, shoreline habitat is dynamic and potentially subject to dynamic sea level rise. Permanent structures should be positioned so that they are minimally threatened by erosion and do not result in the construction of shoreline stabilization structures and loss of shoreline habitat (Yellin, 2014). Shoreline change rates are available to the public at the Georgia Coastal Hazards Portal at http://gchp.skio.usg.edu/.

In Georgia, staff from USFWS and the Georgia Department of Natural Resources (GADNR), and faculty from Georgia Southern University provide technical assistance to Georgia Power Company on implementation of a small-turbine wind energy demonstration project planned for Skidaway Island. Several high priority bird species have been documented near the site, including the federally listed wood stork. In such cases, special attention must be paid to breeding seasons and flight paths. The coast also serves as nesting habitat for bald eagles and an important corridor for migratory landbirds, shorebirds, raptors and wading birds. To minimize potential impact to wildlife, surveys should be conducted prior to siting and construction of wind turbines and infrastructure (Yellin, 2014).

Bats that are most likely to be affected by coastal wind turbines in Georgia are migratory tree bats, although northern yellow bat and tri-colored bat may also be vulnerable. Georgia is not an area with abundant wind resources and successful operation of wind facilities will likely rely on lower wind speeds than other areas of the country. This could put the operation of these facilities in Georgia in direct conflict with bats during peak migration periods (Yellin, 2014). More information about bats and wind energy can be found at the bats and wind energy cooperative at http://www.batsandwind.org/.

Currently, the GADNR has no wind power siting authority, cannot require mitigation, and has no available wildlife guidelines for wind power siting. Local governments have primary authority through zoning authorities or county planning boards. GADNR provides reviews of state or federally funded projects and may enter into agreements to facilitate planning of other projects (Association of Fish and Wildlife Agencies and U.S. Fish and Wildlife Service, 2007).

Highest Priority Conservation Actions

Highest priority conservation actions for wind power can be found in the conservation actions table of Appendix P under the goal of "Reduce impacts from development and other activities."

- Develop procedures for engaging wind developers in the siting, permitting, mitigation, and implementation stages, including offshore sites should offshore wind projects start off of the coast of Georgia. Promote early consultation with the Nongame Conservation Section of Georgia Department of Natural Resources as the first step during the site selection process to minimize impacts to known species/habitats of conservation concern.
- Steer projects away from the areas of highest wildlife diversity. Consider potential shifts in wildlife ranges due to climate change. Minimize siting wind facilities in areas identified as high priority in Georgia's State Wildlife Action Plan.
- Develop a "Risk Map" with summarized information for many rare species and sensitive habitats to be used as an early planning tool for wind energy project siting should the rate of wind power development increase in Georgia.
- Conduct studies on impacts to wildlife of wind power and the effectiveness of mitigation efforts. Use standard protocols to improve comparability to other

studies, enhance coordination among states, and provide a consistent message to managers, decision makers, and the public.

- Identify and apply lessons from wind energy project development in other states and regions.
- Participate in regional efforts to understand impacts to wildlife and develop strategies to minimize the impact of wind power development.
- Conduct outreach to the public and decision makers about the impacts to wildlife of wind power development and potential solutions.

Bioenergy

Georgia ranks first in the country in commercial timberland, making woody biomass a large part of its renewable energy portfolio. In 2013, biomass was responsible for the second most renewable energy (following hydropower) in Georgia with 765 megawatts of power generation (Pew Charitable Trusts, 2014).

Since the original SWAP, federal legislation has stimulated the production of bioenergy. The Energy Independence and Security Act of 2007 increased the mandate for using ethanol through the Renewable Fuel Standard. In 2011, the White House issued the Blueprint for a Secure Energy Future to engage federal agencies, industry, agricultural producers, private organizations, and the public in the bioenergy discussion. The 2008 Farm Bill laid the groundwork for much of the federal bioenergy policy pertaining to agriculture and has now been reauthorized in the 2014 Farm Bill to provide $880 million for bioenergy programs and more inclusion of forestry products (McGuire, 2012).

Bioenergy development has the potential to contribute to energy independence and offset the use of fossil fuels. However, bioenergy development should proceed with consideration of wildlife conservation needs. Potential risks to wildlife from biomass energy development include land conversion, invasive plants, loss of plant diversity and habitat structure, and water quality and quantity impacts (McGuire, 2012).

Land conversion. Energy crops have potential to be grown on many land cover types, including those poorly suited for food production. Most undeveloped lands and areas not intensively farmed provide habitat for fish and wildlife species, especially when linked by conserved habitat corridors. Some areas, like longleaf pine savannas which have declined by 98 percent in the southeastern U.S., provide habitat vital to many native wildlife species. These same areas are also increasingly being viewed as grounds with the highest biomass potential.

Invasive plants. The list of potential bioenergy crops includes many nonnative plants with invasive tendencies and genetically modified native species that have a high likelihood of contaminating native plant communities that are important for native wildlife. Native feedstocks for energy use are better adapted to local environments and are more likely to provide adequate habitat for native fish, wildlife, and pollinators that evolved with these natural biological systems. Already, the cost of managing and controlling invasive species is estimated at $120 billion per year (Pimentel et al. 2005).

Reduced Diversity. Dense and expansive monoculture crops are often used to maximize yield of energy crops. Habitat quality decreases on agricultural land that has single-species crops because of reduced diversity of natural plant species and lack of horizontal and vertical structure. When a forest is poorly managed and/or lacks structural and compositional diversity, there are fewer niches available which results in much less occupancy by wildlife species. When farmland is managed too intensely, horizontal space availability can be much reduced too. The more bioenergy crops mimic natural native habitats, the less impact bioenergy production will have on fish and wildlife populations. For example, harvesting trees from properly thinned forests for bioenergy allows more sunlight to reach a forest floor and conserves native groundcover plant species for wildlife, including burnable conditions for native species that are fire-dependent.

Management impacts. In general, fish and wildlife need plant matter for cover and food, like insects, seed, and browse, and for nesting sites that remain undisturbed during nesting seasons. Slight changes in these habitat components can have a large impact on populations. Impacts can be reduced by harvesting bioenergy crops after the nesting season, limiting pesticide and herbicide use, leaving crop stubble, and conserving field borders and hedgerows with plants native to those sites.

Water quantity and quality. Many aquifers are already being depleted, contributing to water quantity and quality issues. Irrigating bioenergy crops would further exacerbate these issues impacting aquatic habitat and Georgia's water sustainability. Bioenergy crops that use less water, fertilizer, and pesticides than crops they replace could help minimize this impact.

The Association of Fish and Wildlife Agencies developed guidelines for integrating biomass production with habitat maintenance. These guidelines were written by many natural resource professionals and reflect potential methods that could advance bioenergy production in conservation-friendly ways for wildlife. The guidelines focus on maintaining natural plant communities including those in aquatic habitats, biomass plantings on agricultural lands, and harvest procedures. Adherence to these and other guidelines and standards should be promoted. Other standards include the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) standards during the development of field trials of engineered high energy crops; and, any guidelines from NCS that are applicable to local conditions (McGuire, 2012).

Policy considerations for the development of biomass energy crops must be additive to, not replacements for, existing statutory priorities and objectives of federal and state fish and wildlife conservation programs. For example, the Conservation Reserve Program (CRP) within the Conservation Title of the Farm Bill is a potential source of land for biomass production. However, there is a lack of science informing how bioenergy crops can be grown on CRP enrolled lands without compromising existing statutory priorities to conserve and improve the soil, water, and wildlife resources.

Highest Priority Conservation Actions

Highest priority conservation actions for bioenergy can be found in Appendix P under the goal of "Reduce impacts from development and other activities."

- Promote bioenergy production practices consistent with wildlife conservation.
- Develop voluntary best practices for bioenergy companies operating in Georgia.
- Conduct studies and distribute findings on the impacts to wildlife and the effectiveness of mitigation efforts for bioenergy.
- Identify and apply lessons from other states and regions.
- Participate in regional efforts to understand impacts to wildlife and develop strategies to minimize the impact of bioenergy development.
- Conduct outreach to agencies, organizations, landowners, and the public about the potential impacts to fish, wildlife, and habitat of bioenergy development and potential solutions.

Regional Conservation Partnerships

Emerging issues such as mega-petitions for species listings under the Endangered Species Act, and game changing issues such as climate change require new and innovative approaches to address them. Regional conservation partnerships such as the Atlantic Coast Joint Venture and the Southeast Partners in Amphibian and Reptile Conservation address needs for at-risk species across all or part of their range. The Southeastern At-Risk Species Program (SEARS) and the Landscape Conservation Cooperatives (LCCs) are regional conservation partnerships that have been developed since the original version of the SWAP. They provide resources and coordination for preventing wildlife from becoming endangered, climate change adaptation, and maximizing efficiency by reducing redundancy. This subsection describes how these new regional partnerships are achieving successes that could not be accomplished by individual states and proposes conservation actions to maximize their impact.

Southeastern At-Risk Species (SEARS) Program

From 1994-2006, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list an average of 20 species per year under the federal Endangered Species Act (ESA). However, since 2007, the Service has been petitioned to list more than 1,250 species, nearly as many species as the agency listed during the previous 30 years of administering the ESA. The Service was petitioned to list 695 species in 2007, 56 species in 2008, 63 species in 2009, and 451 species in 2010 (USFWS, n.d.).

In 2011, the Service reached a settlement with Wild Earth Guardians and the Center for Biological Diversity under a national multi-district litigation (MDL). Under the agreement in the MDL, the Service must make a decision by 2018 on the list of 251 candidate species and make initial petition findings for more than 600 other species. The Service is under an extremely tight timeline to adequately assess the status of at-risk, candidate, and petitioned species for the ESA. Barriers include a lack of manpower, resources, and basic data on these species. In exchange, the USFWS gets a reprieve from listing litigation from those groups. However, the settlement does not preclude other groups from filing petitions (Smith, 2015).

The Southeast Region of the USFWS must evaluate whether to list more than 400 species as a result of the MDL, including 61 candidate species. More than 100 of the petitioned species occur within Georgia, amplifying the need for up-to-date status information to help inform the 12 month reviews and 90 day findings to determine whether the listing is warranted. But the need has not been matched by the funding required to conduct the work (Gwynn, 2015).

There is also a lack of regional data coordination. There is a need to harness the collective research potential of the states through the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) to address these shortcomings, especially data gaps. SEAFWA's Wildlife Diversity Committee is responsible for advising the SEAFWA Directors and making recommendations on issues and matters regarding nongame and endangered species, both terrestrial and aquatic, which may affect the ability of member states to fulfill their fish and wildlife management responsibilities (Smith, 2015).

Myriad wildlife monitoring programs are carried out by numerous state and federal agencies, nongovernmental organizations, and universities. However, lack of coordination among institutions and programs has resulted in redundancy and inefficiency in data collection, data management, and analysis, affecting abilities to prioritize and evaluate the effects of management activities that cross jurisdictional or project borders. Some long-term data are in danger of being lost due to a lack of long term data management planning. In addition, many priority species remain poorly monitored, resulting in a lack adequate knowledge of population trends, sizes, and habitat requirements to understand their conservation status and the effects of management actions (Smith, 2015).

Working together with other states in the southeastern U.S. and with the USFWS is an effective way to address the large number of at-risk species included in the petitions, as well as candidate species and other high priority species across their range. As a result, the State Directors of SEAFWA approved the Wildlife Diversity Committee to work with the USFWS to develop plans and implement actions collectively that could preclude the need to federally list species.

At the 2012 SEAFWA meeting, State Directors also approved the development of a Species Action Plan to address MDL and petitioned species. The Southeastern At-Risk Species (SEARS) program was developed to implement the SEAFWA Action Plan. Successful implementation will be realized through the development of a method to evaluate the status of at-risk species to prevent federal listings, identify species that are at risk but may preclude listing, and identify species that require federal protection. Working at the regional level is necessary to the issues that cannot be meaningfully addressed by individual states. The SEARS program is positioned to be the largest collaborative directed by state fish and wildlife agencies to effectively address critical landscape-scale wildlife conservation needs. It will complement work accomplished in individual states and through other regional efforts, while keeping the regional work relevant to member states.

Fundamental objectives for the SEARS program include:

- Develop and implement an effective information sharing system or framework that will help states and federal agencies communicate and coordinate activities on MDL species, species of conservation need, and at-risk species.
- Establish a framework of criteria to identify and prioritize which species to tackle together.
- Develop and implement a robust, coordinated and integrated research, inventory, monitoring and status assessment effort across the region to address data gaps and inform conservation planning for prioritized species
- Develop and implement a coordinated approach to addressing threats and overcoming barriers so as to ensure sustainable populations and habitats
- Speak with one voice. Instill public trust and confidence by presenting our science, developing a unified message, and having a clear outcome.

Highest Priority Conservation Actions

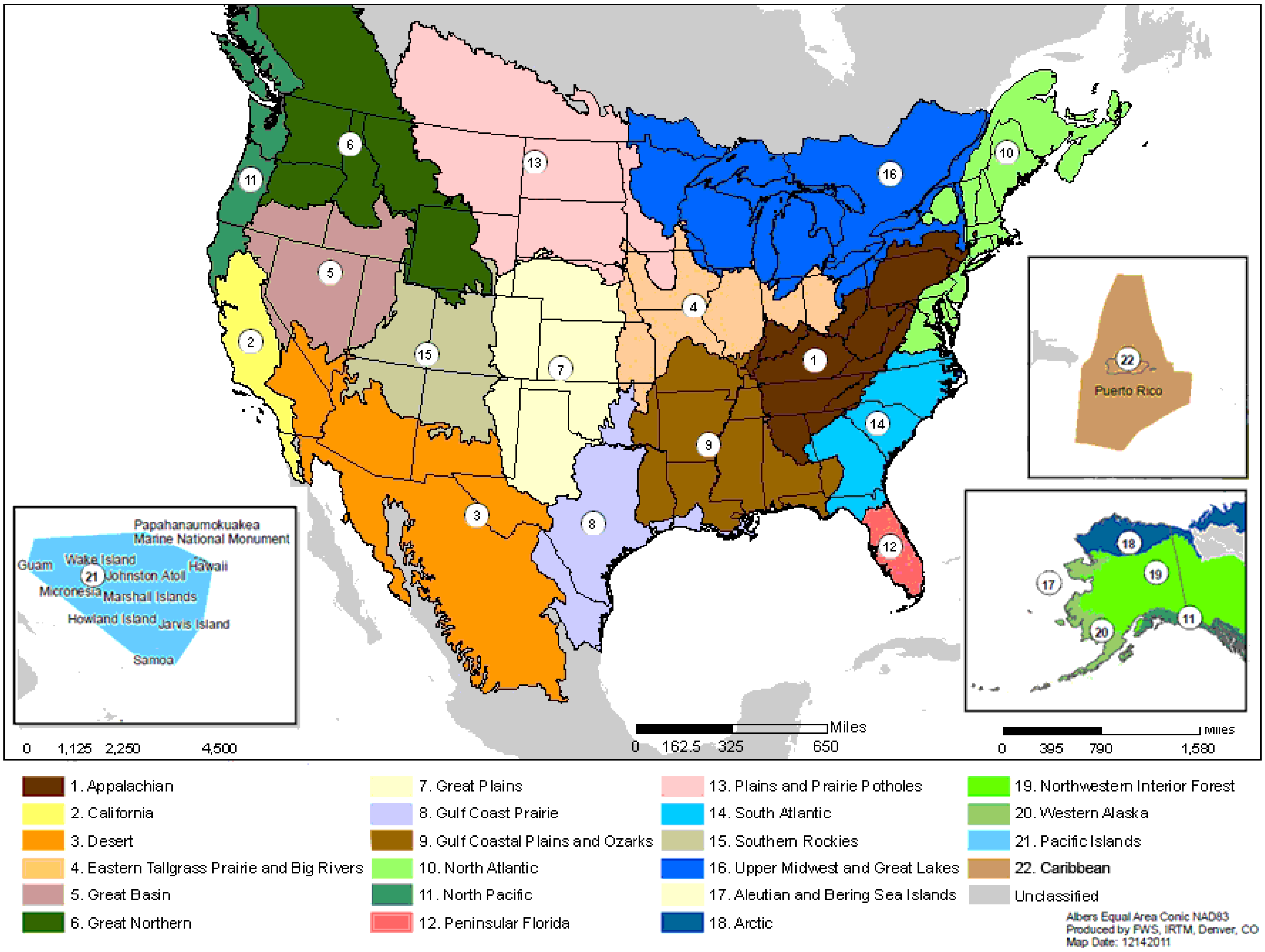
- Participate in the Wildlife Diversity and State Wildlife Action Plan Committees of the Southeastern Association of Fish and Wildlife Agencies.
- Help implement the Southeastern At-Risk Species Program (SEARS) program of the Wildlife Diversity Committee to identify the highest priority species, coordinate data, and identify funding mechanisms.
- Support secure funding for regional conservation.

Landscape Conservation Cooperatives (LCCs)

The Landscape Conservation Cooperatives (LCCs) did not exist in 2005 when the Georgia SWAP was developed, and their establishment and support provides a new framework for conservation planning at the regional level. In 2010, the Department of the Interior (DOI) launched the LCCs to better integrate science and management to address climate change and other landscape scale issues. Collectively, the 22 LCCs form a network of resource managers and scientists from federal, state, and local governments, tribes and first nations, nongovernmental organizations, universities, and interested public and private organizations. These partners work together to identify best practices, connect efforts, identify science gaps, and avoid duplication through conservation planning and design.

The mission of the network of cooperatives is to:

- Develop and provide integrated science-based information about the implications of climate change and other stressors for the sustainability of natural and cultural resources;
- Develop shared, landscape-level, conservation objectives and inform conservation strategies that are based on a shared scientific understanding about the landscape, including the implications of current and future environmental stressors;
- Facilitate the exchange of applied science in the implementation of conservation strategies and products developed by the Cooperative or their partners;
- Monitor and evaluate the effectiveness of LCC conservation strategies in meeting shared objectives;
- Develop appropriate linkages that connect LCCs to ensure an effective network.



Landscape Conservation Cooperatives

Secretarial Order No. 3289 to coordinate the DOI's response to climate change impact on resources, which enabled the launch of the LCCs, also enabled the launch of the DOI Climate Science Centers (CSCs). The CSCs are "regional hubs" of the U.S. Geological Survey's National Climate Change and Wildlife Science Center. The CSCs provide scientific information, tools, and techniques that fish and wildlife managers can use to anticipate, monitor, and adapt to climate change impacts. The research, ecological forecasting, and multi-scale modeling that the CSCs provide is in response to landscape-level priorities as identified by the LCCs, as well as other agencies and communities within each region. The GADNR Nongame Conservation Section participates in the Southeast CSC.

The LCCs were built partly on the Migratory Bird Joint Venture (JV) model. Established in 1987, JVs are self-directed partnerships of agencies, organizations, corporations, tribes, or individuals that conserve habitat for priority bird species, other wildlife, and people. JVs bring together diverse partners under the guidance of national and international bird conservation plans to design and implement landscape-scale conservation efforts. The Wildlife Resources Division of the Georgia Department of Natural Resources participates in the Atlantic Coast JV, which is a regional partnership focused on the conservation of habitat for native birds comprised of the 17 states and key federal and regional habitat conservation agencies and organizations in the Atlantic Flyway of the U.S. from Maine to Puerto Rico.

Three LCCs occur within Georgia: South Atlantic, Appalachian, and Gulf Coastal Plains and Ozarks. By working with the other state agencies and conservation partners within these LCCs, conservation issues can be addressed at the appropriate regional scale. This approach is particularly important when considering climate change impacts, large landscape features, migration corridors, and conservation of large groups of species and habitats. These efforts are important for achievement of longer term and larger scale goals, and working together with these regional partnerships should continue.

When used appropriately, regional coarse scale datasets provide good context for finer scale local datasets. For example, the South Atlantic LCC developed the Conservation Blueprint, a spatially-explicit, living plan that describes the places and actions needed to meet conservation objectives in the face of future change. The blueprint is the consistent, cross-boundary, cross-organization plan for how the conservation community can respond to change.

Climate change, urban growth, and increasing human demands on resources are reshaping the landscape, cutting across political and jurisdictional boundaries. In order to effectively prevent and mitigate for these forces, conservation planning and action must be proactive and address change across organizations, disciplines, and partnerships. The goal of the Southeastern Conservation Adaptation Strategy (SECAS) is to knit together the conservation blueprints of all of the LCCs in the southeastern U.S. to collaboratively define the conservation landscape of the future. SECAS is a shared, long-term vision for lands and waters that sustain fish and wildlife populations that unifies the delivery of conservation action and supports innovation that can be applied across the region. SECAS is a regional initiative led by members of SEAFWA, supported by federal leaders in the Southeast Natural Resources Leadership Group, and developed through a partnership of all of the LCCs in the southeastern U.S. Southeastern LCCs include South Atlantic, Peninsular Florida, Appalachians, Gulf Coastal Plains and Ozarks, and Caribbean and Gulf Coast Prairies LCCs. Involvement by GADNR in this effort to develop a regional strategy for the conservation of wildlife diversity should continue.

Highest Priority Conservation Actions

- Help revise and implement the South Atlantic Conservation Blueprint by providing data on Georgia conservation priorities, identifying research and conservation needs, soliciting new regional partners, and testing ecological indicators and species/habitat models.

Wildlife Conservation on Private Lands

Wildlife conservation tools include land protection action by a public agency or private conservation organization as well as provision of technical assistance or financial assistance to landowners to improve or restore wildlife habitat or meet other natural resource objectives. An array of programs is available to private landowners to help them achieve these objectives. However, landowners sometimes fail to take advantage of these programs simply because it is difficult to determine eligibility, availability, or the relative benefits of one program versus another.

In 1995 WRD began its Private Lands Initiative to intensify efforts in promoting, encouraging, and providing technical assistance for wildlife management on private lands. The Private Lands Initiative developed a strategy for delivering technical assistance to private landowners through USDA programs authorized under the Farm Bill and by developing a partnership with corporate forest landowners known as the Forestry for Wildlife Partnership. In 1998 the Bobwhite Quail Initiative was developed and formed into a separate technical and financial assistance program in the upper Coastal Plain of Georgia. In 1999, the Forest Stewardship Program was incorporated into the Private Lands Initiative to create the Private Lands Program. This program strives to serve private landowners by incorporating the landowner's objectives for their land into a comprehensive wildlife management plan.

Private Lands Program biologists provide information to landowners about federal and state natural resource programs that provide both technical and financial assistance. They also work with private landowners to identify programs best suited to meet these objectives and the agencies that can provide help with enrollment. WRD biologists also participate in the Sustainable Forestry Initiative (SFI) Implementation Committee for Georgia and assist member organizations (which include forest product companies and timber investment management organizations) to meet SFI standards for protection of rare species and natural communities. Georgia Forestry Commission staff provides training and technical assistance to SFI members to ensure compliance with Best Management Practices for forestry. Continued emphasis in this area will be critical to meeting objectives for conservation of natural habitats in Georgia.

The "Landowner's Guide to Conservation Incentives" developed and distributed by WRD staff provides information on a wide variety of programs that are available to Georgia residents. This booklet serves as an introduction to program objectives, funding levels, eligibility, administering agencies, specific benefits to landowners, stipulations for continued support, and other elements. The document provides a matrix of programs and agencies, includes a glossary of program and agency acronyms, and categorizes incentive programs by type of assistance provided (e.g., direct payments, technical assistance, tax incentives, landowner recognition, regulatory relief). The "Landowner's Guide" is available from WRD offices in printed form and is also posted on the WRD website (www.georgiawildlife.com).

Since 2006, the USDA Farm Service Agency has overseen a Conservation Reserve Program (CRP) Longleaf Pine Initiative designed to reforest longleaf pine forests on former agricultural lands in nine southern states. The Wetlands Reserve Program (WRP) is a voluntary program administered by the USDA's Natural Resources Conservation Service offering landowners the opportunity to restore, protect, and enhance wetlands in exchange for retiring eligible land from agriculture. To ensure protection of wetlands that are restored through WRP restoration plans, conservation easements are placed on the properties that restrict certain uses; however, landowners retain ownership and recreation rights and control access to the land. The landowners also receive financial and technical assistance for restoring and protecting the wetlands' values and functions. Numerous other state and federally funded private landowner incentive programs, such as the Environmental Quality Incentive Program (EQIP), Partners for Fish and Wildlife, the Forest Stewardship Program, the Forest Land Enhancement Program, and the Bobwhite Quail Initiative, have been implemented to encourage restoration and maintenance of wildlife habitat and protection of water quality.

In addition to programs administered through the Farm Bill, there are numerous programs managed by other agencies and organizations, including non-governmental organizations. Some of these provide direct funding for land conservation, others provide technical assistance to landowners to achieve conservation goals, and still others provide public recognition for conservation successes.

The Georgia Land Conservation Center provides information and technical assistance to land trusts in the state and administers an in-lieu mitigation banking fund for stream and wetland mitigation projects. Founded in 1993 as the Georgia Environmental Policy Institute, this organization works to support and improve the capacity of land trusts to conserve land. It also works directly with landowners, concerned citizens, government agencies and other organizations to promote legislation, policies, and programs that conserve open space in Georgia.

The primary emphasis in this document is the conservation of natural habitats. However, a number of high priority species make use of habitats that are created or maintained by human activities. These include field edges, utility rights of way, harvested timberlands, and fallow agricultural lands ("old fields"). These anthropogenic habitats resemble natural habitats that have been greatly diminished in the Georgia landscape through fire suppression, the loss of native grazers, or other factors. Numerous opportunities exist to provide assistance to private landowners to maintain and enhance early successional habitats through the Bobwhite Quail Initiative and various Farm Bill related programs.

These programs provide means by which wildlife habitat can be improved with minimal impacts on ongoing agricultural or silvicultural operations. Priorities for restoration of pine savanna communities are incorporated into the SWAP as well as the Forest Action Plan developed by the Georgia Forestry Commission.

Funding levels, conservation emphasis, criteria for eligibility, and other elements of these programs vary over time, so periodic updates of the "Landowner's Guide" are necessary. In addition, public agencies should take advantage of opportunities to collaborate on projects that will focus financial and technical resources to provide the greatest benefit to habitats and species of greatest conservation need on private lands. In order to take advantage of these opportunities, WRD will continue to work with Natural Resources Conservation Service (NRCS), Farm Services Agency (FSA), Georgia Forestry Commission (GFC), land trusts, and other organizations to improve delivery of financial and technical assistance programs. By sharing resources and increasing the number of field staff, these organizations can significantly enhance the number and quality of wildlife conservation programs provided to private landowners. Descriptions of federal, state, and privately funded programs that support wildlife conservation on private lands can be found in the Habitat Restoration Team report.

Highest Priority Conservation Actions

Specific conservation actions that pertain to the enhancement of wildlife conservation practices on private lands and were rated "Very High" or "High" in priority are listed below. Information on lead organizations, partners, funding sources and other details for these and other recommended actions can be found in Appendix P.

- Coordinate utilization of and training for implementation of Georgia's Best Management Practices for Agriculture, and improve wildlife conservation guidelines. Provide technical assistance and information to develop a wildlife conservation component for agricultural BMPs that addresses needs and opportunities for wildlife habitat protection.
- Develop habitat-specific management guidelines to address conservation needs of high priority species in each ecoregion of the state, and provide these to landowners and managers.
- Encourage use of prescribed fire as a habitat management tool on private lands. Provide information and technical assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats.
- Assist DNR Private Lands Program biologists with technical support and outreach to private landowners owning significant botanical sites.
- Collaborate on the revision and implementation of the Georgia State Forest Action Plan.

Old Field Habitats

Old-field is a habitat type most often found after abandonment of pastureland or retirement of crop fields. This habitat type includes a meadow stage and a shrub stage depending on the site's physical characteristics, time since abandonment, and disturbance regime. In its early stages, the site is usually in a meadow-like condition and is dominated by grasses and forbs. As the site ages shrubs and small trees become established and it becomes a shrubland. Eventually, in the absence of a disturbance like fire, the site would succeed into a woodland. While man-made, these habitats mimic many of the conditions found in open pine forest, natural grasslands, open shrublands, and savannas, and are used by an extensive array of wildlife species including many of conservation concern (e.g., Northern Bobwhite, Golden-winged Warbler, Loggerhead Shrike). In some cases natural disturbance regimes that would have created habitat for these rare species no longer operate on a landscape-level scale (e.g., fire) and creation, maintenance, and augmentation of man-made old field habitats is necessary to support, or at least enhance populations of many of these species.

Field borders and similar lands created through Farm Bill programs, the Bobwhite Quail Initiative, and similar programs often have these old field characteristics and provide suitable habitat for rare and declining species that in many cases have lost significant portions of their natural habitat. A good example of this is the Northern Bobwhite (quail) that at one time was a very common species throughout the expansive areas of Longleaf Pine-Wiregrass habitat in the Coastal Plain, and also occurred in significant numbers in natural grassland and recently burned areas throughout much of the state. With the loss of the majority of acreage in these habitat types, anthropogenic habitats like old fields have become increasingly important to the well being of quail and many associated species.

While natural habitats are, and should be, emphasized in this plan, man-made habitats such as old fields should also be recognized as important and incorporated into measures used to conserve species of concern when appropriate.

Wildlife Conservation on Public Lands

Public land management to benefit high priority species and habitats is an important complement to conservation efforts on private lands. While only approximately 8% of the state is in public ownership, these public lands serve critical ecological support

National Park Service, U.S. Forest Service) have a specific mandate to conserve native wildlife species and their habitats. In addition, some public agencies whose primary mission is not wildlife conservation (e.g., U.S. Department of Defense) also manage ecologically significant lands containing high priority species and habitats. There is a need for all public land managing agencies to conduct thorough biological inventories of their properties and address wildlife conservation needs in an ecological landscape context. As impacts to natural communities from various land uses continue to mount, collaborative interagency efforts to restore and maintain natural habitats and populations of rare or declining species will be essential to the overall goal of maintaining biological diversity in Georgia. Biological inventory and management efforts conducted in cooperation with private conservation and research organizations will be increasingly important as well.

Highest Priority Conservation Actions

Highest priority conservation actions (actions ranked “Very High” or “High”) that relate to wildlife conservation efforts on public lands are listed below. Information on lead organizations, partners, funding sources and other details for these and other recommended actions can be found in the Conservation Actions table.

- Implement integrated resource management of state lands and waters (fresh, brackish, and salt), emphasizing restoration and maintenance of natural communities and rare species populations (i.e., ecosystem management). Work with other conservation organizations to address regional conservation needs.
- Revise and update management plans for state lands as needed to address specific management objectives for high priority species.
- Survey state-owned lands for federal and state protected species and other species of concern, and incorporate conservation objectives for these species into management plans.
- Continue to implement rare plant restoration, enhancement, and safeguarding program. Identify needs, develop horticultural guidelines, and initiate rare plant propagation efforts. Improve and implement safeguarding protocols and monitor populations.
- Implement integrated resource management of federal lands and waters (including oceanic habitats), emphasizing restoration and maintenance of natural communities and rare species populations. Work with DNR and other conservation organizations to enhance ecosystem functions and address regional conservation needs.
- Develop an adaptive management approach for high priority plants and natural communities on public lands

Assessments of High Priority Habitats and Species

Assessments of the status of high priority species and habitats represent important components of any wildlife conservation strategy. Several high priority research and survey projects relating to species or habitats within a given ecoregion or physiographic province have been mentioned in Section IV of this document. In addition to these projects, there are several highly ranked projects that are statewide in scope or include several ecoregions. These include priorities identified in recovery plans for federally listed species as well as other identified research needs. The highest priority conservation actions identified by the technical teams, Steering Committee, and other stakeholders that pertain to assessments of high priority habitats and species are found below. For more information, refer to the Conservation Actions table.

Highest Priority Conservation Actions

- Conduct assessments of federal petitioned and candidate species, as well as undersampled high priority species not currently under federal review.
- Implement a statewide habitat mapping effort and conduct assessments of rare natural communities and habitats that support species of conservation need.
- Conduct statewide assessments of aquatic communities to determine biotic integrity of streams. Expand biological survey efforts in high priority streams.
- Conduct surveys for rare plants known historically from Georgia.
- Conduct aerial surveys for federally listed birds (bald eagle nesting surveys and wood stork nesting and roosting surveys).
- Monitor populations of gray and southeastern bats in caves, and conduct surveys of high priority forest-roosting bats.
- Conduct midwinter waterbird survey and piping plover winter survey; conduct research and surveys on southeastern red knot and whimbrels; investigate American oystercatcher ecology and demographics
- Continue long-term monitoring of Pigeon Mountain salamander and other cave-inhabiting salamander populations; conduct surveys for other high priority cave and outcrop species.
- Assess the status of high priority bryophytes, lichens, and graminoids in Georgia.
- Evaluate the status and distribution of high priority snails.

Conservation of High Priority Habitats and Species

Wildlife conservation efforts may be focused on protection or management of natural habitat, management of populations, or management of stressors to those populations and habitats. Several important wildlife conservation themes that span ecoregions or apply to the entire Georgia landscape are described below. Other priorities will be identified through periodic assessments of conservation needs based on the best available data.

Restoration and Management of Fire-Maintained Communities

Many of Georgia's rare or declining species depend on habitats that are maintained by fire. These habitats are declining in extent and condition due to fire suppression and/or lack of prescribed fires. Opportunities exist to improve our management of these fire-dependent communities. Among the impediments to wider application of prescribed fire programs are smoke management problems, restrictions on burning due to non-attainment of air quality standards in metropolitan areas, reluctance of landowners to use prescribed fire due to concerns about liability, lack of understanding of the role of fire in some natural environments, and a lack of technical expertise with regard to the application of prescribed fire in some sensitive habitats.

State agencies play a major role in the administration of prescribed fire programs in Georgia. The Georgia Forestry Commission has the primary role in regulating and issuing permits for prescribed fire activities in the state. It is also involved in fighting wildfires and promotes prescribed fire as the key tool in preventing catastrophic wild fire. This agency issues permits for approximately 1,000,000 acres in Georgia each year.

To expand its capacity for prescribed fire programs to benefit natural communities, the Wildlife Resources Division of Georgia DNR has invested state and federal funds to train its staff, members of partner organizations, and volunteers in prescribed burn methods. It has purchased fire equipment, protective gear, and supplies, and has established a roving fire team using trained volunteers from the Student Conservation Association, AmeriCorps, and other organizations. These efforts have resulted in prescribed burns on many thousands of acres of state land annually. The burns are conducted as components of habitat restoration projects involving cultivation and planting of native ground cover species, thinning of pine stands, removal of "off-site" species, and control of invasive exotic species. In addition, the Wildlife Resource Division conducts targeted outreach efforts to increase public awareness of the need for prescribed fires for habitat restoration and management (Georgia Department of Natural Resources 2010).

Other important outreach and advocacy programs are directed by the Georgia Prescribed Fire Council. This organization includes private landowners, land managers, state and federal agencies, and other nongovernmental conservation organizations. Its mission is to advocate for the use of prescribed fire and to promote public understanding of fire as a management tool. The council worked closely with the Georgia Forestry Commission and the Georgia Environmental Protection Division on revised state smoke management plans to help meet the new U.S. EPA air quality standards, and promotes public education, coordination among conservation organizations, and technical assistance for prescribed fire practitioners and legislators. It has facilitated the adoption of resolutions for the use of prescribed fire by the state and nearly all Georgia county governments.

Formed in 2002, the Interagency Burn Team (IBT) serves to coordinate efforts by public and private organizations to implement prescribed fire programs to benefit important habitats and suites of species in the state. Current member organizations include the U.S. Fish and Wildlife Service, The Nature Conservancy, the U.S. Forest Service, the Georgia Forestry Commission, the Georgia Department of Natural Resources, The Orianne Society, and The Longleaf Alliance. Private lands that harbor rare species and are in close proximity to conservation lands are the primary targets for IBT activities. Each agency nominates sites and provides planning and a qualified burn boss for specific prescribed burns.

All IBT burn crews must be certified by standards developed by the National Wildfire Coordinating Group (NWCG). Funding for the project, which covers staff time and firebreak construction, is provided through the USFWS. When weather conditions are right, the nominating agency calls in the IBT to assist in the burning. The nominator is also responsible for monitoring the effects of the fire and the benefits to rare species. A number of high priority habitats have benefited from this cooperative effort to date, including calcareous prairies, montane longleaf pine-hardwood forest, granite outcrops, and longleaf pine-scrub oak woodlands.

To address the need for restoration of fire-maintained communities, Georgia DNR will continue to work with other agencies to share expertise and develop new methods for implementing prescribed fire in various Georgia habitats, encourage fire ecology research by public and private research institutions, and work with the Environmental Protection Division and the Georgia Prescribed Fire Council to provide reasonable burn windows in metropolitan counties. Fire-dependent habitats on all public lands will be identified and addressed in management plans, and additional fire training and equipment should be provided to managers of state parks and other facilities. Finally, financial and technical assistance and educational outreach efforts are needed to encourage restoration of fire-maintained communities on private lands.

<u>Protection of Stream Buffers and Maintenance of Aquatic Habitat Connectivity</u>

Establishment and maintenance of vegetated riparian buffers is one of the most important and cost-effective conservation measures for protection of water quality and aquatic ecosystem health. Many of Georgia's streams suffer from insufficient stream buffers and are thus at risk of water quality impairment resulting from land-disturbing activities, introduction of toxic chemicals or excess nutrients, and thermal impacts from lack of shading. Establishment of substantial vegetated buffers is highly recommended for all high priority streams. Breaches of these stream buffers should be minimized through careful placement of roads, bridges, utility corridors, and livestock crossings. Access to streams by all-terrain vehicles and livestock should be limited to maintain water quality.

Strategies to protect and maintain healthy stream buffers include working with state and county road departments to improve placement and design of road turnouts, developing standards for stream corridor protection on public lands, and providing information on high priority streams to commercial and non-profit mitigation bankers to encourage restoration and enhancement of vegetated buffers. Other strategies include providing financial incentives to private landowners to fence livestock out of streams, working with local governments and developers to ensure protection of stream buffers when development plans are considered, and working with all-terrain vehicles (ATV) manufacturers to develop and disseminate messages discouraging ATV use in and adjacent to streams.

Mitigation of impacts on streams and rivers due to reservoir construction is required under the Clean Water Act. According to this regulation, any impacts must be compensated with restoration, creation, or preservation of similar habitat; however, monitoring and enforcement of mitigation requirements are often inadequate to ensure compliance (Cowie 2002). Growing pressures for additional water supply impoundments and evidence of increasing impacts from water impoundments and withdrawal suggest that a better understanding of cumulative effects of reservoirs of varying sizes and purposes on system-wide processes is needed. Emphasis on multiple approaches (including water conservation) to meet water demands, as well as avoidance of watersheds with rare species and significant natural communities during reservoir site selection, are important considerations for minimizing environmental impacts.

For existing reservoirs, changes in dam operations that incorporate seasonally variable flows, low flow releases, periodic low flows, and aeration of release waters are potential methods to offset downstream impacts. These approaches have been applied to reservoirs in other states and have been evaluated for implementation in Georgia (Collier, Webb, and Schmidt 2000). Replacement of culverts that serve as barriers to fish passage should be an ongoing priority, especially in watersheds with imperiled stream biota. Finally, opportunities for full or partial dam removal to increase connectivity of stream habitats should be prioritized based on potential benefits to high priority aquatic species.

Protection of Isolated Wetlands

Isolated wetlands comprise an important group of habitats for wildlife, including more than 45 Georgia species of conservation concern (Comer et al., 2005). Studies of the extent and condition of isolated wetlands indicate a consistent trend toward degradation and loss. A study of Carolina bays in Georgia indicated that the majority of the smaller bays showed evidence of hydrologic alterations or other forms of degradation (VandeGenachte and Cammack, 2002). Other examples of important isolated wetlands include solution pits on granite outcrops, shallow depressions in pine flatwoods, Grady ponds, limesink ponds, and sandhill ponds. Depression wetlands that have direct connections to groundwater may be significantly affected by excessive groundwater withdrawal to a point at which the hydroperiod is diminished or even eliminated. Other isolated wetlands have been impacted by introduction of predatory fish, excessive inputs of sediments or nutrients, ditching and draining, or conversion to agricultural uses.

It is more accurate to refer to these wetland systems as “geographically isolated” rather than hydrologically isolated, since research indicates that most of these systems are connected to streams or to other wetlands on a periodic basis, or are replenished by or discharge to underground aquifers (Comer et al., 2005). The level of protection for these wetlands under the federal Clean Water Act is currently being contested in the courts, as is the question of what constitutes a “significant nexus” or connection with jurisdictional waters of the U.S. Some provisions of the federal Food Security Act of 1985 provide financial disincentives for destruction of isolated wetlands. However, legal uncertainty over regulatory authority and agency jurisdiction, combined with the relative ease with which these wetlands can be degraded or obliterated provides a compelling case for increased emphasis on protection, restoration, and maintenance of a large number of each size class and habitat type.

Georgia DNR and other organizations should identify and protect the most significant examples of these wetland habitats through fee-simple acquisition or conservation easements. In addition, programs providing financial and other incentives should be directed to private landowners to encourage the protection, restoration, and management of these important wetlands. Finally, permits for groundwater and surface water withdrawals should be administered with careful consideration of resulting impacts to these and other wetlands.

Protection of Headwater Streams

Headwater streams are found in the upper reaches of watersheds and may have flowing water for only a portion of the year. Headwater streams account for the majority of stream miles in a given watershed. Like isolated wetlands, these habitats are important for a wide variety of wildlife species, including several rare species of concern. These headwater systems are also important for maintenance of habitat quality in the higher-order perennial streams which they feed (Meyer et al 2003). Intermittent/ephemeral streams and associated seepage wetlands are often overlooked when streams and wetlands are mapped. In addition, they have received less research emphasis than perennial streams. In areas where development pressures are high or agricultural uses are prevalent, many of these habitats may be adversely affected by land disturbing activities.

Headwater streams are particularly vulnerable to removal or destruction of riparian buffers, and changes in these upper reaches can threaten the biological integrity of entire river networks through disruptions of food webs (Hutchens and Wallace 2002) and elevated stream temperatures (J. L. Meyer et al. 2005, 2007). Protection of headwater streams and associated wetlands is critical for protection of wildlife diversity and maintenance of water quality. Other states have found it useful to map stream networks with more precision than is provided by standard USGS topographic maps, and have found that a large percentage of small streams were either absent on these topographic maps, or were misclassified (e.g., streams shown as intermittent were actually perennial). Greater emphasis should be placed on accurate mapping and delineation of headwater streams (Ohio Environmental Protection Agency 2002). In addition, more research attention should be focused on these relatively unknown aquatic habitats. The effects of groundwater and surface water withdrawals on headwater streams and associated wetlands should be considered, and the overall contribution of these systems to biological diversity in a given watershed should be investigated in greater detail.

Control of Nonnative Invasive Species Populations

There are an estimated 50,000 nonnative species in the U.S., and the number is steadily increasing. Many of these nonnative species represent serious threats to agriculture, horticulture or forestry. Other nonnative species are more likely to impact natural communities and individual populations of native wildlife species. The long-term effects of nonnative species on native wildlife species are generally considered to be second only to direct habitat destruction or conversion. Approximately 42% of the species listed as Endangered or Threatened under the federal Endangered Species Act are significantly impacted by invasive exotic species. On a national basis, the economic losses and environmental damage caused by exotic species total approximately $120 billion per year (Pimentel et al. 2005). A recent survey of managers of 430 national wildlife refuges indicated that 80% of the refuges recognized problems with invasive exotic organisms. Refuge managers reported more than 790 invasive organisms, including 507 nonnative plants, 208 nonnative animals, and 76 plant and animal diseases (Simonson et al. 2004).

Invasive exotic species constitute a significant threat to Georgia's biological diversity. Many native species are declining due to increasing competition or habitat degradation from invasive exotic species. Feral hogs, red shiners, and flathead catfish are examples of animals that can cause serious impacts to natural communities and native species. A great number of exotic plants such as Nepal browntop, hydrilla, Chinese tallow tree, hydrilla water hyacinth, autumn olive, coastal bermudagrass, and Chinese privet also pose serious threats to Georgia's natural communities. A nonnative forest pest in North Georgia, the hemlock wooly adelgid, has caused a drastic decline in eastern hemlock population. Other recent invaders include the emerald ash borer, kudzu bug, and an introduced ambrosia beetle that serves as a vector for laurel wilt disease. Problems with invasive exotic species have been documented on a number of public lands in Georgia, and control measures have been instituted.

Control efforts for invasive species are generally costly and time-consuming, and must be maintained for many years to be successful. Invasive plants must be physically removed or aggressively treated with herbicides. Plants that are dispersed by wind or animals or that have seeds that persist in the soil are particularly difficult to eradicate. Control of feral swine is challenging due to their fecundity and mobility and requires aggressive trapping and shooting programs. Fungal and insect invasions are difficult to contain because they often spread quickly and pervasively in the absence of natural biological controls. Invasive species management requires careful planning and implementation to provide effective control while minimizing impacts to non-target species and surrounding natural communities. It also requires focusing limited resources in areas that are likely to produce the most significant benefits.

The Georgia Invasive Species Task Force, a partnership formalized in 2009 between the Georgia Department of Natural Resources, the Georgia Forestry Commission, the Georgia Department of Agriculture, and the University of Georgia, was established to coordinate monitoring, reporting, control, and education efforts related to non-native invasive species on a statewide basis. More recently, the Coastal Georgia Cooperative Invasive Species Management Area was established. This partnership of public agencies, private organizations, and individuals is focusing attention on the many invasive species in the 11-county coastal region of Georgia, and may serve as the model for similar regional partnerships around the state. Additional funding and other resources are needed for assessment, monitoring, and control of invasive species throughout the state.

Protection of Caves and Other Karst Environments

Caves, limesinks, sagponds, and springs represent some of the most sensitive natural habitats in Georgia. These karst environments harbor many of Georgia's rarest and most imperiled species, and are susceptible to impacts from a wide variety of human activities, from residential and commercial development to road and utility construction, excessive groundwater withdrawal, recreational activities, and altered water quality. Protection of caves and other karst environments is essential for maintenance of Georgia's biological diversity. Georgia's Cave Protection Act of 1977 (O.C.G.A. 12-4-140) provides for protection of caves, sinkholes, and speleothems (cave formations), prohibits the storage of hazardous materials and dumping of litter, garbage, or other materials in caves, and prohibits the harming, killing or removal of wildlife found within caves except by authorized personnel. It also provides protection against trespass and vandalism, and exempts landowners from liability for injuries sustained by individuals involved in recreational or scientific uses of caves.

There are more than 600 documented caves in Georgia, and the majority of these are located on private land. Established caving groups and experienced cave researchers respect the sensitivity of these habitats as well as the rights of property owners. However, some caves receive significant impacts from careless or unethical individuals. In addition, many of Georgia's caves are threatened by off-site land uses that result in inputs of sediments, excess nutrients, or toxins. Only a small percentage of Georgia's caves have received biological surveys. Additional survey efforts are needed to document the diversity of cave organisms in Georgia and to establish conservation priorities for individual caves. Abandoned mines and tunnels can also provide habitat for cave fauna and should be evaluated as well (Tuttle and Taylor 1994).

Since the arrival of white-nose syndrome (WNS) in Georgia in 2013, biologists from DNR, the U.S. Fish and Wildlife Service, and private consulting firms have been conducting surveys for this deadly disease and monitoring populations of bats in caves, crevices, mines and tunnels. This survey and monitoring work must be continued in the coming years to facilitate range-wide assessments of WNS impacts and to inform conservation plans for affected bats.

Restoration or Reintroduction of Wildlife Populations

This is an important but often overlooked aspect of wildlife conservation. In some cases, a species has been nearly or completed extirpated from a region or state, but suitable habitat exists for reintroduction of the species. In other cases, the extirpation was accompanied by a loss of suitable habitat, so habitat restoration is the necessary first step. Examples of species for which restoration/reintroduction is a primary conservation emphasis include Florida torreya, bog turtle, smooth purple coneflower, shoals spiderlily, spotfin chub, robust redhorse, lake sturgeon, Altamaha spinymussel, and Tennessee heelsplitter. These species require special emphasis on habitat protection and maintenance, propagation of individuals, and reintroduction of these individuals into protected habitat. A special case involves extirpated populations of freshwater mussels. For these species, attention must be paid not only to restoration of suitable habitat, but also to management of fish species that serve as hosts to these mussels. In some cases, the host fish(es) may have been eliminated from the watershed, and must be reestablished in order to provide an opportunity for restoration of the mussel populations.

The Georgia Plant Conservation Alliance member organizations coordinate a rare plant safeguarding program that focuses on conservation of the genetic diversity of rare plant populations and augmentation or restoration of these rare plants in appropriate natural habitats. Rare plant propagation projects are prioritized by the conservation status and needs of species and are linked to habitat restoration or enhancement efforts in the field. This group has been highly successful in restoring or reintroducing populations of globally imperiled species in many conservation sites across the state.

Highest Priority Conservation Actions

Specific conservation actions that relate to conservation of high priority habitats and species statewide or over several ecoregions include the following. Information on lead organizations, partners, funding sources and other details for these and other recommended conservation actions can be found in Appendix P.

- Develop a comprehensive action plan to control invasive exotic species on public and private lands. Increase public awareness of problems caused by invasive exotic plants; reduce use of exotic species and increase use of native plants in erosion control and landscaping
- Control populations of feral hogs to conserve high priority habitats and species. Increase hunting pressure on public and private lands and implement trapping and shooting programs in especially sensitive areas (e.g., barrier island beaches).
- Develop a comprehensive action plan to control exotic species on public and private lands. Increase public awareness of problems caused by invasive exotic species; reduce use of exotic plant species and increase use of native plants in erosion control and landscaping.
- Encourage use of prescribed fire as a habitat management tool on private lands. Provide information and technical assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats.
- Maintain a network of facilities (e.g., Atlanta Botanical Gardens, State Botanical Gardens, Coastal Plain Botanical Gardens) for propagation of rare plants and safeguarding of genetic resources.
- Continue efforts to restore and enhance populations of red-cockaded woodpeckers through implementation of the Conservation Plan for demographically isolated RCW populations.

Education, Outreach, and Communications

The health and well-being of Georgia's plants, wildlife, and people depends on the quality and integrity of the environment. Loss, degradation, and fragmentation of habitat are the greatest problems facing fish and wildlife. To effectively protect Georgia's natural heritage, the public must be aware of and engaged in conservation.

More than 400 organizations including private non-profit and for-profit entities, universities and governmental agencies provide environmental education programs for the citizens of Georgia. A statewide network of about 400 environmental educators, the Environmental Education Alliance (EEA) of Georgia, supports these organizations through their annual conference, an outdoor learning symposium, an accredited environmental education certification program, and networking opportunities. EEinGeorgia.org, the online guide to environmental education in Georgia, makes information about environmental education resources readily available. This comprehensive website is a collaborative effort of the Environmental Protection Division (EPD) of the Department of Natural Resources (DNR), the Department of Community Affairs, the Department of Education (DOE) and EEA. It includes EE lesson plans for all grades and subjects based on the state education standards, a searchable directory of EE organizations and their resources, facts about Georgia's environment, and a calendar of EE events.

The SWAP provides an opportunity to: 1) educate the citizens of Georgia about natural communities and the conservation priorities within their ecoregions; and 2) measure the effectiveness of the campaign. These goals can be accomplished by establishing a baseline of knowledge through a wildlife literacy survey, incorporating those findings into SWAP core concepts and messages, identifying and creating teaching resources that target specific audiences, and taking advantage of Georgia's strong and diverse network of environmental educators and other conservation organizations to effectively communicate how we can all play a role in protecting biodiversity. Future surveys and studies can aim to measure the long-term effectiveness of these efforts. The Education Technical Team report is found in Appendix K.

The Outreach and Communications Technical Team identified opportunities and priorities for communication of SWAP themes and ways that the efforts of the Education Team could be amplified through outreach and in-reach activities. This team report is found in Appendix L.

Highest Priority Conservation Actions

Highest priority conservation actions (actions ranked "Very High" or "High") that relate to improvement of SWAP-related education, outreach, and communications include the following. Information on lead organizations, partners, funding sources and other details for these and other recommended actions can be found in Appendix P.

- Assess the current level of Georgia citizens' awareness about native wildlife and wildlife conservation needs.
- Create educational core concepts with key messages that support the main SWAP themes.
- Improve communication of SWAP messages to regional education networks and community groups

- Identify and increase awareness of existing educational materials to facilitate delivery of SWAP conservation messages to the public. Provide resources and promote opportunities to engage people in the outdoors.
- Educate beachgoers and boaters about the plight of beach nesting birds and passage migrants that use Georgia beaches and offshore bars
- Conduct aquatic species outreach in high priority watersheds
- Work with the Education Team as needed to achieve its recommendations. Specifically: 1) Help create an online survey supporting an assessment of Georgians' wildlife conservation literacy; 2) help with the content of core educational concepts, related messaging and educational materials; 3) help identify SWAP stories per ecoregion for use in regional education networks and community groups.
- Promote the conservation actions, themes and goals of the SWAP to five priority stakeholder groups to increase stakeholders' support for wildlife conservation; awareness of the SWAP, its importance, themes and successes; and, awareness of the partnership effort involved.
- Increase awareness of the SWAP among partner organizations. This "in-reach" will mimic communications with the five stakeholder groups but with the focus on SWAP partner organizations. Work with individual partners will identify best ways to reach their staffs on specific messaging.

Increasing Capacity for Wildlife Conservation

The ability of any agency or organization to meet its objectives depends to a large extent on the availability of necessary resources (staff, funding, equipment, etc.). The various conservation objectives outlined in this document will require financial, technical and other resources well in excess of those available to the Georgia Department of Natural Resources and its conservation partners in 2015. For this reason, an assessment of actions related to increasing capacity for wildlife conservation in Georgia is warranted.

By participating in multi-state interagency conservation initiatives, Georgia DNR can help generate additional funding for high priority wildlife conservation projects. An example is the Southeast Aquatic Resources Partnership (SARP), a 13-state regional aquatic conservation partnership involving state and federal agencies as well as nongovernmental organizations. SARP, which focuses on protection, conservation, and restoration of aquatic resources, is considered a regional component of the National Fish Habitat Initiative (NFHI), which began in 2004 under the auspices of the Association of Fish and Wildlife Agencies. Other examples of regional partnerships, such as Landscape Conservation Cooperatives and Bird Joint Ventures, have been described in an earlier section of this chapter.

Regional partnerships are important for coordination of conservation efforts and development of greater capacity to address regional conservation needs. Other important approaches include development of in-state partnerships to share resources and expertise, reallocation of existing staff to address areas of greatest conservation need, and exploration and development of new funding sources. Examples of important in-state partnerships include the Georgia Plant Conservation Alliance, the Interagency Burn Team, and the Coastal Georgia Cooperative Invasive Species Management Area.

One of the most important areas of collaboration for wildlife conservation is land acquisition. Over the past decade, the State of Georgia has acquired approximately 104,000 acres of land, using state appropriations, federal grants, and private donations. Nearly all of these land acquisition projects involved multiple fund sources and conservation partners. Establishment of a long-term, dedicated source of funding at the state level would help ensure that public agencies have an opportunity to protect critically important conservation lands. Similarly, additional funding at the federal level through the State Wildlife Grants, Land and Water Conservation Fund, North American Wetlands Conservation Act, Forest Legacy, Coastal Wetland Grants, and Recovery Land Acquisition Grants programs would provide greater land conservation capacity to state wildlife agencies and other conservation groups.

In addition to fee-simple acquisition (purchase of land with all property rights), effective preservation tools include long-term and permanent conservation easements on private lands. These are voluntary agreements that allow landowners to limit the type or amount of development on their properties or to protect sensitive natural habitats. In recent years, protection of land through conservation easements has increased dramatically in Georgia, in part due to federal and state tax incentive programs. State agencies such as the Georgia Department of Natural Resources and the Georgia Forestry Commission have partnered with land trust organizations and private landowners to protect thousands of acres of land through easements. Currently, more than 250,000 acres in Georgia are protected through conservation easements held by 52 different organizations. Continuation of federal and state incentives for conservation easements is critical for long-term conservation of wildlife habitats on private lands.

Members of the technical teams and other stakeholders provided recommendations regarding improvements in staffing, funding, database development and use, and other issues. Listed below are the highest rated action items relating to development or augmentation of resources needed for conservation of Georgia's wildlife. See the Conservation Actions table in Appendix P for more details.

Highest Priority Conservation Actions

- Strengthen the network of support for wildlife conservation programs and initiatives. Strengthen coalition of environmental organizations to communicate SWAP objectives and work for improvements in policies, funding, and capacity for wildlife conservation.
- Improve biodiversity databases and increase data-sharing with conservation partners. Develop protocol for electronic submission of rare species datasets to WRD. Establish formal data-sharing agreements with UGA and other conservation partners.

- Establish a consistent source of state funding for land protection to support wildlife conservation.
- Increase availability and use of federal funds for land acquisition (fee-simple and conservation easements) and land management.
- Increase state funding to support WRD's nongame wildlife conservation efforts.
- Facilitate DNR Law Enforcement Division officer training to address nongame wildlife law enforcement needs
- Expand DNR Nongame Conservation Section aquatic program so that each major basin in the state has an aquatic species conservation coordinator.
- Improve capacity to work with corporate landowners to protect wildlife habitat; provide enhanced technical support through additional staff or contractors.
- Improve biodiversity databases and increase data sharing with conservation partners. Establish formal data-sharing agreements with conservation partners.

Reducing Impacts from Development and Other Activities

Continued growth of Georgia's human population and associated loss or fragmentation of natural habitats will undoubtedly result in more impacts to native species. Of particular concern are habitat specialist species adapted to rare or sensitive habitats (e.g., cave-dwelling organisms or granite outcrop plants).

Every effort should be made to minimize impacts of development, recreation, and other activities on these organisms and their habitats. The highest rated conservation actions related to reduction or avoidance of impacts from development and other activities on high priority species and habitats are found below. See the Conservation Actions table in Appendix P for more information.

Highest Priority Conservation Actions

- Expand use of WRD biodiversity data for environmental review, public outreach, permitting, and development of site management plans to minimize impacts on rare species and sensitive habitats.
- Work with the Georgia Department of Transportation and federal agencies to minimize impacts from highway construction and facilitate protection and mitigation of high priority habitats.
- Continue working with the Georgia Department of Transportation, Federal Energy Regulatory Commission, and pipeline companies to minimize the impacts to high priority species and habitats from petroleum pipeline development.
- Work with the Bureau of Ocean Energy Management, developers, and regulators to minimize impacts to high priority species and habitats from the exploration and potential development of resources off the coast of Georgia.
- Conserve populations of rare plants in transmission line corridors; maintain or enhance native vegetation for pollinators and migratory birds.

- Reduce impacts of unpaved roads, parking lots, boat ramps, and camping areas on aquatic habitats.
- Implement targeted dam and culvert removal/replacement projects and mitigation projects to restore and conserve stream banks and channels.
- Provide technical assistance to farmers to protect streams in high priority watersheds
- Facilitate training for and compliance with Best Management Practices for erosion and sedimentation control, stormwater runoff, and stream buffer protection.
- Update Georgia Department of Transportation mussel sampling protocol.

Wildlife Laws and Regulations

State and federal laws pertaining to wildlife conservation provide mandates for state and/or federal agencies to protect natural resources for the benefit of society. These include regulations dealing with the conservation of rare species, natural areas, and specific natural habitats (e.g., caves, salt marshes, coastal dunes), regulation of take of game and nongame wildlife (e.g., hunting and fishing regulations, collecting permits), review and permitting of mining, dam construction, groundwater withdrawal, road construction, utility construction, and similar projects; adjustments to land valuation and taxation based on conservation easements; and laws relating to development of local or regional land use plans and greenspace protection plans. During the course of this planning effort, assessments of existing laws, regulations, and policies were made in order to assess the effectiveness of regulatory efforts in conserving Georgia's wildlife diversity. Some species of wildlife are impacted by direct take or commercial harvest, both of which are regulated by state or federal law.

The intent of this assessment was to examine existing laws and regulations and to determine where opportunities to protect biological diversity could be improved by increasing public awareness of existing laws, promoting interagency cooperation in law enforcement, ensuring appropriate consideration of wildlife impacts in environmental review procedures, and utilizing information on rare species and natural communities to inform local or regional land use plans and greenspace protection plans. Several areas of recommended improvement were identified during this assessment. The highest priority items are listed below.

Highest Priority Conservation Actions

Highest priority conservation actions pertaining to the regulatory aspects of wildlife conservation are listed below. Information on lead organizations, partners, funding sources and other details for these and other recommended actions can be found in the Conservation Actions table.

- Update the state-protected species list and work with partners to improve conservation and management of these species. Conduct a review of Georgia's protected species list at least once every five years and engage key partners to improve management programs for these species.

- Enhance DNR Law Enforcement training and staffing to address nongame wildlife law enforcement needs. Provide additional training on laws and regulations established to protect nongame wildlife and additional staff resources to handle enforcement of nongame and protected species regulations.
- Improve coordination of environmental review procedures within DNR to ensure that potential impacts to rare species and sensitive natural habitats are adequately addressed for all major projects.
- Protect high priority species and habitats through the Statewide Water Planning Process
- Propose a list of species to supplement the list of wild animals set forth in Georgia Code for which a permit or license, or both, is required. The list could include non-native invasive species of the pet trade. Suggest recommendations on specific restrictions or guidelines for issuing permits.

Monitoring and Adaptive Management

One of the goals of this effort is development of plans to monitor high priority species and habitats as well as conservation actions for those elements of biodiversity. Monitoring programs are essential in order to assess the success of conservation programs and to facilitate adjustments in these programs to increase their efficacy; this ability to change management options based on an objective assessment of past efforts is known as adaptive management. The types of data needed for this conservation objective pertain to the quantity, distribution, and condition of habitats and populations.

Monitoring is a valuable conservation tool used by researchers, biologists, and conservation practitioners to help detect change or significant occurrences. From the collection of basic qualitative data by conservation site managers to the analysis of large long-term datasets by statisticians, monitoring can shape conservation and management efforts in a positive way. In Georgia, monitoring of species, natural communities, and landscapes has previously taken place at many scales by different conservation agencies and organizations. The efforts of the SWAP Revision Monitoring Technical Team included determining how individuals and groups are currently monitoring in Georgia and identifying ways to improve monitoring in the next five to ten years.

The 2005 SWAP discussed the importance of monitoring specific priority species and habitats. For the 2015 SWAP Revision, the team summarized priority monitoring projects provided by each SWAP Revision taxa technical team and made recommendations on how to improve monitoring in Georgia. The Monitoring Technical Team report is found in Appendix J.

Given the fact that monitoring is both time-consuming and relatively expensive in terms of labor costs, there is a need to place realistic limits on the number of species and habitats monitored. In addition, opportunities to use volunteer and "citizen scientist" groups should be explored. High priority species for monitoring programs will be those that are readily identifiable in discernible populations large enough to be measured or estimated consistently over time. For habitats, the situation is similar but more complex and problematic. Habitats do not conform to a standard taxonomy, and there are relatively few standardized methods for measuring habitat quality. The creation of comprehensive habitat monitoring programs requires participation by a variety of partners, both public and private.

The approach taken in this planning effort has been to incorporate monitoring activities as components of each proposed conservation action. Focal species and habitats are indicated, lead and partner organizations are identified, and funding sources are listed. In addition, the types of data that will be collected and the relevant performance indicators have been described or outlined in this table. More work is needed in order to develop detailed monitoring programs for each conservation action. However, it is apparent from the diverse array of high priority conservation actions identified in this document that monitoring will take place at a variety of geographic and ecological levels and will involve partnerships with a number of organizations.

In addition, the following specific strategies will be employed as appropriate to improve the monitoring aspects of this conservation strategy.

- Strengthen and expand the fire photo monitoring program. Tasks for improvement include: develop efficient software mechanisms to submit, catalogue, view, and quantitatively analyze photos; expand sites to monitor different management types, WMA's, and reference habitats; and incorporate quantitative data into the protocol at high priority sites.
- Create a state-level matrix of conservation actions undertaken by all major conservation partners and use this as a benchmark to document progress toward conservation goals identified in this strategy (see Conservation Actions table)
- Include monitoring components and standards for conservation projects proposed for funding through the State Wildlife Grants program or other funding sources, and ensure that these include objective and measurable performance indicators.
- Improve citizen and volunteer involvement in monitoring projects. Technology should be used to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects. This includes using online tools, social media, and smart-devices to aid training, share protocols, and collect data.
- Conduct monitoring and research on white-nose syndrome.
- Assess populations of high priority terrestrial birds in the Coastal Plain (e.g. swallow-tailed kite, southeastern American kestrel, painted bunting, Henslow's sparrow).
- Continue calling frog survey routes as part of the North American Amphibian Monitoring Program
- Continue efforts by the WRD Stream Survey Team to monitor streams statewide using Index of Biotic Integrity protocols.

Public-Private Partnerships for Land Conservation

More than 90% of the land base of Georgia is in private ownership. Several programs that represent specific efforts to enlist and engage private landowners in wildlife conservation have been mentioned above. Like other wildlife agencies, WRD depends on support from private landowners to accomplish its mandated objectives. Georgia's wildlife cannot be conserved solely through the actions of public agencies, nor can fee simple land acquisition be the "silver bullet" in land conservation.

The Georgia Land Conservation Program provides loans for conservation projects by local governments and administers the Georgia Conservation Tax Credit Program, an incentive program that provides an income tax credit for donations of land or conservation easements. Other opportunities for public-private partnerships in conservation include the use of general obligation bonds to fund certain types of private ventures to protect "working landscapes" (i.e., forestry or agricultural lands) for specific wildlife conservation goals (Dechter, 2003), state leases of private lands for public recreational access, and application of development fees to rural land protection through application of conservation easements or fee simple acquisition. In the field of rare species recovery, Safe Harbor Agreements and Habitat Conservation Plans provide flexibility as well as regulatory relief for private landowners cooperating with public wildlife agencies.

A new area that has provided opportunities for land conservation is the application of federal funds to protect lands adjacent to military bases from development using conservation easements; this can serve a dual purpose of maintaining base operational viability and protecting important wildlife habitat. State wildlife agencies in Georgia North Carolina, South Carolina, and Florida are currently working with U.S. Department of Defense installations to identify potential areas of common interest in land acquisition and uses. Similar programs may be available for lands adjacent to national parks and other public propertie

Maintaining Georgia's Forest Lands

The success of the Georgia SWAP depends on the existence of healthy, well-managed forests. Presently, Georgia has nearly 24 million acres of forestland, 75% of which is owned by thousands of non-industrial private landowners. These landowners manage their forests for a variety of objectives, including timber production, recreation, wildlife habitat, aesthetics, or quite often for a combination of these.

Many factors will determine whether Georgia will continue to have an adequate, sustainable forested environment to support a diverse wildlife population. Landowners and state policy-makers, those who are in a position to protect the state's forested land from conversion to non-forest uses, must have a long-term view when planning for land management and creating statutory and regulatory policy. Today, there are a number of disturbing trends which over time threaten to reduce the state's forestland and thus diminish the number, range and quality of wildlife habitats. Among these trends are the need for new markets for wood and fiber grown on private forestland, corporate divestiture of timber property, global competition, federal estate tax laws, urban and suburban sprawl and ad-valorem tax policy that taxes forest land on its 'highest and best' use rather than its current use. The degree to which these trends are addressed will determine whether many landowners and tree farm families will keep their land in trees, sell them, or convert them to non-forest uses such as commercial developments.

Future Challenges

The changes that are occurring in the Georgia landscape as a result of population growth and increasing development pressures present daunting challenges to those involved in wildlife conservation. The trend of increasing fragmentation and degradation of natural habitats is likely to continue in the coming decades, driven by local, national, and global economic and demographic factors. Many scientists believe that the next fifty years will be a critical period in the struggle to protect our remaining biological resources.

The following elements are critical for conservation of Georgia's natural heritage: (1) increased emphasis on field research focused on the identification and assessment of species, biotic communities, and ecosystems; (2) greater commitment of resources to identify and protect those habitats that contribute most significantly to biodiversity; (3) further development and funding of conservation programs that emphasize public-private partnerships for broad-scale conservation of "working landscapes"; (4) greater emphasis on land use planning to minimize impacts of future developments on natural habitats; and (5) increased collaboration between researchers and educators to heighten public awareness of the magnitude and significance of biodiversity decline in the state. The Department of Natural Resources will continue to work with a wide array of public agencies, private conservation organizations, research institutions, sportsmen's groups, educators, local governments, and landowners in the coming years to address these critical elements of wildlife conservation.

VI. Procedures for SWAP Review and Revision

The State Wildlife Action Plan (SWAP) outlined in the preceding sections reflects an assessment of wildlife conservation needs and recommended programs to address those needs based on data available in 2013-2015. This picture of the conservation needs of Georgia's species and habitats may change based on the result of additional surveys, results of monitoring efforts associated with management efforts, or new trends in land uses. In addition, the development of new analytical techniques, funding programs, or legislative mandates may result in a need to reassess some of the conservation priorities described in this document. The essence of adaptive management is the ability to change priorities and approaches in respond to new information and/or changing conditions.

The intent of the Wildlife Resources Division is to begin a comprehensive review of the current version of the SWAP within the next eight years, and to adopt revisions to the strategy as deemed necessary based on this review. In order to do this, we propose to reconvene the technical teams and advisory committee to assess and address changing conservation needs for species and habitats in Georgia. The procedure for this review is outlined below:

1) Compile updated information on the current status of high priority plants and animals, as well as their associated habitats
2) Revise lists of high priority species based on updated information on status, condition, and distribution
3) Review conservation actions proposed and implemented during the preceding years and assess the effectiveness of these actions
4) Reassess problems affecting high priority species and habitats as well as research and survey needs
5) Reevaluate education, outreach, and monitoring needs
6) Develop revised strategies for high priority species and habitats based on reassessments of conservation needs and opportunities
7) Compile and summarize proposed strategies and submit these to the advisory committee for review and approval
8) Conduct stakeholder meetings as directed by advisory committee
9) Solicit public input via the WRD website and public meetings
10) Complete revision of the wildlife action plan and begin implementation

This comprehensive review and revision process will begin within eight years following the completion of this version of the SWAP, and the various assessments will be completed within one year. The revision of the SWAP will be completed within two years of the start of the assessment, or no later than August 2025. In addition, informal annual assessments will be undertaken to assess changes in funding levels, laws and regulations, successes and failures in species recovery efforts, and new research findings in order to determine what changes, if any, are warranted in implementation of this wildlife conservation strategy.

Acronyms and Abbreviations Used in This Document

AAS	Adopt-A-Stream
ACCG	Association County Commissioners of Georgia
AFT	American Farmland Trust
AFWA	Association of Fish and Wildlife Agencies
AMBUR	Analyzing Moving Boundaries Using R
APHIS	Animal and Plant Health Inspection Service
ATV	All-terrain vehicle
AVM	Avian Vacuolar Myelinopathy
BCI	Bat Conservation International
Bd	*Batrachochytrium dendrobatidis*
BMP	Best Management Practice
BQI	Bobwhite Quail Initiative
BR	Blue Ridge
CCRP	Continuous Conservation Reserve Program
CP	Coastal Plain
CPGL	Conservation of Private Grazing Lands
CRD	Coastal Resources Division
CRP	Conservation Reserve Program
CREP	Conservation Reserve Enhancement Program
CSC	Climate Science Center
CSP	Conservation Security Program
CU	Cumberland Plateau
CUVA	Current Use Valuation of Conservation Use Property
CWCS	Comprehensive Wildlife Conservation Strategy
CWD	Chronic Wasting Disease
DCA	Department of Community Affairs
DNR	Department of Natural Resources
DOD	U.S. Department of Defense
DOE	Georgia Department of Education
DOI	U.S. Department of Interior
EEA	Environmental Education Alliance of Georgia
ECP	Emergency Conservation Program
EO	Element Occurrence
EPA	Environmental Protection Agency
EPD	Environmental Protection Division
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FWHA	Federal Highway Administration
FLEP	Forest Land Enhancement Program
FLP	Forest Legacy Program
FRPP	Farm and Ranch Lands Protection Program
FSA	Farm Services Agency
FSP	Forest Stewardship Program

FWP	Forestry for Wildlife Partnership
GADNR	Georgia Department of Natural Resources
GAP	Gap Analysis Program
GDA	Georgia Department of Agriculture
GEFA	Georgia Environmental Facilities Authority
GEPI	Georgia Environmental Policy Institute
GDNR	Georgia Department of Natural Resources
GDOT	Georgia Department of Transportation
GFA	Georgia Forestry Association
GFC	Georgia Forestry Commission
GIS	Geographic Information System
GMA	Georgia Municipal Association
GMNH	Georgia Museum of Natural History
GNHP	Georgia Natural Heritage Program
GOS	Georgia Ornithological Society
GPC	Georgia Power Company
GPCA	Georgia Plant Conservation Alliance
GRP	Grassland Reserve Program
GSS	Global Significance Score
GSWCC	Georgia Soil & Water Conservation Commission
GWF	Georgia Wildlife Federation
HCP	Habitat Conservation Plan
HUC	Hydrologic Unit Code
IAFWA	International Association of Fish and Wildlife Agencies
IBI	Index of Biotic Integrity
IBT	Interagency Burn Team
JFSP	Joint Fire Science Program
JV	Joint Venture
LCC	Landscape Conservation Cooperative
LCP	Lower Coastal Plain
LiDAR	Light Detection and Ranging
LIP	Landowner Incentive Program
MDL	Multi-District Litigation
MEAG	Municipal Electric Authority of Georgia
MW	Megawatts
NARSAL	Natural Resources Spatial Analysis Laboratory
NCS	Nongame Conservation Section
NESPAL	National Environmentally Sound Agricultural Laboratory
NFHI	National Fish Habitat Initiative
NFWF	National Fish and Wildlife Foundation
NGO	Nongovernmental organization
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NNL	National Natural Landmark
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service

NRCS	Natural Resources Conservation Service
NWCG	National Wildfire Coordinating Group
NWF	National Wildlife Federation
NWNHS	Nongame Wildlife & Natural Heritage Section
OCGA	Official Code of Georgia
ORV	Off-road vehicle
PARC	Partners in Amphibian and Reptile Conservation
PD	Piedmont
PFW	Partners for Fish and Wildlife
PIF	Partners in Flight
PRHSD	Parks, Recreation, and Historic Sites Division
RC&D	Resource Conservation and Development Council
RCW	Red-cockaded woodpecker
ROW	Right-of-Way
RV	Ridge and Valley
SARP	Southeast Aquatic Resources Partnership
SA/RV	Southwestern Appalachians/Ridge and Valley
SCCI	Southeastern Cave Conservancy, Inc.
SCP	Southern Coastal Plain
SCWDS	Southeastern Cooperative Wildlife Disease Study
SEAFWA	Southeastern Association of Fish and Wildlife Agencies
SEARS	Southeastern At-Risk Species Program
SECAS	Southeastern Conservation Adaptation Strategy
SEIA	Solar Energy Industry Association
SEPARC	Southeast Partners in Amphibian and Reptile Conservation
SERDP	Strategic Environmental Research and Development Program
SFD	Snake Fungal Disease
SFI	Sustainable Forestry Initiative
SINERR	Sapelo Island National Estuarine Research Reserve
SIVVA	Standardized Index of Vulnerability and Value
SLAMM	Sea Level Rise Affecting Marshes Model
SP	Southeastern Plains
Strategy	National Fish, Wildlife, and Plants Climate Adaptation Strategy
SWAP	State Wildlife Action Plan
TCF	The Conservation Fund
TGC	The Georgia Conservancy
TDR	Transferable Development Rights
TMDL	Total Maximum Daily Load
TNARI	Tennessee Aquarium Research Institute
TNC	The Nature Conservancy
TPL	Trust for Public Land
UGA	University of Georgia
UCP	Upper Coastal Plain
URTD	Upper Respiratory Tract Disease
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture

USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
VA	Vulnerability Assessments
VSU	Valdosta State University
WHIP	Wildlife Habitat Incentives Program
WINGS	Wildlife Incentives for Nongame and Game Species
WMA	Wildlife Management Area
WNS	White Nose Syndrome
WRD	Wildlife Resources Division
WRP	Wetlands Reserve Program
WSFR	Warnell School of Forest Resources

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APPENDIX A. High Priority Species and Habitat Summary Data

The summary tables on the following pages provide detailed information on the distribution and habitat associations for high priority animal species and high priority plant species identified in the current assessment.

Distribution by Ecoregion

In the following lists, high priority animal species are listed alphabetically within the following groups:

AA = aquatic arthropods
AM = amphibians
BI = birds
FI = fishes
MA = mammals
MO = mollusks
RE = reptiles
TA = terrestrial arthropods

Ecoregions are indicated by the following abbreviations:

SA/RV = Southwestern Appalachians/Ridge & Valley
BR = Blue Ridge
PD = Piedmont
SP = Southeastern Plains
SCP = Southern Coastal Plain

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Distribution of High Priority Animals by Ecoregion

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
AA	Callinectes sapidus	Blue Crab					X
AA	Cambarus coosawattae	Coosawattee Crayfish		X			
AA	Cambarus cryptodytes	Dougherty Plain Cave Crayfish				X	
AA	Cambarus cymatilis	Conasauga Blue Burrower	X				
AA	Cambarus distans	Boxclaw Crayfish	X				
AA	Cambarus doughertyensis	Dougherty Burrowing Crayfish				X	
AA	Cambarus englishi	Tallapoosa Crayfish			X		
AA	Cambarus extraneus	Chickamauga Crayfish	X				
AA	Cambarus fasciatus	Etowah Crayfish	X	X	X		
AA	Cambarus georgiae	Little Tennessee Crayfish		X			
AA	Cambarus harti	Piedmont Blue Burrower			X		
AA	Cambarus howardi	Chattahoochee Crayfish			X		
AA	Cambarus manningi	Greensaddle Crayfish	X				
AA	Cambarus parrishi	Hiwassee Headwaters Crayfish		X			
AA	Cambarus scotti	Chattooga River Crayfish	X				
AA	Cambarus speciosus	Beautiful Crayfish		X			
AA	Cambarus strigosus	Lean Crayfish			X		
AA	Cambarus truncatus	Oconee Burrowing Crayfish				X	X
AA	Cambarus unestami	Blackbarred Crayfish	X				
AA	Cordulegaster sayi	Say's Spiketail				X	X
AA	Distocambarus devexus	Broad River Burrowing Crayfish			X		
AA	Gomphus consanguis	Cherokee Clubtail	X				
AA	Macromia margarita	Mountain River Cruiser		X			
AA	Ophiogomphus australis	Southern Snaketail				X	
AA	Ophiogomphus edmundo	Edmund's Snaketail		X			
AA	Ophiogomphus incurvatus	Appalachian Snaketail	X	X	X		
AA	Procambarus acutissimus	Sharpnose Crayfish			X	X	
AA	Procambarus gibbus	Muckalee Crayfish				X	
AA	Procambarus petersi	Ogeechee Crayfish					X
AA	Procambarus verrucosus	Grainy Crayfish				X	
AA	Procambarus versutus	Sly Crayfish				X	
AM	Ambystoma bishopi	Reticulated Flatwoods Salamander				X	
AM	Ambystoma cingulatum	Frosted Flatwoods Salamander				X	X
AM	Ambystoma tigrinum tigrinum	Eastern Tiger Salamander	X			X	X
AM	Amphiuma pholeter	One-toed Amphiuma				X	
AM	Aneides aeneus	Green Salamander	X	X			
AM	Cryptobranchus alleganiensis	Hellbender	X	X			
AM	Desmognathus auriculatus	Southern Dusky Salamander				X	X
AM	Eurycea aquatica	Brown-backed Salamander	X				

SA/RV = SW Appalachians/Ridge & Valley; BR = Blue Ridge; PD = Piedmont; SP = Southeastern Plains; SCP = Southern Coastal Plain

Distribution of High Priority Animals by Ecoregion

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
AM	Eurycea chamberlaini	Chamberlain's Dwarf Salamander			X	X	
AM	Gyrinophilus palleucus	Tennessee Cave Salamander	X				
AM	Haideotriton wallacei	Georgia Blind Salamander				X	
AM	Lithobates capito	Gopher Frog				X	X
AM	Necturus punctatus	Dwarf Waterdog			X	X	X
AM	Notophthalmus perstriatus	Striped Newt				X	X
AM	Plethodon petraeus	Pigeon Mountain Salamander	X				
AM	Plethodon savannah	Savannah Slimy Salamander					X
AM	Urspelerpes brucei	Patch-nosed Salamander		X	X		
BI	Ammodramus caudacutus	Saltmarsh Sparrow					X
BI	Ammodramus henslowii	Henslow's Sparrow				X	X
BI	Ammodramus maritimus macgillvraii	Seaside Sparrow (Macgillivray's)					X
BI	Ammodramus nelsoni	Nelson's Sparrow					X
BI	Ammodramus savannarum pratensis	Grasshopper Sparrow	X		X	X	
BI	Calidris canutus	Red Knot					X
BI	Charadrius melodus	Piping Plover					X
BI	Charadrius wilsonia	Wilson's Plover					X
BI	Colinus virginianus	Northern Bobwhite	X	X	X	X	X
BI	Coturnicops noveboracensis	Yellow Rail				X	X
BI	Egretta caerulea	Little Blue Heron				X	X
BI	Egretta tricolor	Tricolored Heron				X	X
BI	Elanoides forficatus	Swallow-tailed Kite			X	X	X
BI	Euphagus carolinus	Rusty Blackbird	X	X	X	X	X
BI	Falco peregrinus	Peregrine Falcon			X		X
BI	Falco sparverius paulus	Southeastern American Kestrel				X	X
BI	Gelochelidon nilotica	Gull-billed Tern					X
BI	Grus americana	Whooping Crane	X		X	X	
BI	Grus canadensis pratensis	Florida Sandhill Crane					X
BI	Haematopus palliatus	American Oystercatcher					X
BI	Haliaeetus leucocephalus	Bald Eagle	X	X	X	X	X
BI	Himantopus mexicanus	Black-necked Stilt					X
BI	Ixobrychus exilis	Least Bittern	X		X	X	X
BI	Lanius ludovicianus	Loggerhead Shrike	X		X	X	X
BI	Laterallus jamaicensis	Black Rail			X	X	X
BI	Limnothlypis swainsonii	Swainson's Warbler	X	X	X	X	X
BI	Mycteria americana	Wood Stork				X	X
BI	Numenius phaeopus	Whimbrel					X
BI	Passerina ciris	Painted Bunting				X	X
BI	Peucaea aestivalis	Bachman's Sparrow	X		X	X	X

SA/RV = SW Appalachians/Ridge & Valley; BR = Blue Ridge; PD = Piedmont; SP = Southeastern Plains; SCP = Southern Coastal Plain

Distribution of High Priority Animals by Ecoregion

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
BI	Picoides borealis	Red-cockaded Woodpecker			X	X	X
BI	Protonotaria citrea	Prothonotary Warbler	X		X	X	X
BI	Rallus elegans	King Rail			X	X	X
BI	Rynchops niger	Black Skimmer					X
BI	Setophaga cerulea	Cerulean Warbler		X			
BI	Setophaga kirtlandii	Kirtland's Warbler		X	X		X
BI	Sphyrapicus varius appalachiensis	Appalachian Yellow-bellied Sapsucker		X			
BI	Sternula antillarum	Least Tern					X
BI	Tyto alba	Barn Owl	X	X	X	X	X
BI	Vermivora chrysoptera	Golden-winged Warbler		X			
FI	Acipenser brevirostrum	Shortnose Sturgeon				X	X
FI	Acipenser fulvescens	Lake Sturgeon	X	X			
FI	Acipenser oxyrinchus desotoi	Gulf Sturgeon				X	
FI	Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon			X	X	X
FI	Alosa alabamae	Alabama Shad				X	
FI	Alosa sapidissima	American Shad			X	X	X
FI	Ameiurus serracanthus	Spotted Bullhead			X	X	
FI	Carpiodes velifer	Highfin Carpsucker			X	X	X
FI	Chologaster cornuta	Swampfish				X	X
FI	Cynoscion nebulosus	Spotted Seatrout					X
FI	Cyprinella caerulea	Blue Shiner	X	X			
FI	Cyprinella callitaenia	Bluestripe Shiner		X	X	X	
FI	Cyprinella gibbsi	Tallapoosa Shiner			X		
FI	Cyprinella xaenura	Altamaha Shiner			X		
FI	Elassoma gilberti	Gulf Coast Pygmy Sunfish				X	
FI	Elassoma okatie	Bluebarred Pygmy Sunfish				X	X
FI	Enneacanthus chaetodon	Blackbanded Sunfish				X	X
FI	Erimonax monachus	Spotfin Chub	X				
FI	Erimystax insignis	Blotched Chub		X			
FI	Etheostoma brevirostrum	Holiday Darter		X	X		
FI	Etheostoma chlorobranchium	Greenfin Darter		X			
FI	Etheostoma chuckwachatte	Lipstick Darter			X		
FI	Etheostoma cinereum	Ashy Darter	X				
FI	Etheostoma ditrema	Coldwater Darter	X				
FI	Etheostoma duryi	Blackside Snubnose Darter	X				
FI	Etheostoma etowahae	Etowah Darter	X	X	X		
FI	Etheostoma gutselli	Tuckasegee Darter		X			
FI	Etheostoma parvipinne	Goldstripe Darter			X	X	
FI	Etheostoma rufilineatum	Redline Darter	X	X			
FI	Etheostoma rupestre	Rock Darter	X	X	X		
FI	Etheostoma scotti	Cherokee Darter	X	X	X		
FI	Etheostoma trisella	Trispot Darter	X				
FI	Etheostoma vulneratum	Wounded Darter		X			

SA/RV = SW Appalachians/Ridge & Valley; BR = Blue Ridge; PD = Piedmont; SP = Southeastern Plains; SCP = Southern Coastal Plain

Distribution of High Priority Animals by Ecoregion

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
FI	Fundulus bifax	Stippled Studfish			X		
FI	Fundulus catenatus	Northern Studfish	X				
FI	Hemitremia flammea	Flame Chub	X				
FI	Hiodon tergisus	Mooneye	X				
FI	Hybopsis lineapunctata	Lined Chub	X	X	X		
FI	Hybopsis sp. 9	Etowah Chub	X		X		
FI	Ichthyomyzon bdellium	Ohio Lamprey	X				
FI	Lampetra aepyptera	Least Brook Lamprey	X	X			
FI	Lucania goodei	Bluefin Killifish				X	X
FI	Lythrurus lirus	Mountain Shiner	X	X			
FI	Macrhybopsis sp. 1	Coosa Chub	X	X	X		
FI	Micropterus cataractae	Shoal Bass			X		X
FI	Micropterus chattahoochee	Chattahoochee Bass		X	X		
FI	Micropterus notius	Suwannee Bass				X	
FI	Micropterus sp. cf coosae "Altamaha/Ogeechee"	Undescribed Redeye Bass			X	X	
FI	Micropterus sp. cf coosae "Savannah"	Bartrams Bass		X	X	X	
FI	Moxostoma carinatum	River Redhorse	X	X			
FI	Moxostoma robustum	Robust Redhorse			X	X	X
FI	Moxostoma sp. 2	Sicklefin Redhorse		X			
FI	Notropis ariommus	Popeye Shiner	X				
FI	Notropis asperifrons	Burrhead Shiner	X	X			
FI	Notropis hypsilepis	Highscale Shiner		X	X	X	
FI	Notropis photogenis	Silver Shiner		X			
FI	Notropis scepticus	Sandbar Shiner		X	X		
FI	Noturus eleutherus	Mountain Madtom	X				
FI	Noturus flavipinnis	Yellowfin Madtom	X				
FI	Noturus munitus	Frecklebelly Madtom	X	X	X		
FI	Percina antesella	Amber Darter	X	X	X		
FI	Percina aurantiaca	Tangerine Darter		X			
FI	Percina aurolineata	Goldline Darter		X			
FI	Percina crypta	Halloween Darter		X	X	X	
FI	Percina jenkinsi	Conasauga Logperch	X	X			
FI	Percina kusha	Bridled Darter	X	X	X		
FI	Percina lenticula	Freckled Darter	X	X			
FI	Percina sciera	Dusky Darter	X	X			
FI	Percina smithvanizi	Muscadine Darter			X		
FI	Percina squamata	Olive Darter		X			
FI	Percina tanasi	Snail Darter	X				
FI	Phenacobius crassilabrum	Fatlips Minnow		X			
FI	Phenacobius uranops	Stargazing Minnow	X				
FI	Phoxinus tennesseensis	Tennessee Dace	X				
FI	Pteronotropis euryzonus	Broadstripe Shiner				X	

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Distribution of High Priority Animals by Ecoregion

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FI	Pteronotropis welaka	Bluenose Shiner				X	
FI	Sphryna lewini	Scalloped Hammerhead					X
FI	Typhlichthys subterraneus	Southern Cavefish	X				
MA	Corynorhinus rafinesquii	Rafinesque's Big-eared Bat	X	X		X	X
MA	Eubalaena glacialis	Northern Atlantic Right Whale					X
MA	Geomys pinetis	Southeastern Pocket Gopher				X	X
MA	Lasiurus intermedius	Northern Yellow Bat				X	X
MA	Megaptera novaeangliae	Humpback Whale					X
MA	Mustela nivalis	Least Weasel		X			
MA	Myotis austroriparius	Southeastern Myotis			X	X	X
MA	Myotis grisescens	Gray Myotis	X		X		
MA	Myotis leibii	Eastern Small-footed Myotis	X	X			
MA	Myotis lucifugus	Little Brown Myotis	X	X			
MA	Myotis septentrionalis	Northern Myotis	X	X	X		
MA	Myotis sodalis	Indiana Myotis	X	X			
MA	Neofiber alleni	Round-tailed Muskrat				X	X
MA	Parascalops breweri	Hairy-tailed Mole		X			
MA	Perimyotis subflavus	Tri-colored Bat	X	X	X	X	X
MA	Puma concolor coryi	Florida Panther					
MA	Sciurus niger shermani	Sherman's Fox Squirrel					X
MA	Sorex dispar	Long-tailed or Rock Shrew		X			
MA	Sorex palustris	Water Shrew		X			
MA	Spilogale putorius	Eastern Spotted Skunk	X	X	X	X	
MA	Sylvilagus obscurus	Appalachian Cottontail		X			
MA	Synaptomys cooperi	Southern Bog Lemming		X			
MA	Tamiasciurus hudsonicus	Red Squirrel		X			
MA	Trichechus manatus	Manatee					X
MA	Tursiops truncatus	Atlantic Bottle-nose Dolphin					X
MO	Alasmidonta arcula	Altamaha Arcmussel			X		X
MO	Alasmidonta triangulata	Southern Elktoe				X	
MO	Amblema neislerii	Fat Threeridge					X
MO	Anodontoides radiatus	Rayed Creekshell			X	X	
MO	Campeloma regulare	Cylinder campeloma	X				
MO	Crassostrea virginica	American Oyster					X
MO	Elimia darwini	Pup Elimia				X	
MO	Elimia inclinans	Slanted Elimia				X	
MO	Elimia induta	Gem Elimia				X	
MO	Elimia mutabilis	Oak Elimia			X		
MO	Elimia ornata	Ornate Elimia	X				
MO	Elimia striatula	File Elimia	X	X			
MO	Elimia timida	Timid Elimia				X	
MO	Elliptio arca	Alabama Spike	X				
MO	Elliptio arctata	Delicate Spike	X				

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MO	Elliptio fraterna	Brother Spike					X
MO	Elliptio nigella	Winged Spike			X		X
MO	Elliptio purpurella	Inflated Spike					X
MO	Elliptio spinosa	Altamaha Spinymussel				X	
MO	Elliptoideus sloatianus	Purple Bankclimber					X
MO	Fusconaia masoni	Atlantic Pigtoe				X	
MO	Hamiota altilis	Finelined Pocketbook	X		X		
MO	Hamiota subangulata	Shinyrayed Pocketbook			X		X
MO	Lampsilis cariosa	Yellow Lampmussel					X
MO	Lampsilis straminea	Southern Fatmucket	X		X	X	
MO	Lasmigona holstonia	Tennessee Heelsplitter	X				
MO	Leptoxis foremani	Interrupted Rocksnail	X				
MO	Leptoxis praerosa	Onyx Rocksnail	X				
MO	Marstonia agarhecta	Ocmulgee Marstonia				X	
MO	Marstonia castor	Beaverpond Marstonia					X
MO	Marstonia gaddisorum	Emily's Marstonia				X	
MO	Medionidus acutissimus	Alabama Moccasinshell	X				
MO	Medionidus conradicus	Cumberland Moccasinshell	X				
MO	Medionidus parvulus	Coosa Moccasinshell	X				
MO	Medionidus penicillatus	Gulf Moccasinshell			X		X
MO	Medionidus simpsonianus	Ochlockonee Moccasinshell					X
MO	Medionidus walkeri	Suwannee Moccasinshell					X
MO	Pleurobema decisum	Southern Clubshell	X				
MO	Pleurobema georgianum	Southern Pigtoe	X				
MO	Pleurobema hanleyianum	Georgia Pigtoe	X				
MO	Pleurobema hartmanianum	Cherokee Pigtoe	X				
MO	Pleurobema pyriforme	Oval Pigtoe			X		X
MO	Pleurocera pyrenella	Skirted Hornsnail	X				
MO	Pleurocera showalteri	Upland Hornsnail	X				
MO	Pleurocera vestita	Brook hornsnail	X				
MO	Pleuronaia barnesiana	Tennessee Pigtoe	X				
MO	Ptychobranchus fasciolaris	Kidneyshell	X				
MO	Ptychobranchus foremanianus	Rayed Kidneyshell	X				
MO	Quadrula kleiniana	Suwannee Pigtoe				X	
MO	Somatogyrus alcoviensis	Reverse Pebblesnail			X		
MO	Somatogyrus rheophilus	Flint Pebblesnail				X	
MO	Somatogyrus tenax	Savannah Pebblesnail			X		
MO	Strophitus connasaugaensis	Alabama Creekmussel	X	X			
MO	Toxolasma corvunculus	Southern Purple Lilliput	X				
MO	Toxolasma pullus	Savannah Lilliput					X
MO	Villosa nebulosa	Alabama Rainbow	X	X			
MO	Villosa umbrans	Coosa Creekshell	X				
RE	Caretta caretta	Loggerhead Sea Turtle					X

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RE	Chelonia mydas	Green Sea Turtle					X
RE	Clemmys guttata	Spotted Turtle				X	X
RE	Crotalus adamanteus	Eastern Diamond-backed Rattlesnake				X	X
RE	Dermochelys coriacea	Leatherback Sea Turtle					X
RE	Drymarchon couperi	Eastern Indigo Snake				X	X
RE	Eumeces anthracinus	Coal Skink				X	
RE	Glyptemys muhlenbergii	Bog Turtle		X			
RE	Gopherus polyphemus	Gopher Tortoise				X	X
RE	Graptemys barbouri	Barbour's Map Turtle			X	X	
RE	Graptemys pulchra	Alabama Map Turtle	X				
RE	Heterodon simus	Southern Hognose Snake				X	X
RE	Lepidochelys kempii	Kemp's or Atlantic Ridley					X
RE	Macrochelys temminckii	Alligator Snapping Turtle			X	X	X
RE	Malaclemys terrapin	Diamondback Terrapin					X
RE	Ophisaurus compressus	Island Glass Lizard				X	X
RE	Ophisaurus mimicus	Mimic Glass Lizard				X	X
RE	Pituophis melanoleucus melanoleucus	Northern Pine Snake	X	X	X		
RE	Pituophis melanoleucus mugitus	Florida Pine Snake				X	X
TA	Acronicta albarufa	Albarufan dagger moth				X	
TA	Alloblackburneus troglodytes	Little gopher tortoise scarab beetle				X	X
TA	Amblyomma tuberculatum	Gopher tortoise tick				X	X
TA	Amblyscirtes alternata	Dusky roadside-skipper			X	X	
TA	Amblyscirtes belli	Bell's Roadside-skipper	X		X		
TA	Amblyscirtes carolina	Carolina roadside-skipper	X	X	X		
TA	Amblyscirtes reversa	Reversed roadside-skipper	X	X			
TA	Aphodius aegrotus	A dung beetle				X	X
TA	Aphodius alabama	A dung beetle				X	
TA	Aphodius baileyi	A dung beetle				X	
TA	Aphodius bakeri	A dung beetle				X	
TA	Aphodius dyspistus	A dung beetle				X	X
TA	Aphodius gambrinus	Amber pocket gopher Aphodius beetle				X	
TA	Aphodius hubbelli	A dung beetle				X	X
TA	Aphodius laevigatus	Large pocket gopher Aphodius beetle				X	X
TA	Aphodius pholetus	Rare pocket gopher Aphodius beetle				X	
TA	Aphodius platypleurus	Broad-sided pocket gopher Aphodius beetle				X	
TA	Aphodius tanytarsus	Long-clawed pocket gopher Aphodius beetle				X	

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Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
TA	Aptenopedes apalachee	Apalachee linear-winged grasshopper				X	
TA	Atrytone arogos arogos	Eastern Aragos Skipper				X	
TA	Autochton cellus	Golden-banded skipper	X	X			
TA	Bombus affinis	Rusty-patched bumblebee	X	X	X	X	X
TA	Bombus borealis	Northern amber bumble		X			
TA	Bryophaenocladius chrissichuckorum	Midge (Heggie's Rock)			X		
TA	Callophrys hesselli	Hessell's hairstreak				X	
TA	Callophrys irus	Frosted elfin				X	X
TA	Catocala grisatra	Grisatra underwing moth				X	
TA	Caupolicana electa	Plasterer bee				X	X
TA	Chelyoxenus xerobatis	Gopher tortoise hister beetle				X	X
TA	Chlosyne gorgone gorgone	Gorgone checkerspot				X	
TA	Cicindela nigrior	Autumn tiger beetle				X	
TA	Crossidius grahami	Ohoopee dunes Crossidius beetle				X	
TA	Cyclocosmia torreya	Torreya trap-door spider				X	
TA	Danaus plexippus	Monarch butterfly	X	X	X	X	X
TA	Dorymyrmex bossutus	Sandhills cone ant				X	
TA	Eotettix palustris	Longleaf spur-throated grasshopper				X	
TA	Erora laeta	Early hairstreak	X	X			
TA	Erynnis martialis	Mottled duskywing		X		X	
TA	Euphoria aeusutosa	Pocket gopher flower beetle				X	
TA	Euphydryas phaeton	Baltimore checkerspot	X	X	X		
TA	Euphyes berryi	Berry's Skipper					X
TA	Euphyes bimacula arbogastii	Two-spotted Skipper					X
TA	Euphyes dukesi	Duke's Skipper					X
TA	Euphyes pilatka	Palatka Skipper					X
TA	Fernaldella georgiana	Ohoopee Geometer				X	
TA	Floritettix borealis	A grasshopper				X	
TA	Geopsammodius ohoopee	Ohoopee dunes scarab beetle				X	
TA	Habronattus sabulosus	Jumping spider (Heggie's Rock)			X		
TA	Hesperia attalus slossonae	Dotted skipper				X	
TA	Hesperia meskei	Meske's skipper				X	
TA	Hesperotettix floridensis	A grasshopper				X	
TA	Hypothyce osburni	Osburn's hypothyce				X	
TA	Idia gopheri	Gopher tortoise burrow noctuid moth				X	
TA	Machimus polyphemi	Gopher tortoise robber fly				X	X
TA	Melanoplus acidocercus	A spur-throat grasshopper				X	

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Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
TA	Melanoplus clypeatus	Shield-tailed spur-throat Grasshopper				X	
TA	Melanoplus longicornis	A spur-throat grasshopper			X		
TA	Melanoplus nossi	Noss' spur-throat grasshopper				X	
TA	Melanoplus sp nov 1	A spur-throat grasshopper				X	
TA	Melanoplus sp nov 2	A spur-throat grasshopper				X	
TA	Melanoplus stegocercus	A spur-throat grasshopper				X	
TA	Melanoplus tumidicercus	A spur-throat grasshopper				X	
TA	Mycotrupes cartwrighti	Cartwright's burrowing beetle				X	
TA	Mycotrupes lethroides	Large Mycotrupes				X	
TA	Neonympha areolatus	Georgia Satyr					X
TA	Neonympha helicta	Helicta satyr			X		
TA	Onthophagus polyphemi polyphemi	Onthophagus tortoise commensal scarab beetle				X	X
TA	Pheidole davisi	Pine barrens Pheidole				X	
TA	Phyciodes batesii maconensis	Tawny crescent		X			
TA	Pieris virginiensis	West Virginia White	X	X	X		
TA	Poanes aaroni howardi	Aaron's skipper					X
TA	Polites baracoa	Baracoa skipper				X	
TA	Polygonia faunus	Green comma		X			
TA	Polyphylla donaldsoni	Donaldson's lined june beetle				X	
TA	Problema bulenta	Rare Skipper					X
TA	Satyrium edwardsii	Edwards hairstreak	X	X	X	X	
TA	Satyrium kingi	King's hairstreak					X
TA	Speyeria diana	Diana fritillary	X	X	X		
TA	Sphodros abbotii	Purse-web spider				X	X
TA	Temnothorax_GA_01	Temnothorax new species		X			
TA	Temnothorax_GA_01	Temnothorax new species	X				
TA	Trimerotropis saxatalis	Lichen or rock grasshopper			X		
TA	Zale perculta	Okefenokee zale moth				X	
		Totals	**110**	**89**	**90**	**151**	**120**

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Name	Common Name	SA_RV	BR	PD	SP	SCP
Acmispon helleri	Carolina Trefoil			X		
Aesculus glabra	Ohio Buckeye	X		X		
Agalinis decemloba	Ten-lobed Purple Foxglove	X	X			
Agalinis georgiana	Georgia Purple Foxglove				X	
Agastache nepetoides	Yellow Giant Hyssop	X				
Agastache scrophulariifolia	Purple Giant Hyssop		X			
Allium speculae	Flatrock Onion			X		
Alnus maritima ssp. georgiensis	Georgia Alder	X				
Amelanchier sanguinea	Roundleaf Serviceberry	X	X			
Amorpha georgiana	Georgia Indigo-Bush					X
Amorpha herbacea var. floridana	Florida Leadbush					X
Amorpha nitens	Shining Indigo-Bush			X		
Amorpha schwerinii	Schwerin's Indigo-Bush			X		
Amphianthus pusillus	Pool Sprite, Snorkelwort			X		
Amsonia ludoviciana	Louisiana Blue Star			X		
Anemone berlandieri	Glade Windflower	X		X		
Anemone caroliniana	Carolina Windflower			X		
Arabis georgiana	Georgia Rockcress	X		X		X
Arnoglossum diversifolium	Variable-Leaf Indian-Plantain					X
Arnoglossum sulcatum	Grooved-Stem Indian-Plantain				X	X
Asclepias purpurascens	Purple Milkweed	X				
Asclepias rubra	Red Milkweed				X	
Asplenium heteroresiliens	Morzenti's Spleenwort				X	X
Astragalus michauxii	Sandhill Milkvetch				X	X
Aureolaria patula	Spreading Yellow Foxglove	X				
Balduina atropurpurea	Purple Honeycomb Head				X	X
Baptisia arachnifera	Hairy Rattleweed					X
Baptisia australis var. aberrans	Glade Blue Wild Indigo	X				
Baptisia megacarpa	Bigpod Wild Indigo			X	X	
Berberis canadensis	American Barberry	X	X	X		
Boechera missouriensis	Missouri Rockcress			X		
Brickellia cordifolia	Heartleaf Brickellia				X	X
Buchnera americana	American Bluehearts	X	X			
Calamintha ashei	Ashe’s Wild Savory					
Calamintha sp. nov. (undescribed)	Indian Grave Mountain Wild Savory			X		
Calamovilfa arcuata	Cumberland Sandreed	X				
Calliphysalis carpenteri	Carpenter’s Ground-Cherry					
Calystegia catesbiana ssp. Sericata	Catesby's Bindweed				X	
Carex acidicola	Acid-Loving Sedge		X			
Carex baltzellii	Baltzell's Sedge				X	
Carex biltmoreana	Biltmore Sedge		X	X		
Carex calcifugens	Lime-Fleeing Sedge					X
Carex decomposita	Cypress-Knee Sedge				X	X

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Carex exilis	Meager Sedge				X	
Carex radfordii	Radford's Sedge			X		
Carex thornei	Thorne's Sedge				X	
Carya laciniosa	Shellbark Hickory	X				
Carya myristiciformis	Nutmeg Hickory	X				
Ceratiola ericoides	Rosemary				X	
Chamaecrista deeringiana	Florida Senna				X	
Chamaecyparis thyoides	Atlantic White-Cedar				X	
Chelone cuthbertii	Cuthbert's Turtlehead		X			
Chelone lyonii	Appalachian Turtlehead	X				
Cirsium virginianum	Virginia Thistle			X		
Clematis fremontii	Fremont's Leatherflower	X				
Clematis socialis	Alabama Leather Flower	X				
Coreopsis integrifolia	Ciliate-Leaf Tickseed				X	X
Coreopsis rosea	Pink Tickseed		X			X
Crataegus aemula	Rome Hawthorn	X		X		
Crataegus aprica	Sunny Hawthorn			X	X	
Crataegus mendosa	Albertville Hawthorn	X			X	
Crataegus mollis	Downy Hawthorn	X				
Crataegus triflora	Three-Flower Hawthorn	X			X	
Crocanthemum nashii	Florida Scrub Sunrose					X
Croomia pauciflora	Croomia			X	X	
Croton elliottii	Pondshore Croton				X	
Ctenium floridanum	Florida Orange-Grass					X
Cuscuta harperi	Harper's Dodder			X	X	
Cymophyllus fraserianus	Fraser's Sedge		X			
Cypripedium kentuckiense	Kentucky Ladyslipper				X	
Danthonia epilis	Bog Oat-Grass		X	X		
Delphinium alabamicum	Alabama Larkspur	X				
Desmodium ochroleucum	Cream-Flowered Tick-Trefoil	X			X	
Dicerandra radfordiana	Radford's Dicerandra					X
Dichanthelium hirstii	Hirst Brothers' Panic Grass					
Diplophyllum andrewsii	Andrews' Diplophyllum (Liverwort)		X			
Draba aprica	Open-Ground Whitlow-Grass			X		
Dulichium sp. nov. (unpublished)	Coosa Prairie Threeway Sedge	X				
Eccremidium floridanum	Florida Pygmy Moss					X
Echinacea laevigata	Smooth Purple Coneflower			X		
Echinacea simulata	Prairie Purple Coneflower	X				
Eleocharis wolfii	Spikerush			X		
Elliottia racemosa	Georgia Plume				X	X
Eriocaulon koernickianum	Dwarf Pipewort			X		
Eriochloa michauxii var. michauxii	Michaux's Longleaf Cupgrass					X
Eriophorum virginicum	Tawny Cottongrass				X	X

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Euphorbia purpurea	Glade Spurge		X			
Eurybia avita	Alexander’s Rock Aster					
Eurybia jonesiae	Piedmont Bigleaf Aster			X		
Eustachys floridana	Florida Finger Grass				X	
Evolvulus sericeus var. sericeus	Creeping Morning-Glory					X
Fimbristylis brevivaginata	Flatrock Fimbry			X		
Fimbristylis perpusilla	Harper's Fimbry				X	
Forestiera godfreyi	Godfrey's Wild Privet					X
Forestiera segregata var. segregata	Florida Wild Privet					X
Fothergilla gardenii	Dwarf Witch-Alder			X	X	X
Fothergilla major	Large Witch-Alder		X			
Frullania appalachiana	Appalachian Frullania		X			
Gentianopsis crinita	Fringed Gentian		X			
Glandularia bipinnatifida var. bipinnatifida	Dakota Vervain				X	
Gymnoderma lineare	Rock Gnome Lichen		X			
Habenaria quinqueseta	Michaux's Orchid				X	X
Hamamelis ovalis	Bigleaf Witch-Hazel				X	
Hartwrightia floridana	Hartwrightia					X
Helenium brevifolium	Bog Sneezeweed				X	
Helianthus glaucophyllus	Whiteleaf Sunflower		X			
Helianthus smithii	Smith's Sunflower		X	X		
Helianthus verticillatus	Whorled Sunflower	X				
Helodium blandowii	Blandow's Feather Moss		X			
Helonias bullata	Swamp-Pink		X			
Hydrastis canadensis	Goldenseal	X	X	X		
Hymenocallis coronaria	Shoals Spiderlily			X		
Hymenophyllum tayloriae	Taylor’s Filmy Fern					
Hypericum adpressum	Bog St. Johnswort				X	
Hypericum erythraeae	Georgia St.-John's-Wort				X	X
Hypnum cupressiforme var. filiforme	Filiform Cypress-Moss		X			
Illicium floridanum	Florida Anise-Tree				X	
Isoetes boomii	Boom's Quillwort				X	
Isoetes flaccida	Florida Quillwort				X	
Isoetes hyemalis	Winter Quillwort				X	
Isoetes junciformis	Rush Quillwort				X	
Isoetes melanospora	Black-Spored Quillwort			X		
Isoetes tegetiformans	Mat-Forming Quillwort			X		
Isotria medeoloides	Small Whorled Pogonia		X			
Jamesianthus alabamensis	Jamesianthus	X				
Juglans cinerea	Butternut	X	X	X		
Juniperus communis var. depressa	Ground Juniper			X		
Justicia angusta	Narrowleaf Water-Willow				X	X
Kalmia carolina	Carolina Bog Myrtle		X		X	

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Lachnocaulon beyrichianum	Southern Bog-Button				X	X
Leavenworthia exigua var. exigua	Least Gladecress	X				
Leiophyllum buxifolium	Sand-Myrtle		X			
Leitneria floridana	Corkwood				X	X
Lejeunea blomquistii	Blomquist's Lejeunea		X			
Liatris tenuifolia var. quadriflora	Florida Narrowleaf Blazing Star				X	
Lilium canadense	Canada Lily	X	X	X		
Lilium michiganense	Michigan Lily	X				
Lilium philadelphicum	Wood Lily	X				
Lilium pyrophilum	Pineland Lily				X	
Lindera melissifolia	Pondberry				X	X
Lindera subcoriacea	Bog Spicebush				X	
Liparis loeselii	Fen Orchid		X			
Litsea aestivalis	Pondspice				X	X
Lobelia boykinii	Boykin’s Lobelia					
Ludwigia spathulata	Creeping Smallflower Seedbox					
Lycium carolinianum	Carolina Wolfberry					X
Lysimachia fraseri	Fraser's Loosestrife	X	X	X		
Lythrum curtissii	Curtiss' Loosestrife				X	
Macbridea caroliniana	Carolina Bogmint				X	
Macranthera flammea	Bog Flameflower				X	
Malaxis spicata	Florida Adders-Mouth Orchid				X	X
Marshallia mohrii	Coosa Barbara's-Buttons	X				
Marshallia trinervia	Broadleaf Barbara's-Buttons	X				
Matelea alabamensis	Alabama Milkvine				X	X
Matelea floridana	Florida Milkvine				X	
Megaceros aenigmaticus	Headwaters Hornwort		X			
Monotropsis odorata	Sweet Pinesap		X	X		
Morella inodora	Odorless Bayberry				X	
Najas filifolia	Narrowleaf Naiad				X	
Nestronia umbellula	Indian Olive			X	X	
Neviusia alabamensis	Alabama Snow-Wreath	X				
Oncophorus raui	Rau's Oncophorus Moss		X			
Onosmodium molle ssp. occidentale	Western Marble-Seed	X				
Oxypolis canbyi	Canby's Dropwort				X	
Oxypolis ternata	Savanna Cowbane				X	X
Packera millefolia	Blue Ridge Golden Ragwort		X			
Panax quinquefolius	American Ginseng	X	X	X	X	
Panax trifolius	Dwarf Ginseng		X			
Paronychia virginica	Yellow Nailwort			X		
Pedicularis lanceolata	Swamp Lousewort		X			
Pediomelum piedmontanum	Dixie Mountain Breadroot			X		
Philadelphus pubescens	Hairy Mockorange	X				

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Distribution of High Priority Plants by Ecoregion

Name	Common Name	SA_RV	BR	PD	SP	SCP
Pinguicula primuliflora	Clearwater Butterwort				X	
Pityopsis oligantha	Few-Flowered Golden-Aster				X	
Plagiochila caduciloba	Brittle-Lobed Leafy Liverwort		X			
Plagiochila floridana	Florida Leafy Liverwort				X	
Plagiochila sharpii	Sharp's Leafy Liverwort		X			
Plagiomnium carolinianum	Carolina Wavy-Leaf Moss		X			
Plantago sparsiflora	Pineland Plantain				X	X
Platanthera blephariglottis	Small White Fringed Orchid					X
Platanthera chapmanii	Chapman's Fringed Orchid					X
Platanthera conspicua	Large White Fringed Orchid				X	X
Platanthera flava var. herbiola	Pale Green Orchid		X			
Platanthera grandiflora	Large Purple Fringed Orchid		X			
Platanthera integra	Yellow Fringeless Orchid				X	X
Platanthera integrilabia	Monkeyface Orchid	X	X	X		
Platanthera peramoena	Purple Fringeless Orchid		X			
Platyhypnidium pringlei	Pringle's Platyhypnidium		X			
Pohlia rabunbaldensis	Rabun Bald Feather-Moss		X			
Polymnia laevigata	Tennessee Leafcup	X				
Portulaca biloba	Grit Portulaca				X	X
Portulaca umbraticola ssp. coronata	Wingpod Purslane			X		
Pteroglossaspis ecristata	Wild Coco				X	X
Ptilimnium ahlesii	Coastal Bishopweed					X
Ptilimnium nodosum	Harperella			X	X	
Quercus oglethorpensis	Oglethorpe Oak			X		
Quercus similis	Swamp Post Oak	X	X			X
Rhexia aristosa	Awned Meadowbeauty				X	
Rhexia salicifolia	Willowleaf Meadowbeauty				X	
Rhododendron eastmanii	May Pink Azalea				X	
Rhododendron prunifolium	Plumleaf Azalea				X	
Rhus michauxii	Dwarf Sumac			X		
Rhynchospora breviseta	Short-Bristle Beakrush				X	X
Rhynchospora crinipes	Bearded Beakrush				X	
Rhynchospora culixa	Georgia Beakrush				X	
Rhynchospora decurrens	Decurrent Beakrush				X	X
Rhynchospora fernaldii	Fernald's Beakrush					X
Rhynchospora harperi	Harper’s Beakrush					
Rhynchospora macra	Many-Bristled Beakrush					X
Rhynchospora pleiantha	Clonal Thread-Leaved Beakrush				X	X
Rhynchospora punctata	Spotted Beakrush				X	X
Rhynchospora solitaria	Solitary Beakrush				X	
Rhynchospora thornei	Thorne's Beakrush	X			X	
Rudbeckia auriculata	Swamp Black-Eyed Susan					
Rudbeckia heliopsidis	Little River Black-Eyed Susan	X				

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Distribution of High Priority Plants by Ecoregion

Name	Common Name	SA_RV	BR	PD	SP	SCP
Ruellia noctiflora	Night-Blooming Wild Petunia					X
Sabatia capitata	Cumberland Rose Gentian	X		X		
Sageretia minutiflora	Climbing Buckthorn				X	X
Sagittaria secundifolia	Little River Water-Plantain	X				
Salix floridana	Florida Willow				X	
Sanguisorba canadensis	Canada Burnet		X			
Sapindus saponaria var. marginatus	Soapberry					X
Sarracenia leucophylla	Whitetop Pitcherplant				X	
Sarracenia oreophila	Green Pitcherplant		X			
Sarracenia psittacina	Parrot Pitcherplant				X	X
Sarracenia purpurea var. montana	Mountain Purple Pitcherplant		X			
Sarracenia purpurea var. venosa	Lowland Purple Pitcherplant				X	
Sarracenia rubra aff. gulfensis	Sweet Pitcherplant				X	
Sarracenia rubra ssp. rubra	Sweet Pitcherplant					X
Schisandra glabra	Bay Starvine			X	X	
Schoenolirion albiflorum	White Sunnybell					X
Schoenoplectus erectus ssp. raynalii	Raynal's Bulrush				X	
Schoenoplectus etuberculatus	Clearwater Bulrush				X	
Schwalbea americana	Chaffseed			X	X	
Scutellaria altamaha	Altamaha Skullcap				X	X
Scutellaria mellichampii	Mellichamp's Skullcap				X	X
Scutellaria montana	Large-Flower Skullcap	X				
Scutellaria ocmulgee	Ocmulgee Skullcap					
Sedum nevii	Nevius' Stonecrop			X		
Sedum pusillum	Granite Stonecrop, Puck's Orpine			X		
Shortia galacifolia	Oconee Bells		X			
Sibbaldiopsis tridentata	Three-Toothed Cinquefoil		X			
Sideroxylon macrocarpum	Ohoopee Bumelia				X	X
Sideroxylon thornei	Swamp Buckthorn					X
Silene ovata	Mountain Catchfly		X		X	
Silene polypetala	Fringed Campion			X	X	
Silene regia	Royal Catchfly	X				
Silphium mohrii	Cumberland Rosinweed	X				
Sium floridanum	Florida Water-Parsnip				X	
Solidago arenicola	Black Warrier Goldenrod	X				
Solidago simulans	Cliffside Goldenrod		X			
Spiraea latifolia	Broadleaf Bog Meadowsweet		X			
Spiraea virginiana	Virginia Spirea	X				
Spiranthes floridana	Florida Ladies-Tresses					X
Spiranthes longilabris	Giant Spiral Ladies-Tresses				X	
Spiranthes magnicamporum	Great Plains Ladies-Tresses	X				
Sporobolus pinetorum	Pineland Dropseed					X
Sporobolus teretifolius	Wire-Leaf Dropseed				X	X

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Distribution of High Priority Plants by Ecoregion

Name	Common Name	SA_RV	BR	PD	SP	SCP
Stachys hyssopifolia var. lythroides	Tallahassee Hedge-Nettle				X	
Stewartia malacodendron	Silky Camellia			X	X	X
Stokesia laevis	Stokes Aster				X	
Streptopus lanceolatus var. lanceolatus	Rosy Twisted-Stalk		X			
Symphyotrichum georgianum	Georgia Aster	X	X	X	X	
Teloschistes exilis	Slender Orange Bush Lichen				X	
Tephrosia mohrii	Dwarf Goat's-Rue				X	
Thalictrum cooleyi	Cooley's Meadowrue				X	
Thalictrum coriaceum	Appalachian Meadowrue		X			
Thalictrum debile	Trailing Meadowrue	X				
Thaspium pinnatifidum	Cutleaf Meadow-Parsnip	X				
Thermopsis fraxinifolia	Ash-Leaved Bush-Pea	X	X			
Thermopsis villosa	Carolina Golden Banner	X	X			
Torreya taxifolia	Florida Torreya				X	
Tridens carolinianus	Carolina Redtop				X	
Trillium decipiens	Mimic Trillium				X	
Trillium persistens	Persistent Trillium		X	X		
Trillium pusillum	Least Trillium	X				
Trillium reliquum	Relict Trillium			X	X	
Trillium sp. nov. (unpublished)	Amicalola Trillium		X			
Trillium sp. nov. (unpublished)	Lookout Mountain Toadshade	X				
Trillium sp. nov. (unpublished)	Southern Decumbent Trillium			X	X	
Triphora trianthophora	Three-Birds Orchid		X	X		
Tsuga caroliniana	Carolina Hemlock		X			
Veratrum woodii	Ozark Bunchflower	X		X	X	
Verbesina walteri	Carolina Crownbeard				X	
Viburnum bracteatum	Limerock Arrowwood	X				
Viburnum rafinesquianum var. affine	Downy Arrowwood			X		
Waldsteinia lobata	Piedmont Barren Strawberry		X	X	X	
Xerophyllum asphodeloides	Eastern Turkeybeard	X		X		
Xyris drummondii	Drummond's Yellow-Eyed Grass				X	X
Xyris scabrifolia	Harper's Yellow-Eyed Grass			X	X	X
Xyris tennesseensis	Tennessee Yellow-Eyed Grass	X		X		
	Totals	**65**	**66**	**66**	**118**	**68**

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HIGH PRIORITY HABITATS BY ECOREGION

The following definitions are based on input from the habitat restoration & historic vegetation technical teams, members of the ecosystem and species technical teams, and information from Wharton (1978) and Mirarchi et al. (2004).

SOUTHWESTERN APPALACHIANS/RIDGE & VALLEY ECOREGIONS

Acidic Meadows Over Sandstone or Shale
Open, grassy habitats over shallow acidic soils; edaphic factors control species composition and diversity. May be moist or dry, depending on topographic setting. These small patch habitats are relatively rare in Georgia.

Calcareous Flatwoods (Hardwood Flats)
Relatively open, flat, shallowly and seasonally wet forested habitats dominated by hardwoods and including rare or uncommon species such as nutmeg hickory and Alabama leatherflower. Shrub and herb diversity is high. A small patch habitat restricted to low-lying areas with clayey calcareous soils.

Calcareous Prairies (Coosa Valley Prairies)
Open grass- and forb-dominated communities over clayey calcareous soils that inhibit growth of woody species. Groundlayer plant species diversity is high, and includes disjunct from midwestern prairies. Includes wet and dry prairie subtypes. These habitats require periodic fire for maintenance.

Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

Caves, Rock Shelters, Talus Slopes
These habitats share certain structural characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. They are typically embedded in a larger matrix of forest habitats. Caves are unique in their lack of sunlight and vegetation and dependence on outside materials for energy flows. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes.

Forested Limestone Slopes and Terraces
This forest type is found at middle elevations along Lookout and Pigeon Mountain. Characterized by submesic hardwood forest, with species composition dependent on aspect and slope position. Includes partially forested limestone ledges along streams.

High Gradient First- and Second-Order Streams
Small, clear, cold, tumbling streams with bedrock riffles and sandy pools. Found at higher elevations and upper ends of steep ravines and slopes. These streams typically experience wide seasonal variations in flow; some receive substantial input from groundwater.

Limestone Glades and Barrens (Cedar Glades)
Open habitats dominated by grasses or forbs, with scattered eastern redcedars and other trees. These habitats contain a large number of endemic plant species. Glades occur on thin, rocky soils, and are

typically dominated by forbs; barrens are in areas with deeper soils and are dominated by grasses. The largest and most important area of cedar glades/barrens in Georgia is centered on Chickamauga-Chattanooga National Military Park.

Mesic Hardwood Forests
Mesic forests of bluffs, ravines, and colluvial flats, characterized by a diverse canopy of hardwood species such as yellow poplar, black cherry, white oak, shagbark hickory, northern red oak, bigleaf magnolia, sugar maple, and American beech. Hemlock and loblolly pine may be minor components in some areas. Mature examples are characterized by a rich understory of shrubs and herbaceous plants. This large patch habitat includes a rich mesic hardwood forest subtype found on calcareous soils.

Medium to Large Rivers
Lower gradient streams of valley bottoms, characterized by sandy, silty, or gravelly substrates. Typically surrounded by agricultural lands on the broad, fertile floodplains. Nearly all examples of large river floodplain forest in the Ridge & Valley region have been converted to other types of land cover.

Montane Longleaf Pine-Hardwood Forests
Dry forests composed of longleaf pine and mixed hardwood species, including mountain chestnut oak, southern red oak, and various scrub oaks. Significant examples occur in the Ridge & Valley region near Rome. Nearly all Georgia examples are fire-suppressed and exhibit lower species diversity than corresponding habitats in Alabama.

Oak Woodlands
An uncommon subxeric vegetation type found at higher elevations, oak woodlands are usually surrounded by xeric pine or pine-oak forest. Canopy dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, with persimmon, blackgum, and other hardwood species. Probably maintained by a combination of infrequent fire and edaphic factors. Pigeon and Lookout Mountain contain good but narrow ecotonal examples.

Pine-Oak Woodlands and Forest
Relatively open subxeric to xeric forest or woodland, typically dominated by shortleaf pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. May also include chestnut oak, scarlet oak, and other dry-site hardwood species. Includes typical shortleaf pine-post oak woodlands as well as mixed pine-oak scrub and dry pine-oak forest.

Red Maple/Blackgum Swamps
Nonalluvial or small stream swamp forests dominated by red maple and swamp blackgum. Often found along small low-gradient streams, in shallow depressions, or on wet flats. Often boggy, with a layer of peat, these wetlands have been impacted by construction of drainage ditches.

Sagponds (Isolated Depressional Wetlands)
Depressions formed by subsidence of soil due to groundwater percolation in the underlying rock. Contain a variety of vegetation types from freshwater emergents to swamp forest, depending on hydroperiod and other factors. Forested types are usually dominated by willow oak, swamp blackgum, and red maple. May include disjunct coastal plain species.

Sandstone Barrens and Outcrops
This edaphic habitat type includes sandstone boulders and outcrops of the Appalachian (Cumberland) Plateau as well as scoured sandstone ledges near streams. These open, rocky habitats are typically bordered by Virginia and shortleaf pine, chestnut oak, and a variety of shrubs.

Springs and Spring Runs; Gravelly Seeps
Springs are highly localized points of groundwater discharge that typically feed spring runs, while seeps may be broader or less defined areas of perennial or seasonal flows. The Ridge & Valley region contains a number of high-discharge springs. The waters of springs and associated habitats can be highly variable, depending on hydrology. These perennially cool and clear waters provide important habitat to a number of animal species, particularly salamanders and fish such as the coldwater darter.

Streams
Moderate to low gradient streams running through lower coves and valleys. Riffle, pool, and shoal habitats may be present. Substrates include gravel, pebbles, boulders, and bedrock. Aquatic plants may also be present. Pools are often silt-bottomed. These streams become turbid after rain. These are generally more productive than headwater streams because of limestone valley bottoms.

Underground Streams
Includes streams of all sizes flowing through caves and other underground passages. These aquatic systems are important for rare species such as the Southern cavefish and Tennessee cave salamander.

BLUE RIDGE ECOREGION

Boulderfield Forests
High elevation mesic hardwood forest; dominated by broadleaf deciduous trees, occupying north-facing areas with angular rocks or blocks of rock and little visible soil. Includes rich flora with northern affinities. Typically very mesic, with trees such as yellow buckeye, sweet birch, yellow birch, rosebay rhododendron. A rare community of the Blue Ridge; only a few examples are known.

Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most examples in this ecoregion are small and fire-suppressed.

Caves, Rock Shelters, Talus Slopes
These habitats share characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. These habitats are usually embedded in a larger matrix of forest habitats. The Blue Ridge contains relatively few caves; these are typically fracture-type caves rather than solution caves. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes.

Floodplain Hardwood Forests
Forested wetlands characterized by a diverse association of deciduous hardwood trees, including both montane and low-elevation species. Generally lacking in the more flood-adapted oaks and hickories

prevalent in Piedmont bottomland hardwood forests. Many of these floodplain forests were converted to agricultural uses early in the history of settlement of this region.

Hemlock-Hardwood-White Pine Forests
Mesic and submesic forests dominated by a mixed canopy of hardwoods and hemlock and/or white pine. Hemlock forests are typically found along small to medium streams, in sheltered valleys and ravines. Thickets of rhododendron and mountain laurel frequently form a dense understory, which is important for many neotropical migratory birds. White pine may share dominance with oak-dominated forests in low- to mid-elevation slopes and sheltered low ridges. A serious threat to this forest type is the hemlock wooly adelgid, which is spreading from east to west across the region. A rare subtype of this forest type containing Carolina hemlock is found in scattered locations in the lower Blue Ridge.

High-Elevation Early Successional Habitats
Includes a variety of vegetation types found at high elevations that are maintained by periodic natural or anthropogenic disturbance. Many high priority species are dependent on this habitat type, including the golden-winged warbler, Appalachian Bewick's wren, star-nosed mole, pygmy shrew, and fringed gentian.

High Elevation Forested Heath Thickets
High elevation habitats characterized by dense thickets of ericaceous shrubs under an open canopy of hardwood trees. Herbaceous layer is sparse to patchy. Typical shrubs include huckleberry, mountain laurel, and rosebay rhododendron.

High Elevation Rocky Summits and Shrub Balds
These are small patch habitats typically found only on the highest peaks of the Blue Ridge in association with northern hardwood forest. Characterized by a mosaic of exposed rock and patches of shrub or herb-dominated vegetation. Trees are mostly dwarfed northern red oak. Shrubs may include Catawba rhododendron, mountain laurel, huckleberry, mountain ash, viburnum, and hawthorn.

Low Elevation Seepy Thickets and Wet Woods
Seasonally inundated or spring-fed wetland habitats. Thickets are dominated by a variety of shrubs. Includes forested habitats along seepage slopes and at the edge of mountain bogs, some of which are maintained by the actions of beaver.

Medium to Large Rivers
Moderate to high gradient rivers with cold, clear riffles, pools, and runs. Substrates may include boulders, bedrock, gravel, and pebbles. Many of these rivers traverse steep gorges. These aquatic habitats are low in productivity compared to streams of the Southwestern Appalachians/Ridge & Valley.

Mixed Pine-Hardwood Forests
Mesic to submesic forests of hardwoods and pines, typically at middle to low elevations over a broad range of topographic conditions. A large patch habitat that comprises a major forest type of the Blue Ridge. Dominants may include yellow-poplar, sweetgum, various oaks, and loblolly, white, and/or shortleaf pine.

Moist Cliff Faces and Spray Cliffs

Vertical to gently sloping rock faces located adjacent to waterfalls or seepage zones. These are wetlands dominated by mosses, liverworts, vascular herbs, and sparse shrubs or scrubby trees adapted to thin soils and high humidity. These small patch habitats represent unusually stable environments, where temperatures are moderated by the constant spray or seepage. Include many bryophytes and ferns representing disjunct occurrences from tropical regions as well as Southern Appalachian endemics.

Mountain Bogs and Wet Meadows

A mosaic of wetland communities usually dominated by shrubs or emergent herbs, with scattered trees. May occur as elongate bands along stream valleys, or in much smaller and more compact patches on flats or slopes. Includes wetlands maintained by beaver activity as well as small, sheltered seepage areas along the headwaters of mountain creeks.

Northern Hardwood Forests

High elevation mesic forests found in upper coves, flats and slopes with northerly aspects, usually at elevations above 3,500 ft. Dominant canopy species include American beech, yellow birch, sugar maple, and yellow buckeye, with white basswood, northern red oak, white ash, and black cherry also present. These forests are subject to broad scale disturbances such as ice storms. Old growth examples are rare and usually restricted to steeply sloped, inaccessible areas.

Oak Forest and Woodlands

This vegetation type includes a wide variety of upland forests dominated by Appalachian oaks. Composition and complexity of oak forests vary with elevation, slope and moisture. In more mesic sites, canopy dominants may include red oak, white oak, and black oak, along with hickories and mesophytic hardwoods. Canopy dominants of more xeric sites may include mountain chestnut oak, scarlet oak, southern red oak, and northern red oak. Also includes subxeric or xeric oak woodlands found on ridges and upper slopes at high elevations. These oak-dominated forests and woodlands represent the most extensive upland vegetation type of the Blue Ridge.

Pine-Oak Woodlands and Forest

Relatively open subxeric forest to xeric woodland, typically dominated by shortleaf pine, pitch pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. A rare subtype is found on serpentine soils. Pitch pine, Virginia pine, red maple and post oak are the dominant canopy trees in this rare community; understory trees of sourwood, dogwood and sassafras are usually thinly scattered and shrubs are sparse to dense.

Rich Mesic Hardwood Forests (Cove Hardwoods)

The mixed mesophytic hardwood forests of the Southern Appalachians are the most biologically diverse habitats in the United States. Variations of this forest type can be found in the Blue Ridge at elevations from 1,000 to 3,800 ft. They are typically found in mesic sites on concave landforms and ravines, or on protected north and east-facing slopes at low elevations. A diverse mixture of mesophytic trees dominates the canopy, including yellow poplar, white basswood, sugar maple, yellow and sweet birch, cucumber magnolia, yellow buckeye, black cherry, eastern hemlock, white ash, blackgum, American beech, red maple, and various oaks and hickories.

Rocky Bluffs and Streambanks

Plant composition of these rocky streamside habitats is variable, depending on stream size, amount of rock, and extent of flooding. These periodically scoured rocky habitats typically support few trees and sparse to moderate shrubs (sometimes thickets). A diverse stratum of light-loving herbs may be present.

Springs and Spring Runs; Gravelly Seeps
Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. These cool clean waters provide important habitat to a number of animal species, particularly salamanders.

Streams
Cold, clear, high gradient streams typically containing riffles, plunge-pools, cascades, and waterfalls. Substrata dominated by bedrock and boulders, but sand and gravel may also be present in depositional areas. These streams have low productivity and aquatic vegetation is rarely present.

Xeric Pine Woodlands
A heterogeneous group of xeric pine-dominated woodlands found on ridges and steep slopes with southerly aspects, knobs, and low-elevation peaks. Below 2,400 ft. shortleaf pine is a dominant, with Virginia pine a common associate. From 2,400 to 2,800 ft. on the driest ridges pitch pine dominates. Above 2,800 ft. on slopes and ridges, Table Mountain pine dominates. All of these habitats require periodic fire for maintenance.

PIEDMONT ECOREGION

Beaver Ponds; Freshwater Marsh
Beaver ponds are temporary impoundments created by beaver on small to medium sized streams. Freshwater marshes develop in shallow beaver ponds and along the edges of larger lakes and ponds. Dominants include a variety of sedges, rushes, grasses, and forbs, with scattered buttonbush, red maple, swamp dogwood, and tag alder. Few Georgia examples exist that are not invaded by the exotic weed, Murdannia. These wetlands provide habitat for a wide variety of wildlife species.

Bottomland Hardwood Forests
Forested wetlands of alluvial river floodplains, characterized by a diverse association of deciduous hardwood trees. Canopy dominants vary, but may include water oak, willow oak, overcup oak, cherrybark oak, swamp chestnut oak, green ash, sweetgum, bitternut hickory, and pignut hickory. Shrub layer may be dense or relatively sparse, containing a variety of mesophytic or hydrrophytic woody plants and often a significant woody vine component. Many of these habitats have been impacted by invasive exotic species such as Chinese privet and Nepalese browntop.

Canebrakes
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most canebrakes in this region are relatively small and fire-suppressed, often occurring along the edges of fields and other clearings.

Granite Outcrops
Diverse mosaics of exposed granitic rock, herb and shrub dominated patches, and wetland microhabitats. Most have shallow solution pits that collect soil and support various stages of plant

succession. These environments support rare or endemic species of plants and animals. The most important of these habitats contain a variety of solution pits, seepage zones, and bare rock exposures. Some outcrops are monadnocks (rise above the ground) while others are flat rock exposures. The Georgia Piedmont is the center of granite outcrop species diversity.

Medium to Large Rivers
Low to moderate gradient meandering rivers, typically with heavy sediment loads. Floodplains are relatively narrow compared to similar rivers in the Coastal Plain. Extensive shoal habitats may occur, especially along the Fall Line. Dominant habitats include runs, pools, and shoals. Substrate is variable, but is dominated by sand in runs and pools and by bedrock in shoals. Aquatic vegetation may be present.

Mesic Hardwood Forests
Non-wetland forests of floodplains, ravines, and north-facing slopes in the Piedmont. These may include species such as American beech, white oak, northern red oak, bitternut hickory, pignut hickory, shagbark hickory, bigleaf magnolia, yellow poplar, blackgum, dogwood, black cherry, and loblolly pine. Typical shrubs include spicebush, sweetshrub, pawpaw, Oconee azalea, rusty viburnum, and pinxter-flower.

Montane Longleaf Pine-Hardwood Forest
A subxeric or xeric mixed forest with longleaf pine, oaks, and hickories. Georgia examples are typically fire-suppressed. Pine Mountain contains notable examples; others can be found along Dugdown and Hightower Mountain and in Paulding Forest and Sheffield WMAs. Includes a rare longleaf pine/Georgia oak subtype found on Hollis quartzite along the main Pine Mountain ridge.

Oak Woodlands and Savannas
Rare upland hardwood habitats found in scattered locations in the Piedmont. These xeric or subxeric oak-dominated woodland are influenced by edaphic conditions (i.e. thin soils, mafic rocks) and periodic fire. Dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, sometimes with shortleaf pine. Sparkleberry and hawbushes are common shrub components. A particularly rare type, the post oak-blackjack oak savanna, was apparently much more common in pre-settlement times; only small, fire-suppressed remnants of these habitats exist today.

Oak-Hickory-Pine Forest
Considered the climax forest of the Piedmont, this forest type formerly covered 50% to 75% of the region; most examples on fertile soils were eliminated by conversion to agricultural uses. Remaining examples are often found in rocky areas that were difficult to convert to agricultural fields. Typically include a variety of hardwood species such as white oak, black oak, southern red oak, pignut hickory, shagbark hickory, mockernut hickory, red maple, blackgum, shortleaf pine, and loblolly pine, with dogwood, rusty viburnum, hog plum, dwarf pawpaw, and various hawbushes in the understory. American chestnut was formerly a major component of the canopy. Examples over circumneutral soils influenced by mafic or ultramafic bedrock are often floristically richer, and may contain species such as Oglethorpe oak, basswood, red mulberry, redbud, and fringetree.

Rocky or Cobbly River Shoals
Shallow, high gradient reaches with swift water and rocky substrates. These habitats are important spawning areas for fish, including darters, shiners, and suckers (such as the extremely rare robust redhorse). In addition, shoals provide foraging areas for wading birds, and sunning areas for turtles. May contain dense growths of riverweed (*Podostemum ceratophyllum*). The shoals spiderlily

(*Hymenocallis coronaria*), a State-protected plant, is found on rocky shoals in the middle reaches of the Savannah, Flint, and Chattahoochee rivers. Many shoals have been degraded by stream impoundments, altered water quality, and excessive silt deposition.

Rocky/Sandy River Bluffs
Exposed rocky or sandy bluffs along rivers in the Piedmont are often characterized by mixed pine-oak vegetation with shortleaf pine, loblolly pine post oak, eastern redcedar, southern red oak, blackjack oak, and white oak. Small trees and shrubs may include hornbeam, winged elm, sparkleberry, winged sumac, yucca, and century plant. More sheltered or east-facing bluffs may have mountain laurel and rosebay rhododendron.

Serpentine Outcrops/Woodland/Savanna
This rare habitat represents a complex mosaic of woodlands and savannas with scattered outcropping of serpentine rocks. The pine-mixed hardwood vegetation includes longleaf pine as a dominant. This type is maintained by fire and edaphic conditions. The only known Georgia examples are fire-suppressed. These habitats include disjunct coastal plain species such as pineland Barbara-buttons and Georgia plume.

Springs and Spring Runs
Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. Springs of the Piedmont have varying mineral content, chemical properties, and temperatures. Includes spring pools and first order streams immediately below springs where rare fish and invertebrates may occur.

Streams
In the upper Piedmont, streams are low to moderate gradient and typically contain well-defined riffles and pools. Substrate consists of gravel, pebble, sand, and silt; some bedrock may also be present. Lower Piedmont streams are lower gradient, have fewer riffles and pools, and their substrates have a higher proportion of silt, clay, and detritus than upper Piedmont streams. Turbidity is highly variable, but most of these streams become highly turbid after rain.

Upland Depression Swamp
A non-alluvial open swamp with water oak, southern shagbark hickory, Oglethorpe oak, and loblolly and shortleaf pine. Coastal plain elements in the understory include swamp palmetto and parsley haw. Usually found on Iredell or Enon soils in the lower Piedmont. These sticky, plastic soils pond water in the spring, resulting in swampy conditions for a portion of the year.

Xeric Pine Woodlands
Pine-dominated habitats of dry, rocky ridgetops and granitic outcrops. Dominants are loblolly, shortleaf, and Virginia pine. These woodland habitats are maintained by a combination of edaphic factors and periodic fire.

SOUTHEASTERN PLAINS ECOREGION

Alluvial (Brownwater) Rivers and Swamps
Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the

dominant substrata and these rivers typically carry heavy sediment loads. Extensive cypress-gum swamps can be found on all major alluvial rivers in the upper portion of the Southeastern Plains. These systems have been impacted by altered flows from upstream dams.

Altamaha Grit Outcrops
These small patch habitats represent mosaics of indurated sandstone outcrops (vertical and horizontal surfaces) interpersed with rock-influenced pine woodland, bogs, and bottomlands. Characterized by several endemic species and plant association.

Atlantic Whitecedar Swamps; Clearwater Stream Swamps
Narrow, linear forested systems along cold, clear streams of the Fall Line sandhills. Characterized by a fairly dense canopy of Atlantic whitecedar, with pond pine, red maple, sweetbay, and other mesic-hydric site species. Clearwater stream swamps are similar but without Atlantic whitecedar in the canopy. The shrub layer is usually well developed and diverse, while the groundlayer herbaceous vegetation is often sparse. These systems are thought to be maintained by periodic fire, beaver activity, and possibly other forms of disturbance.

Bayheads and Titi Swamps
Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). Considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain

Beech-Magnolia Slope Forests
These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

Black Belt Prairies
Small-patch prairie habitats occurring over alkaline Oktibbeha soils. These soils are adhesive when wet and hard when dry, limiting the growth of woody plants. Black Belt prairies consist of herb-dominated patches interspersed with woody scrub component. These habitats are maintained by a combination of soil conditions and periodic fire.

Bottomland Hardwood Forests
Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

Calcareous Swamps
Hardwood dominated swamp forests that are influenced by calcareous soils. Examples include Spring Creek in the Dougherty Plain. These spring-fed swamps may contain rare plants such as

variable-leaved water plantain. Similar habitats are found along tributaries of the Ocmulgee and Ogeechee rivers.

Canebreaks

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

Caves

Found primarily along the Pelham Escarpment in the southwestern portion of the ecoregion. A few caves are also found in karst environments near Cochran and Sandersville. These Coastal Plain caves provide habitat for high priority species such as the southeastern myotis and Georgia blind salamander.

Evergreen Hammocks and Mesic Hardwood Forests

Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

Flint Kaolin Outcrops

Unusual rock outcrops composed of flint kaolin, a hard, flinty conglomerate of metamorphosed sediments. Outcrops are surrounded by xeric mixed oak/pine forest. The plant communities of the outcrops resemble Altamaha Grit. Known only from Columbia County.

Forested Depressional Wetlands

Seasonally or semi-permanently flooded forests of depressional features, including Carolina bays, limesinks, and Grady ponds. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish populations are very important breeding habitats for amphibians such as the flatwoods salamander.

Freshwater "Prairies"

Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is Grand Bay, possibly the largest Carolina bay known. Other examples can be found in the Tallahassee Hills/Valdosta Limesink region. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

Hillside Seeps

Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

Limestone and Marl Outcrops; Calcareous Bluffs
Rich riparian or ravine habitats influenced by limestone substrate. Marl gorges and bluffs are restricted to tributaries of the Chattahoochee River (Town Creek, Kolomoki Creek) near Fort Gaines. These “blue marl gorges” have diverse mesic hardwood forests and unusual seepage cliffs. Mesic calcareous bluffs are also found along the Savannah River and contain plant species of northern affinities.

Longleaf Pine-Scrub Oak Woodlands
Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

Longleaf Pine-Wiregrass Savannas
Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. Can range from mesic to dry, depending on topographic position and soils. Transitions downslope into wet pine savanna. These habitats are heavily dependent on frequent fire for maintenance.

Nonalluvial (Blackwater) Rivers and Swamps
Large, meandering rivers with tea-stained, but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form extensive bars in larger systems. Runs and pools are dominant habitats. Large snags are a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers.

Open-Water Ponds and Lakes (Carolina Bays, Limesinks and Beaver Ponds)
Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. Many wildlife species are dependent on these habitats. Limesinks are generally round, formed by the collapse of underground caverns, and are found primarily in the Dougherty Plain. Carolina bays are characterized by an elliptical shape, NW-SE axis, and a deep sandy rim on the east and south edges. Beaver activity along small branches may semi-permanently inundate areas, creating open wetlands.

Pine Flatwoods
Seasonally wet forests with open to closed pine canopy, often with an ericaceous shrub understory. Canopy dominants may include slash, longleaf, and occasionally pond pine. These habitats generally occur on nonalluvial flats and low terraces, and have a strong herbaceous component (although not as diverse as the longleaf pine savanna). Maintained by periodic fire.

Rocky/Sandy River Bluffs
Subxeric mixed pine-hardwood forest on river bluffs. May contain species such as white oak, southern red oak, post oak, laurel oak, mockernut hickory, shortleaf pine, loblolly pine and spruce pine. The woody understory may include red buckeye, blueberry, and possumhaw. The herb layer is typically sparse, but may include rare species such as Alabama milkvine.

Springs and Spring Runs
Clear, flowing systems with circumneutral pH and stable temperature and flow regimes. Limestone, detritus, and woody debris are dominant substrata. Floodplains of these systems are poorly

developed. Mostly confined to the Dougherty Plain. Many of the larger springs in this ecoregion serve as important cool-water refuges for species such as striped bass.

Steephead Ravines
Rich mesic ravine forests characterized by a diverse canopy of hardwood trees, including American beech, southern sugar maple, southern magnolia, pyramid magnolia, basswood, and sugarberry. The most significant examples are the "Torreya Ravines" of the lower Pelham Escarpment near Lake Seminole. Similar habitats are found in the upper ends of narrow ravines in the Fall Line Sandhills and along the edges of deep limesinks in the Dougherty Plain.

Streams (Blackwater)
Meandering acidic streams with tea-stained, translucent waters and small to moderate-sized floodplains. Blackwater streams are highly acidic, high in dissolved organic materials, and low in suspended materials. Streambeds are characterized by sandy substrates, often with extensive woody debris and live plant roots are often interspersed. Pools and runs are the dominant microhabitats, but these are occasionally interspersed with beaver ponds and limestone outcroppings. These aquatic systems have been impacted by channelization, impoundment, and encroachment by agricultural and silvicultural uses.

Wet Pine Savannas, Herb and Shrub Bogs
Open pine savanna dominated by longleaf or slash pine, with interspersed bogs. Herb bogs are found in low swales or depressions. Herb bogs are often characterized by pitcherplants and a high diversity of forbs. Shrub bogs occur in the ecotones of Carolina bays or cypress ponds and along the drier edges of bay swamps. Dominated by shrubs with a few (usually stunted) scattered pines and a sparse herb layer.

Xeric Aeolian Dunes
Wind-formed deep well-drained dunes found mostly along the eastern side of rivers such as the Ohoopee, Little Ohoopee, Canoochee, and Little Ocmulgee. These unusual xeric habitats are dominated by deciduous or evergreen scrub oaks and scattered pines, with little groundcover other than patches of wiregrass and lichens. A number of rare plants are associated with these habitats, including sandhills rosemary and Ashe's savory.

SOUTHERN COASTAL PLAIN ECOREGION

Alluvial (Brownwater) Rivers and Swamps
Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the dominant substrata and these rivers typically carry heavy sediment loads. Dominant canopy trees are baldcypress and tupelo gum; the understory tree/shrub vegetation may be patchy, often consisting of swamp priet, water elm, swamp dogwood, red maple, and Carolina ash. Cypress and gum-dominated swamps can be found along the Altamaha, Savannah, and Ogeechee rivers. These systems have been impacted by altered flows from upstream dams.

Barrier Island Freshwater Wetlands and Ponds
Usually found in broad flats or in elliptical to linear interdune depressions on Georgia's coastal barrier islands. These wetland habitats are variable in physiognomy and species composition; deeper, more permanently flooded ponds often have a large extent of open water; shallower ponds are usually

dominated by a combination of submergent, emergent and/or floating macrophytes. Trees or shrubs are present mainly along the edges of the ponds. These habitats have been impacted by groundwater withdrawals, fire suppression, and invasive exotic plants such as Chinese tallow tree.

Bayheads and Titi Swamps
Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). Considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain

Beech-Magnolia Slope Forests
These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

Bottomland Hardwood Forests
Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

Brackish Marsh and Salt Marsh
Salt marshes are salt-tolerant grasslands, dominated by cordgrasses and rushes, over soils with circumneutral pH. Extremely productive habitats. Brackish marshes occupy a wide ecotonal zone in the vicinity of river mouths.

Canebreaks
Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

Coastal Beaches and Sand Bars
Beaches and sand bars are dynamic, high-energy intertidal systems that represent important habitat for shorebirds and sea turtles. Longshore movement of sand on barrier islands results in erosion at the north end and building up at the south end. These unvegetated habitats are important foraging areas for coastal shorebirds; sea turtles nest in the foredunes at the upper ends of sandy beaches.

Coastal Dunes and Bluffs
These habitats consist of sparsely vegetated sandy interdunes, rear dunes, and bluffs. They constitute important habitats for a number of high priority species adapted to harsh temperatures and salt spray. Coastal dune habitats include a number of important microhabitats such as interdune meadows and depressions, shrub thickets, and dune scrub forests. Similar vegetation can be found along eroded or exposed coastal bluffs.

Coastal Scrub-Shrub Wetlands

Shrub dominated estuarine communities found along the upper border of salt marsh or brackish marsh. These habitats are infrequently flooded by tidal action and form ecotones between wetland and terrestrial environments. Typical shrubs include groundsel tree, marsh elder, yaupon holly, wax myrtle, Florida privet, and false willow. Wind-pruned redcedar may also be present.

Estuarine and Inshore Marine Waters

Estuaries (brackish water between barrier islands and mainland) and near-shore ocean waters. Estuaries serve as nurseries for many species of fish and shellfish as well as habitats for manatees and other marine mammals. Plant composition is influenced by tidal regime and salinity.

Evergreen Hammocks and Mesic Hardwood Forests

Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

Forested Depressional Wetlands

Seasonally or semi-permanently flooded forests of depressional features in broad interstream flats. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish populations are very important breeding habitats for amphibians such as the flatwoods salamander.

Freshwater "Prairies"

Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is the Okefenokee Swamp. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

Hillside Seeps

Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

Longleaf Pine-Scrub Oak Woodlands

Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

Longleaf Pine-Wiregrass Savannas

Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. Can range from mesic to dry, depending on topographic position and soils. Transition downslope into wet pine savannas, pine flatwoods, or other wetlands. These habitats are heavily dependent on frequent fire for maintenance.

Maritime Forest and Coastal Hammocks
Coastal forests dominated by live oak and palmetto; hammocks are small islands of maritime forest usually surrounded by brackish water and/or salt marsh. These are restricted to a narrow band of shoreline and barrier islands. Characterized by sandy soils and wind-pruned canopy trees. Provide important habitat for neotropical migrant birds.

Mud and Sand Flats
Periodically inundated mud and sand deposits located in estuarine or inshore marine waters. These unvegetated habitats are generally covered at high tide and exposed at low tide. They serve as important feeding areas for a number of coastal shorebirds such as plovers, sandpipers, and dowitchers.

Nonalluvial (Blackwater) Rivers and Swamps
Large, meandering rivers with tea-stained, but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form extensive bars in larger systems. Runs and pools are dominant habitats. Large snags are a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers.

Offshore Marine Waters
Georgia's offshore marine waters provide habitat for a number of high priority species, including loggerhead, green, Kemp's ridley, and leatherback turtles, North Atlantic right whales, and bottlenose dolphins. Hard-bottom areas are especially important habitats for marine fish and sessile organisms.

Open-Water Ponds and Lakes
Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. These habitats are relatively uncommon in this region. Maintained by periodic fire and fluctuating water levels.

Pine Flatwoods
Mesic or wet forests on flat, poorly-drained areas of the lower Coastal Plain. Dominated formerly by longleaf pine, now typically by slash pine, occasionally with loblolly or pond pine. Contains a well-developed shrub layer consisting of saw palmetto, gallberry, lowbush blueberry, and other ericaceous species. One of the most extensive and prevalent habitats of this ecoregion.

Tidal Rivers and Freshwater Tidal Marsh
Includes the tidally influenced portions of rivers and creeks and associated wetlands. Freshwater tidal marshes are wetlands found along the margins of tidal rivers and creeks above the brackish water zone, typically dominated by giant cutgrass, sawgrass, pickerel weed, wild rice, cattail, rushes, and a variety of other herbs.

Wet Pine Savannas, Herb and Shrub Bogs
Wet pine savannas are poorly drained wetlands with open to sparse canopies dominated by longleaf, slash, and/or pond pine. The shrub layer may be sparse, consisting mainly of gallberry, wax myrtle, and blueberries. The herbaceous layer is often diverse and dense, dominated by grasses, sedges, composites, orchids, and lilies. May include small peat-filled depressions dominated by titi and other shrubs or by herbaceous bog plants.

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Appendix B. Birds Technical Team Report

Prepared by Todd Schneider and Tim Keyes, Team Leaders

Technical Team Members

Team Leaders
Todd Schneider, WRD, Nongame Conservation Section – Wildlife Biologist
Tim Keyes, WRD, Nongame Conservation Section – Wildlife Biologist

Team Members participating at Bird Technical Committee Meetings
Jim Bates, U.S. Fish and Wildlife Service, Ecological Services, Ft. Benning - Biologist
Rebecca Byrd, Georgia Department of Transportation - Ecologist
Larry Carlile, Ft. Stewart, Fish and Wildlife Branch - Chief of Planning and Monitoring
Scott Coleman, Little St. Simons Island - Natural Resources Manager
Chris Coppola, U.S. Fish and Wildlife Service, Ecological Services, Townsend - Biologist
Dean Demarest, U.S. Fish and Wildlife Service – Region 4, Nongame Bird Coordinator
Jenifer Hilburn, St. Catherines Island Foundation, Altamaha Riverkeeper - Biologist
Malcolm Hodges, The Nature Conservancy - Ornithologist, Land Steward
Elizabeth Hunter, University of Georgia – Ph.D. Candidate
Nathan Klaus, WRD, Nongame Conservation Section – Wildlife Biologist
Charlie Muise, Atlanta Audubon Society, Important Bird Areas Program - Biologist
Jim Ozier, WRD, Nongame Conservation Section - Program Manager, Wildlife Biologist
Carrie Straight, U.S. Fish and Wildlife Service, Ecological Services, Athens - Biologist
Reggie Thackston, WRD, Game Management Section – Private Lands Program Supervisor
Jim Wentworth, U.S. Forest Service – Wildlife Biologist
Troy Wilson, U.S. Fish and Wildlife Service - Region 4, Assistant Nongame Bird Coordinator

Team Members participating through email and correspondence
Giff Beaton, Independent Ornithologist, bird records expert
Richard Chandler, University of Georgia – Ornithologist, Assistant Professor
Bob Cooper, University of Georgia – Ornithologist, Professor
Bob Sargent, Warner Robins Air Force Base/Georgia Ornithological Society – Wildlife Biologist
Terry Johnson, WRD, Nongame Conservation Section - Program Manager (Retired)
John Parrish, Georgia Southern University – Ornithologist, Professor (Emeritus)
Jim Cox, Tall Timbers Research Station – Ornithologist, Researcher

Invited but unable to participate:
Ray Chandler, Georgia Southern University - Ornithologist, Professor
Ellie Covington, U.S. Army Corps of Engineers - Biologist
Joe Meyers, U.S. Geologic Survey, Patuxent Wildlife Research Center – Researcher (Retired)
Greg Balkcom, WRD, Game Management Section - State Waterfowl Biologist

Approach

On January 8, 2014 a one-day meeting was convened at Charlie Elliott Wildlife Education Center near Mansfield to update and revise the SWAP bird species list. Those invited to attend represented a broad range of expertise both geographically and taxonomically. Many of these people had participated in development of the original SWAP bird list (2005), although a significant number of people new to the process also attended. Prior to the meeting participants were provided with the 2005 SWAP bird list for review, as well as a summary of the revision process and expectations for the meeting. During the meeting participants discussed individual species on the list at length and determined whether information for a particular species needed to be revised or added. They also discussed whether a species should remain on the list or be removed, as well as possible new species that should be added. While this process was relatively efficient, we were only able to get through a portion of the species on the list and decided that another meeting would be necessary to complete the task. A second one-day meeting was convened on July 8, 2014 at the Nongame Conservation Section Office in Forsyth. At this meeting species not previously discussed were reviewed and new species proposed for the list were discussed and approved or rejected by the group. While working on the bird list we also discussed updates and changes to the status of species on the Georgia Protected Species List and the Georgia Special Concern Species Tracking List. These suggested changes were documented in the bird list spreadsheet. Later we sent out the updated bird list from this meeting to everyone on our mailing list to seek any additional input and to allow everyone to vote on the species suggested for addition or deletion.

Decisions on all species discussed at these two meetings were made based on expert opinion that was supported by peer reviewed scientific literature, technical reports, ornithological records, other databases, and conservation plans including, but not limited to, the Partners in Flight North American Landbird Conservation Plan, the North American Waterbird Conservation Plan, United States Shorebird Conservation Plan, the North American Waterfowl Management Plan, and the North American Bird Conservation Initiative. Determination of species to include on the list was based primarily on the species' population status, trends, habitat status and threats, rarity, vulnerability, and ability to serve as an indicator of ecological integrity of specific habitats or habitat conditions. Species included on the list are those species known, or thought to be, most critically in need of immediate conservation action. In a few cases the species included on this list serve as umbrella species that represent a guild of species, habitat type(s), or habitat condition(s) that is significantly declining (e.g., Northern Bobwhite, Prothonotary Warbler). While this list is fairly comprehensive it should be considered a work in progress and modified as needed to best address conservation concerns in the future.

Assessment Results

The SWAP bird committee reviewed the original 33 species on the 2005 SWAP list, and proposed the removal of one species and the addition of 8 species. In addition, 2 species were recommended for addition to the Georgia Special Concern Species Tracking List.
Removal: Bicknell's Thrush was recommended for removal based upon the fact that it is a transient through the state, virtually impossible to distinguish from the ubiquitous Gray-cheeked

Thrush (even in the hand), and the consensus that there is no meaningful management activity that we could undertake that would have any direct impact on the species. The only other species on the SWAP list that is strictly a transient is Kirtland's Warbler, which was maintained on the list due to its federal endangered species status and other considerations.

Additions: The group agreed that the following species should be added to the list; Seaside Sparrow, Saltmarsh Sparrow, Nelson's Sparrow, Rusty Blackbird, Whooping Crane, Little Blue Heron, Prothonotary Warbler, and Yellow Rail. Seaside, Saltmarsh, and Nelson's Sparrows use coastal saltmarshes for all or part of their life cycle and are threatened by sea level rise, development, and possibly excessive predation. The Rusty Blackbird has declined by 90% or more over the last few decades, the causes for this decline are not well understood. Georgia bottomland forests provide potentially important habitat for overwintering birds. Whooping Cranes now regularly migrate through the state led by ultralight aircraft, or on their own, as they travel between their wintering site in Florida and breeding site in Wisconsin. Some also overwinter in Georgia, and there have even been cases of Whooping Cranes being illegally shot in the state in recent years. Little Blue Heron remains a species of concern and appears to be undergoing a range-wide decline. The Prothonotary Warbler was suggested as another species that should be included on the list based upon both a declining population trend (BBS data) and its suitability as an umbrella species for birds of bottomland and swamp forest habitats. One other species on our SWAP list, the Northern Bobwhite, is similarly used as an umbrella species for grassland and pine savanna habitats. Yellow Rail was added to the list despite very little knowledge of its status in the state. It is considered a high conservation priority throughout its range and clearly winters here in unknown numbers. The broader concern for the species warrants additional survey effort in Georgia.

Discussed: The committee discussed whether several high priority pelagic species (e.g., Bermuda Petrel, Black-capped Petrel) should be added to the list. While there was no disagreement regarding the status of these imperiled pelagic species, it was determined that since these birds virtually never come into state waters (within 3 miles of shore), there would be no direct management actions we could take that would meaningfully affect these species.

Tracked List: The group discussed the possible addition of the Roseate Spoonbill, which has been documented nesting in the state since the 2005 SWAP list was completed, and the Reddish Egret. It was determined that both species warrant tracking at a state level (Georgia Special Concern Species Tracking List) but do not rise to the level of concern needed for inclusion on the SWAP list.

The status of Loggerhead Shrike was expanded to include both breeding and wintering subspecies.

High Priority Bird Species in Georgia

Common Name	Species
Saltmarsh Sparrow	Ammodramus caudacutus
Henslow's Sparrow	Ammodramus henslowii
Seaside Sparrow (MacGillivray's)	Ammodramus maritimus macgillivraii
Nelson's Sparrow	Ammodramus nelsoni
Grasshopper Sparrow	Ammodramus savannarum
Red Knot	Calidris canutus
Piping Plover	Charadrius melodus

Wilson's Plover	Charadrius wilsonia
Northern Bobwhite	Colinus virginianus
Yellow Rail	Coturnicops noveboracensis
Little Blue Heron	Egretta caerulea
Tricolored Heron	Egretta tricolor
Swallow-tailed Kite	Elanoides forficatus
Rusty Blackbird	Euphagus carolinus
Peregrine Falcon	Falco peregrinus
Southeastern American Kestrel	Falco sparverius paulus
Gull-billed Tern	Gelochelidon nilotica
Whooping Crane	Grus americana
Florida Sandhill Crane	Grus canadensis pratensis
American Oystercatcher	Haematopus palliatus
Bald Eagle	Haliaeetus leucocephalus
Black-necked Stilt	Himantopus mexicanus
Least Bittern	Ixobrychus exilis
Loggerhead Shrike	Lanius ludovicianus
Black Rail	Laterallus jamaicensis
Swainson's Warbler	Limnothlypis swainsonii
Wood Stork	Mycteria americana
Whimbrel	Numenius phaeopus
Painted Bunting	Passerina ciris
Bachman's Sparrow	Peucaea aestivalis
Red-cockaded Woodpecker	Picoides borealis
Prothonotary Warbler	Protonaria citrea
King Rail	Rallus elegans
Black Skimmer	Rynchops niger
Cerulean Warbler	Setophaga cerulea
Kirtland's Warbler	Setophaga kirtlandii
Appalachian Yellow-bellied Sapsucker	Sphyrapicus varius appalachiensis
Least Tern	Sternula antillarum
Barn Owl	Tyto alba
Golden-winged Warbler	Vermivora chrysoptera

Examples of High Priority Species

Pine Savanna/Grassland Specialists

Much of South Georgia was in pine savanna habitat prior to European colonization of the state. Pine savanna also occurred locally in the Piedmont and portions of the mountains, although generally on a much smaller scale. The Red-cockaded Woodpecker, Bachman's Sparrow, Henslow's Sparrow, Loggerhead Shrike, Southeastern American Kestrel, and Northern Bobwhite thrived in these savanna habitats, particularly in the Coastal Plain. Starting in the 1700s longleaf pine savanna was converted to agriculture, harvested for lumber, and lost due to fire suppression, human development, and as a result of injuries trees sustained during pine sap extraction for turpentine and naval stores. More open grasslands were scattered throughout portions of the state where soils, geology, micro-climate, frequent fire, and other physical or ecological forces shaped vegetative communities by inhibiting or preventing woody vegetation from growing. Many of these areas were lost due to fire suppression, but plowing for agriculture, overgrazing, and attempts to grow trees in these “wastelands” also reduced the number of functional grasslands remaining.

The result of this onslaught of human activity today is a landscape devoid of expansive areas of pine savanna and very few remaining open grasslands. However, some larger areas of pine savanna survived these assaults, artifacts of unique historical occurrences. Two good examples of these are the Red Hills quail plantations, saved by wealthy industrialists as personal recreation lands, and the two largest military bases, Ft. Stewart and Ft. Benning, who’s military mission over several decades led to the conservation on hundreds of thousands of acres of pine savanna habitat. Today these areas hold significant numbers of Red-cockaded Woodpeckers and Bachman’s Sparrows, and likely substantial numbers of some of the other species mentioned previously. In the case of the Red-cockaded Woodpecker, Ft. Stewart has served as a source for reintroduction efforts to other sites. Conservation efforts for several pine savanna species are building and expanding off these core areas.

Beach-nesting Birds

This group of birds includes the solitary nesting species - Wilson’s Plover and American Oystercatcher - and colonial nesters such as Gull-billed Tern, Black Skimmer, and Least Tern. The factors that result in their inclusion as high priorities for conservation in Georgia are extremely limited and vulnerable breeding habitat, historic reductions in populations, and reduction in the number of extant, low disturbance, nesting locations. The species listed above represent a partial list of species in need of conservation action.

Beach nesting birds are dependent on similar, specific, beach attributes to fulfill nesting and chick rearing requirements. The attributes include wide accretional beach, adequate beach elevation to thwart normal tidal inundation, a degree of isolation from uplands, and proximity to quality feeding sites. These attributes rarely combine on the Georgia Coast, especially for the colonial birds dependent on the greatest level of isolation. When the attributes do combine, the resulting beach is frequently also favored by recreationists, ensuring frequent disturbance during incubation and chick rearing in spring and early summer. The primary threats to these species are 1) increasing access to historically isolated areas of coastal Georgia by recreational users and their dogs, 2) vehicular use of beaches for travel, recreating, law enforcement, and sea turtle nest patrols, 3) reductions in the number of nesting locations due to sea level rise, 4) contaminants including dioxin, mercury, PCBs, and toxaphene, 5) physical loss of emergent sands due to beach nourishment projects, and 6) feral, introduced, and invasive animals, including cats, pigs, horses, bobcats, donkeys, coyotes, and fire ants.

Immediate conservation actions are needed and include; 1) Developing a state legislative mechanism that automatically provides protection for newly developing, persistent, emergent, sand bars on the outer coast. Currently only five sand bar islands, including Little Egg Island Bar, St. Catherine Island Bar, Pelican Spit, Satilla Marsh Island, and Williamson Island, are covered under the Georgia Natural Resources Board, Shorebird and Sea Bird Habitat Protection

Rule; 391-4-7-.03 (also known as the Bird Island Rule), which protects seabird and shorebird nesting and roosting at these sites. Since sand bar habitats are highly dynamic and ephemeral protected seabird nesting locations can easily be lost to storms, erosion, or other factors. A legal mechanism is needed to protect recently formed or created sand bar habitats as well as future sand bars as they are established and become valuable to seabirds for nesting. The recently created dredge spoil island in Brunswick Harbor has become one of the most important sea bird colonies in the state, but since its creation post-dates the Bird Island Rule, which became effective on May 20, 1998, there is no specific protection for the site, making it difficult for Law Enforcement to enforce posted closure. This, and similar sites, should be included within the Bird Island Rule to assist with enforcement. 2) Continue to work with island managers to recognize and protect higher value shorebird nesting locations through signage and symbolic fencing where appropriate, 3) Limit or eliminate vehicular use of beach areas recognized for high beach-nesting values. Examples include the south end of Middle Beach on Ossabaw Island, all of Little St. Simons Island, the south end of Sea and Jekyll islands, Little Cumberland Island, and the South end of Cumberland Island. Limit or eliminate night patrols for sea turtle nesting projects, 4) Identify and control the source of contaminants that could negatively impact the health and reproductive ability of waterbirds, 5) Restrict use of nearshore sand sources for beach nourishment projects, opting for deeper water locations, 6) Eradicate feral hogs, cats, and coyotes on islands where they are found. Reduce feral horse populations on Cumberland Island. Continue to control fire ants as needed on Little Egg Island Bar and Satilla Marsh Island, 7) Continue to educate recreationists frequenting sensitive beach nesting locations and, 8) continue to build regional coordination with monitoring and management. Many colonial seabirds move significantly year to year, and in order to accurately assess their population numbers and trends, it is imperative that states within the Southeast coordinate their efforts.

Isolated Wetlands Dependent Birds

Some of the most at risk species are those dependent on isolated wetlands including Tricolored Heron, Little Blue Heron, Wood Stork, King Rail, Least Bittern, and Black-necked Stilt. These birds represent a much larger group of species that include all of our wading birds, most of our rails, many migrant shorebirds, resident and migratory passerines, waterfowl, and grebes. Wading birds in particular require specific flooded woodland habitats in which to nest. Most wading bird rookeries in Georgia are located within 20 miles of the coast. Even along the immediate coast, freshwater wetlands are used not only for nesting, but also heavily as feeding locations.

Primary threats include; 1) lack of state or federal protection for isolated freshwater wetlands in Georgia, unless a specific location is recognized as a Wood Stork rookery with Endangered Species Act implications, 2) direct loss of isolated wetlands due to increased residential and industrial development and intensive silvicultural practices, 3) environmental contaminants particularly mercury, PCBs, and toxaphene, 4) agricultural and industrial groundwater withdrawal which dries wetlands, 5) climate change scenarios with predicted increases in the variability of rainfall, leading to increased drought conditions punctuated with more extreme rainfall events. This altered rainfall pattern may present new challenges at both ends of the rainfall spectrum, from drought conditions where nesting is not possible, to flood conditions where nests are lost and foraging areas are flooded making them unsuitable for feeding.

These species are in need of immediate management action and recommended conservation actions are; 1) promote state legislation that protects isolated wetlands and non-flowing waters. This will help safeguard and stabilize waterbird populations as well as those of other dependent wildlife, 2) use GIS and remote sensing to determine locations for all freshwater wetlands in regions experiencing heavy development, 3) contact landowners of the most valuable sites to discuss important wildlife values of wetlands and long-term conservation options, 4) pursue acquisition or easements for the highest valued locations, and 5) make development of a regional survey/monitoring protocol for wading birds a priority. Our most recent statewide wading bird survey is 20 years old.

High Priority Habitats and Associated Species

Southwestern Appalachians/Ridge & Valley

Hardwood Forests

The greatest bird conservation issue in this region is conversion of hardwood and mixed pine/hardwood forest to monocultures of loblolly pine, urbanization, and agriculture. A large percentage of natural vegetation has been cleared for other uses, and mature forest and the birds dependent on mature forest are less secure here than in any other physiographic area in the Southern Appalachians. The long-term health of populations of priority birds including Acadian Flycatcher, Wood Thrush, and Yellow-throated Warbler will depend on maintenance and management of remnant forest as well as aggressive restoration efforts. It is recommended that at least eight upland hardwood forest patches greater than 4,000 hectares be sustained and that the number of such patches in the 4,000 to 40,000 hectare range be increased. More than 80% of the mixed mesophytic hardwood acreage within these patches should be managed for long rotation or old growth.

Southern Yellow Pine

Existing short-rotation pine, while of less benefit to birds than mature forest, is nevertheless much more valuable than more intensive land uses, and it is recommended that the current percentage of land in this cover type be retained. All existing southern yellow pine and mixed pine hardwood habitats should be actively and appropriately managed with fire, and current acreage should be increased where possible. Priority species associated with mature pine forests in the Ridge and Valley include Brown-headed Nuthatch and Bachman's Sparrow.

Scrub-Shrub and Early Succession

Suppression of natural disturbance regimes has depleted scrub-shrub and woodland habitats and birds adapted to those conditions such as Prairie Warbler, Orchard Oriole, and Red-headed Woodpecker persist largely in the early succession phases of actively managed forests. The needs of these birds, including game species such as American Woodcock and Northern Bobwhite, should be considered within the context of forest habitat objectives.

Blue Ridge

Mature Forests

This remains the most heavily forested physiographic area in the Southeast. Species of conservation concern in this habitat include Black-throated Blue Warbler, Yellow-throated Vireo, and Cerulean Warbler. The amount of land in agriculture has decreased in the last century, being replaced by forest. Nevertheless, BBS data indicate bird population declines in the Southern Blue Ridge in excess of those in any other areas in the region. Declines are seen in long-distance migrants, short-distance migrants, and permanent residents. However, this information should be interpreted with some caution since BBS routes are situated along roads, and most roads in the Southern Blue Ridge are in valleys where there has been a great deal of development and habitat loss in recent years. These perceived trends may not be representative of population conditions in the bulk of the forested area in this region. This, however, is not necessarily a safe assumption, and there is cause for concern in at least some of the forest types and conditions.

Although some forest types, such as Appalachian oak, remain widespread, most of the area is in a mid-successional stage of closed canopy with a poorly developed understory and ground cover. Many mature forest birds including Wood Thrush, Worm-eating Warbler, and Canada Warbler may be suffering from this deficiency in structure. This will correct itself over time, although perhaps not soon enough to conserve some declining species such as Cerulean Warbler; therefore, some conservationists advocate hastening the process through management. In fact, selective logging was used to improve habitat for Cerulean Warblers in an area where they occur on the Chattahoochee National Forest. In any case, a much greater extent of old-growth conditions in general is desirable for mature forest birds. Much of the mature forest in the Blue Ridge occurs on National Forest lands that are classified as unsuitable for commercial harvest activities, and it is likely that these areas will eventually provide substantial blocks of old-growth habitat. Although largely in USFS ownership, mature forest habitat and associated bird species may also be threatened by several exotic pest species including the Hemlock Wooly Adelgid, Gypsy Moth, and Asian Long-horned Beetle, which are advancing down the Appalachians. Upon arrival in other areas, these species dramatically altered forest structure and bird populations, and the Hemlock Wooly Adelgid has already caused considerable loss of streamside hemlock habitats in the Chattahoochee National Forest.

Early Successional Forest

Other high priority birds inhabit early successional conditions, which also have decreased in extent in recent years. Indeed, the Appalachian subspecies of Bewick’s Wren may have become extinct in the past two decades because of loss of this type of habitat. Maintenance of a suitable amount of mid- and high elevation early successional or woodland habitat is a priority conservation need particularly for species such as Golden-winged Warbler, Ruffed Grouse, and Appalachian Yellow-bellied Sapsucker.

Riparian Forests

The lowest elevation riparian forests are most affected by forest loss and fragmentation in recent years. Management of riparian zones and retention or restoration of fragments of suitable size is another conservation need in the Southern Blue Ridge and of particular importance for Swainson’s Warbler, Louisiana Waterthrush, and Kentucky Warbler.

Piedmont

Grasslands and Scrub-Shrub

Open woodlands, grasslands, and savannas were common as late as the 1800s in the Piedmont, and because Native American settlements were apparently common in the area, agricultural fields and other large openings were historically part of the landscape. The three greatest challenges facing the conservation of habitat in the Piedmont today are unchecked urbanization, intensification of agriculture and forest management, and suppression of natural disturbance regimes. Of these, the former is of much greater concern because its effects are essentially permanent. Urban sprawl is an increasingly important issue nationwide and the human population in the Southern Piedmont is growing rapidly. However, no comprehensive planning for growth is in place. Agriculture and forestry are significant land uses in the Southern Piedmont. The general decline in abundance of grassland species is mostly related to changing land use patterns from agriculture to intensive forestry. Remaining agricultural lands are intensively managed, often consisting of frequently harvested or grazed pastures of exotic grass species. The result is a loss of stable, grassland habitats with associated influences on species of conservation concern including Blue Grosbeak, Northern Bobwhite, Grasshopper Sparrow, and Red-headed Woodpecker.

Mature Forests of Southern Pine and Upland Hardwood

Although overall increasing forest acreage and maturity in the Piedmont would suggest greater security for vulnerable bird species, many species' populations have shown declines in patches of protected mature forests embedded within suburban settings where they were once common. Conservation opportunities to manage and maintain bird habitats will require significant involvement from public land managers, public agencies, and private industrial and non-industrial landowners. Public lands are an important component of the Southern Piedmont and may serve as core areas from which to manage or expand habitat. Timber companies are the largest private landowner in the Piedmont, creating tremendous opportunity for increased cooperative management strategies to accomplish bird conservation objectives. Private, non-industrial landowner incentive programs can be increased in key areas as well, further adding to core habitat acreage. Priority species dependent on Southern Pine forests include Red-cockaded Woodpecker, Brown-headed Nuthatch, and Bachman's Sparrow. Upland Hardwood forests are needed to support Wood Thrush and Kentucky Warbler.

Bottomland Hardwood Forests

Encroachment from urbanization, industrialization, and intensive pine management influence both the extent and connectivity of riparian forests in the Piedmont. In addition, closed canopy forests that lack a diverse understory and degradation of water quality due to development and sedimentation and chemical run-off from roads can negatively influence species such as Swainson's Warbler and Louisiana Waterthrush. Altered hydrology can also influence habitat quality for these species as well as Prothonotary Warbler. Consideration must be given to connecting large blocks of riparian forest, management prescriptions to improve understory structure, and appropriate management activities in streamside areas.

Southeastern Plains and Southern Coastal Plain

Pine Forests

As in other pine-dominated uplands of the Southeast**,** fire suppression, conversion to other land uses, and short-rotation pine plantations have significantly altered the nature of the South Atlantic Coastal Plain. Maintenance and restoration of large tracts of fire maintained pine savanna are the keys to health of high priority pine and pine-grassland bird species including Red-cockaded Woodpecker, Southeastern American Kestrel, Bachman's Sparrow, and Brown-headed Nuthatch. Pine plantations have some wildlife value, and maintenance of a diversity of age classes over landscapes can help maintain many bird species, including some that are of reasonably high priority.

Bottomland Hardwood

The bottomland hardwood bird community requires large tracts of forest in river systems including the Savannah, Altamaha, Ogeechee and Satilla. These areas are needed to support significant numbers of breeding Swallow-tailed Kite, Northern Parula, Prothonotary Warbler, and Swainson's Warbler. Maintenance and restoration of large patches of bottomland forest ranging in size from 2,000 to 40,000 hectares in this physiographic area should assure the health of these birds.

Maritime Forest and Scrub-Shrub

Coastal maritime forest and scrub-shrub habitats not only support much of the eastern population of Painted Bunting but also are extremely important for in-transit migrants. Much of this forest has been developed for intensive human use, and what remains should be maintained. Although likely secure on several barrier islands, on the mainland, birds occupying these habitats may face additional challenges from parasitism by Brown-headed Cowbirds and increased predation by feral and domestic cats as well as avian predators such as crows and jays.

Coast and Islands

About eighty species of waterbirds and several species of rails and songbirds use the coastal environs of Georgia during some part of their annual cycle. Some of these birds are coastal specialists, dependent on habitats found only on, or primarily within the coastal zone for all of their life-sustaining needs. Due to their specialization, many coastal dependent waterbirds are experiencing population stresses, or biological bottlenecks as a result of direct habitat loss or indirect loss due to disturbance. As breeding and feeding sites are increasingly restricted in scope and number, the flexibility needed by our priority species to respond to natural changes in their nesting and feeding habitats is eliminated. These coastal specialists are included on our High Priority Species List. High priority habitats critical to some of our most threatened bird species are described.

Beach/Dune/Tidal Flats, Pools, and Creeks

These tidally influenced habitats form a particularly diverse and rich waterbird area. High priority species including all of our seabirds, and our highest ranked shorebirds such as Piping Plover, Red Knot, Wilson's Plover, American Oystercatcher, Marbled Godwit, and Whimbrel are all obligate tidal lands species. Of our priority wading birds, Tricolored Herons are restricted to our coastal zone, and roughly half of the state's Wood Storks depend, in part, on the tidal pools and feeder creeks for foraging.

The most pressing waterbird conservation issues on Georgia's tidally influenced habitats include sea level rise and human disturbance of nesting areas by day-use recreation. Two of Georgia's shorebirds, and virtually all of Georgia's resident seabirds, including Brown Pelican, Royal Tern, Gull-billed Tern, Sandwich Tern, Laughing Gull, Least Tern, and Black Skimmer, nest directly on the ground on terrace and dune habitats that are only a few feet above mean sea level. These sites are increasingly under threat of the effects of tidal inundation from rising water level and possibly increased tidal amplitudes. Additionally, these species depend on disturbance-free beaches and Georgia's barrier beaches have been discovered by a rapidly increasing human population interested in shoreline recreational activities. The state needs a long-term mechanism to ensure disturbance-free nesting areas in this highly dynamic, ephemeral landscape. All of our waterbirds depend on healthy abundant live food resources. Water quality will play a major role in the future of the migrant, wintering, and resident breeding birds on the Georgia Coast. Development of uplands, including hammocks, is impacting estuarine water quality with siltation and contaminant loading. Increased dock and marina development will deliver petroleum residues from increased numbers of boats. All of the water flowing down our five major Atlantic drainage rivers mixes with seawater to create the rich estuarine waters of the coastal marshes. Everything put into the watersheds of the Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's rivers eventually ends up on the coast, influencing the quality and quantity of invertebrate and vertebrate foods for waterbirds. River born contaminants will end up in waterbird food resources, eventually influencing their health and reproductive potential. Contaminant control and monitoring will be an important aspect of waterbird conservation efforts.

Saltmarsh

The expanse of saltmarsh between Georgia's barrier islands and mainland comprises about one third of all saltmarsh habitat on the U.S. Atlantic Coast. This area harbors a number of obligate saltmarsh bird species and subspecies including the Seaside Sparrow, Saltmarsh Sparrow, Clapper Rail, and Worthington's Marsh Wren, as well as other species dependent upon saltmarsh habitats including Nelson's Sparrow and possibly the Black Rail. Sea level rise is the greatest threat to saltmarsh habitats, although contaminants, siltation, dredging, filling, petroleum residues, and predation by upland mammals may also be significant threats.

Isolated Freshwater Wetlands

All of our wading birds are either entirely dependent, or primarily dependent upon isolated freshwater wetlands for nesting. Wading birds nest above the freshwaters of Carolina bays, gum swamps, flooded interdune swales, cypress domes, and temporary depressional wetlands; anywhere shrubs and trees are sitting in standing water throughout the spring and early summer. Our high priority wading bird species also feed regularly in freshwater wetlands throughout the year. There are no state or federal laws currently protecting isolated freshwater wetlands in Georgia. Dewatering is eliminating freshwater wetlands throughout the Coastal Plain, particularly on interior timberlands, and on the coast where development pressures are highest. To successfully manage our priority wading bird populations, we need to adequately address the loss of isolated freshwater wetlands, seeking a mechanism to protect the sites of highest current and future value.

High Priority Areas

1. Chattahoochee National Forest – Particularly Brawley Mountain and the Ivy Log/Gum Log area. The last site where nesting Golden-winged Warblers still occur in Georgia is at the Brawley Mountain site. About 200 acres of habitat for Golden-wings was created here recently by logging and prescribed burning, although numbers have dwindled due to the delay in finally getting this habitat on the ground. Ivy Log/Gum Log is the only nesting site for Cerulean Warblers in the state and habitat maintenance work was done here recently.

2. Piedmont NWR and Oconee National Forest – Breeding Red-cockaded Woodpeckers and Bachman's Sparrows occur at these sites as well as many other bird species of lower conservation concern.

3. Bond Swamp NWR – This national refuge and the surrounding Ocmulgee River corridor are home to one of the larger populations of Swainson's Warbler.

4. Altamaha River Delta – This is an important area for shorebirds and waterbirds including Whimbrels, Red Knots, Piping Plovers, Wilson's Plovers, American Oystercatchers, Least Terns, Gull-billed Terns, Black Skimmers and many more. It provides breeding habitat as well as migration stop-over and wintering habitat.

5. Barrier Islands – Most provide nesting, stop-over, and wintering habitat. Those particularly important to shorebird stop-over and wintering are Little St. Simons, middle beach on Ossabaw, Sapelo, the south ends of St. Simons and Jekyll, Little Cumberland, and the south end of Cumberland. Several of the less developed islands, particularly Wassaw, Blackbeard, Sapelo, and St. Catherines, provide substantial habitat for Painted Buntings as well.

6. Little Egg Island Bar, St. Catherines Island Bar, Pelican Spit, Satilla Marsh Island, and Brunswick Harbor Dredge Spoil Island – These isolated islands provide the best waterbird nesting sites in the state. Species that nest here include Brown Pelican, Gull-billed Tern, Sandwich Tern, Least Tern, Royal Tern, American Oystercatcher, Black Skimmer, and Wilson's Plover. These areas are also heavily used by birds during migration stop-over and in winter.

7. Altamaha WMA – This management area provides a significant amount of habitat for high priority marsh birds such as the King Rail and Least Bittern. Wood Storks also occasionally feed here as do Gull-billed Terns.

8. Okefenokee NWR – This is the only site in the state known to have breeding Florida Sandhill Cranes. This refuge may also harbor a significant number of King Rails, although that is unknown at present. Pine uplands here support Red-cockaded Woodpeckers and Bachman's Sparrows.

9. Savannah, Ogeechee, Altamaha, Satilla, and St. Marys Rivers – The flood plains and adjacent uplands are the stronghold for nesting Swallow-tailed Kites in the state. The Altamaha and Satilla Rivers appear to be the most important of these.

10. Ft. Stewart, Ft. Benning, the Red Hills region – These are our most expansive areas of pine savanna habitat and harbor the largest populations of Red-cockaded Woodpeckers and Bachman's Sparrow in the state. Other high priority birds that occur here in numbers are Southeastern American Kestrel, Loggerhead Shrike, and Henslow's Sparrow. Silver Lake WMA and Joseph Jones Ecological Research Center also have significant number of Red-cockaded Woodpeckers and Bachman's Sparrows.

11. Paulk's Pasture, Townsend, and Moody Forest WMAs – Henslow's Sparrows winter here in good numbers. These are our best known and studied sites for this species.

12. Coastal Saltmarsh – Substantial numbers of nesting MacGillivray's Seaside Sparrows occur throughout low marsh areas of the saltmarsh. Other high priority species including the Nelson's Sparrow and Saltmarsh Sparrow winter here in significant numbers. Black Rails may nest in high marsh areas, although this has not been confirmed.

Problems Affecting High Priority Species and Habitats

The overwhelming threat to high priority species is loss of suitable habitat and this loss is caused by a variety of factors. Urban and suburban expansion causes both direct loss of habitat and degradation of habitat quality, exposing birds to increased risk of predation from domesticated and natural predators and parasitism by brown-headed cowbirds. Coastal development, including an explosion of dock construction and a push to build bridges to many marsh hammocks is a significant problem for many species. Habitat fragmentation is also a significant threat resulting in loss of some species as breeding birds in remnant patches of habitat and reduced productivity of those that remain. Chemical, and possibly bacterial and viral, contamination of habitats and food resources impacts some high priority species, particularly on the coast. Recently it has become clear that climate change will likely be one of the most significant threats to wildlife and their habitats in the future. Some of its potential impacts in Georgia are listed below.

A large suite of birds and other wildlife species are threatened by the loss of the longleaf pine ecosystem or other mature, frequently burned pine forests. Restrictions on the management of forests and wetland habitats including thinning and harvest, prescribed fire, and manipulation of water levels threaten the health of habitats and associated species. Human disturbance stresses numerous high priority species including beach nesting birds, migrating and wintering shorebirds, birds utilizing rookeries for nesting, and birds using pre-migration staging areas. Poorly understood threats include anthropogenic causes of mortality including collisions with lighted buildings, communications towers, and wind turbines. Recent changes in federal Clean Water Act protections for small wetlands could also negatively affect many wetland-dependent species. For migratory species, threats may occur outside of Georgia's physical boundaries such as loss of winter or migratory stopover habitat, poisoning or shooting in countries with fewer protections, collection for the pet trade, or, in the case of pelagic species, conflicts with fishing gear and lighted navigational aids, masts, and other structures on ships.

***Climate Change*:**
While there is a significant amount of uncertainty surrounding the impacts climate change will have on our native species, there are several broad areas of concern. It is likely that a warming

climate will cause the ranges of many species to shift northward, possibly leading to negative interactions with other species or less favorably environmental conditions that affect reproduction and survival. Some species will likely lose a significant amount of habitat because there are spatial and temporal impediments to habitat migration. This may result in dramatic population declines, extirpations, or even extinctions of species. A number of species including, Seaside Sparrow, Saltmarsh Sparrow, and Nelson's Sparrow, have been added to this SWAP bird list specifically because of the threats posed by climate change.

Sea Level Rise

The fact that Georgia's coast is relatively undeveloped and has limited shoreline hardening should allow the coast to migrate and adjust better than the more developed shorelines of other states as sea level continues to increase. However, portions of our coast with beach development and shoreline hardening will likely lose their beaches and developed areas inland may serve as barriers to saltmarsh migration. Another concern is the rapidity with which sea level rise is predicted to occur. Establishment of new beaches and saltmarsh may not be able to keep pace with net loss of these habitats, thereby significantly reducing the amount of habitat available for these highly specialized birds.

Direct impacts: The overall impact on beach nesting birds will depend on the balance between erosion and accretion, and the relative frequency of high tide events. There is evidence that the amplitude of high tide events is increasing at a greater rate than mean sea level rise. This may pose a serious threat to many coastal nesting species, from the seabirds and shorebirds that nest on our beaches to the rails, sparrows, and wrens that nest in our coastal marshes. Tidal inundation already causes numerous nest failures each year among all of these coastal species.

Fresh water impoundments on the immediate coast provide critical fresh water resources to a wide range of species from waterfowl and marsh birds to shorebirds and wading birds. It will be more difficult to maintain these impoundments structurally as sea level continues to rise, and to maintain fresh water in them as salt water invades the river systems.

Indirect Impacts: As sea level rises, and salt water pushes further up our rivers, there will be alterations in coastal habitats that will likely impact breeding and migratory species. A number of priority wading birds, including the Federally Threatened Wood Stork, regularly forage in the intertidal marshes that will likely be impacted as sea level rises. There will also be a retreat upriver of tidal forests as salinity increases.

Trophic asynchrony

Many species of migratory songbirds have been documented returning to their breeding grounds and nesting earlier in the season as the climate continues to warm. There is a concern that the timing of peak bird nesting, and the flush of insects that feed their young, will become asynchronous, leading to lower productivity rates.

Trophic asynchrony is likely much more of a problem in the Arctic, where climate change has been occurring more rapidly than in temperate regions. This would potentially influence several arctic nesting shorebirds that are on Georgia's SWAP bird list, particularly the red knot and whimbrel. Arctic warming may influence breeding habitat, prey availability, quality, and timing, and potentially shift or alter other ecological interactions.

Range Shifts

As climate warms, it is likely that there will be a northward shift of the range of some species where suitable habitat is available. Georgia's Blue Ridge Mountains provide the southernmost breeding range for a number of species and it is quite plausible that we may lose some of these nesting populations if they shift their breeding grounds northward. SWAP listed species that may move north out of Georgia include Golden-winged Warbler and Cerulean Warbler. Others include Blue-winged Warbler, Canada Warbler, Winter Wren, Veery, Red-breasted Nuthatch, and Brown Creeper.

Ocean Warming

As oceans warm, there is the risk of altering the prey base that supports our coastal birds. Fish die-offs and related seabird colony collapse in the North Pacific have been linked to warming ocean waters. Most evidence on the Atlantic coast at this point is fairly speculative however.

Addressing all of these conservation issues will require a combination of regulatory enforcement, protection through acquisition and easement, appropriate management through management plans, agreements and incentives, technical assistance and advisement to land managers, and outreach to the public. Landowners, land managers, and Georgia's citizens must appreciate not only the value of our natural resources, including birds and other wildlife, but must also be educated as to the threats facing these species and protections and management actions required to preserve these valuable resources.

Research and Survey Needs

Several areas of research and survey have been identified to assist in the conservation of priority bird species in Georgia. These needs fall into several broad categories.

Secretive Species

Some groups of birds, particularly secretive marsh birds and nocturnal species, are poorly understood. Inventory and monitoring protocols for these species should be developed and implemented, and should be compatible with similar efforts in other parts of the Southeast or the species' range. Since the original SWAP was completed in 2005, several survey and monitoring efforts have been initiated for secretive or difficult to detect species. In recent years the Standardize North American Marsh Bird Monitoring Protocols have been used to survey King Rails and Least Bitterns (as well as other species) at several sites. Data from these surveys are compatible with those collected across the U.S. and Canada and can be aggregated with other data to look at population trends at local, regional, national, or continental scales. Surveys for Black Rails are being conducted using protocol developed in the Chesapeake Bay region of Virginia and Maryland. These surveys fit into a larger effort to monitor this species across the Atlantic and Gulf Coasts. Surveys of nightjars, songbirds, and other species are also using standardized protocols which allow the data to be used at regional or national levels.

Productivity

Although distribution and perhaps abundance of many species is fairly well known, productivity in various habitat types and conditions needs further study. The influence of external agents including contaminants, toxins, and pathogens on both survival and productivity are poorly understood for most species. Recent research and survey work in Georgia has addressed issues of nesting success and productivity of Wood Storks at some nest sites, and very recently work on nesting success and productivity was started for MacGillivray's Seaside Sparrow in our saltmarshes.

Management

Management issues in need of further study include the use of fire and the frequency, intensity, and timing of burning to benefit specific bird species. We must also conduct research and monitor responses to determine the influence of management strategies targeting particular species or groups of species such as game birds or endangered species on other high priority species. For example, do frequent burning and use of restrictor plates on cavities, common management techniques for Red-cockaded Woodpecker, affect the habitat quality of mature pine forests for Southeastern American Kestrel and Brown-headed Nuthatch? Do management practices promoted in agricultural landscapes for Northern Bobwhite also provide habitats for breeding and wintering songbirds? How effective are predator control efforts at key beach nesting waterbird sites?

Permitting for offshore energy exploration has already begun. This includes both offshore wind energy development as well as oil and gas exploration. For birds the risks are several. Any offshore infrastructure, especially with lighting that attracts birds, may become a collision hazard. Any spill would affect pelagic as well as near-shore coastal species. Colonial seabirds would be particularly vulnerable to a spill. The coastal support and transport infrastructure required to support offshore energy extraction may also seriously impact coastal habitat**.**

While the development of renewable energy sources in Georgia, such as solar and wind farms, should be encouraged, there are potentially negative impacts to wildlife from these developments. Siting issues must be very carefully considered to minimize any impacts to birds. Primarily, physiographic features that concentrate migratory birds and bats should be avoided entirely. Other sensitive sites such as wading bird colonies and Bald Eagle nests should be considered in any siting decision as well.

Winter Distribution and Ecology

Surveys of the winter distribution, habitat use, and ecology of high priority birds are needed for Georgia, because our state serves as an important wintering area for resident species and for many species that breed far north of our borders.

Migration

Perhaps one of the most difficult periods to study in the annual cycle of migratory birds, migration is no less important. A statewide survey of spring and fall migrant occurrence, distribution and abundance is needed. In addition, the distribution, quality and spatial characteristics of migration stopover habitat are poorly understood. For migratory species of birds breeding in Georgia, such as Swallow-tailed Kite, understanding extent and causes of mortality during migration are critical to the long-term health and stability of the population.

Taxonomy

The taxonomy of some bird species needs additional scrutiny and in many cases Georgia may provide significant habitats for distinctive or geographically isolated subspecies such as the Appalachian Yellow-bellied Sapsucker, Southeastern American Kestrel, and Florida Sandhill Crane.

Influences Beyond Georgia

We must also be involved in efforts to understand the population effects of influences that occur outside of our state boundaries and in assisting our international conservation counterparts in seeking solutions for any limiting factors, regardless of where they occur.

Monitoring

It is imperative that we better communicate, coordinate, and share information with other agencies, organizations, and institutions working to conserve our birds. This needs to be done at the state, regional, national, and international levels. Presently some of the national/international coordinated efforts we are participating in include the Breeding Bird Survey, U.S. Nightjar Survey, and International Shorebird Survey. These programs offer central data storage, retrieval, and analysis. We also participate in several other national and regional conservation efforts; however, these are more loosely coordinated and most do not offer a mechanism for central data handling. Coordinated monitoring and data storage for seabirds across the Southeast states should be pursued, since colonial seabirds often move dramatically from year to year, and this would enable us to better understand their status and trends. In cases such as this a shared database would be the best option. The Avian Knowledge Network offers collaborative databases and this network could be used as a central clearinghouse for data storage and dissemination for many of our bird conservation efforts.

Land Conservation

The Satilla River corridor provides some of the most important Swallow-tailed Kite nesting sites in the state, almost all of which are on private lands. Based on the colonial nature of the species, and their site fidelity, protecting known nesting clusters must be one of the highest priorities for the species. This can be achieved through easements, WRP program enrollment, or fee simple purchase. An enormous long-term land conservation need is providing corridors and areas for beach and saltmarsh habitats to mitigate to as sea level rises. This will be one of our greatest conservation challenges in the coming decades.

Outreach and Education

Most wading bird colony sites are on private lands and as such it will be necessary to increase our outreach and education efforts aimed at landowners so that we can effectively work with the landowners to manage these sites. This is also true for Swallow-tailed Kite nesting aggregations as well as for other species. Outreach and education efforts need to also reach out to boaters and beachgoers to aid in protecting beach nesting birds from human disturbance. Campaigns like the American Bird Conservancy's "Swim, fish, and play from 50 yards away" could be used effectively in these efforts.

Significant 2005 SWAP priority action item accomplishments for birds

GOAL • Assess status of high priority species

1. Assess populations of high priority terrestrial birds in the Coastal Plain (e.g., Swallow-tailed Kite, Southeastern American Kestrel, Painted Bunting, grassland species).

Work with swallow-tailed kites is ongoing. We have been monitoring nests in the Atlantic drainage rivers and expanded survey work westward in the state, which has led to documentation of kite nesting further west and north than previously known. Have participated in multi-state roost surveys to better estimate population numbers and tested use of nesting platforms and vocal and visual lures as a possible way to establish new nesting sites. This was very successful. Initiated nest monitoring program for Southeastern American Kestrels using power poles and nest boxes along major power line corridors. This effort is ongoing. Tracked kestrels using radio-telemetry to define home range and habitat use along these power line corridors and at other sites with nest boxes. Completed a 3-year multi-state breeding season survey of Painted Buntings to assess population size of the Southeast Atlantic population. This survey led to a population estimate that was several times larger than the previous estimate. Used radio-telemetry to define home range and habitat use of breeding Loggerhead Shrikes. Have conducted surveys for Henslow's Sparrows for several years at several sites. At three of these sites we have intensively monitored populations for 5 years including banding birds to aid in developing a population index or estimate as well as other demographics. Conducted surveys for Bachman's Sparrows and Swainson's Warblers on state-owned and leased properties to determine presence/absence as well as numbers on occupied sites. Assessed the effects of clearcut size on use of clearcuts by Bachman's Sparrows during the breeding season on private industrial forest lands.

2. Conduct aerial surveys for federally listed birds (Bald Eagle nesting surveys; Wood Stork nesting and roosting surveys).

We have conducted annual Wood Stork nest colony flights at least once, and often twice, each year to determine numbers. Several colonies (usually 9-12) are monitored for productivity. Low altitude photography is used in conjunction with visual counts to estimate numbers. Annual nest surveys for Bald Eagles have been conducted every year. Surveys include a flight in January to determine whether nests are active and to locate new nests. The second survey, flown in March, documents nesting success and productivity. Since Bald Eagles are no longer federally listed and have been increasing in number every year since the surveys started we may consider down-scaling these survey efforts in the future.

3. Conduct midwinter waterbird survey and Piping Plover winter survey; conduct research and surveys on Southeastern Red Knot and Whimbrels; investigate American Oystercatcher ecology and demographics

Continue to conduct mid-winter waterbird and Piping Plover survey annually. Have expanded shorebird efforts to include the International Shorebird Survey. Support Virginia Tech with more frequent Piping Plover surveys. Conducted or supported 2 intensive Red Knot band resighting efforts, with more planned. Satellite tagged 8 Whimbrels in Georgia to track movements to breeding grounds. Most used Hudson Bay, but we did confirm a link to the

Mackenzie River Basin population. Also documented routes traveled by birds in fall to wintering areas, including some interesting interactions with severe weather (e.g. hurricanes) and some key wintering sites were discovered. Discovered that some Whimbrels were killed by hunters in the Caribbean, a source of mortality not widely recognized previously. Continue to conduct annual nesting population survey of American Oystercatchers. Studies of incubation and effects of predator control are being conducted on oystercatchers as well. In addition, counts of wintering oystercatchers have been done as a part of a larger Atlantic Coast effort.

4. Expand Breeding Bird Survey routes

The number of breeding bird survey routes has been increased to 96, with approximately 72-75 being run annually. Significant effort has been made to recruit new observers and this effort will continue in the future.

GOAL • Conserve high priority habitats

5. Continue cooperative management for Golden-winged Warbler and other species requiring mid- to high-elevation early successional habitats in the Blue Ridge

A substantial amount of habitat for Golden-winged Warblers was created at Brawley Mountain on the Chattahoochee National Forest by the U.S. Forest Service, with DNR assistance, using logging and prescribed fire. Unfortunately, this habitat creation was delayed for several years due to an environmental group's concerns and few Golden-winged Warblers remain at this site.

GOAL • Conserve high priority species

6. Continue Waterbird Conservation Initiative

Have been heavily engaged in this initiative conducting surveys, monitoring, research, and habitat management related to seabirds, shorebirds, and wading birds. Managed vegetation encroaching on sand spit islands and other beach habitats using prescribed fire, herbicides, dredge spoil deposition, and other tools to create or preserve and enhance nesting and roosting habitat for colonial waterbirds and shorebirds including Least and Gull-billed Terns, American Oystercatchers, and many other species. Worked cooperatively with the Game Management Section to create and maintain shorebird habitat at Altamaha WMA. Have implemented predator control to eliminate coyotes on barrier islands, where they can essentially reduce most beach nesting bird productivity to zero, as well as control of other predators that affect productivity such as feral hogs and raccoons. Worked with the U.S. Army Corps of Engineers to construct and manage an artificial island in Brunswick Harbor for waterbird and shorebird bird nesting.

7. Implement Red-cockaded Woodpecker conservation on private lands

Have successfully translocated Red-cockaded Woodpeckers to Joseph Jones Ecological Research Center, a private research facility, and to The Nature Conservancy's lands at Moody Forest WMA. Worked with quail plantation owners in the Red Hills region using Safe Harbor to assure these private lands are properly managed to provide habitat for RCWs.

8. Update State-protected species list and work with partners to improve management for these species.

State Protected Species List was updated in 2008. Have been working with numerous partners to improve management of these species. Recommendations on status changes for some species on this list were developed during our SWAP bird list revision meetings.

GOAL • Improve environmental education and outreach

9. Develop technical educational materials (e.g., Georgia Breeding Bird Atlas, revised natural community classification system)

Georgia Breeding Bird Atlas published in 2010. Species accounts for birds on the state protected species list placed on the Wildlife Resources Division website for use by biologists, consultants, researchers, and the general public.

GOAL • Improve public land management

10. Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands (Red-cockaded Woodpecker is mentioned in description, but not specifically in the conservation action).

Have translocated 116 Red-cockaded Woodpeckers from lands with surplus birds to Joseph Jones Ecological Research Center, Moody Forest WMA, and Silver Lake WMA. The Red-cockaded population at the Jones Center had been extirpated. With translocation effort there are now approximately 29 active RCW clusters. Moody Forest was down to a single bird prior to translocation efforts there. Now there are several birds in one or two clusters. The number on Silver Lake went from five family groups (clusters) to 25 clusters with translocation efforts.

11. Manage and monitor coastal bird islands to conserve populations of beach-nesting birds.

Regularly monitor all of these sites for nesting seabirds and shorebirds. Managed vegetation on sand spit islands and other beach habitats, control predators where needed.

GOAL • Increase capacity for wildlife conservation

12. Improve biodiversity databases and increase data-sharing with conservation partners

Have shared Breeding Bird Atlas database with Patuxent Wildlife Research Center in their effort to assemble a database containing as many breeding bird atlas datasets as possible. Continue to add bird records to the Biotics conservation database.

Appendix C. Mammals Technical Team Report

Prepared by Jim Ozier,* Katrina Morris,* and Clay George, Nongame Conservation Section, Georgia Department of Natural Resources

Technical Team Members and Approach

Because of their recognized expertise, the following individuals were invited to participate on the SWAP revision mammal team via email on September 20, 2013, and specifically invited to the mammal team meeting via email on November 5, 2013; seven of these were also involved with the initial 2005 mammal team:

Dr. Michael Bender, Department of Biology, Gordon State College
Dr. Brad Bergstrom, Department of Biology, Valdosta State University
Bobby Bond*, Game Management Section, Georgia Department of Natural Resources
Dr. Steven Castleberry*, Warnell School of Forestry and Natural Resources, University of Georgia
Nikki Castleberry*, Museum of Natural History, University of Georgia
Dr. Mike Chamberlain, Warnell School of Forestry and Natural Resources, University of Georgia
Doug Chamblin*, Office of Environmental Services, Georgia Department of Transportation
Dr. Michael Conner, Joseph W. Jones Ecological Research Center
Dr. Tara Cox, Department of Marine and Environmental Science, Savannah State University
Dr. Mark Ford, Virginia Cooperative Fish and Wildlife Research Unit, Virginia Tech
Dr. Greg Hartman*, Department of Biology, Gordon State College
Dennis Krusac, Southern Regional Office, U. S. Forest Service
Dr. Susan Loeb, U. S. Forest Service Southern Research Station, Clemson University
Pete Pattavina*, Ecological Services, U. S. Fish and Wildlife Service
Carol Ruckdeschel, Cumberland Island Museum
Dr. Jason Scott, Forest Resources Department, Abraham Baldwin Agricultural College
Dr. Doug Waid (ret), Forest Resources Department, Abraham Baldwin Agricultural College
Greg Waters, Game Management Section, Georgia Department of Natural Resources
Dr. Jim Wentworth*, Chattahoochee National Forest, U. S. Forest Service

Each invitee received the report and other products from the 2005 mammal team, our current working priority species table, and a link to the full online 2005 SWAP. Available participants (*) met December 16, 2013 at the Rum Creek Nongame Conservation Section office near Forsyth where they reviewed and discussed priority mammal (except bats and marine species) conservation needs. Katrina Morris helped coordinate a review of priority bat conservation needs the following day (December 17, 2013) as part of the Georgia Bat Working Group meeting at Gordon State College, Barnesville. Most of those present at the December 16 meeting were present, as well as the following additional participants:

Cecilia Ball, Habitat for Bats
Robert Ball, Habitat for Bats
Dr. Jackie Belwood, Georgia Highlands College

Chris Brookshire, Golder Associates, Inc.
Dottie Brown, Ecological Solutions, Inc.
Dr. Stephen Burnett, Clayton State University
Jim Candler, Georgia Power Company
Laci Coleman, Eco-Tech Consultants
Brian Davis, Office of Environmental Services, Georgia Department of Transportation
Ben Dickerson, Georgia Power Company
Lee Droppelman, Eco-Tech Consultants
Dennis Krusac, Southern Regional Office, U. S. Forest Service
Alton Owens, Eco-Tech Consultants
Dr. William Paschal, LaGrange College
Jimmy Rickard, Ecological Services, U. S. Fish and Wildlife Service
Kim Romano, Ecological Solutions, Inc.
Vicky B. Smith, A-Z Animals
Vanessa Terrell, University of Georgia
Dr. Mark Yates, LaGrange College

Additionally, Clay George and Dr. Tara Cox worked separately on the coast to address marine species.

Participants reviewed the draft table of 23 priority species, discussed and updated all data fields, and made the following recommendations:

Add humpback whale (*Megaptera novaeangliae*) – These whales are sighted occasionally in Georgia state and federal ocean waters, they are listed as endangered under the ESA and Georgia Endangered Wildlife Act, and they are threatened by human activities such as shipstrikes and fishery entanglement.

Add northern long-eared bat (*Myotis septentrionalis*) – This species is proposed for listing by the US Fish and Wildlife Service due to impacts from WNS.

Add little brown bat (*Myotis lucifugus*) and eastern pipistrelle (Tri-colored Bat) (*Perimyotis subflavus)* – These are being considered for listing by the US Fish and Wildlife Service due to impacts from WNS.

Add spotted skunk (*Spilogale putorius*) – There are very few records of this species in Georgia and they are apparently in decline throughout much of their range.

Drop star-nosed mole (*Condylura cristata*), masked shrew (*Sorex cinereus*), and Florida black bear (*Ursus americanus floridanus*) from the list. The group felt that these species were sufficiently secure for the short-term. The Florida black bear population in the vicinity of the Okefenokee Swamp is hunted and appears to be doing fine.

Conservation Priorities

Bats – Sixteen species of bats are known to occur in Georgia. During the development of the initial SWAP, six species were considered at risk and in need of additional protection and further research; three additional species are included this time. Work funded by State Wildlife Grants provided a great deal of new information on all of our SWAP species of concern.

Since the development of the initial SWAP bats in the eastern U.S. have been subjected to a new and very serious threat. White-nose Syndrome (WNS) was first documented in New York in the winter of 2006-2007. The disease is caused by a newly discovered fungus (*Pseudogymnoascus destructans*) and has killed millions of cave-dwelling bats in the eastern U.S. (www.whitenosesyndrome.org). WNS was detected in Georgia in 2013 and is now known from 7 counties in the northern part of the state; it continues to spread across the U.S. and Canada. Because of this disease, the U.S. Fish and Wildlife Service has proposed one species for listing under the Endangered Species Act (ESA) and is currently reviewing several others. Georgia has been active completing WNS surveys, participating in research projects and completing education activities across the state. Georgia will continue to monitor the spread of the disease across the state and document the impacts to our bat populations. We will also continue to participate in research projects both to better understand the disease and also to test potential treatment options for WNS. Education has been a critical component of the battle against WNS, helping the caving community and general public to better understand bats, their benefits and the things that threaten their existence. The SWG programs and other federal funding sources have been critical to provide biologists in Georgia with the resources to complete this work in the state.

Another relatively new threat to bats is development of facilities for wind-generated electricity. A recent report estimated that 650,000 to more than 1,300,000 bats were killed between 2000–2011 in the U.S. and Canada. Another study estimated that more than 600,000 bats may have died at wind energy facilities in the U.S. in 2012. The majority of these bats are tree roosting species so far, thus they are not directly impacted by WNS. However, threats from white-nose syndrome, wind energy development, and habitat modification and loss all combine to put several species of bats at risk of serious declines and possibly extinction in the foreseeable future.

Because of the recent declines in bat populations across the eastern use, Beneficial Management Practices (BMPs) for public, private and industrial forests have become a critical need. Currently, BMPs are being developed as part of the Conservation and Recovery Working Group organized during the White-nose Syndrome workshops. This group includes individuals from federal and state agencies, universities, non-profits, industrial forestry and other interested individuals. Sub-groups are currently working on BMP development and these guidelines will be reviewed and revised before being released and implemented. Georgia will continue to work on development and revision of these BMPs. We will implement BMPs for bats on state lands and continue current beneficial practices that are already in action. We will also advise federal agencies and private companies and individuals on implementation of these practices. Many of the BMPs already in place for other species benefit bats as well. Future bat BMPs will be designed to be a part of overall healthy forest management and will benefit a variety of other high priority species.

Another critical issue includes working with Nuisance Wildlife Control Operators (NWCOs). Bats cause widespread nuisance problems when they occupy buildings, sometimes in large numbers. We need to continue to work to see that nuisance bat situations are handled promptly and in a manner that avoids harm to the bats. Exclusions should be conducted outside the season when non-volant young are present if possible, and the provision of alternate roost structures should be encouraged.

Indiana (*Myotis sodalis*), gray (*Myotis grisescens*) and small-footed (*Myotis leibii*) bats were identified as high priority species in the initial SWAP. All have been impacted by WNS, though gray bats appear to be less susceptible; little mortality has been detected at sites that have shown positive for the disease. We should continue using emergence counts at summer roosts and winter counts at hibernacula to monitor this species. Most historically occupied caves have been heavily disturbed and are no longer used, but it is likely that additional occupied caves remain to be discovered. Identifying and protecting all important sites is critical for the protection of this species in Georgia.

The Indiana bat has been heavily impacted by WNS in the Northeastern U.S. We have no current records of this species in caves in Georgia, but a maternity site was recently discovered in some snags in Gilmer County through radio telemetry, and almost certainly there are other summer sites in northern Georgia. We need to continue to attempt to identify any summer maternity areas using banding, radio-telemetry, Anabat (or other bat detector) surveys and mist netting. Though differentiating between Myotid species using bat detectors is difficult, positive *Myotis* calls can be used to target mist-net surveys to determine species presence.

The small-footed bat has also been impacted by WNS in the northeastern US, however to a lesser degree than the Indiana bat. These bats often go undetected in winter hibernacula surveys either because they roost in areas difficult to survey or they use sites other than caves in winter. Further work to determine important winter and summer sites for this species is critical to better understanding the range and critical habitats for this bat in Georgia. Work should include visual outcrop surveys, radio-telemetry, cave surveys, Anabat (or other bat detector) surveys, harp trapping and mist netting. Banding is a concern for this species because of its use of crevices. Many feel that this bat is more likely to become injured by bands impeding movement or getting stuck in rock crevices. We currently do not recommend banding this species in Georgia.

The little brown bat was not considered a high priority species during the initial SWAP development. Though the range in Georgia is limited geographically, it was thought that this species was common across the Eastern U.S. and north Georgia. However, WNS syndrome has caused major declines in little brown bats in the Northeastern U.S. Because of declines from WNS, the little brown bat will be added as a high priority species in the SWAP revision. Very few of these bats are found in hibernacula in Georgia so it is likely that most of the bats captured in summer hibernate further north. However, these sites are likely already impacted by WNS and we expect to see declines in summer captures of this species in the future. Future work should include banding, radio-telemetry, Anabat (or other bat detector) surveys, cave surveys, harp trapping and mist netting. Though differentiating between Myotid species using bat detectors is difficult, positive *Myotis* calls can be used to target mist-net surveys to determine species presence.

During the development of the initial SWAP, the tri-colored bat (formerly Eastern pipistrelle) was considered to be a very common bat in Georgia. It has been found in low numbers in most caves and in some of the highest numbers known in a few winter sites in Georgia. It is also detected during summer mist-net and Anabat surveys across the state. However, WNS is impacting populations of this species in the Eastern U.S. including Georgia. Because of declines from WNS, the tri-colored bat will be added as a high priority species in the SWAP revision. The vast majority of hibernating bats in Georgia are tri-colored bats. It was thought that these bats may be able to survive WNS infection better in the Southern states because of shorter, milder winters and the availability of some food almost year-round. However, surveys during the first years of WNS infection detected a decline of about one-third at known sites. This suggests that this species may be vulnerable to WNS across the range. Future work should include banding, radio-telemetry, Anabat (or other bat detector) surveys, cave surveys, harp trapping and mist netting. In addition, work to determine if coastal populations of this species do not migrate to caves during winter is critical. Efforts to implement conservation measures for this species outside of caves will be especially difficult because of its use of a variety of habitat types and its widespread geographic distribution.

Surveys revealed many new locations for Rafinesque's big-eared bat *(Corynorhinus rafinesquii*) and gave us a much better idea of the important habitat factors that make an area suitable for this species. As was our initial suspicion, we discovered this secretive species was more common than indicated by known occurrence records, though it is still rare throughout the state and suitable habitat is limited. We identified important conservation areas for "Raf bats," the most critical being the Altamaha River corridor; this species was used as an example of one that would benefit from protection of the Altamaha corridor and other floodplain forests. During recent drought years, more mature bottomland hardwood forests were lost that likely provided habitat for this species. Identifying these critical areas and protecting and managing them to promote the growth of bottomland hardwood forests is critical. In the northern portion of the range of this species, the threat of WNS was a concern. However, it does not appear that they are susceptible to the disease. It is still important to identify the best sites for them in northern Georgia and continue to monitor them as the disease spreads through the Southeast.

Southeastern myotis (*Myotis austroriparius*) also rely on bottomland hardwood forests and can use the same trees as Rafinesque's big-eared bats. However, this species also relies on cave habitats, especially for large maternity roosts in the summer. Continuing to monitor these sites using thermal imagery or the best available technology is important to track population changes over time. Gathering additional information on the most important sites for this species and their seasonal movements is also very important. The southeastern myotis in SW Georgia may also use sites in Florida and Alabama. None of the three states understand the movements or best sites for this species in the region. Multi-state projects research and survey projects could help answer some of these questions and inform an effective conservation strategy. This species is not known to be affected by WNS yet, but continued monitoring of the southward spread of the disease is needed.

We now have a better understanding of northern yellow bat (*Lasiurus intermedius*) roosting habitat following recent work on Sapelo and Little St. Simons Islands. Interestingly, only two females were captured during this project. Large scale movements of this bat are completely unknown and it is possible that they occupy different areas during different seasons. We continue to collect Anabat calls along the coast, which should also help to identify the best sites for this species; it is likely that urban areas provide suitable habitat. Research and survey projects to better understand the movements and critical habitats for this species are needed across its range.

Marine species -- Seven species of baleen whales, at least 22 species of toothed whales and dolphins, and one sirenian occur in Atlantic Ocean waters offshore of Georgia. Most of these species occur well offshore, are transient, or only enter Georgia state waters when they are ill, stranded or otherwise outside of their normal habitat. Four marine mammal species are known to occur regularly within the U.S. Territorial Sea offshore of Georgia (i.e., within 12 nautical miles of shore): the West Indian manatee (*Trichecus manatus*), North Atlantic right whale (*Eubalaena glacialis*), humpback whale, and bottlenose dolphin (*Tursiops truncatus*). Manatees, right whales and humpback whales are each listed as endangered under federal and state law. Bottlenose dolphin stocks that occur in Georgia waters are listed as “strategic” stocks under the Marine Mammal Protection Act (MMPA) due to their small population sizes and/or depleted status. All four species are directly impacted by human activities that occur in Georgia waters and have been included in this plan accordingly.

North Atlantic right whales are among the most endangered whale species with a population numbering approximately 450 whales. Waters along the South Carolina, Georgia and northeast Florida coast are an important wintering ground and only known calving ground for this species. Right whales are present from November to April and are most frequently observed 10-45 km east of the Georgia shoreline. The most immediate threats to right whales are mortality and injury from ship strikes and entanglement in commercial fishing gear. Coastal and marine development (including recreational, commercial and military activities) poses a growing threat to whales and their habitat. Climate change may negatively impact forage availability in Northeast U.S. and Canada, and the suitability of Southeast wintering habitat (whale distribution in the Southeast is strongly correlated with water temperature). DNR conducts a wide variety of right whale conservation activities in accordance with the North Atlantic Right Whale Recovery Plan (NMFS 2005) using funds primarily from NMFS. This project is implemented in cooperation with Florida Fish and Wildlife Conservation Commission (FWC), NMFS and other partners. Right whales are the highest priority marine mammal species in Georgia because of their small population size and the importance of Georgia waters to the population’s recovery.

Approximately 11,500 humpback whales inhabit waters throughout the North Atlantic Ocean. Humpbacks migrate between high latitude summer foraging grounds and winter mating/calving grounds in the West Indies. Small numbers of humpback whales, primarily juveniles, have been sighted within 30 km of the Southeast U.S. coast during winter and spring in recent decades. It is unknown whether these whales are wayward migrants, winter residents, or a combination. Like right whales, the primary threats to humpback whales are ship strikes, commercial fishing entanglements, and coastal and marine development. As such, efforts to conserve right whales will indirectly benefit humpback whales. DNR monitors humpback whales opportunistically during right whale monitoring efforts. Additional data on humpback whale distribution and abundance are needed, especially during April and May after right whale monitoring has concluded.

Bottlenose dolphins are the only marine mammal species found year-round in Georgia waters. Georgia dolphins can be categorized into “estuarine” and “coastal” stocks. Estuarine stocks are non-migratory resident groups that inhabit estuaries, brackish tidal rivers and ocean waters within 1 km of shore. Estuarine stocks are geographically constrained, and have relatively small population sizes accordingly (perhaps 200-300 individuals per sound system). Coastal stocks inhabit near-shore ocean waters year-round and move into estuarine habitats at various times of year. The coastal stock along the Georgia and South Carolina coast likely numbers at least 4,000 dolphins. Coastal and estuarine stocks overlap spatially near the beaches and ocean inlets, but genetic research indicates that there is limited interbreeding between stocks. Entanglement in fishing gear and habitat degradation are threats to all dolphin stocks. Harassment and behavioral changes from dolphin feeding may be growing problems in some areas in Georgia. Estuarine dolphins in the Brunswick, GA area have been impacted negatively by high concentrations of persistent environmental contaminants. DNR, NMFS, NOAA’s National Ocean Service and local cooperators monitor bottlenose dolphins using the Georgia Marine Mammal Stranding Network, by conducting photo-identification studies, and through other targeted research. Funding has been provided by NMFS, the Nongame Conservation Fund and private groups.

Manatees inhabit all tidal and near-shore ocean waters along the Georgia coast from April to October. The number of manatees that migrate into coastal Georgia is unknown, but is probably a small fraction of the Florida Atlantic subpopulation, which numbers at least 2,000 manatees. Aerial surveys at Cumberland Sound (along the Georgia/Florida border) found that abundance varies widely within and among seasons, with more than 50 manatees during summer in peak years, to less than 10 manatees during early spring and fall, and during lower years. Manatees disperse widely into coastal Georgia and northward into the Carolinas each summer. They forage on marsh cordgrass (*Spartina alterniflora*) and other emergent vegetation which is abundant throughout coastal Georgia. Threats to manatees in Georgia include watercraft collisions, attraction to artificial freshwater and warm-water sources, and coastal development. Harmful algal blooms (e.g., “red-tides”) and abnormally cold winters regularly cause mass mortalities in Florida waters. Climate-change may exacerbate these impacts in the future, which could impact the number of manatees inhabiting Georgia waters. DNR conducts a wide variety of manatee conservation activities in accordance with the Florida Manatee Recovery Plan (USFWS 2001) using funds primarily from the USFWS and Navy. Recovery efforts are conducted in close cooperation with USFWS, the U.S. Geological Survey, FWC and other partners.

<u>Coastal plain pine savanna species</u> – The extensive, open pine savannas of the southeastern coastal plain have disappeared from the vast majority of this community’s former range. Conversion to agricultural fields, pasture, tree farms, residential areas, roads, etc., has eliminated and fragmented this habitat type, and lack of fire on the landscape has reduced the suitability of many areas.

Although the taxonomy and ranges of fox squirrel subspecies are in question, we consider Sherman's fox squirrel (*Sciurus niger shermani*), which is the large subspecies found in the upper peninsula of Florida and the Okefenokee Swamp region of Georgia, to be of conservation concern because of its rareness and apparent close relationship with declining open longleaf pine habitat. A recent study, funded through a State Wildlife Grant did not find genetic evidence to support subspecific designations, but the results are inconclusive due primarily to small sample sizes. Management to restore suitable savanna-type habitat should benefit this iconic animal and many others of conservation concern.

Southeastern pocket gophers (*Geomys pinetis*) need soft, sandy soil with a grassy/herbaceous groundcover. Loss of longleaf pine savannas has apparently heavily impacted populations, and where they are still found they are often treated as pests because of their burrows. These burrows, however, provide crucial habitat for several other species of wildlife, some invertebrates of which are rarely if ever found elsewhere. DNR needs to work with landowners who still have suitable habitat for these species to promote proper management with frequent fire and responsible timber harvest. Restoration of degraded habitat could also play an important role in building populations of these species eventually. A 2006 roadside survey for Southeastern pocket gophers (*Geomys pinetis*) confirmed suspected recent declines. Of 272 historical locations in 41 counties, gophers were found at only 65 locations in 18 counties. However, the survey did not include known sites in Thomas County on large tracts of private land. Addition of these and other opportunistically discovered sites brought the total to 106 sites in 20 counties. Relatively high densities were identified at 5 locations in Burke, Taylor, Baker, Early, and Camden counties; the population in Thomas County could be added to this list as well. Although pocket gophers appear to do well in some disturbed habitats, such as hay fields, habitat and population fragmentation are significant obstacles to recovery for this species. Reintroduction to suitable sites appears to be a useful management approach; however, opportunistic attempts to trap gophers at sites in Marion and Schley counties for potential relocation to Sand Hills WMA in Taylor County have not been successful so far.

<u>High elevation forest species</u> – The mountains of northeastern Georgia represent the extreme southern limits of the ranges of several species of mammals, including the long-tailed shrew (*Sorex dispar*), water shrew (*Sorex aquaticus*), hairy-tailed mole (*Parascalops breweri*), Appalachian cottontail (*Sylvilagus obscurus*), red squirrel (*Tamiasciurus hudsonicus*), southern bog lemming (*Synaptomys cooperi*), and least weasel (*Mustela nivalis*). Many of these probably represent relict populations left isolated in high elevation sites as the boreal forests retreated northward following the last ice age. Though Georgia provides only a very small amount of the total occupied habitat and supports only a very small portion of the entire population for these species, maintenance of these range extremes could conserve a disproportionate amount of the species' genetic diversity because of isolation and adaptation. In general, these species need high quality forested habitat, with accompanying clean streams, rich soils, and rocky outcrops. In Georgia, much of this habitat occurs on national forest land and is under no immediate threat. However, DNR should work with the Forest Service and private landowners to avoid alteration of these important habitats. The ranges of these species might be particularly vulnerable to climate change. A small increase in average temperature would likely result in a northward retreat, reducing or eliminating occupied habitat in Georgia.

Appendix D. Reptiles and Amphibians Technical Team Report

Prepared by John B. Jensen, Team Leader

Technical Team Members

Dr. Kimberly Andrews, Georgia Sea Turtle Center – Herpetologist
Dr. Bill Birkhead, Columbus State University - Professor
Dr. Carlos Camp, Piedmont College – Professor
Larry Carlisle, D.O.D./Ft. Stewart Military Reservation – Wildlife Biologist
Nikki Castleberry, University of Georgia Museum of Natural History - Curator
Christopher Coppola, U. S. Fish and Wildlife Service – Wildlife Biologist
Mark Dodd, WRD – Wildlife Biologist
Matt Elliott, WRD – Program Manager
Dr. Zach Felix, Reinhardt College - Professor
Thomas Floyd, WRD – Wildlife Biologist
Greg Greer, Greg Greer Enterprises - Herpetologist
Dr. Bob Herrington, Georgia Southwestern University - Professor
Robert Hill, Zoo Atlanta - Herpetologist
Robert Horan, WRD – Wildlife Technician
Jen Howze, Joseph W. Jones Ecological Research Center – Herpetologist
Dr. Chris Jenkins, The Orianne Society - Director
John Jensen, WRD – Wildlife Biologist
Dr. Joyce Klaus, WRD – Wildlife Technician
Dr. Brad Lock, Zoo Atlanta – Veterinarian
John Macey, D.O.D./Ft. Stewart Military Reservation – Wildlife Biologist
Dr. John Maerz, University of Georgia – Professor
Mark Mandica, Atlanta Botanical Garden – Herpetologist
Katy McCurdy, U. S. Fish and Wildlife Service – Wildlife Biologist
Dr. Jessica McGuire, WRD – Wildlife Biologist
Dr. Joe Mendelson, Zoo Atlanta – Herpetologist
Dr. Terry Norton, Georgia Sea Turtle Center – Veterinarian
Dr. Dennis Parmley, Georgia College and State University – Professor
Todd Pierson, University of Georgia – Student
Ashley Raybould, WRD – Wildlife Technician
Ashley Rich-Robertson, Georgia Department of Transportation - Biologist
Dr. Lora Smith, Joseph W. Jones Ecological Research Center – Herpetologist
Dirk Stevenson, The Orianne Society – Herpetologist
Kevin Stohlgren, The Orianne Society – Herpetologist
Vanessa Terrell, University of Georgia - Researcher

Invited but unable to participate:
Dr. Michael Black, Georgia State University – Professor
Dr. Lance McBrayer, Georgia Southern University – Professor/Curator
Robert Moulis, Chatham County – Herpetologist
Dr. Mark Patterson, Gwinnett County Parks and Recreation – Conservation District Coordinator

Dr. David Rostal, Georgia Southern University – Professor
Dr. Adam Safer, Georgia State University – Professor

Approach

Two one-day herp team workshops were held: Georgia Wildlife Federation Headquarters on 15 November 2013; Little Ocmulgee State Park 14 January 2014. The first meeting began with a progress report on amphibian and reptile action items identified in the 2005 SWAP to inform the team on accomplishments and continued needs (summary of accomplishments provided below). Following this report and continuing through the remainder of both meeting dates, the team was presented with the 2005 spreadsheet of high priority species to amend based on information learned since the previous effort. This spreadsheet identifies each species' abundance, range, population trend, threats, protection needs, inventory needs, monitoring needs, research needs, and importance in Georgia as it relates to global conservation of the species. This effort required the knowledge of professionals who work closely with reptiles and amphibians in Georgia and their conservation, and the team assembled for this evaluation certainly represented that need. In addition to expert opinion provided by team members, information on conservation concerns and needs was gleaned from peer-reviewed scientific literature, technical reports, and natural history museum databases.

Thirteen species from the 2005 priority list (*Graptemys geographica*, *Desmognathus aeneus*, *Desmognathus folkertsi*, *Necturus maculosus*, *Plestiodon* [formerly *Eumeces*] *egregius*, *Plethodon metcalfi*, *Plethodon shermani*, *Plethodon teyahalee*, *Plethodon websteri*, *Pseudacris brachyphona*, *Pseudobranchus striatus*, *Stereochilus marginatus*, and *Tantilla relicta*) were not selected by the team for inclusion in the 2015 priority list because they were considered either too peripheral in Georgia or not rare/threatened enough to warrant conservation attention equal to the others. In fact, the status of several of these species was unknown or poorly known in 2005, but studies and observations since then revealed enough stability to consider them of significantly lesser conservation concern. Conversely, six that were not on the 2005 list species (*Ambystoma tigrinum*, *Eurycea aquatica*, *Eurycea chamberlaini*, *Ophisaurus compressus*, *Plethodon savannah*, and *Urspelerpes brucei*) were added to the new one. The full 2015 high priority species list is shown below in Table 1.

The team also discussed the current list of state protected reptiles and amphibians and recommended changes based on current status and threats (this information is not presented here, but will be used when the state protected list is formally reviewed). Following the meeting, the team leader "cleaned-up" the spreadsheet and resubmitted to the team for final review. This finalized spreadsheet was used by the team leader as an important tool for recommending top priorities for conservation action.

Significant 2005 SWAP Priority Action Items Accomplishments

1. Conduct status survey for hellbender.

   A 2005 survey by Jeff Humphries checked stream segments in proximity to historical occurrence records in 21 areas. This contracted survey established a baseline for a long-term, landscape-level survey and population monitoring effort initiated in 2011. Primary objectives include monitoring known populations over time and documenting additional populations from stream basins that had not been sampled before. From 2011-2014, hellbender surveys of 57 streams totaling 47.8 km of stream habitat were conducted by snorkeling and flipping rocks. Researchers caught, weighed, measured, photographed, and individually marked 350 hellbenders. Tissue samples were collected from 305 hellbenders for museum archival and for use in genetics research. Each hellbender was sampled for chytrid fungus (*Bd*) and Ranavirus. Results from the analysis of these and future samples will help in a range-wide assessment of the health of the species. A Georgia hellbender species status assessment was submitted to USFWS to assist in a range-wide assessment in response to a petition to list the hellbender under the federal Endangered Species Act. In cooperation with The Orianne Society, WRD also conducted a hellbender survey throughout much of the north Georgia mountains using environmental DNA (eDNA). In 2013, 150 water samples were collected from 98 streams, including some that had not been sampled before, plus streams with known hellbender populations, streams with historical occurrences and several streams outside of the species' known distribution in Georgia (the Tennessee River drainage). Hellbender DNA was not detected in any of the sampled streams in northwestern Georgia or any of the streams outside of the Tennessee River drainage, with the exception of one previously documented site. However, DNA was detected in 12 streams where hellbenders had not been previously documented.

2. Conduct surveys of potential habitat for bog turtle and associated species and evaluate methodology for use in other habitats in North Georgia.

   In an effort to monitor known populations and identity new bog turtle populations, an average of 150 traps per year have been set in 33 different mountain bog sites for a total of over 71,000 trap days since 2007. In 2005, the Natural Resources Spatial Analysis Laboratory (NARSAL) of UGA was contracted to conduct a GIS-based bog habitat survey of an 11 county area encompassing the Blue Ridge Physiographic Province and adjacent areas. 330 sites were initially identified in the NARSAL survey. In collaboration with the University of Georgia and Clemson University a species distribution model was built in MaxEnt software by creating a relative suitability map based on relationships between known bog turtle occurrences and the ten selected environmental characteristics typical of suitable bog turtle habitat. As a result of these two mapping efforts, over 300 sites have been ground-truthed or otherwise excluded as potential habitat for rare bog flora and fauna in Georgia; 18 separate wetland sites have been selected for bog turtle trapping surveys resulting in the discovery of 4 new bog turtle occurrences, increasing the number of known occurrences in Georgia by 40%. An additional 80 wetland sites identified through GIS, remain to be assessed for potential suitability

3. Identify potential habitat for flatwoods salamander and other high priority Coastal Plain species; survey habitats for populations of high priority species.

   Areas of suitable habitat on public and on private lands within the historical range of the flatwoods salamander, striped newt, and gopher frog were identified through numerous sources including the analysis of topographic and soil survey maps, aerial imagery, a digital elevation model, GIS-based habitat modeling, and information provided by local resource managers, biologists, and agency staff. Surveys for pond breeding amphibians were conducted by dip-netting wetlands following ground-truthing of potential sites on the ground or by helicopter survey. Thirty-five tracts of private land were surveyed primarily for flatwoods salamanders, as well as suitable wetlands on Chickasawhatchee, Mayhaw, and Grand Bay WMAs, Dixon Memorial Forest, and Okefenokee NWR. Survey efforts failed to identify new populations of flatwoods salamanders. Opportunistic surveys for gopher frogs and striped newts detected the former at two previously unknown sites. No new striped newt sites were discovered during this period, but continued persistence was documented at previously known, extant sites.

Sean Graham conducted a WRD-sponsored status survey for the southern dusky salamander in Georgia. Only seven individuals from two sites were found in Georgia, despite widespread historical occurrences. Additional information resulting from this survey can be found in the following publication:
Graham, S. P., E. K. Timpe, and L. R. Laurencio. 2010. Status and possible decline of the southern dusky salamander (*Desmognathus auriculatus*) in Georgia and Alabama, USA. Herpetological Conservation and Biology 5:360-373.

4. Develop private landowner incentives for conservation of flatwoods salamanders.

An analysis of the feasibility of implementing the Safe Harbor Policy as a conservation strategy for flatwoods salamander was conducted. Through interaction with private landowners while conducting flatwoods salamander surveys, it became clear that in order to gain access to many private landholdings some form of legal assurances or conservation incentives must be available. Following a thorough policy analysis, recommendations were made to the US Fish and Wildlife Service for a unique application of the Safe Harbor Policy for the flatwoods salamander that would require no additional regulative mechanism. These policy recommendations would allow for “A Priori Zero Baseline” Safe Harbor Agreements in exchange for access to a particular private property to conduct flatwoods salamander surveys. Extensive drought from 1998 to 2009, coupled with disruption of metapopulation dynamics through extensive habitat fragmentation on the landscape are thought be the primary factors in the presumed extirpation of *A. bishopi* and near extirpation of *A. cingulatum* in Georgia, thus making the implementation of conservation incentives for this species in Georgia moot. However, recommendations resulting from this policy analysis are applicable to any plant or reclusive animal species requiring direct access to private lands to survey for species presence and may still show promise in the conservation of such species.

5. Assess status of diamondback terrapin populations and determine impact of vehicle-induced mortality and incidental captures on populations.

Dr. John Maerz, UGA Warnell School of Forest Resources, conducted a statewide survey of Georgia’s tidal creeks to assess diamondback terrapin abundance. Single-year mark-recapture estimates of terrapin abundance were obtained for 29 randomly chosen tidal creeks. Researchers estimated that 88% of Georgia’s tidal creeks were occupied with an abundance estimate of approximately 92,000 sub-adult and adult terrapins. Terrapin density was found to decline with increasing commercial crabbing activity and there was no measurable impact on abundance with proximity to roads. The overall conclusion of the study was that terrapins were relatively widespread and moderately abundant in Georgia with some notable areas of high density.

6. Continue long-term monitoring of Pigeon Mountain salamander populations; conduct surveys for other high priority cave and outcrop species.

   Carlos Camp of Piedmont College and WRD staff seasonally (once per season) monitored cave-dwelling salamanders at six caves on Pigeon and Lookout mountains every year during this period and observed stable populations of Pigeon Mountain salamanders and other salamander species for which enough encounters were made to assess trends. Additional information resulting from this monitoring effort can be found in the following publications:
   Camp, C. D., and J. B. Jensen. 2007. Seasonal patterns of lipid storage in two salamander species in northwestern Georgia. Journal of the North Carolina Academy of Sciences 123:110-118.
   Camp, C. D., and J. B. Jensen. 2007. Use of twilight zones of caves by plethodontid salamanders. Copeia 2007:594-694.
   Camp, C. D., J. A. Wooten, J. B. Jensen, and D. F. Bartek. 2014. Role of temperature in determining relative abundance in cave twilight zones by two species of lungless salamanders (family Plethodontidae). Canadian Journal of Zoology 92:119-127.

   Numerous caves were surveyed for Tennessee cave salamanders but no new populations were discovered.

   The discovery of green salamanders on Rocky Mountain in the Ridge and Valley (previously unknown from this province) prompted further staff surveys throughout the Georgia portion of this province and resulted in numerous new occurrences.

7. Conduct genetic, taxonomic, and reproductive studies of high priority species. (e.g., bog turtle reproduction; loggerhead genetics; parameters of healthy alligator snapping turtle population).

   Although genetic dependent sex determination (GSD) is the likely mode of sex determination in the bog turtle, discovery of temperature dependent sex determination (TSD) in this species would have significant implications for headstarting methods used in the conservation of the southern bog turtle population. Eggs collected from Georgia's wild turtles in 2011 were used in the initiation of a multi-year cooperative study between the Chattahoochee Nature Center and WRD intended to determine GSD/TSD. However, temperature-controlled incubation of eggs for this experiment was suspended in 2012 due to limited egg availability and lack of egg variability or survival. Funding was granted in 2014 for a study intended to identify sex chromosomes in bog turtles, which would demonstrate GSD without risking the health or future reproduction of any individuals.

   Georgia DNR collaborated with Dr. Joe Nairn and Dr. Brian Shamblin, UGA Warnell School of Forest Resources, to conduct a statewide genetic mark-recapture estimate of adult female loggerhead sea turtle abundance from 2008 to 2014. A single viable egg was taken from each nest in Georgia. Maternal DNA was extracted from egg samples, and nesting females were identified using 18 novel microsatellite loci. To date, 2,242 individual females have been identified nesting on Georgia beaches. Estimates of annual adult female abundance ranged from 288 to 733 females. Other important reproductive parameters were also estimated including site fidelity, clutch frequency, and remigration interval.

WRD conducted a long-term capture-mark-recapture study of alligator snapping turtles in Spring Creek in southwest Georgia. Because a previous survey by staff had shown that this population had the highest capture rate of surveyed populations in Georgia – suggesting it may be among the state's healthiest populations surveyed – we sought to characterize demographics here as a reference for evaluating recovery in other populations. The study ended in 2014, totaling 163 captures of 71 individual turtles in a 2.5-mile stretch of the creek. WRD and Auburn University researchers are analyzing capture-mark-recapture data from the 16-year period to examine population demographics, growth rates and longevity.

8. Investigate site fidelity and habitat use by eastern indigo snakes.

   UGA–Warnell School was contracted to conduct this work and served as PhD dissertation research for Natalie Hyslop. A radiotelemetry study from 2002-2004 investigated the habitat use, survival, movements, and home ranges of the species in southeastern Georgia. 32 snakes (19 M, 13 F) at sites on Fort Stewart and adjacent private property were tracked. Annual home ranges were found to be large (male = 510 ha; female = 101 ha). Models for annual home range size estimates suggested a positive correlation with body size, negative influence of sex (being female), and negative association with habitat undergoing restoration opposed to areas used commercially. Snakes used the highest diversity of habitats in late spring and summer as they moved from their dry upland winter and early spring habitats to wetter, lowland summer ranges; however, snakes continued to periodically use upland xeric habitats throughout the warmer months. Snakes in this study maintained close association with underground shelters, especially throughout the winter. Most fall and winter locations were recorded at gopher tortoise burrows. Snakes relied less on these burrows in spring and summer. Additional information resulting from this study can be found in the following publications:

   N. L. Hyslop, R. J. Cooper, and J. M. Meyers. 2009. Seasonal shifts in shelter and microhabitat use of *Drymarchon couperi* (eastern indigo snake) in Georgia. Copeia 2009:458-464.

   N. L. Hyslop, J. M. Meyers, R. J. Cooper, and T. M. Norton. 2009. Survival of radio-implanted *Drymarchon couperi* (eastern indigo snake) in relation to body size and sex. Herpetologica 65:199-206.

   N. L. Hyslop, D. J. Stevenson, J. N. Macey, L. C. Carlile, C. L. Jenkins, J. A. Hosteetler, and M. K. Oli. 2011. Survival and population growth of a long-lived threatened snake species, *Drymarchon couperi* (eastern indigo snake). Population Ecology DOI 10.1007/s10144-011-0292-3.

9. Restore mountain bogs; continue bog turtle headstart and population establishment efforts and use non-releasable turtles for education/outreach efforts.

A robust field experiment was initiated in 2007: "The Efficacy of Prescribed Fire, Mechanical Woody Stem Removal, and Herbicide Application in the Restoration and Maintenance of Southern Appalachian Mountain Bog Habitats in an Early Seral State by Mimicking Natural Disturbance." The final round of data collection was completed in 2013. A manuscript analyzing the results of this study is in preparation. Vegetative composition of 20 mountain bogs (10 with documented bog turtle occurrences, 10 previously trapped without detection) has been mapped and vegetation classified according to National Wetland Inventory standards. Changes to vegetative composition and hydrologic functionality of these same sites over time are being determined through historical aerial photographic interpretation. All of these data are being collected in an effort to determine subtle environmental variables affecting habitat suitability for the bog turtle over time. A total 17 captive-reared bog turtles were released within a restored mountain bog on the Chattahoochee NF in 2004 and 2005. These turtles are progeny of a captive breeding colony of 7 wild bog turtles from 3 separate Georgia bogs. The sudden loss of all 7 turtles has severely affected Georgia's ability to produce captive-reared turtles for release. Fortunately much of the 2006 cohort of captively-reared hatchlings make up a captive breeding colony today. An effort to breed these captives was initiated in 2011. Since 2007, no viable eggs have been produced in captivity nor have any hatchlings from wild-caught gravid females survived. An outdoor bog turtle enclosure is currently under construction and a cooperatively developed standardized protocol for bog turtle headstarting has been initiated among conservation partners, both of which are expected to improve headstarting results in Georgia in the future with the ultimate objective of additional releases of headstarted bog turtles into restored habitat.

10. Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of freshwater turtles, and develop appropriate regulations.

    A stakeholder's group was formed and met several times to develop appropriate regulations. The Board of Natural Resources approved the recommended regulations which became official in January 2012 (O.C.G.A. 391-4-16). In summary, anyone wishing to possess more than 10 freshwater turtles in Georgia is required to obtain a commercial turtle permit and annually report details of their harvest. Commercial turtlers will be subject to annual quota limits of 100 to 1000 turtles, depending on the species. We believe that these limits are strict enough to prevent overharvest while being generous enough to allow limited commercial enterprise. And, because we now have harvest data made available to us, if these limits prove inadequate to sustain turtle populations, we will have the supportive information necessary to adjust the rules.

11. Address venomous snake exception in state law (O.C.G.A. 27-1-30) prohibiting disturbing or destroying wildlife habitats.

    Senate Bill 322, which simply struck the venomous snake exception language, passed and was signed into law making it illegal to use gasoline or other chemicals to drive rattlesnakes from gopher tortoise burrows.

12. Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of eastern diamondback rattlesnakes, and develop appropriate regulations.

    This action item was not addressed, but remains a priority in the 2015 SWAP revision.

13. Continue sea turtle stranding and salvage network. Monitor impacts of coastal fisheries on sea turtles and effectiveness of nest protection efforts. Consider construction of a Georgia SeaTurtle Center on Jekyll Island.

    Georgia DNR maintained a network of volunteers, managers, and researchers to monitor beaches for stranded sea turtles. Stranded sea turtles were identified by species and morphometric measurements were collected. Gross necropsies are conducted on approximately 65% of carcasses to determine sex and probable cause of death. The number of stranded sea turtles ranges from 84 to 804 annually. Major threats to sea turtles based on necropsies included incidental capture and drowning in the shrimp trawl fishery and watercraft related injuries. In order to further assess the effects of the shrimp trawl fishery on sea turtles, Georgia DNR conducted bi-monthly aerial surveys to document trawler abundance and distribution. Trawler distributions were correlated with stranding patterns to assist law enforcement personnel in planning TED compliance boardings.

    Georgia DNR maintained a network of volunteers, managers, and researchers to monitor beaches for sea turtle nesting activity. Approximately 85 % of Georgia's barrier island beaches were monitored daily from1 May through 1 October for sea turtle nesting activity. Nests deposited at low beach elevations were relocated to minimize embryo mortality from tidal inundation. Nest screening and predator control were used to minimize nest loss to predators. Nests were inventoried following hatchling emergence to assess reproductive success. Loggerhead nesting data shows a significant increasing trend in nesting in Georgia since comprehensive surveys were initiated in 1989 (n=25 years).

    Georgia DNR assisted with fund-raising and design of the Georgia Sea Turtle Center. The Georgia Sea Turtle Center opened to the public in 2007 and is the centerpiece of the sea turtle conservation program on Jekyll Island. The GSTC is an integrated conservation program that includes research, education and rehabilitation.

14. Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands.

    In 2007, in partnership with Atlanta Botanical Garden, University of Georgia, The Nature Conservancy, Zoo Atlanta, U.S. Department of Defense, Joseph W. Jones Ecological Research Center, and Bear Hollow Zoo, WRD began a project that involved collecting gopher frog eggs from healthy populations, rearing them to late-stage tadpoles or post-metamorphic froglets, and releasing them at an unoccupied but high-quality protected site at Williams Bluffs Preserve in Early County, which is within the species' historical range. The goal: Establish a self-sustaining breeding population of gopher frogs at a protected site. 5,621 gopher frogs, mostly metamorphs, have been reared and released during this period. While previous years of drought prevented mature gopher frogs the opportunity to breed in the release pond – and biologists' ability to assess the success of the project – in 2013 we were provided sufficient rainfall to fill the wetland basin. Multiple male gopher frogs were heard calling in the pond that year and a single egg mass was discovered. Males were also heard calling in 2014. Camera surveys of gopher tortoise burrows in the uplands surrounding the wetland showed juvenile and adult gopher frogs using the burrows. Together, these discoveries indicate that released juveniles are surviving to adulthood in the uplands and successfully breeding in the wetland.

Yuchi WMA, a DNR tract identified as having an unsustainably low gopher tortoise population size in its current state, was established as a recipient site for tortoises displaced by development. Thirty-six adult tortoises have been released, and radio telemetry conducted on 10 of them has shown strong fidelity to the release site. Beginning in 2014, juvenile tortoises hatched and head-started from eggs collected at stable populations are being used to further augment the population. Twelve juvenile tortoises with attached radio-transmitters were released in soft-release pens for a three-week period, then allowed free roam once they became well-acclimated to the site. Researchers with UGA are tracking the free-ranging juveniles to evaluate growth, habitat use, home range and survivorship. 20 nests collected from the stable donor sites in 2014 resulted in 142 hatchlings being raised in captivity for release in spring 2015.

Although repatriation of striped newts did not occur in Georgia during this period, Georgia striped newts and WRD staff contributed significantly to efforts in Florida. A small number of striped newts collected from the Fall Line Sandhills WMA breeding pond by staff and others established captive breeding populations at Jacksonville and Memphis zoos. 490 larvae have been produced at these two zoos and were released in an Apalachicola National Forest wetland in 2013 and 2014. Researchers have documented emigration of 36 fully developed land-bound newts from the recipient wetland.

15. Develop technical educational materials.

WRD funded and led the effort to produce the state's only comprehensive guide book to amphibians and reptiles:
Jensen, J. B., C. D. Camp, W. Gibbons, and M. J. Elliott. 2008. Amphibians and Reptiles of Georgia. University of Georgia Press, Athens, GA. 575 pp.

Brochures include:
Forest Management Practices to Enhance Habitat for the Gopher Tortoise
Venomous Snakes of Georgia
Is it a Water Moccasin? (revision/reprint)

High Priority Amphibians and Reptiles

Common Name	Scientific Name
Reticulated Flatwoods Salamander	*Ambystoma bishopi*
Frosted Flatwoods Salamander	*Ambystoma cingulatum*
Eastern Tiger Salamander*	*Ambystoma tigrinum*
One-toed Amphiuma	*Amphiuma pholeter*
Green Salamander	*Aneides aeneus*
Loggerhead Sea Turtle	*Caretta caretta*
Green Sea Turtle	*Chelonia mydas*
Spotted Turtle	*Clemmys guttata*
Eastern Diamond-backed Rattlesnake	*Crotalus adamanteus*
Hellbender	*Cryptobranchus alleganiensis*
Leatherback Sea Turtle	*Dermochelys coriacea*
Southern Dusky Salamander	*Desmognathus auriculatus*
Eastern Indigo Snake	*Drymarchon couperi*
Brown-backed Salamander*	*Eurycea aquatica*
Chamberlain's Dwarf Salamander*	*Eurycea chamberlaini*
Georgia Blind Salamander	*Eurycea wallacei*
Bog Turtle	*Glyptemys muhlenbergii*
Gopher Tortoise	*Gopherus polyphemus*
Barbour's Map Turtle	*Graptemys barbouri*
Alabama Map Turtle	*Graptemys pulchra*
Tennessee Cave Salamander	*Gyrinophilus palleucus*
Southern Hognose Snake	*Heterodon simus*
Kemp's or Atlantic Ridley	*Lepidochelys kempii*
Gopher Frog	*Lithobates capito*
Alligator Snapping Turtle	*Macrochelys temminckii*
Diamondback Terrapin	*Malaclemys terrapin*
Dwarf Waterdog	*Necturus punctatus*
Striped Newt	*Notophthalmus perstriatus*
Island Glass Lizard*	*Ophisaurus compressus*
Mimic Glass Lizard	*Ophisaurus mimicus*
Pine Snake	*Pituophis melanoleucus*
Southern Coal Skink	*Plestiodon anthracinus pluvialis*
Pigeon Mountain Salamander	*Plethodon petraeus*
Savannah Slimy Salamander*	*Plethodon savannah*
Patch-nosed Salamander*	*Urspelerpes brucei*
* = species not on 2005 SWAP	

Examples of High Priority Habitats

Southwestern Appalachians/Ridge & Valley

Caves, springs, and rock outcrops
A great diversity of salamanders, including three of high conservation concern (green, Pigeon Mountain, and Tennessee cave salamanders), depend on these habitats. Caves and rock outcrops can obviously be impacted by mining operations, a continued threat in this region. Forest moisture required by terrestrial salamanders may be compromised by land alteration. Water quality of springs and subterranean streams is threatened by septic tanks and other sources of toxins from upslope developments.

Sag ponds
Fishless, temporary wetlands are critical breeding habitats for a number of amphibians, yet they are frequently deepened and stocked with fish, or drained.

Blue Ridge

Cove hardwood forests
Salamanders reach their highest worldwide diversity in the Southern Blue Ridge, and cove hardwood habitats harbor much of this diversity. Maintenance of mesic forest conditions and low silt loads in embedded seeps and small streams is threatened by development and forestry activities that do not follow Best Management Practices (BMPs).

Mountain bogs
Primarily of concern because of the dependence on this habitat by the endangered bog turtle, although numerous other reptiles and amphibians can be found here. The majority of these habitats are formed in low mountain valleys, mostly in private ownership. Streams within mountain bogs are often channelized, diverted, or impounded, rendering them unsuitable for bog turtles. Beavers may be the primary force behind creation of these habitats, but their activities are rarely tolerated by most landowners. Maintaining these naturally successional habitats requires active management in the form of hand-clearing shrubs and hardwoods, prescribed fire, and targeted herbicide application.

Medium to large streams
Those found in the Tennessee River drainage are home to the hellbender, a huge, fully aquatic salamander that is very sensitive to stream perturbations. Siltation from improper erosion control during land clearing activities and inadequate forested buffers is perhaps the greatest threat. Accumulations of silt reduce or eliminate space between critical rock shelters, and suffocate eggs and larvae. Forestry activities should follow industry-approved BMPs to avoid impacts to streams.

Piedmont

Spring seeps

The recently discovered patch-nosed salamander is only known to occur in a few headwater streams or seeps in the upper Piedmont of eastern Georgia and adjacent South Carolina, thus protection of the surrounding forests is critical to maintaining suitable water quality.

Otherwise, the Piedmont does not contain habitats uniquely important to herps of conservation concern, and with the notable exception above, few of these species range into this province.

Southeastern Plains and Southern Coastal Plain

Isolated wetlands

Includes Carolina bays, sinkhole ponds, cypress domes, and other depressional wetlands. A number of high priority herps (gopher frog, frosted flatwoods salamander, reticulated flatwoods salamander, eastern tiger salamander, and striped newt) depend on the fishless (or lacking of large, predatory fish), temporary conditions provided by isolated wetlands. However, most of these species spend considerably more time burrowed in adjacent uplands. Conservation of these species requires attention to both wetland and upland habitat needs. These wetlands are exempt from any protection under the Clean Water Act, thus they can be filled, drained, or deepened for permanency. The adjacent uplands are often impacted by conversion to silviculture, agriculture, residential and industrial development, or are neglected, fire-suppressed, and overgrown with hardwoods. Prescribed fires in surrounding uplands should be allowed to burn into isolated wetlands, which often necessitates that burning be periodically conducted during the summer when these ponds are most often dry.

Longleaf pine-wiregrass habitats

Includes pine flatwoods, sandhills, and upland pine forest. Many species of reptiles and amphibians are endemic, or nearly so, to this broad habitat type. Thus, it is not surprising that the 97% loss of this habitat range-wide has led to drastic declines of closely associated herpetofauna. Priority species include those above that breed in isolated wetlands, plus mimic glass lizard, eastern indigo snake, southern hognose snake, pine snake, eastern diamond-backed rattlesnake, and gopher tortoise. Silviculture, agriculture, residential and industrial development, and fire suppression have all contributed to loss and alteration of longleaf-wiregrass habitats, and ultimately to declines of the aforementioned herp species. Prescribed burning on an appropriate rotation is the single best tool for maintaining these habitats, but mechanical and chemical means may be necessary to restore some sites before fire alone can be effective. Removal of longleaf pine stumps for the resin and rosin industry significantly reduces important refugia available to numerous snake species, including eastern indigo snake, eastern diamond-backed rattlesnake, and Florida pine snake. This practice should be prohibited on state lands and discouraged elsewhere.

Hammocks and other high ground within and adjacent to salt marshes

Georgia's extensive salt marshes are home to a unique and very specialized turtle of conservation concern, the diamondback terrapin. Terrapins must nest in sandy soil above the high tide level. Unfortunately, these higher grounds are premium land for developments and roads, which reduces the available nesting sites for terrapins and leads to high mortality of females and hatchlings while crossing roads. Early successional habitats on hammocks and in secondary dune systems are also favored habitats for eastern diamond-backed rattlesnakes and island glass lizards.

Ocean beach/dunes

Georgia's ocean beach/dune habitat is critical for the recovery and maintenance of threatened loggerhead turtle populations. Loggerheads typically nest on ocean beaches between the high tide line and the front of the primary dune. Beachfront property is also perhaps the most highly prized real estate in Georgia for residential development and recreation. Human activities have resulted in a wide variety of direct and indirect impacts to this important habitat. Indirect effects include reduced sediment input to the coastal sand-sharing system as a result of the impoundment of Georgia's major river systems. In addition, the construction of jetties and shipping channels has altered natural sand movement patterns increasing erosion on some beaches. Direct impacts to beach dune habitats include coastal development and construction activities such as beach nourishment projects, shoreline stabilization (rock armoring), home construction, artificial lighting, and increased recreational use. Disallowing the construction of structures in the dynamic dunefield will reduce the need to install shoreline stabilization structures and resulting loss in available nesting habitat.

High Priority Areas

Partners in Amphibian and Reptile Conservation (PARC) developed a Priority Amphibian and Reptile Conservation Areas (PARCAs) project. PARCAs are a non-regulatory designation whose purpose is to raise public awareness and spark voluntary action by landowners and conservation partners to benefit amphibians and/or reptiles. Areas are nominated using scientific criteria and expert review, drawing on the concepts of species rarity, richness, regional responsibility, and landscape integrity. Modeled in part after the Important Bird Areas program developed by BirdLife International, PARCAs are intended to be coordinated nationally but implemented locally at state or regional scales. Importantly, PARCAs are not designed to compete with existing landscape biodiversity initiatives, but to complement them – providing an additional spatially explicit layer for conservation consideration.

PARCAs are intended to be established in areas:
- capable of supporting viable amphibian and reptile populations
- occupied by rare, imperiled, or at-risk species, and
- rich in species diversity or endemism

A meeting of amphibian and reptile experts in Georgia (listed below), most of which were also on the SWAP revision herp technical team, was hosted by WRD and convened on 12 June 2012 to determine Georgia's PARCAs. More information on the process can be found in: Apodaca, J.J., S., Spear, and C.L. Jenkins. 2014. Determining Priority Amphibian and Reptile Conservation Areas in the south Atlantic landscape, and assessing their efficacy for cross-taxa conservation. Final Report for the South Atlantic Landscape Conservation Cooperative.

Georgia PARCAs Meeting attendees (* = denotes SWAP herp team member):
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Dr. Lora Smith, Joseph W. Jones Ecological Research Center – Herpetologist *

Thomas Floyd, WRD – Wildlife Biologist *
Malcolm Hodges, The Nature Conservancy - Ecologist
Matt Elliott, WRD – Program Manager *
Dr. Bill Birkhead, Columbus State University - Professor *
John Jensen, WRD – Wildlife Biologist *
Dirk Stevenson, The Orianne Society – Herpetologist *
Dr. Carlos Camp, Piedmont College – Professor *
Javan Bauder, The Orianne Society – Herpetologist
Dr. Chris Jenkins, The Orianne Society - Director *

<u>Georgia PARCAs (refer to Figure 1)</u>

1. Lookout/Pigeon Mountains - Highest salamander species richness in GA, and only place with four species of *Plethodon*. Includes entire range of the Georgia endemic Pigeon Mountain salamander and only known Georgia site(s) for Tennessee cave salamander. Green salamanders are commonly found in rock outcrops in this area. Species endemic to karst regions such as cave salamander and southern zigzag salamander thrive here. Also includes amphibian species normally associated with Coastal Plain such as tiger salamander and southern cricket frog. Mountain chorus frogs and the one of the largest breeding populations of four-toed salamanders range-wide use sag ponds on the mountain tops.

2. Armuchee Ridges – This Ridge and Valley Province PARCA includes species endemic to karst regions, such as the cave salamander. Green salamanders occur in the rocky outcrops and brown-backed salamanders are found in artesian springs and their outflow streams.

3. Conasauga River – A high quality stream with populations of both Alabama and northern map turtles.

4. Cohutta Mountains – Perhaps the largest contiguously forested region in the state, with attendant, high salamander diversity. Also contains headwaters of Conasauga River on the western side; the eastern side contains headwaters for streams that contain hellbenders and possibly mudpuppies.

5. Rich Mountain/ Snake Nation - High salamander diversity including a genetically unique form of Chattahoochee slimy salamander. Contains headwaters for streams that contain hellbenders and possibly mudpuppies.

6. Nantahala Mountains - High salamander diversity (e.g., 6 species of *Desmognathus*). Includes salamanders having strong genetic influence from the red-legged salamander, a North Carolina endemic. Possible occurrence of pigmy salamander. Streams of the Tennessee River drainage harbor hellbenders. Includes populations of eastern milk snakes and coal skinks.

7. Upper Chattooga Basin - High salamander diversity, especially *Desmognathus* (at least 5 spp.). Only place in Georgia with southern Appalachian and southern gray-cheeked salamanders. Green salamanders occur in forested areas with rock-outcroppings.

8. Tugaloo Basin - Second highest salamander species richness in Georgia, especially genus *Desmognathus* (5 spp.). Includes all but one (in SC) known population of the locally endemic patch-nosed salamander, as well as green salamanders.

9. Paulding Forest – A uniquely intact Piedmont region with ridge-tops characterized by montane longleaf habitats, and the only Georgia PARCA representing true Piedmont ecoregion. Locally occurring mountain chorus frogs are among the interesting herps here.

10. Ft. Gordon – Uplands support gopher tortoises and southern hognose snakes, as well as the Georgia endemic Savannah slimy salamander. Streams contain excellent populations of dwarf waterdogs. Spotted turtles and pine snakes are also likely to occur here.

11. Yuchi WMA/Plant Vogtle – Contains Pleistocene beach dune-origin sandhills that are a stronghold for southern hognose and pine snakes. Gopher tortoises also present, though depleted from past human collection for food. Dwarf waterdogs, Chamberlain's dwarf salamanders, and spotted turtles are likely in the blackwater streams and riparian zones. The Savannah slimy salamander, a Georgia endemic, may occur in the uplands.

12. Pine Mountain/ Upper Flint River - An isolated Appalachian-origin ridge in the lower Piedmont that harbors species more characteristic of montane regions, such as wood frogs and spring and seepage salamanders, as well as species typically found in the coastal plain, such as eastern coral snakes. The largest populations known for Webster's salamander are found here. High priority species, Barbour's map turtle and alligator snapping turtle, are found in the river.

13. Ft. Benning/ Western Fall Line Hills – Straddling the Fall Line, Ft. Benning and the surrounding lands are a significant herp diversity hotspot. High priority species in this area include gopher tortoise, Barbour's map turtle, alligator snapping turtle, eastern diamond-backed rattlesnake, pine snake, southern hognose snake, southern coal skink, gopher frog, tiger salamander, Chamberlain's dwarf salamander, and striped newt.

14. Chickasawhatchee Swamp/Ichauway Plantation – Chickasawhatchee Swamp, a.k.a the Swamp of Toa, is the second largest wetland in Georgia and boasts populations of Florida green watersnakes (not a high priority species, but rare in GA) and alligator snapping turtles, and the larger streams in this region have Barbour's map turtles in abundance. Upland communities of longleaf pine support gopher tortoises, eastern diamond-backed rattlesnakes, pine snakes, southern hognose snakes, and non-breeding habitat for reticulated flatwoods salamanders, gopher frogs, tiger salamanders, and striped newts, all of which breed in nearby isolated wetlands. This area is underlain by the Floridan Aquifer which is home to the Georgia blind salamander.

15. Lake Seminole Region – Longleaf pine communities and embedded isolated wetlands provide habitat for gopher tortoises and eastern diamond-backed rattlesnakes. A small, remnant population of eastern indigo snakes also is found here, the only known remaining population in SW Georgia. Lower Chattahoochee and Flint rivers, as well as Spring Creek,

are inhabited by good populations of Barbour's map and alligator snapping turtles. Chamberlain's dwarf salamanders are found in seepages in this region. This area is underlain by the Floridan Aquifer which is home to the Georgia blind salamander.

16. Georgia Red Hills – Premier longleaf pine-wiregrass region of GA, some of which contains virgin forest. Well-managed, primarily for the benefit of bobwhite quail and red-cockaded woodpeckers, but benefits all longleaf pine herp specialists. High priority species include gopher tortoise, eastern diamond-backed rattlesnake, pine snake, one-toed amphiuma, and tiger salamander. Included Ochlocknee River contains a healthy alligator snapping turtle population.

17. Alapaha River and Sandhills – Aeolian sandhills on east side of the river offer habitat for the following high priority species: Gopher tortoise, eastern indigo snake, pine snake, and eastern diamond-backed rattlesnake. Embedded isolated wetlands serve as breeding habitat for striped newt, gopher frog, and tiger salamander. Alapaha River is inhabited by the Suwannee River alligator snapping turtle, a distinct, newly described species that is rarer in Georgia than the species found in other drainages. Spotted turtles also occur in wetlands here.

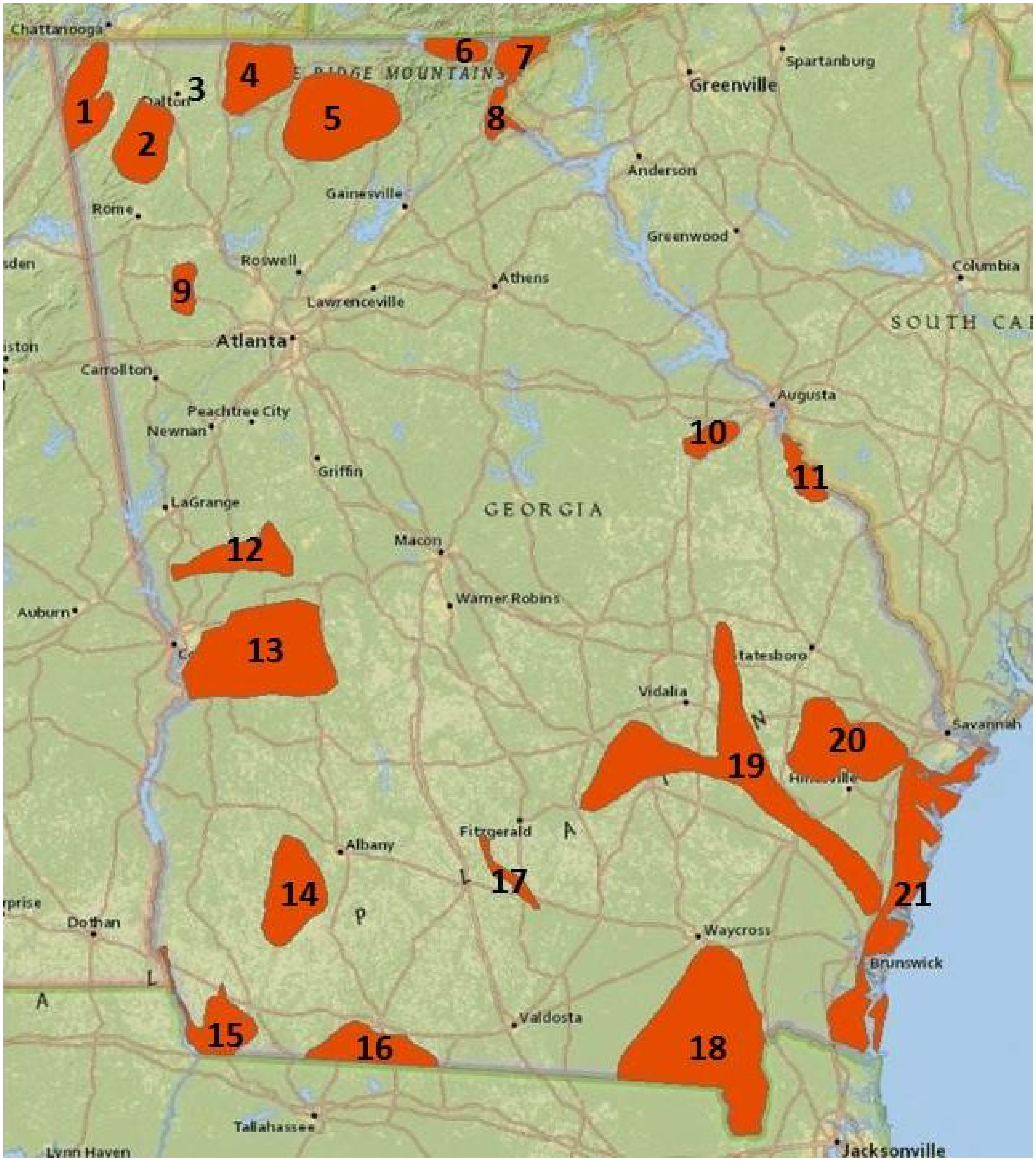
18. Okefenokee Swamp – This is the largest wetland in Georgia and includes both embedded (islands) and adjacent upland habitats. Striped crayfish snakes and Florida red-bellied turtles are found at very few other places in Georgia. Frosted flatwoods salamander, striped newt, gopher frogs, gopher tortoises, eastern indigo snakes, eastern diamond-backed rattlesnakes, and perhaps mimic and island glass lizards all occur here.

19. Altamaha-Ocmulgee-Ohoopee River Corridors – Aeolian sandhills on north and east sides of these rivers and adjacent summer habitat retreats harbor the best remaining populations of eastern indigo snakes in the state, if not in their entire range. Gopher tortoises, spotted turtles, pine snakes, and eastern diamond-backed rattlesnakes also thrive here. Isolated wetlands serve as breeding habitat for striped newt, gopher frog, and tiger salamander. Dwarf waterdogs likely occur in the streams.

20. Ft. Stewart – Largest contiguous old-growth longleaf pine-dominated ecosystem in the state, harboring the only known extant population of frosted flatwoods salamanders in Georgia. Many other rare or unique herps thrive here including gopher tortoise, spotted turtle, eastern diamond-backed rattlesnake, pine snake, southern hognose snake, gopher frog, tiger salamander, southern dusky salamander, and striped newt. The most recently documented mimic glass lizard was found at Ft. Stewart.

21. Barrier Islands and Salt Marshes – Nesting (island beaches) and/or foraging habitat (estuaries and nearshore waters) for four marine turtles (green, loggerhead, Kemp's ridley, and leatherback sea turtles). Estuaries and imbedded marsh islands are habitat for diamondback terrapins. Other rare species found in upland areas in this region include island glass lizards and dense populations of eastern diamond-backed rattlesnakes.

Figure 1 – Georgia PARCAs



High Priority Conservation Actions

Surveys

Because most amphibians and reptiles are very cryptic in behavior, currently known occurrences of many species in the state are likely unrepresentative of their full distribution. Surveys for new populations of priority species will remain an important conservation action. A new technique that may be especially useful for our most cryptic high priority amphibians involves filtering water from aquatic habitats to detect environmental DNA (eDNA) of targeted species. This has been used successfully in Georgia for hellbenders, patch-nosed-salamanders, flatwoods salamanders, striped newts, and gopher frogs. eDNA surveys for some of these species may be expanded and we will explore the utility of this technique for other good candidates, such as Tennessee cave and brown-backed salamanders. Trained detection dogs have proved effective for detecting difficult to find reptiles and may be useful for such priority species as southern hognose snakes and mimic glass lizards. Georgia is home to 18 amphibian and reptile species that are under federal review by USFWS as candidate species or species that have been formally petitioned for listing, and we will be assisting the Service by conducting status surveys or providing status reports. Most of these status surveys are underway, some being funded by a Section 6 grant. Federal candidate species: Striped newt, gopher tortoise. Petitioned species: Gopher frog, one-toed amphiuma, hellbender, green salamander, Chamberlain’s dwarf salamander, Tennessee cave salamander, Georgia blind salamander, Pigeon Mountain salamander, patch-nosed salamander, southern hognose snake, Florida pine snake, eastern diamond-backed rattlesnake, alligator snapping turtle, spotted turtle, Barbour’s map turtle, Alabama map turtle.

Population Monitoring

A critical component of successful conservation efforts involves monitoring to evaluate the population stability of the target organism(s). Monitoring priority species will be done at different scales and use various methods. Some species, such as flatwoods salamander, striped newt, and gopher frog, will continue to be annually monitored for breeding activity at known, recently extant ponds. Eastern indigo snake occupancy monitoring has been employed at selected sites in the sandhills of the lower Altamaha River basin and will be periodically (every 2-3 years) continued here and expanded to other areas (likely Alapaha and Satilla river sandhills). Similarly, occupancy modeling has been used to monitor eastern hellbender populations in select mountain streams and will be continued every three years. A statewide index of abundance for diamondback terrapins, perhaps also using occupancy models, will be developed and designed to assess their trends in abundance over time. Trends in adult female sea turtle abundance will be assessed through nest monitoring programs and genetic mark-recapture sampling. Sea turtle strandings will be monitored (and necropsies performed to determine cause of death) as an index of threats in coastal marine waters. WRD is a signatory to the Gopher Tortoise Candidate Conservation Agreement, and through this has committed to monitoring tortoise population sizes and age classes of state and select private lands harboring the species every 7-10 years using line-transect distance sampling. We may also develop monitoring approaches and implementation for other priority species, such as green salamanders, spotted turtles, and one-toed ampiumas. WRD will continue to administer the North American Amphibian and Monitoring Program (NAAMP) in Georgia. This citizen science-based effort utilizes volunteers to monitor calling activity of frogs along 73 stratified-random driving routes across the state during three survey periods each year.

Disease Screening and Monitoring

Newly emerging diseases are a growing conservation concern for many of our priority species, some of which are known to be highly susceptible while others have been unchallenged thus far but are potentially vulnerable. Diseases and disease-causing pathogens include Snake Fungal Disease (potentially harmful to all snake species), Upper Respiratory Tract Disease (affects gopher tortoises and box turtles), ranavirus (affects many amphibians and some turtles; gopher frogs are highly vulnerable based on laboratory trials), and amphibian chytrid fungi (*Batrachochytrium dendrobatidis* and *B. salamandrivorans*). Potentially or known-to-be vulnerable high priority amphibians and reptiles will be sampled for these and other emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.

Translocation, Captive Rearing, and Head-starting

Habitat loss and the resulting fragmentation it causes have left many populations of amphibians and reptiles severely isolated. Because most of these species have very limited dispersal abilities, restoring them in areas where they have been heavily reduced (augmentation) or eliminated (repatriation) often requires translocations or captive breeding/rearing and release programs. WRD has been actively working to establish a new gopher frog population using wild-collected eggs, tadpole rearing, and releases of metamorphs. This will be continued and likely expanded to other sites. Similarly, juvenile gopher tortoises head-started from wild-collected eggs are being used to augment the small resident population on Yuchi WMA, a project that will also be continued and perhaps expanded to other sites. Augmentation of the Yuchi WMA tortoise population has also involved translocations of tortoises displaced by development elsewhere. While the cause of the displacement is a concern for this and other species, we will opportunistically salvage vulnerable tortoises and strategically use them to augment Yuchi WMA and other tortoise-depleted, but protected state lands. Captive breeding/rearing, head-starting and releases of bog turtles will also continue. Other priority species that may be future candidates for captive breeding/rearing and head-starting efforts include flatwoods salamanders, striped newts, and southern hognose snakes.

Research

Research is an integral part of many amphibian and reptile conservation efforts, in-part because for many of these species we still have more questions than answers about aspects of their life history, natural history, taxonomic status, etc. High priority species for which basic natural history remains poorly known include Chamberlain's dwarf salamander, patch-nosed salamander, Georgia blind salamander, Tennessee cave salamander, southern dusky salamander, brown-backed salamander, dwarf waterdog, one-toed amphiuma, spotted turtle, southern hognose snake, and southern coal skink. Taxonomic questions exist for green salamander (are those found in three different and widely separated physiographic provinces genetically unique?), southern coal skink (are the isolated coastal plain populations actually representative of a distinct species rather than subspecies?), and Florida pine snake (similar question as coal skink). Determining the demographic patterns and habitat use of juvenile sea turtles in coastal waters will be important to understanding patterns in seasonal abundance, and is critical for assessing the impacts of coastal offshore development projects and other activities such as vessel interactions.

Legislation/Regulation/Enforcement

Changing existing laws and regulations, or developing new legislative or regulatory recommendations, may be necessary to ensure conservation of certain exploited amphibians and reptiles. Adding to the state list of protected species is one avenue for conservation, but that alone is not always sufficient. Concerns voiced during the technical team meetings that would require legislative or regulatory attention to adequately address include prohibiting the shooting of basking turtles (which is done indiscriminately and is a threat to map turtles), regulating the attendance of set lines ("bush-hooks"), their placement, and their immediate removal after a fishing effort (these incidentally capture and kill certain reptiles including map turtles and alligator snappers), and prohibiting or limiting commercialization (primarily for skin and venom trade) of eastern diamond-backed rattlesnakes. To further address concerns for that latter species, we will continue dialogue with the Whigham Community Club in hopes of reforming the last remaining Georgia rattlesnake roundup into a wildlife-friendly festival, as was successfully done in Fitzgerald and Claxton. The shrimp trawl fishery is the primary source of mortality for sea turtles in Georgia. Shrimpers are required to use Turtle Excluder Devices (TEDs) in all trawl nets to reduce incidental capture and drowning of sea turtles. Poor TED compliance rates have hampered sea turtle recovery efforts in Georgia. Assuring high compliance with TED regulations is necessary for population recovery. In addition, a limited-entry system for the shrimp trawl fishery should be developed to reduce overall trawling effort and interactions with sea turtles. All other trawl fisheries should be monitored for sea turtle mortality (whelk, jellyfish) and conservation measures should be put in place if mortality is observed. Applying the North American Model of Wildlife Conservation to all of our amphibians and reptiles, an idea formally approved at the 2014 AFWA Business Meeting, should be pursued in Georgia to ensure sustainable use of herpetofaunal resources.

Conservation Planning

One of the greatest threats to diamondback terrapins is drowning in commercial and recreational crab pots. To address this, a terrapin conservation plan for these crab pot fisheries will be developed and implemented. The terrapin conservation plan should include the use of Terrapin Excluder Devices (TEDs), pot soak time requirements, closure areas, removal of abandoned pots, and the monitoring of the effectiveness of conservation efforts. Another significant threat to terrapins is mortality of nesting females on coastal roadways. To address this we will continue to experimentally assess methods and develop management guidelines for reducing terrapin mortality on coastal roadways, including techniques for installing seasonal barrier fences.

Addressing/Monitoring Climate Change Impacts

Warmer average temperatures, increased drought frequency and intensity, and sea level rise are predicted outcomes of climate change in the southeastern United States that are likely to have adverse effects on herpetofauna. Effects on habitat suitability are the most wide-ranging, but in the case of most of our turtle species and the American alligator, species that exhibit temperature-dependent sex determination, warming temperatures may skew sex ratios adversely. WRD cooperators will continue to monitor the length of incubation for all sea turtle nests in the state, which is significantly correlated with incubation temperature and sex ratio. Additionally, WRD will continue periodic qualitative surveys of sea turtle nesting habitat on all barrier island beaches, categorizing each 100 m section as erosional or depositional based on beach and dune morphological characteristics. Annual surveys are compared to determine changes in the erosional state of sea turtle nesting habitat. Researchers at UGA conducted an "Amphibian and Reptile Climate Change Vulnerability Assessment" (Barrett, K., J.C. Maerz, and N. P. Nibbelink. 2012. Amphibian and Reptile Climate Vulnerability Assessment. Attachment A In Missouri Department of Conservation (Ed.), State Wildlife Action Plan Implementation Resources and Capacity Building Tools for Amphibian & Reptile Conservation, Final Report to US Fish & Wildlife Service. Competitive State Wildlife Grant No. U-3-R-1. FBMS No. F09AP00202. Jefferson City, MO) for select southeastern species, including ten (flatwoods salamander, tiger salamander, one-toed amphiuma, green salamander, hellbender, striped newt, gopher frog, eastern indigo snake, bog turtle, and gopher tortoise) that we consider high priority in Georgia. The predictions are dire for all high priority Georgia species in showing significant reductions in climatically suitable habitat. The assessment maps indicate where climatically suitable habitat is predicted to remain in 2050, and for the striped newt and flatwoods salamander, no habitat is predicted to remain. Several of the high priority species assessed (striped newt, flatwoods salamander, hellbender, eastern indigo snake, gopher tortoise) are part of continuing population monitoring efforts in Georgia, and over time we will be able to compare observations of them from the field with the predictive models. For pond-breeding amphibians such as striped newts, tiger salamanders, and gopher frogs, creating permanent fishless wetlands by installing flexible plastic liners in natural or excavated depressions is one method to mitigate for climate change impacts that may be explored.

Appendix E. Fishes and Aquatic Invertebrates Technical Team Report

Prepared by Brett Albanese, Jason M. Wisniewski and Andrew GaschoLandis

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Executive Summary

As part of the 2015 revision of Georgia's State Wildlife Action Plan (SWAP), the SWAP aquatic species technical team assessed the conservation status and needs of 251 rare aquatic species (fishes, mollusks, crayfishes, insects, and other aquatic invertebrates). The assessment was completed using expert opinion, published reports, and range maps that depicted watersheds categorized by the date of the species' last known occurrence as well as locations of occurrences and recent survey sites. While many species persist in all or most of their historically-occupied watersheds, an alarming proportion of fishes (42%), mollusks (43%) and crayfishes (25%) have been documented from half or fewer of their Georgia historic watersheds within the last decade. Lack of recent watershed occurrences can be attributed to either lack of sampling or population declines. Information gaps were particularly evident for aquatic insects and other arthropod species, which were frequently categorized as "unknown" for assessment criteria.

Overall, a significant number of Georgia's aquatic species can be considered imperiled. Eighty-six species are globally imperiled (G1-G2), half of which are mollusks. Within the state, 152 species are considered imperiled (S1-S2) and four dozen more are historic (SH—not seen in 20-40 years, but could still be extant) or considered extirpated (SX). Based on their degree of imperilment, information needs, and need for conservation within the next 5-10 years of SWAP implementation, the technical team identified 165 high priority species. The high priority species list includes 22 federally-listed species, a single candidate species, 46 species that are petitioned for federal listing (some additional petitioned species were not high priority because they are considered stable or extirpated from the state), and 109 species that are currently state-listed or merit state listing according to the species technical team (numbers do not add up because some species occur in multiple categories). Altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction were identified as significant threats to the greatest number of high priority aquatic species. While these results are sobering and indicate the magnitude of the aquatic conservation problem in Georgia, there have been some improvements since the first SWAP plan was completed in 2005. For example, seven species have been proposed for removal from the state-protected species list and an additional eight state-listed species were downgraded to a less imperiled listing category. Additionally, the status of some species proposed for listing under the U.S. Endangered Species Act (ESA), such as the Altamaha Arcmussel and the Apalachicola Floater, has improved since the first assessment due to the discovery of new populations.

In addition to numerous species-specific actions, the aquatic technical team identified 53 high priority conservation actions to be addressed during SWAP implementation. Proposed actions include distributional surveys and monitoring, research and conservation planning that will improve the effectiveness of conservation efforts, on the ground conservation actions, and environmental education and outreach. Meeting the conservation needs of SWAP high priority species is a daunting task and will require increased capacity and coordination, as well as the implementation of conservation actions with the potential to simultaneously benefit multiple species. The identification of watersheds that protect the greatest number of high priority aquatic species should help identify the places where a multi-species approach will be most effective.

Introduction

Like other southeastern states, Georgia occurs within one of the most diverse regions for aquatic species richness in the temperate world (Abell et al. 2000). Georgia is among the top five states in the number of native species of mussels (127 species), fishes (265 species), and crayfishes (70 species). Unfortunately, Georgia is also ranked among the top states in the number of imperiled aquatic species (Taylor et al. 2007; Jelks et al. 2008; Johnson et al. 2013). Threats to Georgia's aquatic diversity and habitats are representative of the threats contributing to the global freshwater biodiversity crisis (Dudgeon et al. 2005) and include water pollution, flow alteration, habitat degradation and fragmentation, invasive species, and climate change. These threats are associated with urbanization, agricultural runoff and irrigation, dams and water withdrawals, riparian alteration, historic land use, and other human activities.

In an effort to prioritize conservation actions to conserve and restore Georgia's aquatic diversity, Georgia assessed the conservation needs of 376 aquatic taxa as part of the development of a State Wildlife Action Plan (SWAP) in 2005. Completing the SWAP plan was necessary for funding under the State Wildlife Grants (SWG) program, but also provided an opportunity to systematically assess the status and conservation needs of Georgia's species and habitats. The SWAP 2005 assessment identified 74 fishes, 75 mollusks, 47 aquatic arthropods, and 212 waterbodies as high priority for conservation efforts. It also resulted in the addition of 42 aquatic species to Georgia's protected species list, the development of an online guide to rare species (Georgia Department of Natural Resources 2010), and provided guidance for many of the aquatic conservation projects that have been completed by GADNR and its partners since that time (Table 1).

Table 1. Examples of aquatic conservation projects initiated since completion of Georgia's State Wildlife Action Plan in 2005. Almost all of these projects address high priority species, habitats, or conservation actions identified in the 2005 SWAP Plan. Projects were completed by a variety of agencies, organizations, and other conservation partners. ACF = Apalachicola, Chattahoochee, and Flint drainage.

Project Title	**Year Completed**
ACF (Sawhatchee Creek) Mussel Monitoring	Ongoing
ACF (Spring Creek) Mussel Monitoring	Ongoing
ACF Crayfish Surveys	2007
ACF Dam Removals (Eagle & Phoenix and City Mills Dams)	2013
ACF Mussel Identification Workshops	Ongoing
ACF Reservoir/Flow Management Alternatives Study	2014
ACF Sheffields Mill Creek (Sawhatchee System) Stabilization Project	Ongoing
Alabama Shad Management Plan-ACF basin	2013
Altamaha River Mussel Monitoring	2008
Altamaha River Mussel Population Genetics Study	2010
Amber Darter Genetics Study	2011

Project Title	**Year Completed**
American Shad Management Plan for Altamaha River	2012
Blackbanded Sunfish Survey	2014
Blue Shiner Genetics Study	2008
Bluenose Shiner Survey	2007
Captive Propagation Techniques for Several Rare GA Aquatic Species	Ongoing
Cherokee Darter Genetics Study	2006
Conasagua Fishes Monitoring	Ongoing
Conasauga (Dill Creek) Fish Passage Removal	2011
Conasauga (Holly Creek) Mussel Monitoring	Ongoing
Conasauga (Holly Creek) Restoration Project (0.7 mile)	Need Date
Conasauga (Petty Farm) Stream Corridor Protection	2009
Conasauga Conservation Area	Ongoing
Conasauga Intersex Fishes/Human Health Study	Ongoing
Conasauga Nitrate/Estrogen/Glyphosate and Agricultural Runoff Studies	Ongoing
Conasauga Riparian Restoration (Alaculsey Valley)	2006
Conasauga Snorkel Hole Fish Education Program	Ongoing
Conasauga Spring Restoration (Colvard Springs)	Ongoing
Conasauga Sub-basin Prioritization	2009
Coosa Fish Passage Barriers –Priority Removal Evaluation	Ongoing
Coosa Mussel Reintroduction Study	Ongoing
Coosawattee Fishes Survey (Goldline, Bridled and Holiday darters)	2013
Coosawattee Flow Habitat Relationship Study	2010
Corps Permit Requirements for Culverts and Utility Crossings	2010
Crayfishes of Georgia Website	2012
Edmund’s Snaketail and Cherokee Clubtail Dragonfly Surveys	2008
Etowah (Raccoon Creek) Restoration Monitoring	Ongoing
Etowah (Raccoon Creek) Basin Land Acquisition and Restoration	Ongoing
Etowah (Raccoon Creek) Fish Passage Project, Braswell Mtn. Rd	2013
Etowah (Shoal Creek) Preservation	Ongoing
Etowah (Smithwick Creek) Preservation and Restoration	Ongoing
Etowah Darter Genetics Study	2006
Etowah Fishes Monitoring	Ongoing
Etowah Fishes Stressors Study	2007
Etowah Habitat Conservation Plan Management Strategies	Ongoing
Etowah Mainstem Riparian Buffer Corridor Establishment	Ongoing
Fishes of Georgia Website	2008
Flint Mussel Age, Growth and Physiology Study	2014
Flint River Habitat Conservation Planning Project	Ongoing

Project Title	**Year Completed**
Flint River Mussel Monitoring	Ongoing
Goldline Darter Genetics Study	2012
Interagency Mussel Survey Protocol	2008
Lake Blackshear/Lake Harding Downstream Dissolved Oxygen Improvements	2008, 2011
Lake Sturgeon Reintroduction Program	Ongoing
Livestock Riparian Fencing Program (Partners for Fish and Wildlife)	2012
Multistate Prioritization of Small Barriers for Removal	Ongoing
Piedmont Blue Burrower Crayfish Survey	2010
Robust Redhorse Gravel Bar Monitoring	Ongoing
Robust Redhorse-Broad River Population Assessment	2013
Robust Redhorse-Ocmulgee River Population Assessment	2014
Robust Redhorse-Oconee River Telemetry Study	2012
Robust Redhorse-Ogeechee River Population Assessment	2013
Savannah Ecosystem Flows Alternatives Study	Ongoing
Say's Spiketail Dragonfly Survey	2008
Shoal Bass Genetic Integrity, Population Status, and Viability Studies	Ongoing
Sicklefin Redhorse Monitoring	Ongoing
Stream Fish Occurrence in Response to Impervious Surface Study	2008
Tennessee (South Chickamauga Creek) Fish Community/Passage Study	Ongoing
Tennessee (Toccoa River) Rare Fishes Survey and Riparian Assessment	2011
Tennessee Basin Mussels Survey	2014

Almost a decade has passed since the conservation needs of Georgia's aquatic species have been systematically assessed. In addition to the large number of conservation projects completed or initiated since 2005 (Table 1), substantial efforts have been made to update the GADNR Rare Species Database (also known as the NatureServe Biotics database) as well as databases maintained by the GADNR Stream Survey Team, the Georgia Museum of Natural History and the U.S. Fish and Wildlife Service (FWS), Georgia Ecological Services Office. In addition, the need for up-to-date status information has been amplified because of the large number of Georgia aquatic species that have been petitioned for listing under the ESA. Petitioned species must undergo an intensive 12 month review to determine if listing under the ESA is warranted. Because of the limited resources available for the conservation of ESA listed species, it is important that the 12-month finding is based on the best available information.

The purpose of this assessment is to identify the current conservation status, conservation needs (e.g., surveys, monitoring, management) and high priority conservation actions for Georgia's rare aquatic species. A companion report has identified high priority watersheds for conservation (Albanese et al. 2015).

Assessment Methods

We initially included 196 species in the assessment because they were designated as high priority for conservation in our SWAP plan in 2005. We added additional species because they had been formally petitioned for listing under the ESA or because of some concern or uncertainty about their current conservation status. Ultimately, 251 species were included in the current assessment, including 103 fishes, 28 crayfishes, 24 aquatic insects, 9 “other” arthropods (isopods, amphipods, shrimps, etc.), 56 mussels, and 31 snails. With the exception of three estuarine species, all species occur within freshwater or use freshwater habitats for some portion of their life cycle. We generally did not include historic or extirpated species in the assessment, unless there was uncertainty about their status or a realistic expectation for reintroduction or rediscovery.

The species assessment was carried out by technical team members during three single-day meetings held at the Georgia Wildlife Federation’s Alcovy Conservation Center in Covington, Georgia. We held separate meetings for freshwater fishes, freshwater mollusks (mussels and snails), and aquatic arthropods (crayfishes, insects, and cave invertebrates) during January and February 2014. Technical team members were split into groups, with each group assessing different groups of species based on their faunal and regional expertise. The following groups were identified: crayfishes, aquatic insects and cave invertebrates, Gulf/Atlantic Slope Basin mussels, Mobile Basin mussels, Tennessee Basin mussels, snails (all basins), Atlantic Slope Basin fishes, Mobile Basin fishes, Gulf Slope Basin fishes, and Tennessee Basin fishes.

We created an Access database (Microsoft Corp., Redmond WA, USA) to record the results of the species assessment. Assessment data fields were grouped into the following seven categories: current status, habitat, range, trends and threats, conservation needs, recommendations, and documentation. Definitions for some fields were slightly modified for relevance to aquatic species, as shown in Appendix 1. For each species, technical team members assigned qualitative categorical rankings to range size, the importance of Georgia protection efforts to global conservation, population trends, and degree of threat. Selecting from a list of 25 standardized threat descriptions, they also selected the three most significant threats to each species. The database included long comment boxes for specific recommendations for protection, inventory, monitoring, management, and research needs. Technical team members were asked to recommend changes to the State Rarity Rank (SRANK), status under Georgia’s Endangered Wildlife Act, whether the species should be identified as high priority in the revised SWAP, and whether the species should be tracked as a special concern species in Georgia’s Rare Species Database (i.e., NatureServe Biotics database). The hierarchical relationship between these different conservation status categories is shown in Figure 1. Finally, for species designated as a high priority, we asked team members to identify up to four important watersheds for the conservation of each species, as described in our Georgia SWAP High Priority Watershed report (Albanese et. al 2015). The technical team spent approximately 5-20 minutes discussing each species while GADNR staff recorded their comments in the database. In addition, technical team members were provided an opportunity to review and edit draft assessment results in May 2014 and the draft assessment report in September 2014.

Key reference materials (e.g., taxonomic and distribution guides, reports), Georgia landcover maps and conservation status assessment maps were provided to technical team members to facilitate assessment completion. Conservation status assessment maps categorize USGS 10 digit Hydrologic Unit Code (HUC 10) watersheds by the year of the most recent occurrence of the species and also include locations of known occurrences and recent survey sites. These maps were used to help identify high priority watersheds for conservation, but also helped inform assessments of range size, trends, and areas in need of survey. We chose the HUC 10 spatial scale because we believe it provides a practical scale for the conservation of high priority watersheds (McGurrin and Forsgren 1997). In addition, mapping at finer spatial scales (HUC 12) was not prudent because many have not been surveyed. Using the maps, we determined the total number of HUC10 watersheds known for each species as well as the number of watersheds where the species has been documented within the last 10 years. A more detailed description of our conservation status assessment maps, along with conservation status maps for 193 species included in our SWAP assessment is found on the following web page: http://www.georgiawildlife.com/conservation_status_assessment_maps. We were not able to make maps for the remaining 58 species (primarily invertebrates) because of insufficient distributional data.

Species occurrence records used to make the conservation status assessment maps were compiled from the following sources: 1) GADNR Rare Species Database. This dataset includes records from research projects carried out by GADNR or its contractors, publications, consultant reports, and scientific collection permit reports, 2) GADNR Stream Survey Team Database. This dataset includes records collected from wadeable streams throughout Georgia between 1998-2011, 3) GADNR Fisheries Standardized Sampling Database. This dataset includes records collected from large rivers and reservoirs throughout Georgia between 1984-2013, but focuses primarily on game fishes and large-bodied species (http://www.georgiawildlife.com/fishing/fisheries-management), and 4) Records from the Georgia Museum of Natural History (http://museum.nhm.uga.edu/). These records are a compilation of historic and recent surveys performed by independent researchers as well as research staff of the University of Georgia. Additional species occurrence records provided by assessment team members were added to the databases as needed after technical team meetings.

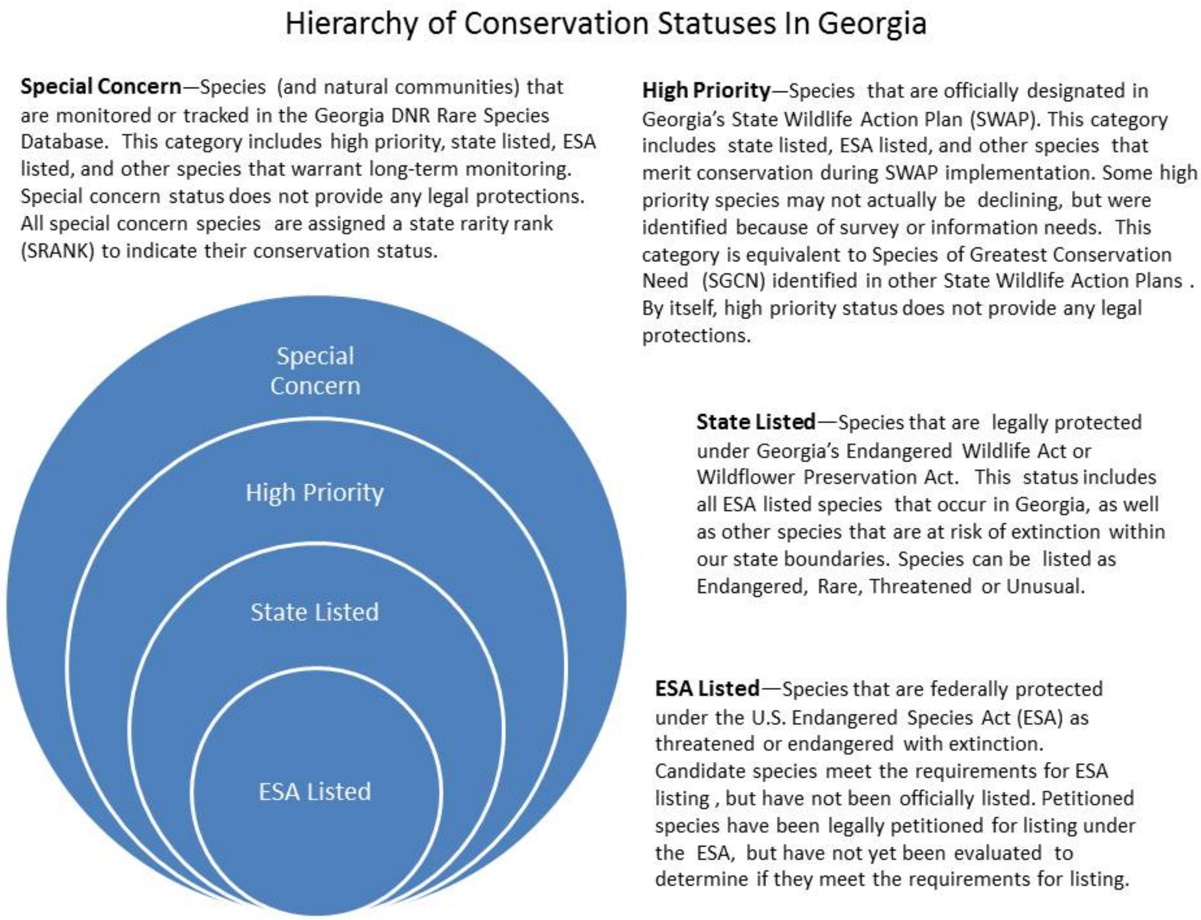


Figure 1. Hierarchy of frequently used conservation status categories in Georgia. Although there are rare exceptions (e.g., an ESA listed species that is not state-listed because it is considered extirpated), the figure shows how the more restrictive categories containing fewer species are nested within the larger, less restrictive categories. Thus an ESA listed species is almost always designated as state listed, high priority and special concern.

Assessment Results

Categorical Assessment Criteria: Range, Georgia Importance, and Trends

The majority of fishes and mollusks and all of the crayfishes included in the assessment were categorized as having a very small to narrow geographic range (Figure 2). To put this in perspective, the majority of fishes (61%) and mollusks (54%) are known from fewer than 10 HUC 10 watersheds and 82% of the crayfishes assessed are known from five or fewer watersheds (Figure 3). Protection efforts in Georgia were considered critical or very important to the global conservation of the majority of mollusks and crayfishes included in the assessment and almost half of the fishes (Figure 4). Population trends were categorized as unknown for the vast majority of species included in the assessment largely due to the technical team's unwillingness to speculate without detailed trend data (Figure 5). Several species that have been monitored periodically in the past (e.g., Altamaha Spinymussel, Robust Redhorse) were categorized as rapidly declining or declining but many crayfish species were categorized as stable. While some species are persisting in all or most of their historically-occupied watersheds, an alarming proportion of fishes (42%), mollusks (43%) and crayfishes (25%) have been documented from half or fewer of their Georgia historic watersheds within the last decade (Figure 6). These results stem from lack of recent, targeted surveys for some species, but also suggest that some populations have likely declined or have become extirpated. For example, examination of the conservation status map for the Frecklebelly Madtom (*Noturus munitus*) illustrates that this species has not been detected in the Conasauga River system in over 10 years despite extensive survey efforts. Due to lack of information, the majority of insects and other invertebrates were categorized as unknown for range size, Georgia importance to conservation, and population trends.

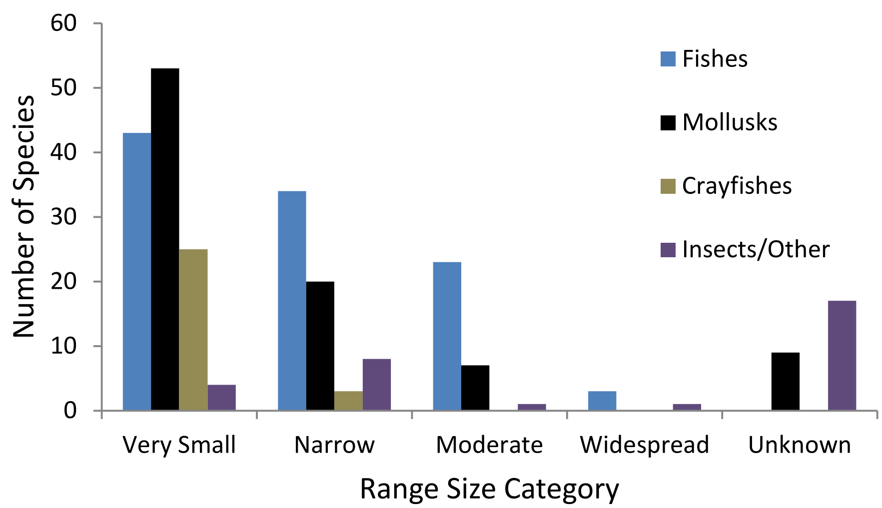


Figure 2. Range size category by taxonomic group as determined for Georgia's 2015 SWAP revision.

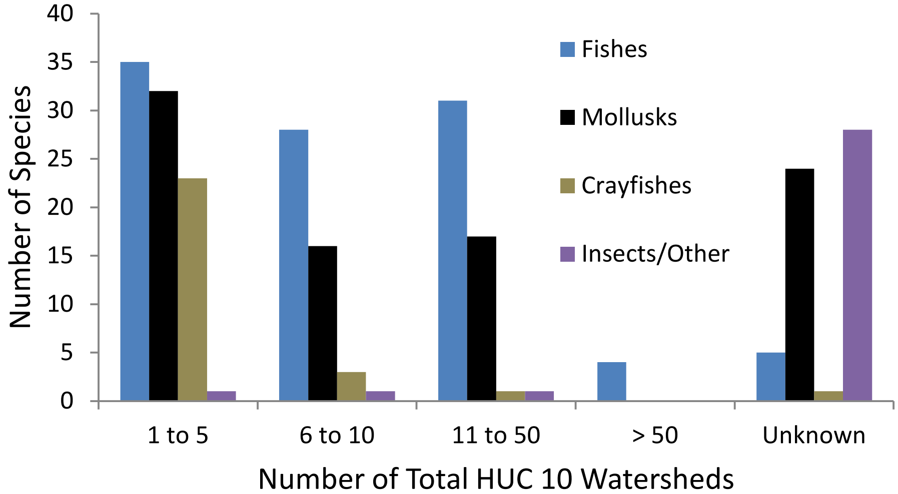


Figure 3. Total number of HUC 10 watersheds species have been documented from, summarized by taxonomic group for all species assessed during Georgia's 2015 SWAP revision.

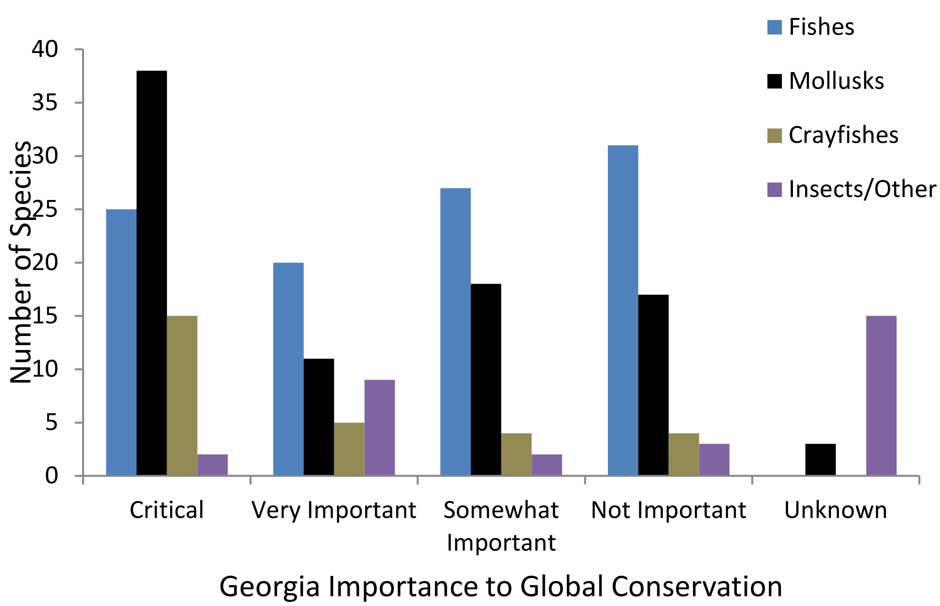


Figure 4. Importance of Georgia populations to global conservation for all species considered in Georgia's 2015 SWAP revision, summarized by taxonomic group.

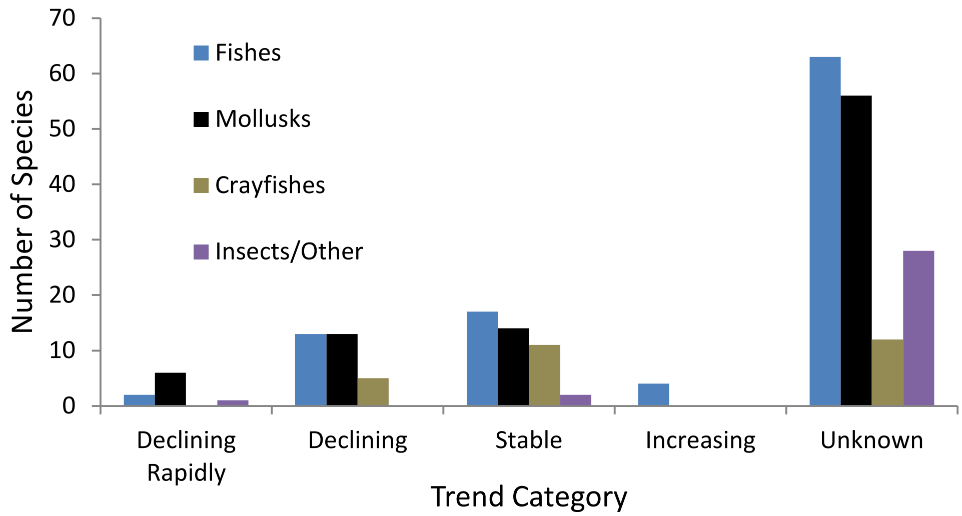


Figure 5. Trend category by taxonomic group as determined for all species assessed during Georgia's 2015 SWAP revision.

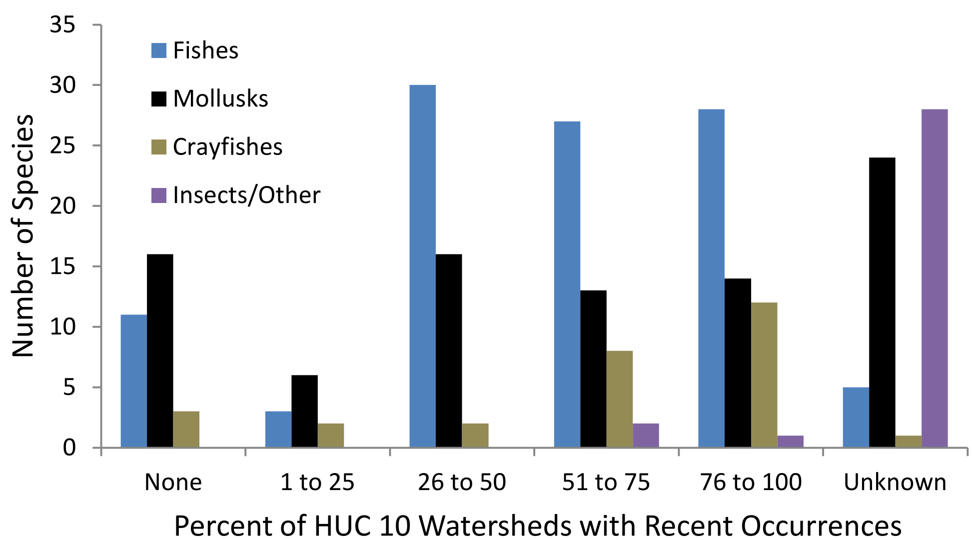


Figure 6. Percent of historic HUC 10 watersheds with recent occurrences (within the past decade) of species assessed during Georgia's 2015 SWAP revision, summarized by taxonomic group. This figure does not include species that were considered extirpated when the assessment was initiated.

Special Concern, High Priority, and State Protection Status Recommendations

The technical team recommended a significant increase (n=28) in the number of special concern species, mostly due to the addition of several globally rare snail species with no or very few occurrences in our database (Table 2). In contrast, the number of species designated as high priority declined by 33 species, which reflects a desire to focus our limited resources. Nonetheless, there are still 165 high priority aquatic species recognized in Georgia. Finally, in contrast to the first SWAP plan which resulted in the addition of 42 aquatic species to Georgia's protected species list, changes proposed by the current technical team would not result in a net increase in the number of state-listed species. Proposed changes include the removal of five fishes and five mollusks and the addition of one fish, five mollusks, three crayfishes, and one insect (Note: three of the mollusks are proposed for removal because they are extirpated or no longer recognized from Georgia). These are only proposed changes and will have to be formally considered and approved by the Board of Natural Resources as specified in DNR Rule 391-4-10. The technical teams also changed the status category (e.g., Threatened to Endangered) for 10 state-protected species to better reflect their current biological status. Eight of these species were downlisted to a less imperiled status category (e.g, Endangered to Threatened), while two species were elevated to a more imperiled category. Table 3 lists the current and proposed status of all species considered in the assessment.

Overall, a significant proportion of Georgia's aquatic species can be considered imperiled (Table 4). Eighty-six species are considered imperiled globally, half of which are mollusks. Almost twice as many species (n=152) are considered imperiled within the state of Georgia and dozens of species (n=48) are historic or considered extirpated from the state. Over half of the 41 federally-listed animal species currently occurring in Georgia are aquatic species. Similarly, an additional 48 extant aquatic species have been petitioned for listing under the ESA. However, our assessment results suggest that the status of some of these petitioned species may be improving. For example, the Apalachicola Floater was changed from S1 (critically imperiled) to S4 (apparently secure) and proposed for removal from the state-protected species list due to the discovery of new populations.

Table 2. Number of species that are special concern (SC), designated as high priority (HP) and state-protected (SP) as recommended during the 2005 SWAP plan and the 2015 revision.

Group	SC2005	SC2015	HP2005	HP2015	SP2005	SP2015
Fishes	80	89	74	78	58	54
Mollusks	62	79	75	57	28	28
Crayfishes	27	26	20	24	20	23
Insects/Other	26	29	27	7	3	4
Total	195	223	196	166	109	109

Table 3. Global rarity rank (GR, as determined by NatureServe), current status under the ESA, whether or not it is petitioned for ESA listing (PETIT.), state rarity rank (SR), state protection status (SP), high priority status (HP) and special concern status (SC) as recommended in the 2005 SWAP Plan or in the current (2015) revision. See Appendix I for status definitions.

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Fishes												
Acipenser brevirostrum	Shortnose Sturgeon	G3	LE	NO	S2	S2	E	E	YES	YES	YES	YES
Acipenser fulvescens	Lake Sturgeon	G3G4		NO	S1	S3			YES	YES	YES	YES
Acipenser oxyrinchus desotoi	Gulf Sturgeon	G3T2	LT	NO	SX	SX			YES	YES	YES	YES
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon	G3T3	LE	NO	S3	S3	E	E	NO	YES	YES	YES
Alosa aestivalis	Blueback Herring	G3G4		NO	SNR	S3			NO	NO	NO	NO
Alosa alabamae	Alabama Shad	G2G3		YES	S1	S1	T	T	YES	YES	YES	YES
Alosa sapidissima	American Shad	G5		NO	S5	S5			NO	YES	NO	NO
Ameiurus serracanthus	Spotted Bullhead	G3		NO	S2	S3	R	R	YES	YES	YES	YES
Anguilla rostrata	American Eel	G4		YES	S3S4	S4			NO	NO	NO	NO
Carpiodes velifer	Highfin Carpsucker	G4G5		NO	SNR	S2S3			NO	YES	NO	YES
Chologaster cornuta	Swampfish	G5		NO	S2S3	S2S3			NO	YES	YES	YES
Clinostomus funduloides	Rosyside Dace	G5		NO	S1S3	S4			NO	NO	YES	NO
Clinostomus funduloides ssp. 1	Smoky Dace	G5T3Q		NO	S2S3	S3			NO	NO	NO	YES
Cynoscion nebulosus	Spotted Seatrout	G5		NO		S5			NO	YES	NO	NO
Cyprinella caerulea	Blue Shiner	G2	LT	NO	S1	S2	E	E	YES	YES	YES	YES
Cyprinella callitaenia	Bluestripe Shiner	G2G3		YES	S2	S2	R	R	YES	YES	YES	YES
Cyprinella gibbsi	Tallapoosa Shiner	G4		NO	S2S3	S3			YES	YES	YES	YES
Cyprinella xaenura	Altamaha Shiner	G2G3		YES	S2S3	S2S3	T	T	YES	YES	YES	YES
Elassoma gilberti	Gulf Coast Pygmy Sunfish	G4G5		NO	S1S3	S2S3			NO	YES	YES	YES
Elassoma okatie	Bluebarred Pygmy Sunfish	G2G3		NO	S1S2	S1	E	E	YES	YES	YES	YES
Enneacanthus chaetodon	Blackbanded Sunfish	G3G4		NO	S1	S1	E	E	YES	YES	YES	YES
Erimonax monachus	Spotfin Chub	G2	LT	NO	SX	SX			YES	YES	YES	YES
Erimystax insignis	Blotched Chub	G4		NO	S2	S2	E	T	YES	YES	YES	YES
Etheostoma brevirostrum	Holiday Darter	G2		YES	S2	S1	E	E	YES	YES	YES	YES
Etheostoma chlorobranchium	Greenfin Darter	G4		NO	S1	S2	T	R	YES	YES	YES	YES
Etheostoma chuckwachatte	Lipstick Darter	G3		NO	S1S2	S2	E	E	YES	YES	YES	YES
Etheostoma cinereum	Ashy Darter	G2G3		YES	SH	SX			YES	YES	YES	YES
Etheostoma ditrema	Coldwater Darter	G2		NO	S1	S1	E	E	YES	YES	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Etheostoma duryi	Blackside Snubnose Darter	G4		NO	S1	S1	R		YES	YES	YES	YES
Etheostoma edwini	Brown Darter	G5		NO	S3	S5			NO	NO	NO	NO
Etheostoma etowahae	Etowah Darter	G1	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Etheostoma fricksium	Savannah Darter	G4		NO	S2	S2			NO	NO	YES	YES
Etheostoma gutselli	Tuckasegee Darter	G3G4		NO	S2	S2			NO	YES	YES	YES
Etheostoma parvipinne	Goldstripe Darter	G4G5		NO	S2S3	S2S3	R	R	YES	YES	YES	YES
Etheostoma rufilineatum	Redline Darter	G5		NO	S1S3	S1S3			YES	YES	YES	YES
Etheostoma rupestre	Rock Darter	G4		NO	S2	S2	R	R	YES	YES	YES	YES
Etheostoma scotti	Cherokee Darter	G2	LT	NO	S2	S2	T	T	YES	YES	YES	YES
Etheostoma serrifer	Sawcheek Darter	G5		NO	S2	S2			NO	NO	YES	YES
Etheostoma tallapoosae	Tallapoosa Darter	G4		NO	S2S3	S3	R		YES	NO	YES	YES
Etheostoma trisella	Trispot Darter	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Etheostoma vulneratum	Wounded Darter	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Etheostoma zonale	Banded Darter	G5		NO	S1S2	S3			YES	NO	YES	NO
Fundulus bifax	Stippled Studfish	G2G3		NO	S1	S1	E	E	YES	YES	YES	YES
Fundulus catenatus	Northern Studfish	G5		NO	S1S2	S2	R	R	YES	YES	YES	YES
Fundulus cingulatus	Banded Topminnow	G4		NO	S1	S1			YES	NO	NO	YES
Fundulus luciae	Spotfin Killifish	G4		NO	S1S3	SU			NO	NO	NO	YES
Fundulus rubrifrons	Redfaced Topminnow	G4		NO	SU	SU			NO	NO	YES	YES
Hemitremia flammea	Flame Chub	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Hiodon tergisus	Mooneye	G5		NO	S1	S1		T	YES	YES	YES	YES
Hybopsis amblops	Bigeye Chub	G5		NO	S2	S3			YES	NO	NO	NO
Hybopsis lineapunctata	Lined Chub	G3G4		NO	S2	S2	R	R	YES	YES	YES	YES
Hybopsis sp. 9	Etowah Chub	G1Q		NO	S1	S1S2			YES	YES	NO	YES
Ichthyomyzon bdellium	Ohio Lamprey	G3G4		NO	S1S2	S1	R	R	YES	YES	YES	YES
Lampetra aepyptera	Least Brook Lamprey	G5		NO	S3	S2			NO	YES	NO	YES
Lethenteron appendix	American Brook Lamprey	G4		NO	SNA	S1			NO	NO	NO	YES
Lucania goodei	Bluefin Killifish	G5		NO	S1	S1	R	R	YES	YES	YES	YES
Lythrurus bellus	Pretty Shiner	G5		NO	S2	S3			YES	NO	YES	YES
Lythrurus lirus	Mountain Shiner	G4		NO	S3	S3			YES	YES	YES	YES
Macrhybopsis sp. 1	Coosa Chub	G3G4		NO	S2	S1	E	E	YES	YES	YES	YES
Micropterus cataractae	Shoal Bass	G3		NO	S3	S2			NO	YES	YES	YES
Micropterus chattahoochee	Chattahoochee Bass	GNR		NO		S1			NO	YES	NO	YES
Micropterus notius	Suwannee Bass	G3		NO	S2	S2	R	R	YES	YES	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Micropterus sp. cf coosae "Alt."	Undescribed Redeye Bass	GNR		NO		S3			NO	YES	NO	YES
Micropterus sp. cf coosae "Sav."	Bartrams Bass	GNR		NO		S3			NO	YES	NO	YES
Moxostoma carinatum	River Redhorse	G4		NO	S2	S3	R	R	YES	YES	YES	YES
Moxostoma lachneri	Greater Jumprock	G4		NO	S3	S3			NO	NO	NO	NO
Moxostoma robustum	Robust Redhorse	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Moxostoma sp. 1	Apalachicola Redhorse	G3		NO	S3	S3			NO	NO	YES	YES
Moxostoma sp. 2	Sicklefin Redhorse	G2Q	C	NO	S1	S1	E	E	YES	YES	YES	YES
Moxostoma sp. 4	Brassy Jumprock	G4		NO	S3S4	S3			NO	NO	NO	YES
Notropis ariommus	Popeye Shiner	G3		YES	S1	S1	E	E	YES	YES	YES	YES
Notropis asperifrons	Burrhead Shiner	G4		NO	S2	S2	T	T	YES	YES	YES	YES
Notropis chalybaeus	Ironcolor Shiner	G4		NO	S2S3	S3			NO	NO	YES	YES
Notropis harperi	Redeye Chub	G4		NO	S3	S3			YES	NO	NO	NO
Notropis hypsilepis	Highscale Shiner	G3		NO	S3	S3	R	R	YES	YES	YES	YES
Notropis photogenis	Silver Shiner	G5		NO	S1	S1	E		YES	YES	YES	YES
Notropis scepticus	Sandbar Shiner	G4		NO	S2	S2	R	R	YES	YES	YES	YES
Noturus eleutherus	Mountain Madtom	G4		NO	S1	S1	E	E	YES	YES	YES	YES
Noturus flavipinnis	Yellowfin Madtom	G1	LT	NO	SX	SX			YES	YES	YES	YES
Noturus munitus	Frecklebelly Madtom	G3		YES	S1	S1	E	E	YES	YES	YES	YES
Percina antesella	Amber Darter	G1G2	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Percina aurantiaca	Tangerine Darter	G4		NO	S1	S2	E	T	YES	YES	YES	YES
Percina aurolineata	Goldline Darter	G2	LT	NO	S1	S2	E	E	YES	YES	YES	YES
Percina crypta	Halloween Darter	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Percina jenkinsi	Conasauga Logperch	G1	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Percina kusha	Bridled Darter	G2		YES	S1	S1	E	E	YES	YES	YES	YES
Percina lenticula	Freckled Darter	G3		NO	S1	S2	E	T	YES	YES	YES	YES
Percina sciera	Dusky Darter	G5		NO	S1S2	S3	R		YES	YES	YES	YES
Percina shumardi	River Darter	G5		NO	S1	SX	E		YES	NO	YES	YES
Percina smithvanizi	Muscadine Darter	G3		NO	S2	S3	R	R	YES	YES	YES	YES
Percina squamata	Olive Darter	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Percina tanasi	Snail Darter	G2G3	LT	NO	S1	S1	E	E	YES	YES	YES	YES
Phenacobius crassilabrum	Fatlips Minnow	G3G4		NO	S1	S2	E	T	YES	YES	YES	YES
Phenacobius uranops	Stargazing Minnow	G4		NO	S1	S1	T	T	YES	YES	YES	YES
Phoxinus tennesseensis	Tennessee Dace	G3		NO	S1	S1	E	E	YES	YES	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Pteronotropis euryzonus	Broadstripe Shiner	G3		YES	S2	S3	R	R	YES	YES	YES	YES
Pteronotropis metallicus	Metallic Shiner	G4		NO	S2?	S3			NO	NO	YES	YES
Pteronotropis stonei	Lowland Shiner	G5		NO	S3S4	S4			NO	NO	NO	NO
Pteronotropis welaka	Bluenose Shiner	G3G4		NO	S1	S1	T	T	YES	YES	YES	YES
Salvelinus fontinalis	Brook Trout	G5		NO	S5	S3			NO	NO	NO	NO
Sphryna lewini	Scalloped Hammerhead	GNR		NO		S2S3			NO	YES	NO	NO
Typhlichthys subterraneus	Southern Cavefish	G4		NO	S1	S1	E	E	YES	YES	YES	YES
Umbra pygmaea	Eastern Mudminnow	G5		NO	S2S3	S3S4			NO	NO	NO	NO
Mollusks (Mussels and Snails)												
Alasmidonta arcula	Altamaha Arcmussel	G2		YES	S2	S3	T		NO	YES	YES	YES
Alasmidonta triangulata	Southern Elktoe	G1Q		YES	S1	S1	E	E	NO	YES	YES	YES
Alasmidonta varicosa	Brook Floater	G3		YES	S2	S2			NO	NO	YES	YES
Amblema elliottii	Coosa Fiveridge	G3		NO	S2	S3			NO	NO	YES	YES
Amblema neislerii	Fat Threeridge	G1	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Anodonta couperiana	Barrel Floater	G4		NO	SNR	S4			NO	NO	NO	YES
Anodonta heardi	Apalachicola Floater	G1G2		YES	S1	S4	R		NO	NO	YES	YES
Anodontoides radiatus	Rayed Creekshell	G3		YES	S2	S2	T	T	NO	YES	YES	YES
Athearnia anthonyi	Anthony's River Snail	G1	LE	NO	SH	SH			NO	NO	YES	NO
Athearnia crassa	Boulder Snail	GX		NO		SNA			NO	NO	NO	NO
Campeloma regulare	Cylinder campeloma	G4		NO	S2	S2		T	NO	YES	YES	YES
Crassostrea virginica	American Oyster	G5		NO		S4			NO	YES	NO	NO
Elimia albanyensis	Black-crest Elimia	G3Q		NO	S5	S5			NO	NO	NO	NO
Elimia boykiniana	Flaxen Elimia	G2Q		NO	SH	SH			NO	NO	YES	YES
Elimia caelatura	Savannah Elimia	G3		NO		S3			NO	NO	NO	YES
Elimia capillaris	Spindle Elimia	GX		NO	SU	SX			NO	NO	YES	NO
Elimia darwini	Pup Elimia	G1		NO		S1			NO	YES	NO	YES
Elimia inclinans	Slanted Elimia	G1G2		NO		S1S2			NO	YES	NO	YES
Elimia induta	Gem Elimia	G2		NO		S2			NO	YES	NO	YES
Elimia lecontiana	Rippled Snail	G2G3		NO		S3			NO	NO	NO	YES
Elimia mutabilis	Oak Elimia	G2Q		NO		S2			NO	YES	NO	YES
Elimia ornata	Ornate Elimia	G1		NO	S1	S1			NO	YES	YES	YES
Elimia striatula	File Elimia	G2		NO	S1	S1			NO	YES	YES	YES
Elimia timida	Timid Elimia	G1		NO		S1			NO	YES	NO	YES
Elliptio ahenea	Southern Lance	G3		NO	SNR	S2			NO	NO	NO	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Elliptio arca	Alabama Spike	G2G3Q		YES	S1	S1	E	E	NO	YES	YES	YES
Elliptio arctata	Delicate Spike	G2G3Q		YES	S1S3	S2	E	E	NO	YES	YES	YES
Elliptio fraterna	Brother Spike	G1		YES	S1	S1			NO	YES	YES	YES
Elliptio monroensis	St. John's Elephantear	G2G3		NO		S2			NO	NO	NO	YES
Elliptio nigella	Winged Spike	G1		NO	S1	S2		T	NO	YES	YES	YES
Elliptio occulta	Hidden Spike	GNR		NO		S4			NO	NO	NO	YES
Elliptio purpurella	Inflated Spike	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Elliptio roanokensis	Roanoke Slabshell	G3		NO	S2	S2			NO	NO	YES	YES
Elliptio spinosa	Altamaha Spinymussel	G1G2	LE	NO	S1S2	S1	E	E	NO	YES	YES	YES
Elliptoideus sloatianus	Purple Bankclimber	G2	LT	NO	S2	S2	T	T	NO	YES	YES	YES
Fusconaia masoni	Atlantic Pigtoe	G2		YES	S1	S1	E	E	NO	YES	YES	YES
Hamiota altilis	Finelined Pocketbook	G2G3	LT	NO	S1S2	S2	T	T	NO	YES	YES	YES
Hamiota subangulata	Shinyrayed Pocketbook	G2	LE	NO	S2	S2	E	E	NO	YES	YES	YES
Lampsilis binominata	Lined Pocketbook	GX		NO	SX	SX			NO	NO	YES	YES
Lampsilis cariosa	Yellow Lampmussel	G3G4		NO	S2	S3			NO	YES	YES	YES
Lampsilis straminea	Southern Fatmucket	G5T		NO	S3	S2		R	NO	YES	NO	YES
Lasmigona alabamensis	Alabama Heelsplitter	G3		NO	S1	S1			NO	NO	YES	YES
Lasmigona etowaensis	Etowah Heelsplitter	G3		NO	S3	S3			NO	NO	YES	YES
Lasmigona holstonia	Tennessee Heelsplitter	G3		YES	S1	S1			NO	YES	YES	YES
Leptodea ochracea	Tidewater Mucket	G3G4		NO		S3			NO	NO	NO	YES
Leptoxis foremani	Interrupted Rocksnail	G1	E	NO	S1	S1	E	E	NO	YES	YES	YES
Leptoxis praerosa	Onyx Rocksnail	G5		NO	S1	S1			NO	YES	YES	YES
Marstonia agarhecta	Ocmulgee Marstonia	G1		YES	S1	S1			NO	YES	YES	YES
Marstonia castor	Beaverpond Marstonia	G1		YES	S1	S1			NO	YES	YES	YES
Marstonia gaddisorum	Emily's Marstonia	G1		NO		S1			NO	YES	NO	YES
Marstonia halcyon	Halcyon Marstonia	G4		NO		S3			NO	NO	NO	YES
Medionidus acutissimus	Alabama Moccasinshell	G2	LT	NO	S1	S1	T	E	NO	YES	YES	YES
Medionidus conradicus	Cumberland Moccasinshell	G3G4		YES	SH	S1			NO	YES	YES	YES
Medionidus parvulus	Coosa Moccasinshell	G1Q	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Medionidus penicillatus	Gulf Moccasinshell	G2	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Medionidus simpsonianus	Ochlockonee Moccasinshell	G1	LE	NO	SH	SH	E	E	NO	YES	YES	YES
Medionidus walkeri	Suwannee Moccasinshell	GNR		YES		SX			NO	YES	NO	YES
Notogillia sathon	Satyr Siltsnail	G5		NO		S3			NO	NO	NO	YES
Pleurobema decisum	Southern Clubshell	G2	LE	NO	S1	S1	E	E	NO	YES	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Pleurobema georgianum	Southern Pigtoe	G1	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Pleurobema hanleyianum	Georgia Pigtoe	G1	E	NO	S1	S1	E	E	NO	YES	YES	YES
Pleurobema hartmanianum	Cherokee Pigtoe	G1		NO	SNR	S1			NO	YES	NO	YES
Pleurobema pyriforme	Oval Pigtoe	G2	LE	NO	S2	S1	E	E	NO	YES	YES	YES
Pleurocera foremani	Rough Hornsnail	G1	E	NO	SNA	SX			NO	NO	YES	NO
Pleurocera pyrenella	Skirted Hornsnail	G2		YES	SH	S2			NO	YES	YES	YES
Pleurocera showalteri	Upland Hornsnail	G2Q		NO	S1	S1		E	NO	YES	YES	YES
Pleurocera trochiformis	Sulcate Hornsnail	G2		NO	SH	SH			NO	NO	YES	NO
Pleurocera vestita	Brook hornsnail	G3		NO	S2	S2			NO	YES	YES	YES
Pleuronaia barnesiana	Tennessee Pigtoe	G2G3		YES	SNR	S1		R	NO	YES	YES	YES
Potamilus purpuratus	Bleufer	G5		NO	S1	S1?			NO	NO	YES	YES
Ptychobranchus fasciolaris	Kidneyshell	G4G5		NO	SH	S1			NO	YES	YES	YES
Ptychobranchus foremanianus	Rayed Kidneyshell	G1		NO	S1	S1	E	E	NO	YES	YES	YES
Quadrula asperata	Alabama Orb	G4		NO	S4	S3			NO	NO	NO	YES
Quadrula kleiniana	Suwannee Pigtoe	G2G3		NO	SNR	S2			NO	YES	NO	YES
Quadrula rumphiana	Ridged Mapleleaf	G4		NO	S3	S3			NO	NO	YES	YES
Somatogyrus alcoviensis	Reverse Pebblesnail	G1Q		YES	S1	S1			NO	YES	YES	YES
Somatogyrus rheophilus	Flint Pebblesnail	G1		NO		S1			NO	YES	NO	YES
Somatogyrus tenax	Savannah Pebblesnail	G2G3Q		NO	S2S3	S2S3			NO	YES	YES	YES
Spilochlamys turgida	Pumpkin Siltsnail	G5		NO		S4			NO	NO	NO	YES
Strophitus connasaugaensis	Alabama Creekmussel	G3		NO	S1	S1	E	E	NO	YES	YES	YES
Toxolasma corvunculus	Southern Purple Lilliput	G1		NO	S1	S1?			NO	YES	YES	YES
Toxolasma lividum	Purple Lilliput	G3Q		YES	SH	SX			NO	NO	YES	NO
Toxolasma parvum	Lilliput	G5		NO	SH	S4			NO	NO	NO	NO
Toxolasma pullus	Savannah Lilliput	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Truncilla donaciformis	Fawnsfoot	G5		NO	S1	S1?			NO	NO	YES	YES
Villosa nebulosa	Alabama Rainbow	G3		YES	S2	S2			NO	YES	YES	YES
Villosa umbrans	Coosa Creekshell	G2		YES	S1S2	S2			NO	YES	YES	YES
Villosa vanuxemensis	Mountain Creekshell	G4		NO	S1S2	S3			NO	NO	YES	YES
Crayfishes												
Cambarus chaugaensis	Chauga River Crayfish	G2		YES	S1	SNA			YES	NO	YES	NO
Cambarus coosawattae	Coosawattee Crayfish	G2		YES	S1	S2	E	T	YES	YES	YES	YES
Cambarus cryptodytes	Dougherty Plain Cave Crayfish	G2		YES	S1S2	S2	T	T	YES	YES	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Cambarus cymatilis	Conasauga Blue Burrower	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Cambarus distans	Boxclaw Crayfish	G5		NO	S1	S1		E	YES	YES	YES	YES
Cambarus doughertyensis	Dougherty Burrowing Crayfish	G1		NO	S1	S1	E	E	YES	YES	YES	YES
Cambarus englishi	Tallapoosa Crayfish	G3		NO	S2	S2	R	T	YES	YES	YES	YES
Cambarus extraneus	Chickamauga Crayfish	G2		YES	S2	S2	T	T	YES	YES	YES	YES
Cambarus fasciatus	Etowah Crayfish	G3		YES	S2	S2	T	T	YES	YES	YES	YES
Cambarus georgiae	Little Tennessee Crayfish	G2G3		YES	S1	S1	E	E	YES	YES	YES	YES
Cambarus harti	Piedmont Blue Burrower	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Cambarus howardi	Chattahoochee Crayfish	G3Q		NO	S3	S2	T	T	YES	YES	YES	YES
Cambarus longirostris	Longnose Crayfish	G5Q		NO	S1	S1			YES	NO	YES	YES
Cambarus manningi	Greensaddle Crayfish	G4		NO	S2	S1?			NO	YES	YES	YES
Cambarus parrishi	Hiwassee Headwaters Crayfish	G2		YES	S1	S1	E	E	YES	YES	YES	YES
Cambarus parvoculus	Mountain Midget Crayfish	G5		NO	S1	S3			YES	NO	YES	NO
Cambarus scotti	Chattooga River Crayfish	G3		NO	S2S3	S2	T	T	YES	YES	YES	YES
Cambarus speciosus	Beautiful Crayfish	G2		YES	S2	S2	E	T	YES	YES	YES	YES
Cambarus strigosus	Lean Crayfish	G2		YES	S2	S2	T	T	YES	YES	YES	YES
Cambarus truncatus	Oconee Burrowing Crayfish	G2		NO	S1S2	S2	T	T	YES	YES	YES	YES
Cambarus unestami	Blackbarred Crayfish	G2		NO	S2	S3	T	R	YES	YES	YES	YES
Distocambarus devexus	Broad River Burrowing Crayfish	G1		YES	S1	S1	T	T	YES	YES	YES	YES
Orconectes forceps	Surgeon Crayfish	G5		NO	S1	S1S2			YES	NO	YES	YES
Procambarus acutissimus	Sharpnose Crayfish	G5		NO	S2	S2		R	NO	YES	YES	YES
Procambarus gibbus	Muckalee Crayfish	G3Q		NO	S3	S2	T	T	YES	YES	YES	YES
Procambarus petersi	Ogeechee Crayfish	G3		NO	S3	S2		R	NO	YES	NO	YES
Procambarus verrucosus	Grainy Crayfish	G4		NO	S2	S2	R	R	YES	YES	YES	YES
Procambarus versutus	Sly Crayfish	G5		NO	S1	S1	R	R	YES	YES	YES	YES
Insects/Other Invertebrates												
Acanthametropus pecatonica	Pecatonica River Mayfly	G2G4		NO	S2	SU			YES	NO	YES	YES
Acroneuria arida	Elegant Stone	G3		NO	S3	S3			YES	NO	YES	YES
Acroneuria petersi	Etowah Stonefly	G3		NO	S3	S3			YES	NO	YES	YES
Amerigoniscus curvatus	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
Amerigoniscus georgiensis	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
Anepeorus simplex	Wallace's Deepwater Mayfly	G2G4		NO	SU	SH			YES	NO	YES	YES

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
Apobaetis etowah	A Mayfly	G5		NO	S1	S1			YES	NO	YES	YES
Beloneuria georgiana	Georgia Beloneurian Stonefly	G2		NO	S2	S2			YES	NO	YES	YES
Caecidotea cyrtorhynchus	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
Callinectes sapidus	Blue Crab	GNR		NO		S4			NO	YES	NO	NO
Cordulegaster sayi	Say's Spiketail	G2		YES	S1S2	S2	T	T	YES	YES	YES	YES
Eubranchipus stegosus	A Fairy Shrimp	G1		NO	SNR	SU			YES	NO	NO	YES
Gomphus consanguis	Cherokee Clubtail	G3		YES	S1S2	S2	T	T	YES	YES	YES	YES
Heterocloeon berneri	Berner's Two-winged Mayfly	G2G3		NO	S1	S1			YES	NO	YES	YES
Homoeoneuria dolani	Blackwater Sand-filtering Mayfly	G3G4		NO	SNR	SU			YES	NO	YES	YES
Leptophlebia cupida	A MAYFLY	G5		NO	SNR	SU			YES	NO	YES	NO
Leuctra moha	Blackwater Needlefly	G3		NO	S3	SU			YES	NO	YES	YES
Macromia margarita	Mountain River Cruiser	G3		YES	S1	S1S2			NO	YES	NO	YES
Neoephemera compressa	A Mayfly	G1G3		NO	SNR	SU			YES	NO	YES	YES
Ophiogomphus australis	Southern Snaketail	G1G2		NO	SNR	S1		T	NO	YES	NO	YES
Ophiogomphus edmundo	Edmund's Snaketail	G1G2		YES	S1	S1	E	E	YES	YES	YES	YES
Ophiogomphus incurvatus	Appalachian Snaketail	G3T2T3		YES	SNR	S2			NO	YES	NO	YES
Paraleptophlebia georgiana	A Mayfly	G1G3		NO	SNR	SH			YES	NO	YES	YES
Paraleptophlebia swannanoa	A Mayfly	G4		NO	SNR	SU			YES	NO	YES	YES
Remenus duffieldi	Georgia Springfly	G2		NO	S2	S2			YES	NO	YES	YES
Rhithrogena fasciata	A Mayfly	G3G4		NO	SNR	SU			YES	NO	YES	YES
Siphloplecton simile	A Mayfly	G1G2Q		NO	SNR	SU			YES	NO	YES	YES
Stygobromus grandis	A Cave Obligate Amphipod	G1		NO	SNR	SU			YES	NO	YES	YES
Stygobromus minutus	A Cave Obligate Amphipod	G2G3		NO	SNR	SU			YES	NO	YES	YES
Stylurus ivae	Shining Clubtail	G4		NO	S3	S2?			NO	NO	NO	YES
Stylurus notatus	Elusive Clubtail	G3		NO	SNR	SNA			YES	NO	YES	NO
Uncinocythere warreni	A Cave Obligate Shrimp	G1		NO	SNR	SU			YES	NO	YES	YES

Table 4. Number and percentage of Georgia native species that are imperiled or critically imperiled across their global range (G1-G2), imperiled within the state of Georgia (S1-S2), or are considered historic (SH) or extirpated (SX) from Georgia. The number of species that are currently listed under the ESA (includes one candidate species), as well as the number that have been formally petitioned (PETIT.) for listing under the ESA is also reported. The number of SH and SX species includes 30 species that were not considered in this assessment (and not in Table 3). The number of ESA and petitioned species does not include species that are considered historic or extirpated from Georgia.

Group	G1-G2 (%)	S1-S2 (%)	SH or SX (%)	ESA	PETIT.
Fishes	16 (6)	58 (21.9)	6 (2.3)	10	12
Mollusks	43 (20.4)	58 (27.5)	38 (18.0)	13	20
Crayfishes	13 (18.6)	25 (35.7)	0 (0.0)	0	11
Insects/Other	14 (?)	11 (?)	4 (?)	0	5
Total	86 (?)	152 (?)	48 (?)	23	48

Summary of Threats

The majority of fishes, mollusks, and crayfishes were categorized as moderately to very threatened (Figure 7). Altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction were identified as the top five threats to the greatest number of high priority aquatic species (Figure 8). These same threats generally affected large numbers of high priority species in the different aquatic regions of the state (Figure 9). However, the threat of residential development emerged as the single-most important threat to Tennessee Basin species, but was less important in other regions. Additionally, excessive groundwater and surface water withdrawal affects a large number of high priority aquatic species in the Gulf drainages of southwestern Georgia.

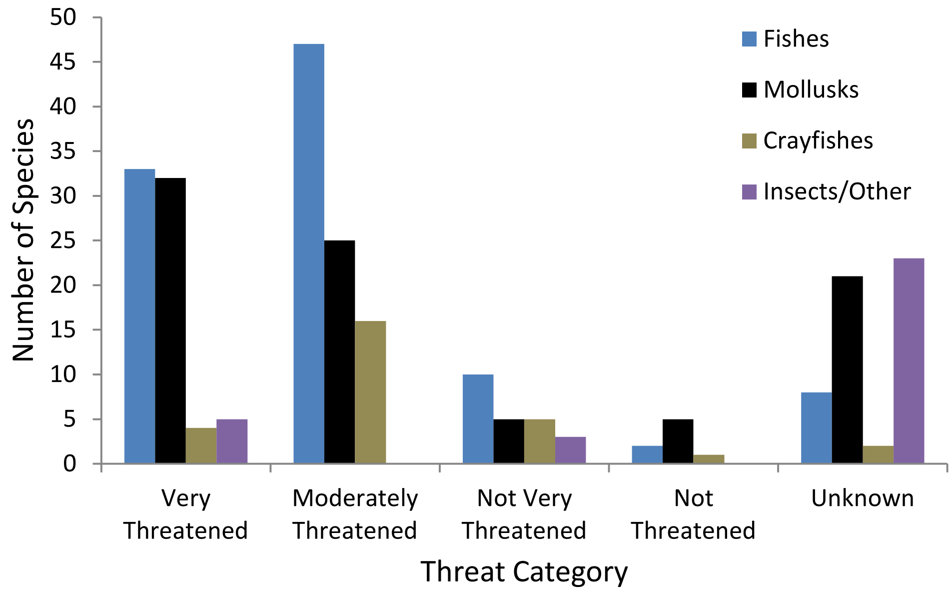


Figure 7. Degree of threat affecting species considered in Georgia's 2015 SWAP revision, summarized by taxonomic group.

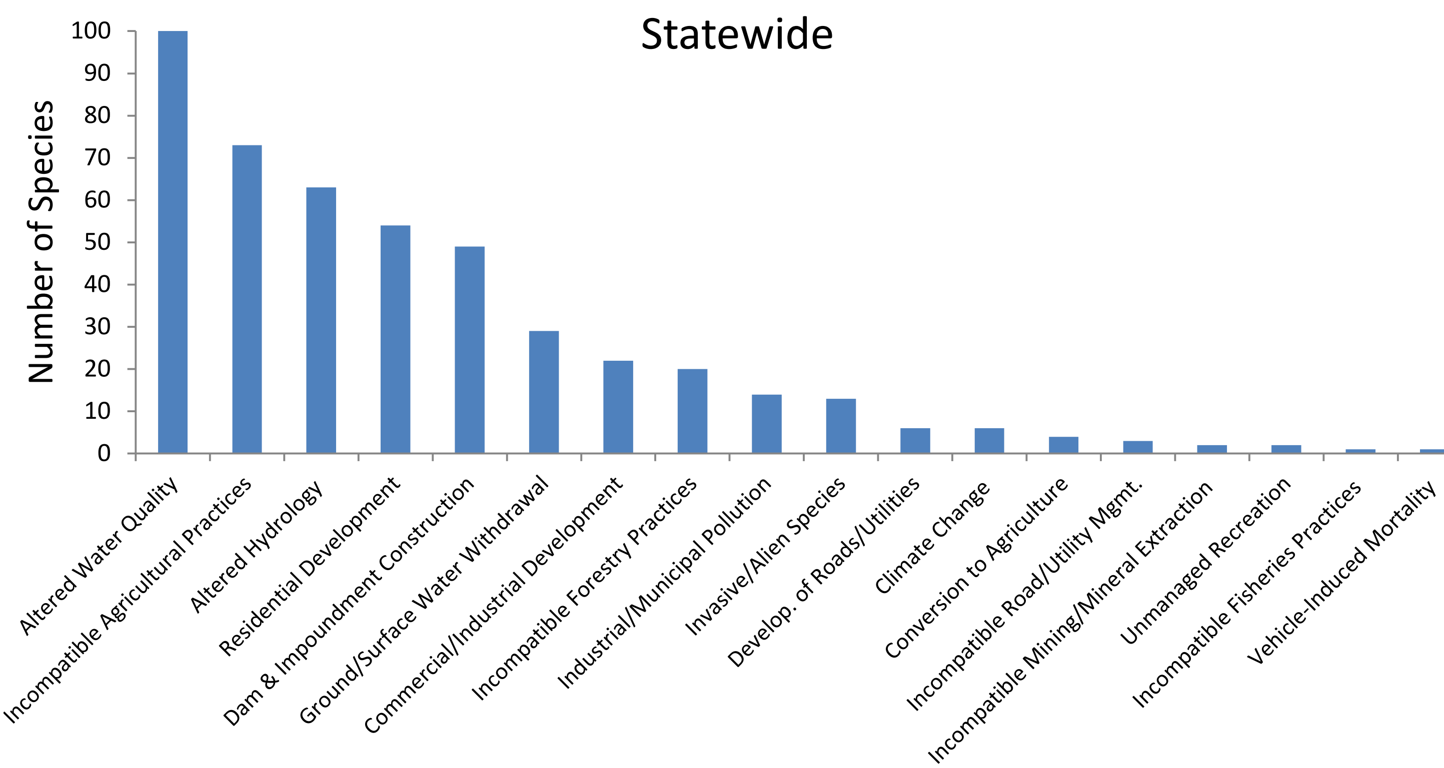
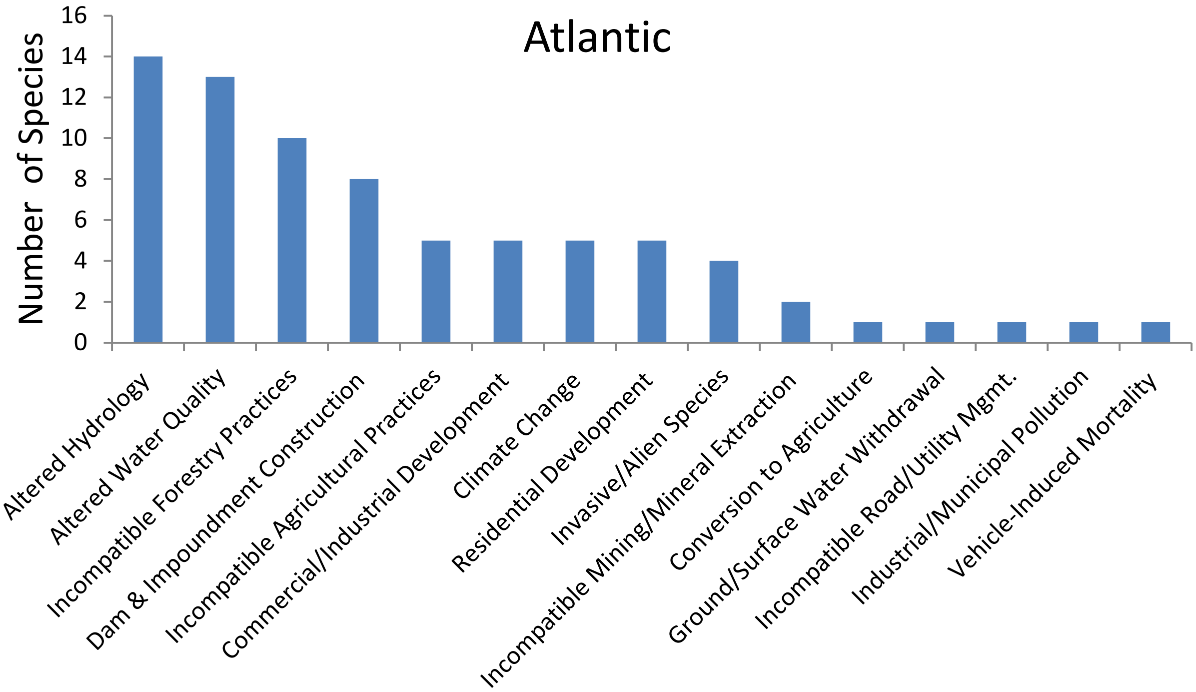
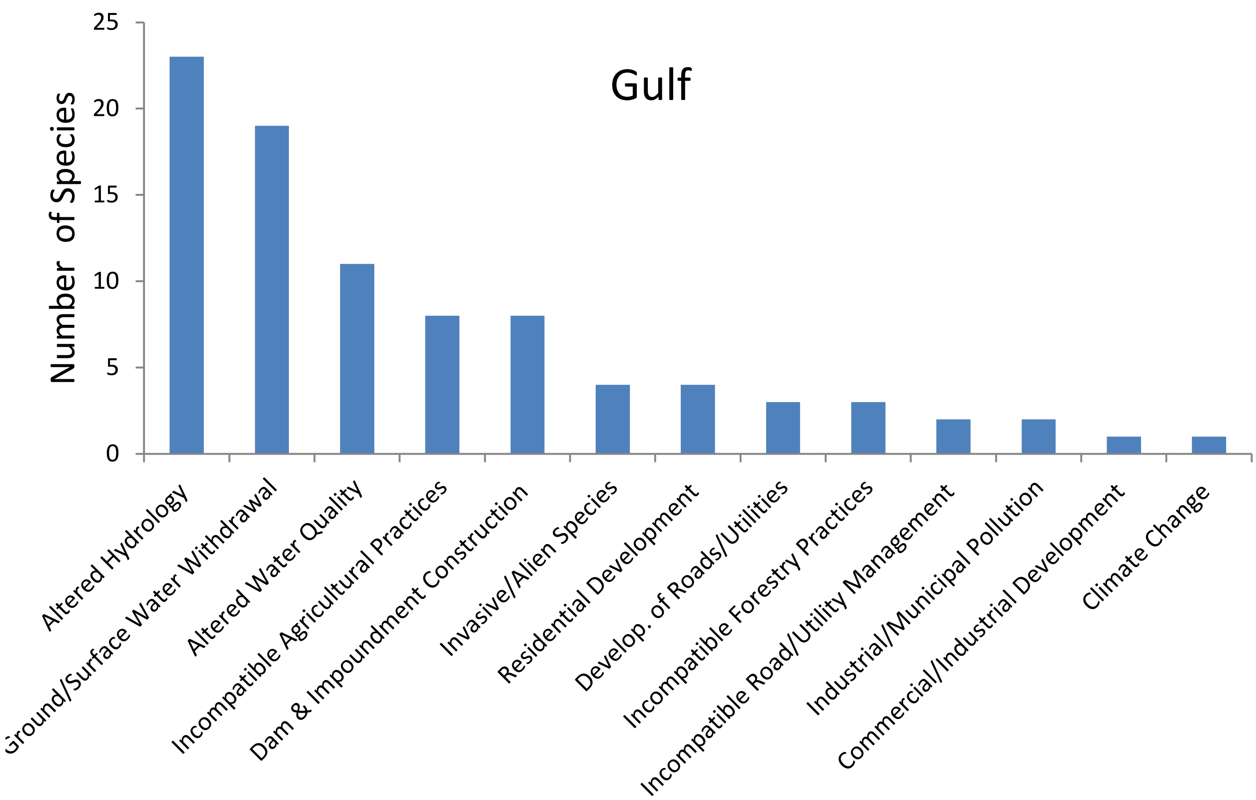


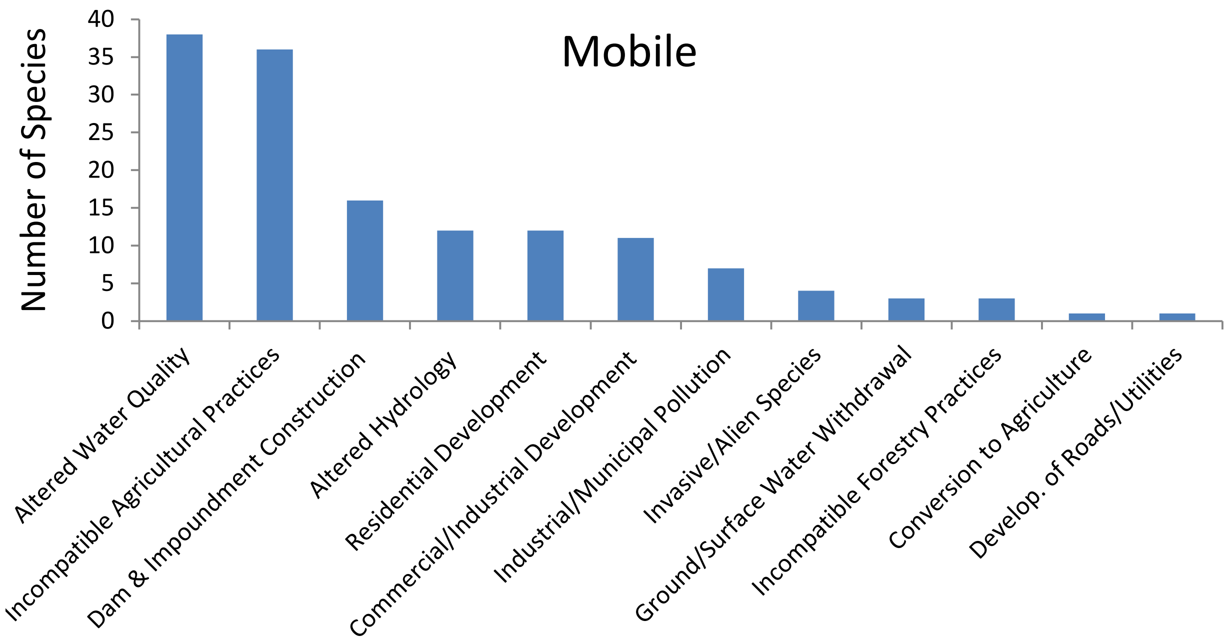
Figure 8. Number of high priority species affected by each threat identified during the 2015 revision of Georgia's SWAP. See standardized threat descriptions in Appendix I.



Atlantic
Number of Species
0
2
4
6
8
10
12
14
16
Altered Hydrology
Altered Water Quality
Incompatible Forestry Practices
Dam & Impoundment Construction
Incompatible Agricultural Practices
Commercial/Industrial Development
Climate Change
Residential Development
Invasive/Alien Species
Incompatible Mining/Mineral Extraction
Conversion to Agriculture
Ground/Surface Water Withdrawal
Incompatible Road/Utility Mgmt.
Industrial/Municipal Pollution
Vehicle-Induced Mortality



Gulf
Number of Species
0
5
10
15
20
25
Altered Hydrology
Ground/Surface Water Withdrawal
Altered Water Quality
Incompatible Agricultural Practices
Dam & Impoundment Construction
Invasive/Alien Species
Residential Development
Develop. of Roads/Utilities
Incompatible Forestry Practices
Incompatible Road/Utility Management
Industrial/Municipal Pollution
Commercial/Industrial Development
Climate Change



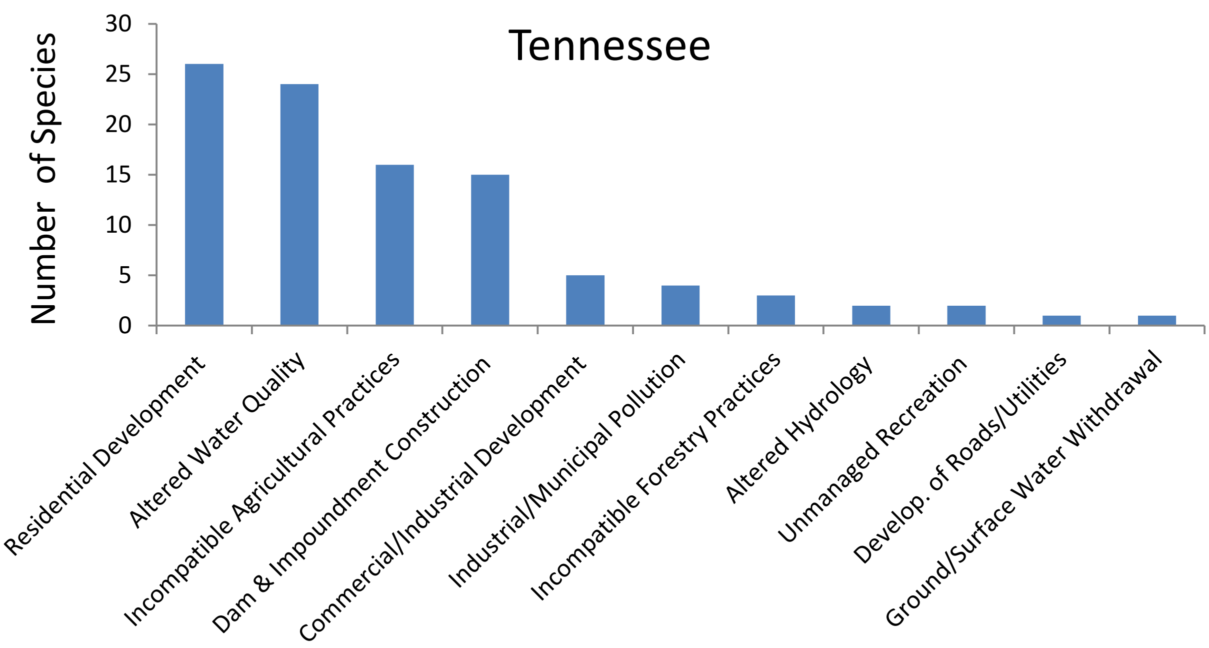


Figure 9. Number of high priority species affected by each threat identified during the 2015 revision of Georgia's SWAP, with data enumerated separately for Atlantic, Gulf, Mobile, and Tennessee basins. See standardized threat descriptions in Appendix I.

High Priority Conservation Actions

The technical teams identified hundreds of species-specific conservation actions which were recorded in the species assessment database and will be useful for future management. We extracted conservation actions from the database with the potential to benefit multiple species and/or habitats. Our own GADNR biologists also identified additional conservation actions based upon our own vision for improving our aquatic conservation program. We asked technical team members and a handful of other species experts that could not participate in the SWAP revision to rate all 44 conservation actions through an online survey program (Survey Monkey). Fifty-two people completed the survey. All of the ratings averaged 5.8 or higher on a continuous 10 point scale, where 1= a low priority action that should not be completed, 5 = an action that would benefit high priority habitats and or species, but is not critical to complete within the next 5-10 years, and 10 = an action that is likely to benefit multiple high priority species and habitats and should be initiated immediately. After the survey was completed, we received recommendations for 9 additional conservation actions from technical team members. To be consistent with prioritizations carried out by other SWAP technical teams, we used average ratings (score) to place actions into very high (score of 8.0 or higher), high (score of 7.0-7.9), and medium (5.8-6.9) categories. Three of the unrated actions were placed in the very high category because of their potential to benefit a large number of species and habitats; the remaining unrated actions were placed into the high category. All actions categorized as "very high" priority are listed in Table 5. The complete list of conservation actions, along with more detailed action descriptions, potential partners and funding sources, and other information is included in a separate excel file that should **always accompany this document**.

Table 5. "Very High" conservation actions identified by SWAP aquatic species technical teams. Score indicates the average rating on a 10 point scale from 52 respondents that completed an online survey. Projects are ranked by score, except for three that were not rated (NR). See excel file for a full list of conservation actions and a more detailed description of each action.

ID	Conservation Action	Type	Score	Rank
3	Protect Aquatic Connectivity in Free-flowing Streams.	Actions and Policies	9.1	1
4	Develop Environmental Flow Recommendations	Actions and Policies	8.8	2
5	Land Acquisition and Easements in High Priority Watersheds.	Actions and Policies	8.7	3
6	Technical Assistance to Local Governments to Protect Streams in High Priority Watersheds	Actions and Policies	8.6	4
7	Invasive Species Outreach and Regulation	Outreach and Education	8.5	5
8	Technical Assistance to Farmers to Protect Streams in High Priority Watersheds	Actions and Policies	8.5	6

ID	Conservation Action	Type	Score	Rank
9	Protect High Priority Species and Habitats through the Statewide Water Planning Process	Conservation Planning	8.4	7
10	Expand GADNR Nongame Conservation Section Aquatic Program	Conservation Planning	8.3	8
11	Targeted Dam and Culvert Removal/Replacement Projects.	Actions and Policies	8.3	9
12	Riparian Forest Restoration	Actions and Policies	8.0	10
13	Aquatic Conservation Planning Meetings for Coosa, Tennessee, Atlantic Slope and Gulf drainages	Conservation Planning	8.0	11
14	Evaluate Status and Distribution of High Priority Snails.	Survey and Monitoring	8.0	12
1	Shoal Creek Watershed Project	Actions and Policies	NR	NR
2	Conasauga River Water Quality and Contaminants Study	Conservation Research	NR	NR
53	Oyster Reef Restoration and Enhancement	Actions and Policies	NR	NR

Discussion

As in the original plan, the aquatic species assessment for the 2015 revision of Georgia's SWAP identified an enormous list of high priority species, threats, and conservation actions needed to protect and restore Georgia's rich aquatic diversity. Meeting the conservation needs of 165 high priority aquatic species distributed around the state is a daunting task. Compounding this challenge are the 48 aquatic species that are petitioned for listing under the ESA, as these species may require additional assessment to determine if they merit listing and additional monitoring, management, and coordination if they merit formal listing or conservation through other mechanisms (e.g., formal partnerships to conserve species, like the Robust Redhorse Conservation Committee or Candidate Conservation Agreements between the U. S Fish and Wildlife Service and stakeholders). We hope that the information contained in this plan can help guide and prioritize the conservation of Georgia's rare aquatic species in the coming years. In pursuit of this goal, we have provided additional recommendations below to consider during SWAP implementation.

Clearly, there is a need to focus on protection and restoration of aquatic habitats supporting multiple species. To that end, we have attempted to identify conservation actions that would benefit multiple species and habitats. For example, monitoring large river aquatic communities and water quality in the Conasauga and Etowah river systems (actions 28, 29, 2) will allow us to gauge population health of a large number of high priority species as their supporting watersheds change either positively (e.g., land protection, improved land management) or negatively (e.g., increased urbanization). We are have also identified watersheds that protect the greatest number of high priority aquatic species in a separate report (Albanese et al. 2015), which should help identify the places where a multi-species approach will be most appropriate. However, there will still be a need for species-specific conservation (e.g. actions 31, 36).

The top threats facing Georgia aquatic species include altered water quality, altered hydrology, residential development, and dam and impoundment construction. Focusing on threats affecting multiple species can also increase the efficiency of aquatic conservation efforts in Georgia. For example, finding alternatives to the development of new drinking water reservoirs in high priority watersheds would reduce threats to a large number of high priority species around the state and was our top rated conservation action (action 3). Similarly, initiatives to protect instream flows (e.g., Southern Instream Flow Network) would benefit multiple species, particularly in Gulf drainages where altered hydrology and water withdrawals were considered a threat to dozens of high priority species (action 4).

Conserving Georgia's rare aquatic species and habitats will require greater investments in aquatic conservation as well as improved coordination (e.g., action 18). This is evident from the large number of species that still require protection and restoration almost a decade into the implementation of our first SWAP plan. While much has been accomplished (Table 1), there are significant information gaps for groups such as aquatic insects, snails, and cave invertebrates. Similarly, there are many HUC10 watersheds without recent occurrences of high priority species, indicating either declines or the need for additional sampling.

Fortunately, there are a large number of agencies, non-profit organizations, and local citizens that are working collaboratively on aquatic conservation in Georgia (Table 6). Many of these institutions have overlapping responsibilities and geographic scopes, but each group plays a unique and vital role in aquatic conservation. One of the great challenges is coordinating efforts between groups so that limited resources are utilized in the most effective manner possible. While there have been substantial individual and group efforts to coordinate activities (e.g., SWAP, Coosa Summit), there is no established framework for regular aquatic conservation planning in Georgia. Action 13 suggests aquatic conservation planning meetings to be held at least once every five years in different regions of the state. Perhaps these meetings could be integrated with the statewide water planning process, as suggested by action 9. It is not clear what institution would take a lead role in organizing these meetings and it would likely require additional capacity (e.g., action 10).

Shoal habitat in Talking Rock Creek (Coosawattee River system). Several high priority aquatic species, including the Goldline Darter, Bridled Darter, and Beautiful Crayfish have been documented from this stream.

Table 6. Organizations that contribute to the conservation of rare aquatic species in Georgia and examples of their conservation activities. This is meant to be a representative, but **not a complete list**.

Institution	Examples of Conservation Activities
Conservation Fisheries Incorporated (CFI)	captive propagation and reintroduction, monitoring
Environmental Consulting Firms	rare species monitoring, mitigation
GADNR, Coastal Resources Division (CRD)	Oyster restoration, conservation, monitoring
GADNR, Environmental Protection Division (EPD)	macroinvertebrate community monitoring, water quality regulations
GADNR, Fisheries Management Section (FM)	fish community monitoring
GADNR, Nongame Conservation Section (NCS)	environmental review, species monitoring, database management, state-listed spp.
Georgia Aquarium	education and outreach, research
Georgia Colleges and Universities	research, professional training, monitoring
Georgia Cooperative Fish and Wildlife Research Unit	research, professional training
Georgia Department of Transportation (GDOT)	mitigate impacts from transportation projects
Georgia Forestry Commission (GFC)	Forestry BMPs for water quality
Georgia Museum of Natural History (GMNH)	database management, fish monitoring, Fishes of Georgia website
Georgia Power	Robust Redhorse, management of regulated rivers
Georgia River Network/Local Watershed Groups	outreach, watershed protection, advocacy
Georgia Wildlife Federation (GWF)	outreach, advocacy
Georgia Water Coalition (GWC)	advocacy
Landtrusts and other Conservation Organizations	Land acquisition and conservation easements
National Marine Fisheries Service (NMFS)	anadromous species
Natural Resources Conservation Service (NRCS)	farm bill programs to protect streams
National Park Service (NPS)	monitoring of NPS resources
North American Native Fishes Association (NANFA)	native fish outreach
River Basin Center	research, technical assistance to communities, professional training
Tennessee Aquarium Conservation Institute (TNACI)	database management, outreach, fish community monitoring, habitat restoration
The Nature Conservancy (TNC)	aquatic habitat restoration, land protection
U. S. Fish and Wildlife Service (FWS)	environmental review, database management, ESA, conservation actions, research
U. S. Geological Survey (USGS)	research, monitoring, technical support to regulatory agencies
U.S. Army Corps of Engineers (USACE)	mitigation program, management of regulated rivers
U.S. Environmental Protection Agency (EPA)	water quality regulations and monitoring, research
U.S. Forest Service (USFS)	watershed management, monitoring

Acknowledgments

We are grateful to the technical team members for volunteering their time and expertise for the species assessment as well as their helpful comments during the editing of this document. Catherine Reuter, Deb Weiler and Anakela Popp generated the conservation status assessment maps and helped run the three SWAP technical team meetings. Dr. Jon Ambrose presented an overview of the SWAP process at each technical team meeting. Thom Litts helped create the species assessment database and Greg Krakow wrote the GIS algorithm needed to generate the conservation status assessment maps. We thank the staff of the Georgia Wildlife Federation for providing excellent conference facilities.

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Appendices

Appendix 1. Description of data fields for aquatic species assessment database.

Font Color Scheme:
Black Font, reference fields that generally do not need updating
Green Font, OK to update field, but not absolutely necessary
Red Font, Important to update during species assessment meeting.

Species Info (Banner)

Sci. NAME: State Scientific Name
The scientific name of the element (species or natural community) recognized in the state, based on standard scientific nomenclature or terminology accepted by the natural heritage program

Note: Freeze this field during species assessment meeting.

SCOMNAME: State Common Name
The common name of the element that is recognized at the state level

SRANK: State Rarity Rank

S1 = Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. (Typically 5 or fewer occurrences or very few remaining individuals or acres)

S2 = Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. (Typically 6 to 20 occurrences or few remaining individuals or acres)

S3 = Vulnerable, Rare and uncommon in the state. (Usually 21 to 100 occurrences)

S4 = Widespread, abundant, and apparently secure in state, with many occurrences, but the element is of long-term concern. (Usually more than 100 occurrences)

S5 = Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.

Note: Other factors (e.g., threats and trends) in addition to number of occurrences are considered when assigning a rank, so the numbers of occurrences suggested for each numeric rank above are not absolute guidelines.

S#S# = A range between two numeric ranks. Denotes uncertainty about the exact rarity of the element.

SNR = Unranked: Element is not yet ranked in the state.

SU = Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.Possibly in peril in the state, but status uncertain; need more information.

SH = Historical/Possibly extirpated: Element occurred historically in the state (with expectation that it may be rediscovered), perhaps having not been verified in the past 20-40 years, and suspected to be still extant.
SX = Presumed Extirpated: Element is believed to be extirpated from the state

SNA= Not Applicable—A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[1]

[1] A conservation status rank may be not applicable for some species, including long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species or ecosystems, for several reasons, described below.

Qualifiers:
? = Inexact or uncertain: For numeric ranks, denotes inexactness; for SE, denotes uncertainty of exotic status. (should not be used with S#S#, SU, SNR, SNA, SX or SH)

SEOTRACK: State Element Tracking

Indicates whether element is currently tracked as a "Special Concern Species" in Biotics.
Y = Yes W = Watch List (plants only) N or blank = No P=partial (part of range)

STATE STATUS: State-protected Status under the Georgia Endangered Wildlife Act.

Status Page

GRANK: Global Rarity Rank (assigned by NatureServe)

G1 = Critically imperiled globally
G2 = Imperiled globally
G3 = Rare or uncommon
G4 = Widespread, abundant, and apparently secure, but with cause for long-term concern
G5 = Demonstrably widespread, abundant, and secure
G#G# = A range between two numeric ranks. Denotes uncertainty about the exact rarity of the element.
G? = Unranked
GU = Unrankable
GH = Historical
GX = Extinct
HYB = Hybrid

Subrank:
T = Taxonomic subdivision (trinomial)

Qualifiers:

- ? = Inexact numeric rank
- Q = Questionable taxonomy
- C = Captive or cultivated only

IUCN: IUCN Red List Rank
Rank based on the IUCN Red List of Threatened Species ver. 2013.1 (www.iucnredlist.org)

- NE = Not evaluated
- DD = Data deficient
- LC = Least concern
- NT = Near threatened
- VU = Vulnerable
- EN = Endangered
- CR = Critically endangered
- EW = Extinct in the wild
- EX = Extinct

OTHERRANK_AFS_1:
This field can be used to specify status under another ranking system used by a particular organization (e.g., Partners in Flight, American Fisheries Society), depending on the taxonomic group under consideration. If used, field can be renamed as appropriate. Use this field for the most recent assessment

OTHERRANK_AFS_2
This field can be used to specify status under another ranking system used by a particular organization (e.g., Partners in Flight, American Fisheries Society), depending on the taxonomic group under consideration. If used, field can be renamed as appropriate. Use this field for the older assessment

USESA: Status under U.S. Endangered Species Act
The following abbreviations are used to indicate the legal status of federally protected plants and animals or those proposed for listing.

LE	Listed as endangered. The most critically imperiled species. A species that may become extinct or disappear from a significant part of its range if not immediately protected.
LT	Listed as threatened. The next most critical level of threatened species. A species that may become endangered if not protected.
PE or PT	Candidate species currently proposed for listing as endangered or threatened.
C	Candidate species presently under status review for federal listing for which adequate information exists on biological vulnerability and threats to list the taxa as endangered or threatened.
PDL	Proposed for delisting.
E(S/A) or T(S/A)	Listed as endangered or threatened because of similarity of appearance.
(PS)	Indicates "partial status" - status in only a portion of the species' range. Typically indicated in a "full" species record where an infraspecific taxon or population has U.S. ESA status, but the entire species does not.

USESA_PETITIONED

Checkbox to indicate a species with a significant 90 day finding from FWS, but has not been issued a 12 month finding. Technical Team leader needs to populate this field before meeting.

SWAP_HighPriority_2005
Check box to indicate that species was recognized as a high priority species during the initial SWAP plan. This field should be checked for all existing high priority species. However, some groups may decide to assess the conservation status of additional species that may be of conservation concern.

Habitat Page

SSHABITAT: State Short Habitat Description
A brief description of the element's habitat in Georgia (less than 120 characters)

SHABCOM: State Habitat Comments
Summarize the habitats and microhabitats commonly used by this organism within Georgia. (This field can be used to expand upon the brief habitat description provided in the SSHABITAT field).

SENDEMIC: State Endemic
Enter the appropriate letter code from the list below indicating whether the element is endemic to Georgia. (Leave this field blank if the element is not endemic to the state).

Y = Yes: the element is endemic to the state.
P = Probable: the element is probably endemic to the state.
B = Breeding: the element is endemic to the state as a breeder only.

SW_APPALACHIANS
Check box to indicate that species occurs in Southwestern Appalachians Ecoregion

RIDGE_VALLEY
Check box to indicate that species occurs in Ridge and Valley Ecoregion

BLUE_RIDGE
Check box to indicate that species occurs in Blue Ridge Ecoregion

PIEDMONT
Check box to indicate that species occurs in Piedmont Ecoregion

SOUTHEASTERN PLAINS
Check box to indicate that species occurs in Southeastern Plains Ecoregion

SOUTHERN COASTAL PLAIN
Check box to indicate that species occurs in Southern Coastal Plain Ecoregion

Range Page

SRANGE: State Range
Enter the code for the present range of the element in Georgia. For aquatic species, we are using the total number of HUC10 watersheds that the species is known from (historic and recent) as an approximation of range size.

A = Very small range, less than 3% of state territory, known from 5 or fewer HUC 10 watersheds

B = Narrow range, less than 10% of state territory. Known from 10 or fewer HUC 10 watersheds

C = Moderately widespread, less than half of state territory. Known from fewer than 50 HUC watersheds

D = Widespread, more than half of state territory. Known from more than 50 HUC 10 watersheds

U = Unknown

HUC10_TOTALRANGE
The total number of HUC 10 watersheds with any occurrences, either historical or recent

HUC10_RECENTRANGE
The number of HUC10 watersheds with documented occurrences during the last 10 years (2004-2013)

SRANGECOM: State Range Comments
Generally describe the range of the element within the state, using the names of counties, physiographic provinces, ecoregions, etc., as appropriate. For physiographic provinces, use the following abbreviations: CU = Cumberland Plateau; RV = Ridge & Valley; BR = Blue Ridge; PD = Piedmont; CP = Coastal Plain. In the case of disjunct elements, include how distant known occurrences of this element in Georgia are from the nearest populations elsewhere.

GA_IMP: Georgia Importance
Assign a code from the list below to indicate the estimated importance of protection efforts in Georgia to global conservation of the element.

A = Protection in Georgia is critical to global conservation of this element.
B = Protection in Georgia very important to global conservation of this element
C = Protection in Georgia somewhat important to global conservation of element.
D = Protection in Georgia not likely to affect global conservation of element.
U = Unknown

For example, if loss of Georgia populations would increase the risk of overall extinction, then the species should get an A for GA_imp.

GA_IMPCOM: Georgia Importance Comments
Provide comments to explain the importance of protection efforts in Georgia to the global conservation of this element.

REGION_LOOKUP:
Indicates primary drainage distribution of species. This field may be used to divide your technical team up into basin specific groups.
1= Atlantic, 2 = Gulf, 3 = Mobile (Coosa), 4 = Tennessee

Trend/Threats Page

STREND: State Trend
Enter the appropriate code from the list below for the description that best characterizes the trend in the element's distribution over its state range:

A = Declining rapidly. Quantitative data (population size, occupancy rate.) showing that the species is currently declining (i.e., within the past decade) across a significant portion of its range in the state (e.g., affecting 1/3 or more of populations). Or any other evidence (expert opinion) suggesting that the species is currently declining in a significant portion of its state range.

B = Declining. Quantitative data (population size, occupancy, etc.etc.) showing that species is currently declining, but that declines are not rapid or are only affecting a limited number of populations. Or any other evidence (expert opinion) suggesting that the species is currently declining gradually or in a limited number of populations.

C = Stable

D = Increasing

U = Unknown

STRENDCOM: State Trend Comments
Provide comments concerning trends in the element's distribution in Georgia. Reference data sources used to justify category selected, if any.

STHREAT: State Threats
Indicate the degree to which the element is directly or indirectly threatened in Georgia. Threats could include habitat conversion, direct exploitation of the species, influence of disease or predators, etc.

A = Very threatened in the state; species or community severely exploited or threatened by natural or man-made forces.
B = Moderately threatened statewide; habitat or community lends itself to alternate uses.
C = Not very threatened statewide; self-protecting by unsuitability for other uses.
D = Unthreatened on a statewide basis, although it may be threatened in minor portions of the state.
U = Unknown

STANDTHREAT1: Drop down box to record first of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

STANDTHREAT2: Drop down box to record second of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

STANDTHREAT3: Drop down box to record third of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

STHREATCOM: State Threat Comments
Give examples of actual threats, if known, in the state. Include any specific threat information that is not captured by the standardized threats above

Standardized Threat Descriptions from 2005 SWAP Plan. Ones that may be particularly relevant to aquatic species are in red font.

1. Acidified Rainfall and Other Atmospheric Pollution:

Includes acid deposition from the atmosphere (both wet and dry) and other air-borne pollutants or nutrients. Acidified rainfall generally has a pH lower than 5.5. It is typically, but not exclusively, related to aerosols, volatile compounds, and semi-liquid pollutants. Impacts include acidifying aquatic systems, impairing plants' ability to evaporate water and exchange gases, and nutrient leaching and toxic accumulation in soil.

2. Incompatible Agricultural Practices

Includes agricultural practices that impact the environment well outside the actual agricultural operation through releases of excess nutrients, toxins, or sediments. Includes practices that degrade stream or wetland habitat quality.

3. Altered Fire Regimes:
Includes fire exclusion, fire suppression, alteration of habitats through unnatural timing, Frequency, or intensity of prescribed burns, and other incompatible fire management practices. Fire regimes are affected by altered community composition (e.g., increase of non-pyric species such as oak) and habitat fragmentation. Fire is an important ecological process that drives many of the terrestrial habitats in Georgia.

4. Altered Hydrology
Includes construction and use of ditches, levees, dikes, and drainage tiles, flow diversion, dredging, channelization, filling of wetlands and headwater streams, destabilization of stream banks or channels, head-cutting, and other alterations to stream morphology or hydrologic regimes. Results in degradation or destruction of aquatic and wetland habitats.

5. Altered Water Quality
Includes various forms of point and non-point source pollution, such as herbicides, pesticides, sediments, nutrient loading, and thermal modifications that directly impact water quality. Sources are quite varied and include waste water discharges, excessive soil disturbance near streams, increased impermeable surface area resulting from development, and loss of vegetation in riparian buffers.

6. Commercial/Industrial Development
Includes development of structures and infrastructure (buildings, utilities, driveways and roads) for commercial or industrial purposes, usually in an urban setting. Impacts may include direct habitat destruction, fragmentation, altered thermal regimes, and indirect pollution sources that alter water quality.

7. Conversion to Agriculture
Includes the conversion of natural habitats to anthropogenic habitats managed for agricultural crops, pasture, horticulture, or silviculture. Usually involves removal of native vegetation, site preparation, and planting of off-site or non-native species. Results in habitat destruction or fragmentation and may impact water quality.

8. Dam and Impoundment Construction
Includes the construction of dams and impoundments (from agricultural ponds to large reservoirs) that directly affect stream flows and fragment aquatic habitat. Results in impacts to the impounded portion of the stream as well as habitats above and below the dam.

9. Development of Roads or Utilities
Includes construction of new roads (interstate highways, state highways, and county roads) and utility right-of-ways (e.g., electrical transmission lines, water/sewer, gas pipelines) that result in habitat destruction or fragmentation and creation of new avenues for invasion by exotic species.

10. Disease
Includes fatal or debilitating disorders resulting from infections, poisons, pathogenic microorganisms, or parasites. The most serious impacts generally result from introduced vectors or pathogens (e.g., sudden oak death, hemlock wooly adelgid, chestnut blight). Impacts can be devastating to the species directly attacked as well as natural communities.

11. Excessive Groundwater and Surface Water Withdrawal
Includes direct groundwater and surface water withdrawals for agricultural, industrial, and municipal water supplies. Excessive withdrawal can result in lowered water tables, diminished local aquifer discharges, and reductions in water available to sustain stream base flows, spring discharges, isolated wetlands, karst environments, and seepage communities.

12. Excessive Herbivory

Involves high, generally unsustainable rates of herbivory that intensively affect species or entire natural communities. Usually attributed to the impacts of herbivorous species that are either non-native or native but have been released from typical natural population limiters (e.g., white-tailed deer in areas of limited hunting).

13. Excessive Predation
Includes impacts to animal populations caused by predators that extensively and intensively impact the demographics of either a select species or entire species assemblages. These predators may either be non-native species or native species that are released from typical natural population limiters.

14. Incompatible Forestry Practices
Involves poor forestry practices that impact species of concern. This includes failure to follow BMPs and site management activities that result in altered structure and composition of adjacent natural habitats or degraded stream or wetland habitats.

15. Global Warming/Climate Change
Defined as consistent, directed change in climatic conditions at regional scales. Such changes may include increases or decreases in average temperatures, changes in the rates, distribution, frequency, or timing of precipitation, and frequency and intensity of storm events. Local effects are often difficult to quantify.

16. Illegal Dumping
Includes all forms of illegal dumping of by-products, ranging from household trash to light industrial waste, to chemical toxins, as well as the impacts resulting from the movement of these wastes from the original site of dumping. Effects on high-priority habitats may range from minor to serious (e.g. dumping inan ephemeral pool on a granite outcrop).

17. Incompatible Fisheries Practices
Includes harvest or management of fish or shellfish by methods that are destructive to native species or aquatic habitats. Includes forms of harvest that result in heavy rates of by-catch, losses of reproductively critical age classes, or increased mortality of imperiled species.

18. Incompatible Mining/Mineral Extraction
Includes extraction of minerals, oil, or gas or similar activities that result in the disturbance or destruction of natural habitats as well as secondary impacts such as sedimentation or releases of toxins. Impacts may include increased sediment loads, downstream scouring, habitat destruction and disturbance, fragmentation, and creation of migration routes for invasive exotic species.

19. Incompatible Road/Utility Management
Includes management of roads or utility corridors that results in excessive releases of sediment or provides access for non-native species, as well as vegetation management practices that are environmentally “unfriendly” (e.g. indiscriminant use of herbicides).

20. Industrial/Municipal Pollution
Includes toxins and air-borne pollutants, thermally altered effluent, and other point source pollutants derived from industrial/commercial land uses in an urban or suburban setting. Involves direct impacts in the form of chemical or thermal stresses to species or natural communities.

21. Invasive/Alien Species
Includes exotic species as well as native species that have become invasive due to past habitat alterations (e.g. hardwood encroachment of long leaf pine habitats following fire suppression). Impacts include competition, hybridization, and predation as well as long-term alterations of ecological systems and processes (e.g. hydrologic changes, changes in soil attributes, altered fire regimes).

22. Poaching or Commercial Collecting

Includes commercial exploitation, poaching, and unscrupulous or excessive collecting of animals or plants by individual or corporate operators. Impacts may include mortality of individuals, population declines, and changes in community composition.

23. Residential Development

Includes primary and secondary home construction as well as development of associated infrastructure (e.g. subdivision roads and driveways, sewer and stormwater utilities). Impacts may include habitat destruction, disturbance, fragmentation, and introduction of invasive species.

24. Unmanaged Recreation

Includes recreational overuse, particularly by ATVs (all-terrain vehicles), but also hiking, biking, caving, horseback riding, rock climbing, and boating (or use of jet skis) in sensitive areas or at rates considered unsustainable in the environments where they occur. Impacts may include habitat destruction and disturbance as well as impaired water quality.

25. Vehicle-Induced Mortality

Includes mortality of animals resulting from collisions with automobiles, boats, or other vehicles. Also includes impacts to plants resulting from vehicular traffic along roadsides, trails, or waterways.

Needs Page

SPROTEOS: State-protected Element Occurrences

Enter the appropriate code (from the list below) for the approximate number of adequately protected occurrences of the element in the state. For an aquatic species population to be considered protected, enough land in the watershed would have to be owned or in easement such that all significant threats to the species are abated (except perhaps for Climate change).

A = Believed to be none protected.
B = At least one protected occurrence.
C = Several protected occurrences.
D = Many protected occurrences.
U = Unknown whether any occurrences are protected.

SPROTNEED: State Protection Needs

Note the most important protection needs for the element in Georgia. Examples:

"Protect habitat at all three known occurrences."

SINVENNEED: State Inventory Needs

Enter comments on the need for additional field inventory work for this element in Georgia. Also enter comments as to the relative completeness of the knowledge of existing element occurrences and where to look for additional occurrences (especially when dealing with poorly known elements where many additional element occurrences are likely to exist). For example,

“Survey Chickamauga Creek population”
“Search for potential population in the Chattahoochee above Lake Lanier”

MONIT.REQS: Monitoring Requirements

Reference any monitoring studies that are already ongoing.
Describe recommended monitoring procedures and/or monitoring needs for this element.
Be specific, if possible. Some examples of what we are looking for

“Demographic monitoring ongoing and should be continued”
“Demographic monitoring needed”

"Occupancy monitoring ongoing and should be continued"
"Occupany monitoring needed"
"CPUE monitoring ongoing and should be continued"
"CPUE monitoring needed"
"Habitat monitoring ongoing and should be continued"
"Habitat monitoring required"
"Species-specific monitoring not required for this species."

SSTEWNEED: State Stewardship Needs
Enter comments on stewardship (management) needs for this element in Georgia. For example,

"Evaluate potential for reintroduction into Talking Rock Creek"
"Stream bank stabilization needed to protect Suches Creek population"
"Culvert removal needed in Salacoa Creek system"

SRSRCHNEED: State Research Needs
Enter comments on research needs (e.g., taxonomy, reproductive behavior, movement patterns) for this element in Georgia. Results of research should increase our ability to manage or conserve the species.

Recommendations Page

REC_SRANK: Drop down box to record S Rank recommended by the Technical Team. S Rank is based upon rarity, trends, and threats.

REC_SEOTRACK
Drop down box to record GADNR Rare Species Database tracking status recommended by Technical Team. Records for this species will be maintained in Biotics and used for environmental review, conservation planning, etc. Species without real conservation needs should not be on this list.

REC_SPROT
Drop down box to record State Protection status recommended by Technical Team.
The following abbreviations are used to indicate the status of state-protected plants and animals or those proposed for state protection in Georgia.

E Listed as endangered. A species which is in danger of extinction throughout all or part of its range

T Listed as threatened. A species that is likely to become an endangered species in the foreseeable future throughout all or parts of its range.

R Listed as rare. A species which may not be endangered or threatened but which should be protected because of its scarcity.

U Listed as unusual (and thus deserving of special consideration). Plants subject to commercial exploitation would have this status.

SWAP_HighPriority_2014
Check this box if the species should be kept on the high priority list or added to the high priority list. High priority species are species with conservation needs (e.g., research, monitoring, restoration, protection, etc.) that should be addressed in the next 5-10 years. These are the species that will be used to identify and rank the relative importance of high priority watersheds. At a minimum, all federally protected, state-protected, and candidate species, should be designated as high priority. Petitioned species should also be high priority, unless the committee believes the species is not an important target for conservation. Other species with important conservation needs should be designated as high priority. GRank and GA_IMP should be considered when

designating high priority species, so that conservation resources are not allocated to peripheral species that are otherwise secure. High priority species are equivalent to Species of Greatest Conservation Need identified by other states.

HighPriorityShed1-4: HUC10 watershed selected by technical team to protect best occurrences of the species. Consider date of occurrences, existing protection, existing condition (e.g., landcover), and threats when selecting the watershed. Order designated is not important.

Goals for high priority watershed selection:
4 watersheds for G1* species
3 watersheds for G1G2 and G2 species.
2 watersheds for G2G3 and higher

Exception: We will not apply this criterion to highly migratory species whose populations do not vary within an individual HUC 10, such as sturgeon, American eels, etc. Also, if the best available science suggests that an individual population of a species could not persist within a single HUC 10, additional watersheds will be selected until a population would have enough habitat to persist (e.g., a sucker species that is known to migrate from a large river into a smaller watershed for reproduction). *Note: If the technical team disagrees with the GRank, we can base this on what the tech team thinks is an appropriate GRANK. Also, some G1 species may not occur within 4 watersheds, so we may end up selecting all known watersheds for some species. The aquatic habitat team will optimize this list across taxa, so don't consider other species when you identify watersheds independently for each species.

RECOMMEND: Recommendations
Summarize recommendations for high-priority actions relating to this element. It is not necessary to repeat information captured by other recommendation fields (e.g., REC_SPROT). Examples:

"Need updated surveys for this species in the lower Ogeechee River basin"

"Habitat enhancement on existing public lands critical for conservation in Georgia"

Make sure you delete any recommendations from existing plan that are no longer relevant.

Documentation Page

CONTACT: Contact
Name(s) of primary contact(s) for information on this element (this may be a technical team member, author of a report, or some other source of information).

REFERENCES: References
Can be used to provide abbreviated bibliographic references as needed.

ADDITIONAL_COMMENTS. Use this field to record any important information not captured in other parts of the assessment form.

ASSESSMENT_COMPLETED
Check this box when you and technical team members have completed the assessment for this species. Good job

Discussion

As part of the 2015 revision of Georgia's State Wildlife Action Plan, we identified 221 high priority watersheds for conservation. Collectively, these watersheds are important for conserving the best known populations of high priority aquatic species, all extant occurrences and critical habitat units of ESA listed aquatic species, migratory corridors for high priority diadromous species, important coastal habitats, and representative aquatic communities from around the state. The majority of these watersheds (165) were designated because they contained at least one important population of a high priority aquatic species. These 165 watersheds were further prioritized based upon the number and global rarity of high priority species.

We also carried out a corresponding GIS assessment of the degree of protection, existing condition, as well as trends and future threats to all Georgia watersheds. Below we provide examples of how the assessment data can be used to help identify specific conservation actions in three high priority watersheds. We chose these specific watersheds because they help illustrate a wide range of threats and conservation actions that are relevant to watersheds throughout the state. Where appropriate, we have referenced some of the specific conservation actions identified by The Fishes and Aquatic Invertebrates Assessment Team (Albanese et al. 2015). More information about these conservation actions can be found in an excel file that should always accompany this report.

Example 1, Armuchee Creek

Armuchee Creek (#318; Figure 2) is a high priority watershed in the Ridge and Valley portion of the Coosa River drainage in northwest Georgia. It supports important populations of 10 high priority aquatic species (3 mussels, 3 fishes, 2 snails, a crayfish and a dragonfly), placing it among watersheds with the highest global significance scores in the state. It has a high percentage of forest cover (71.1%) and a relatively high percentage of protected lands (32.9%; Table 2). Outside of forest areas, pasture (12.6%) and cultivated crops (2.6%) are the dominant land cover types, with low total urban cover (0.7%), and a moderate amount of developed open space (3.5%; Figure 22). Index of Biotic Integrity (IBI) fish community sampling has been conducted at 5 sites in the watershed, with most recent scores including poor (unnamed trib), fair (Lavender Creek), good (1 site each in East and West Armuchee Creeks), and excellent (a different site in West Armuchee Creek). Armuchee Creek still contains high quality aquatic habitat (Figure 23) and most reaches are predicted to be at low to moderate risk for habitat degradation (Figure 14). However, sampling in 2012 did document extensive mats of filamentous algae, which could indicate nutrient pollution (Figure 24). The density of dams is relatively low (1 per 166 Km of stream length; Table 2; Figure 10) and the density of stream crossings is moderate (Figure 11).

In contrast to many other north Georgia watersheds, recent landuse changes and urban growth models do not evince dramatic changes for the Armuchee Creek watershed in the future. The largest change between 2001-2011 was the loss of 3.7% forest cover, but developed land (+0.2%) and cultivated crops (-0.1%) changed little. Only a small number of pixels increased in imperviousness between 2001-2011 (Figure 19). Similarly, urban growth is not predicted to be extensive in the watershed in either 2020 or 2050 (Figure 20 and Figure 21). While Armuchee

Creek has exhibited little recent development and is not predicted to urbanize, the neighboring watershed to the south is (#319). In addition, the current pattern of public ownership and roads in the watershed suggest that any additional development would be concentrated near rivers and streams.

Several SWAP conservation actions may be appropriate for the Armuchee Creek watershed. High resource quality and the low density of existing dams demonstrates the need for protection of aquatic connectivity in free-flowing systems (action #3). This action can be implemented by avoiding construction of new dams and improving aquatic organism passage through poorly designed stream culverts (see Georgia's Stream Crossing Handbook). The importance of pasture as a land cover type and the potential nutrient issue mentioned above suggest the value of technical assistance to farmers to protect streams in high priority watersheds (action #8). Targeted aquatic species outreach (action #32) would help generate local interest and support for conserving the watershed and could be completed in conjunction with additional surveys and monitoring (action #47).

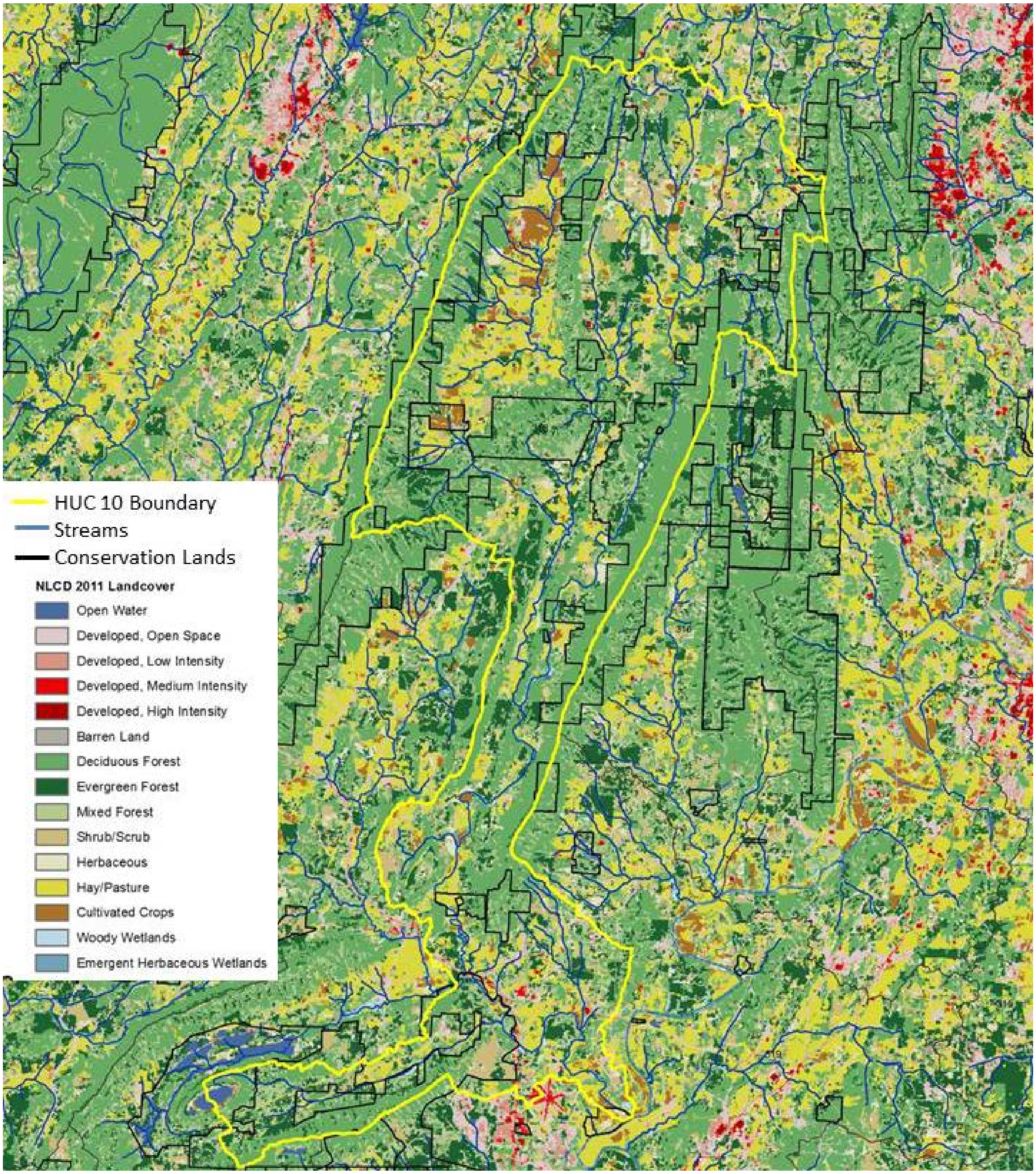

Figure 22. National Land Cover Classification (NLCD 2011) for the Armuchee Creek HUC 10 watershed, with streams and conservation land boundaries also shown.

Figure 23. High quality aquatic habitat in Armuchee Creek, including a patch of native emergent vegetation, a shallow backwater habitat, a rocky riffle with moderate to swift current, and an intact and mature riparian forest.

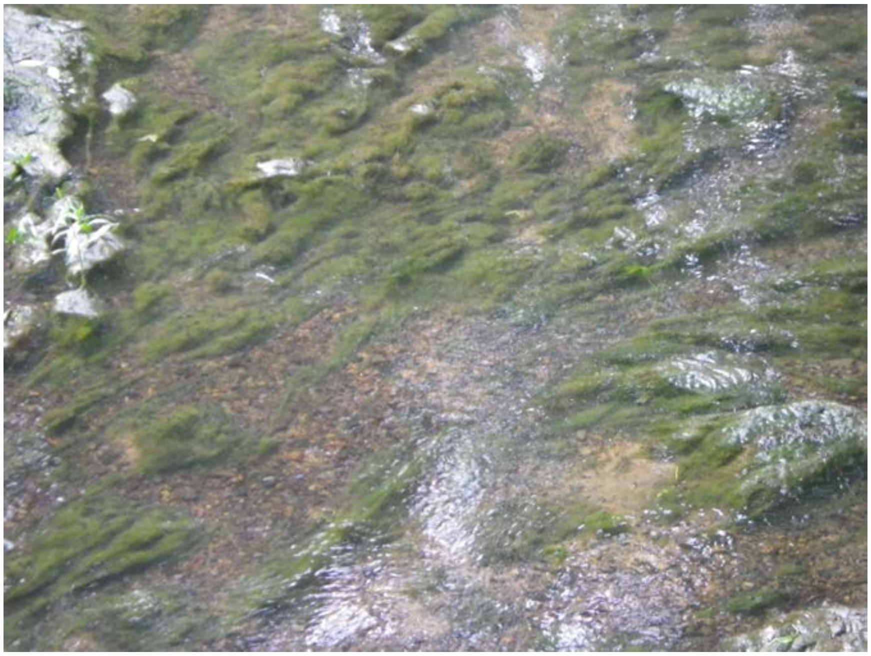

Figure 24. Patch of filamentous algae in Armuchee Creek. Extensive beds of filamentous algae can be an indicator of nutrient enrichment problems and may degrade habitat conditions for aquatic species.

Example 2, Upper Nottely River

The upper Nottely River (#361; Figure 2) is in the Blue Ridge ecoregion of north Georgia near the North Carolina border. It is categorized as having moderate global significance because of important populations of Blotched Chub (*Erimystax insignis*) and Eastern Hellbender (*Cryptobranchus alleganiensis*). It is also a potential reintroduction site for the undescribed Sicklefin Redhorse (*Moxostoma* sp.), which likely occurred in the watershed before Lake Nottely was created. Like Armuchee Creek, the Upper Nottely River has a high percentage of forest cover (76.5%) and protected lands (36.4%) and low total urban cover (1.2%) (Table 2; Figure 25). Outside of forested areas, the only land cover types representing more than 2% of watershed area are developed open space (9.2%) and pasture/hay (7.4%; Table 2). There is relatively low dam density (1 per 63 km of stream length; Figure 10; Table 2), but the density of road crossings is relatively high (Figure 11). Index of Biotic Integrity scores indicate widespread impairment of fish communities, with 15 of 21 sites scoring fair, poor, or very poor (Figure 12). The risk of habitat degradation is generally low and moderate, but there is a high to very high risk of degradation in the city of Blairsville and along U.S Highway 76 (Figure 14). Overall land cover has changed little between 2001-2011. However, additional urbanization is expected at scattered locations throughout the watershed by 2020 (Figure 20) and extensive urbanization is expected by 2050 (Figure 21).

While there is relatively high forest cover and a significant amount of protected land, the Nottely River watershed exhibits some signs of stress that will likely be exacerbated as urbanization continues. Because of steep mountainous terrain in the Blue Ridge ecoregion, most development and agricultural activities are limited to small floodplain areas near rivers and streams (Figure 25). Thus, the spatial pattern of land use may contribute to the widespread degradation suggested by the IBI scores. Another important factor is the impact of both small dams and Lake Nottely on aquatic connectivity, which can decrease the resilience of aquatic species populations by blocking colonization and other movements required for life-cycle completion. The large number of road crossings in the watershed also suggests that culverts may further restrict aquatic organism passage. Other sources of habitat degradation include bank erosion and nutrient enrichment associated with cattle grazing, development in riparian areas associated with vacation homes and tourism, and sedimentation from unpaved roads (personal observations). These impacts are not restricted to the Nottely River system, but are representative of impacts to streams throughout the Blue Ridge in Georgia (Owers et al. 2012).

As in Armuchee Creek, our assessment results suggest the importance of several SWAP conservation actions. Technical assistance to farmers (#8) could involve the development of alternative watering sites and fencing in reaches where cattle are currently accessing streams. There are also opportunities for riparian zone restoration (#12) in both agricultural and residential areas. The greatest challenge, though, will be protecting aquatic habitats from projected urbanization. Technical assistance to local governments (#6) could help identify and implement innovative policies to minimize the myriad of impacts associated with new development (e.g., impervious surfaces, stream crossings, water supply development, sewage treatment, etc.). The policies developed for the Etowah Habitat Conservation Plan would be a good starting point for consideration.

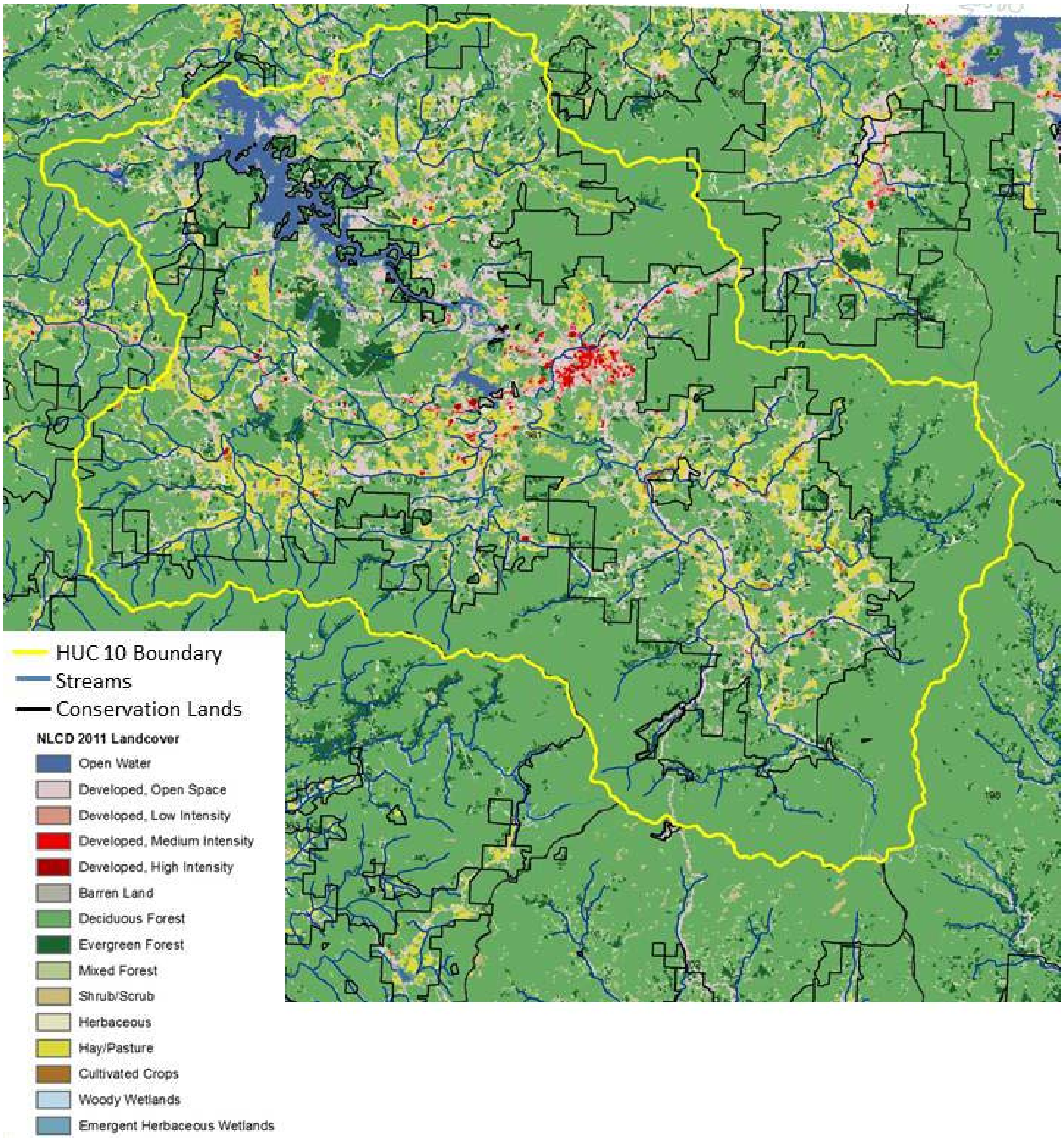

Figure 25. National Land Cover Classification (NLCD 2011) for the Upper Nottely River HUC 10 watershed, with streams and conservation land boundaries also shown.

Example 3, Spring Creek

Spring Creek (#296) is a high priority watershed in the Southeastern Plains portion of the Flint River drainage in southwest Georgia (Figure 2). It supports important populations of 7 high priority aquatic species (5 mussels, 1 fish, and 1 reptile), placing it among watersheds with the highest global significance scores in the state (Table 1). Predominant land cover types are cultivated crops (48.6%), forest (21.4%), woody wetlands (10.2%), and pasture/hay (6.0%; Table 2; Figure 26). Total urban (3.1%) and developed open space (3.6%) represent a small portion of the watershed. There are no dams (Figure 10) and the density of road crossings is moderate (Figure 11). Index of Biotic Integrity fish community sampling has not been conducted in the watershed, but 12.7% of stream length is impaired due to other water quality criteria (Table 2). The risk of habitat degradation is primarily moderate and high (Figure 14). Overall, land cover was stable between 2001-2011 and only modest increases in urbanization are predicted for 2050. Despite the dominance of cultivated crops in the watershed, Spring Creek still provides high quality habitat for aquatic species (Figure 27). We attribute this to the occurrence of woody wetlands and forested habitat along the mainstem of Spring Creek as well as the supply of high quality water from underlying aquifers. The most significant threat to the persistence of species is the impact of severe and persistent drought coupled with agricultural water use. These two factors have resulted in record low stream flows in 9 of the past 15 years, with extensive portions of Spring Creek stagnating or going completely dry for extended time periods (Figure 28). In addition, the high density of cultivated crop agriculture appears to contribute substantial sediment loads into the creek, which degrades habitat quality and reduces the availability of deeper refuge pools during droughts. Despite these threats, this watershed contains perhaps the best remaining populations of two federally endangered mussel species. In addition, it supports 47% of all the freshwater mussel species known in the Apalachicola-Chattahoochee-Flint River Basin.

The most important conservation action for the Spring Creek watershed is the development of environmental flow recommendations (action #4), which involves identification of the timing and magnitude of stream flows needed to sustain ecosystems and provide for human use. It is an understatement to say that this issue has received considerable attention from the general public, researchers, the agricultural community, and various state and federal agencies. Nonetheless, providing adequate streamflows in Spring Creek will require continued focus, investment, and cooperation. Working with stakeholders through the statewide water planning process (action #9) and through other mechanisms is necessary to develop solutions to environmental flow issues in Spring Creek and other southwest Georgia streams. Continued monitoring of mussels (action #33) will help ensure that species are persisting and help measure their response to different management actions which protect stream flows during droughts (i.e. adaptive management). Targeted aquatic species outreach should help generate local interest and support for conservation efforts (action #32).

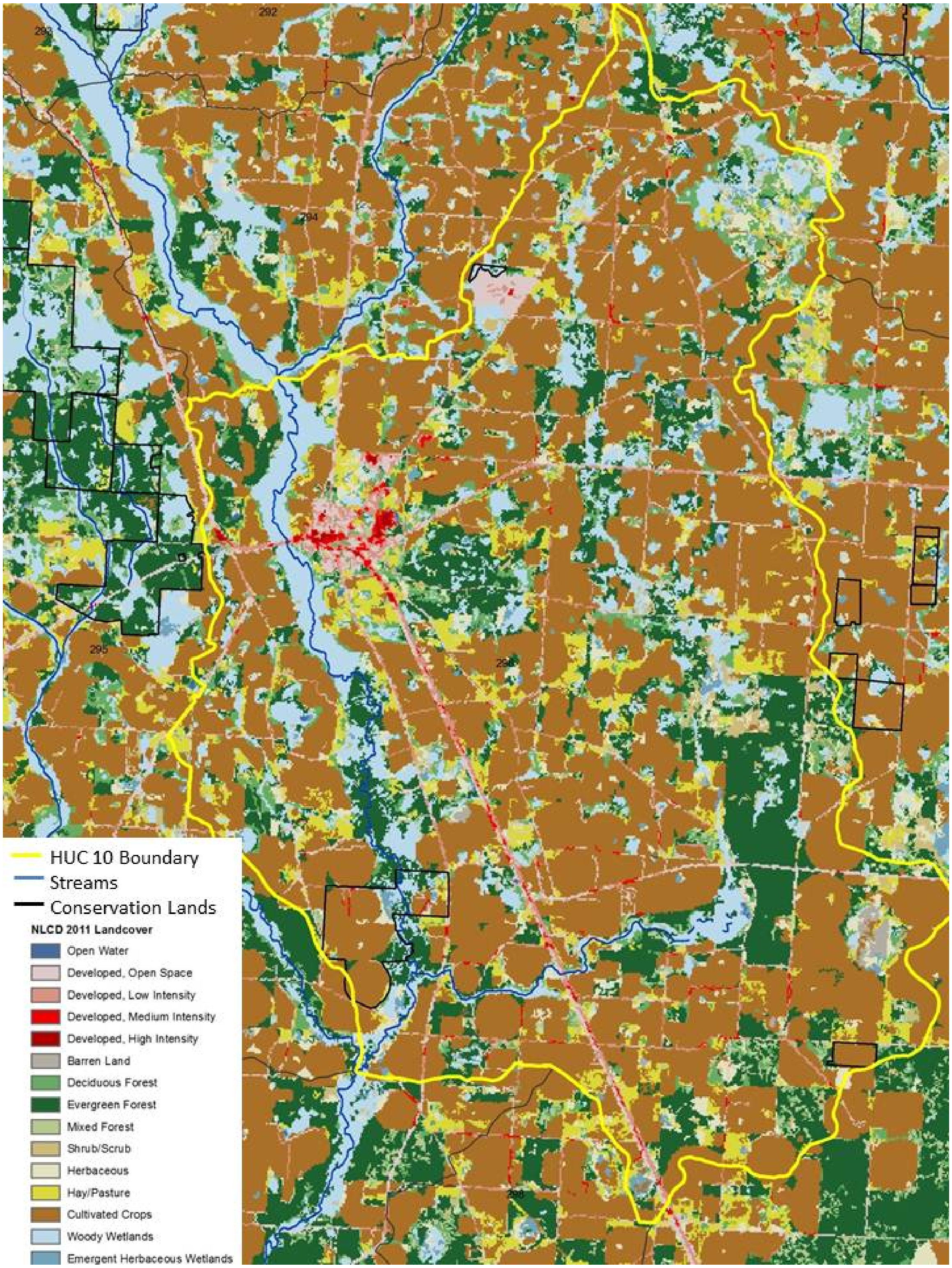

Figure 26. National Land Cover Classification (NLCD 2011) for the Spring Creek watershed, with streams and conservation land boundaries also shown.

Figure 27. High quality habitat in Spring Creek, which includes extensive woody debris and undercut banks, clear water with deep runs and pools, and an extensive and mature riparian forest. Photo by Jason Wisniewski.

Figure 28. Reach of Spring Creek impacted by low stream flows associated with drought and agricultural water use. Photo by Jason Wisniewski.

Additional Recommendations for Conservation of High Priority Watersheds

We acknowledge that there are some limitations and caveats to consider when utilizing this report to guide conservation. First, there is underlying error in the process of classifying land cover types using satellite data (Wickham et al. 2013). Thus, while these data may identify a **potential** threat to water quality, it is important to verify actual impacts to water quality before investing resources into a project. Similarly, data sets such as the National Inventory of Dams are known to underestimate the true number of dams. There are many additional data sets that can help support more detailed conservation planning in high priority watersheds. For example, the Southeastern Aquatic Connectivity Assessment Project (SEACAP) has developed an online tool to help identify the most ecologically significant barriers to the movement of aquatic species. This tool could be used to identify which dam to remove to provide the greatest overall benefit to aquatic ecosystems within a high priority watershed. Another example would be the use of aerial photography and other remote sensing imagery (Klemas 2014) to identify specific areas for the protection and restoration of riparian zones.

With these considerations in mind, we still believe that the information contained in this report provides a useful starting point for watershed-level conservation in Georgia. It is our hope that this information will help support:

1. Efforts by conservation groups and government agencies to protect and restore southeastern aquatic species diversity, which is considered globally significant (Abell et al. 2000; Jelks et al. 2008). Watersheds with the highest global significance scores are a priority for implementing conservation projects carried out by groups such as American Rivers, The Nature Conservancy, Southeastern Aquatic Resources Partnership, The Tennessee Aquarium Conservation Institute, and The U.S. Fish and Wildlife Service.
2. Efforts by Georgia and its conservation partners to protect and recover Georgia's high priority aquatic species. The SWAP Fishes and Aquatic Invertebrates Team identified altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction as significant threats to a large number of high priority aquatic species. Addressing these threats on a statewide basis is unrealistic, but they can be addressed by focusing efforts in individual high priority watersheds.
3. Efforts to protect water quality and provide compatible recreational opportunities, such as angling, boating, or hiking. While the goal of a group or agency may not be to protect aquatic species per se, there are numerous opportunities to protect natural resources to the benefit of species, habitats, and local citizens. An example would be the establishment of a community natural area in a high priority watershed.

Acknowledgments

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Appendix I: Data Layers Used in Watershed Assessment

1. Degree of Protection

    a. **Proportion Conservation Land** (+): Percent of watershed owned or under permanent conservation easement and managed for natural resource protection Source: Conservation Lands Database and Protected Areas Database for portions of HUC10 watersheds outside the state of Georgia.
    Data Type: Exploratory

2. Existing Condition

    a. **Proportion Forest** (+): Proportion of the HUC10 that is classified as Deciduous Forest, Evergreen Forest or Mixed Forest.
    Source: National Land Cover Dataset (NLCD 2011)
    Data Type: Potential Predictor

    b. **Proportion of Cultivated Crops (-):** Proportion of the HUC10 that is classified as Cultivated Crops.
    Source: National Land Cover Dataset (NLCD 2011)

Data Type: Potential Predictor

c. **Proportion Developed 1 (-):** Proportion of the HUC10 that is classified as Developed Low, Developed Medium, or Developed High Intensity.
Source: National Land Cover Dataset (NLCD 2011)
Data Type: Potential Predictor

d. **Proportion Developed 2 (-):** Proportion of the HUC10 that is classified as Developed Low, Developed Medium, Developed High Intensity or Open Space. Calculated using 2011 version of 2001 and 2011 NLCD Land cover data.
Source: National Land Cover Dataset (NLCD 2011)
Data Type: Potential Predictor

e. **Percent Impervious (-):** To assess the potential impact of urban development and infrastructure on aquatic environments, we used the NLCD impervious surface coverage for 2011. Percent impervious represents the fraction of impervious surface within a 30 x 30m cell.
Source: NLCD 2011 impervious surface coverage
Data Type: Potential Predictor

f. **Dam Density (-):** These data are summarized in two ways: as the number of dams divided by watershed area (hectares) and the number of dams divided by stream length (km). Stream length was based upon NHD hydroline (fine resolution).
Source: 2013 National Inventory of Dams
Data Type: Exploratory, since it does not include many small dams

g. **Road Crossing Density (-):** number of crossings divided by watershed area, developed by placing a point at the intersection of stream and road crossing data sets. This is a general indicator of the potential for aquatic habitat fragmentation associated with poorly designed culverts and other impacts associated with roads. All underground conduit, pipelines, and artificial paths were removed from the stream data set to minimize crossings that would likely be bridges or have limited aquatic habitat
Source: 2007 and 2012 GDOT Road geodatabase (inside GA), U.S. and Canada Detailed Streets, (TomTom North America, Inc.; outside GA)
Data Type: Exploratory

h. **Index of Biotic Integrity Scores (IBI) (+):** IBI fish community sampling in 1094 stream reaches sampled between 1998-2011 was used to determine if stream reaches

are impaired or meet their designated uses under the Clean Water Act. Streams with no fish, a very poor, or a poor IBI category are designated as “impaired”, whereas streams rated fair, good, or excellent are designated as “meet”. Additional analyses could average IBI score by watershed.
Source: Georgia DNR Stream Survey Team
Data Type: Potential Predictor

i. **Proportion Impaired (-):** Proportion of total stream length in watershed not supporting their designated uses (i.e., 303d listed streams). Calculated total m of impaired waters divided by total m of waters in the watershed. Streams can be listed for violating a variety of water quality criteria, including biotic integrity (based fish or macroinvertebrate community), temperature, dissolved oxygen, heavy metals, algae, fecal coliform and other factors. Thus, this data set is more inclusive than the information provided by Index of Biotic Integrity scores alone. More information on Georgia’s 303d list can be found here.
Source: 2012 303d Stream Data.
Data Type: Exploratory

j. **Habitat Condition Index (-):** This index was developed to reflect the cumulative influence of landscape variables on aquatic habitat and is based upon land use, population density, roads, dams, mines, and point-source pollution sites. The index is based on landscape variables and predicts the risk of habitat degradation at the scale of an individual stream reach or local catchment. Scores range from 1 (highest risk of habitat degredation) to 5 (lowest risk of habitat degredation). Risk of Current Habitat Degradation is classified as very low = 4.34-5.0, low = 3.5-4.33, moderate = 2.51-3.49, high = 1.51-2.5, very high =1.0-1.5, and unscored reach = 0.
Esselman et al. (2011) describe the approach in more detail.
Source: National Fish Habitat Plan 2010 Habitat Condition Scores
Data Type: Potential Predictor

3. Recent Trends and Future Threats

a. **Forest Change (+/-):** Forest change was expressed in two ways. First, as the change in the proportion of each watershed classified as any of the forest types between 2001 and 2011 (negative indicates loss of forest). Second, as a loss/gain map for each cell (30 x 30m block of area) in the landscape. Forest loss was attributed to cells that were classified as Deciduous forest, Evergreen forest or Mixed forest in 2001 and classified as a non-forest type in 2011. Forest gain was defined as any cells classified as a non-forest type in 2001 and classified as one of the forest types in 2011.
Source: NLCD 2001 to 2011 Land Cover from to Change Index
Type: Potential predictor

b. **Cultivated Crop Change (+/-):** Change in the proportion of watershed classified as cultivated crops between 2001 and 2011. Also presented as a loss/gain map and calculated as described for forest change.
Source: NLCD 2001 to 2011 Land Cover from to Change Index
Type: Potential predictor

c. **Change in Proportion Developed I:** Change in proportion of each watershed classified as Developed Low, Medium, and High Intensity between 2001-2011 (negative indicates loss of landuse type).
Source: 2011 versions of 2001 and 2011 NLCD.
Type: Potential Predictor

d. **Change in Proportion Developed II:** Change in proportion of each watershed that is classified as Developed Low, Developed Medium, Developed High Intensity, or Open Space between 2001-2011 (negative indicates loss of landuse type).
Source: 2011 versions of 2001 and 2011 NLCD.
Type: Potential Predictor

e. **Change in Percent Impervious (+/-):** Contains the difference in percent developed imperviousness of pixels that changed between NLCD 2001 percent developed imperviousness (2011 Edition), and NLCD 2011 (2011 Edition) percent developed imperviousness. " - http://www.mrlc.gov/nlcd06_data.php
Source: 2001 Percent Developed Imperviousness (2011 Edition) and 2011 Percent Developed Imperviousness.
Type: Exploratory

f. **Predicted Urbanization (SLEUTH):** The SLEUTH-3r model was used to simulate the extent of urban growth throughout the southeastern United States as part of the Southeast Regional Assessment Project for the USGS National Climate Change and Wildlife Science Center. The model uses six datasets (slope, land use, exclusion, urban, transportation, and hillshade) to predict the probability of future urbanization at various time intervals. We selected model outputs for 2020 and 2050 and overlayed watershed boundaries.
Source: SLEUTH Models for DSL-SERAP, Decadal Predictions 2000 – 2100
Type: Exploratory

Appendix II: Other Important Data Layers Considered but Not Included in the Watershed Assessment

a. 2001 Riparian Condition Assessment (-): Percent agricultrual and urban land cover within 30 m of stream (-)
This data set identifies the percent of agricultural and urban land cover within 100 feet of stream banks (30 m). This data set has some limitations that preclude its use as a predictor variable. For example, a few canopy trees on the stream bank would result in classification as forest even though houses, pavement, or lawns could be underneath the canopy trees. In addition, large sections of rivers were excluded from the data set due to mapping errors. Nonetheless, it may be useful for looking at coarse temporal trends in stream buffers and identifying management actions for individual HUC 10s. The model can be re-run with 2011 NLCD data, but that has not yet been completed.
Source: SALCC Conservation Planning Atlas
Data Type: Exploratory

b. SARP SE Connectivity Assessment Data (SEACAP) : The goal of this project is to assess stream connectivity throughout the southeast, based on locations of dams and other barriers to aquatic organism passage. The data set was released in early 2015 and will be important for determining the ecological benefit of dam removal and culvert improvement projects.
Source: Southeast Aquatic Resource Partnership
Data Type: Exploratory

c. Chemical Spill Data (-): Data documenting toxic spills and fish kills into waterways. This was identified as a data need during discussion.
Source: Unknown

d. Concentrated Animal Feeding Operations (-): This was identified as a data need during discussion. This data would show the locations of concentrated animal feeding operations (CAFO) and help identify areas where conservation actions could help reduce water quality impacts.
Source: Unknown

e. SparrowWater Quality Dataset. The U.S. Geological Survey Sparrow dataset provides models and water quality data for streams and watersheds. Models for Georgia include suspended sediment, carbon, phosphorus, and nitrogen.
Source: USGS SPARROW Project

f. Invasive Species Data. This provides list of non-native aquatic species at the HUC 8 scale. Although this dataset is at a different scale than the HUC 10 used in this assessment,

knowledge of invasive species could provide insight to potential threats to aquatic species identified in the SWAP.
Source: USGS Nonindigenous Aquatic Species Page

g. Risk of Flow Alteration (-): This dataset reflects the combined effects of water consumption, evapotranspiration, and impervious cover. Data can be viewed online in map viewer.
Source: Data Basin Webpage

h. Permitted Groundwater and Surface Water withdrawals (-): This data set would help estimate risk to streamflow from water withdrawals. One important caveat is that actual water use may not be well characterized from the number of permits in each watershed. Of these two withdrawal types, surface water withdrawal data would be more meaningful, as influence of groundwater wells is much more variable depending on local geology. USGS conducts a national water census every 5 years, which might be a better way to assess threat of water use.
Source: EPD or USGS

i. Predicted Stream Temperatures: A data set that shows predicted stream temperature and precipitation changes associated with climate change at the stream reach scale. This would help understand potential impacts to species in high priority watersheds.
Source: Unknown

Appendix G. Terrestrial Invertebrates Technical Team Report

Prepared by Matt Elliott

Technical Team Members

Dr. Jerry Payne – Entomologist, University of Georgia (Retired)
Dr. James Adams – Entomologist/Professor, Dalton State College, GA
Pierre Howard – Independent Naturalist/Georgia Conservancy
Dr. JoVonn Hill – Entomologist, Mississippi State University/Mississippi Entomological Museum
Giff Beaton – Independent Naturalist/Field Guide Author
Dirk Stevenson – Herpetologist/Naturalist, The Orianne Society
David Hedeen – Ecology Team Leader, Georgia DOT
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Dave Almquist, Invertebrate Zoologist, Florida Natural Areas Inventory
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David Withers, Zoologist, Tennessee Natural Heritage Inventory Program

This list reflects persons who have participated in email, telephone, or in-person discussions related to the State Wildlife Action Terrestrial Invertebrates update. A subset of the list participated in a group discussion at the Wildlife Resources Conservation Center in Social Circle on February 27, 2014. Others participated via email, telephone conversation, or individual meeting.

Approach

Terrestrial invertebrates are the most diverse taxon to be considered in Georgia's State Wildlife Action Plan (SWAP) update, but the most poorly understood. Most species of terrestrial invertebrate lack fundamental information on abundance, range, population trend, threats, or protection needs. Especially in the past there have been relatively few professionals familiar with these taxa in the Southeast from a conservation (as opposed to pest-reduction) perspective, and many species groups remain unrepresented in data that have been acquired. Since completion of the initial SWAP, the situation has improved for many taxa. Lepidoptera remain the best-studied order, and interest in this taxon has exploded in recent years especially amongst birders. In addition, groups such as ants, tiger beetles, and grasshoppers have also seen growing interest, and a growing body of information related to their abundance and conservation.

In the previous iteration of the SWAP in 2004, committee team members developed and refined a list of special concern terrestrial invertebrates for Georgia, but did not attempt to designate high-priority species. An abbreviated list of high-priority habitats was also compiled. In the second SWAP iteration we put together for the first time a list of high-priority terrestrial invertebrates, refined the special concern list, and have expanded the list of high-priority habitats as well as developed a preliminary list of threats.

High Priority Species

A number of species were recognized as high-priorities for conservation in Georgia. These are listed in the Table 1 and include species endemic to Georgia or with a similarly restricted range, narrow habitat requirements, declining populations, or significant threats (of either direct mortality or to habitat). More detailed information regarding individual species may be found in Section IV.

Scientific Name	Common Name	Order
Cyclocosmia torreya	Torreya trap-door spider	Areneae
Habronattus sabulosus	Jumping spider (Heggie's Rock)	Areneae
Sphodros abbotii	Purse-web spider	Areneae
Alloblackburneus troglodytes	Little gopher tortoise scarab beetle	Coleoptera
Aphodius aegrotus	A dung beetle	Coleoptera
Aphodius alabama	A dung beetle	Coleoptera
Aphodius baileyi	A dung beetle	Coleoptera
Aphodius bakeri	A dung beetle	Coleoptera
Aphodius dyspistus	A dung beetle	Coleoptera
Aphodius gambrinus	Amber pocket gopher Aphodius beetle	Coleoptera
Aphodius hubbelli	A dung beetle	Coleoptera
Aphodius laevigatus	Large pocket gopher Aphodius beetle	Coleoptera
Aphodius pholetus	Rare pocket gopher Aphodius beetle	Coleoptera
Aphodius platypleurus	Broad-sided pocket gopher Aphodius beetle	Coleoptera
Aphodius tanytarsus	Long-clawed pocket gopher Aphodius beetle	Coleoptera
Chelyoxenus xerobatis	Gopher tortoise hister beetle	Coleoptera
Cicindela nigrior	Autumn tiger beetle	Coleoptera

Crossidius grahami		Coleoptera
Euphoria aeusutosa	Pocket gopher flower beetle	Coleoptera
Geopsammodius ohoopee		Coleoptera
Hypothyce osburni		Coleoptera
Mycotrupes cartwrighti		Coleoptera
Mycotrupes lethroides		Coleoptera
Onthophagus polyphemi polyphemi	Onthophagus tortoise commensal scarab beetle	Coleoptera
Polyphylla donaldsoni	Donaldson's lined june beetle	Coleoptera
Bryophaenocladius chrissichuckorum	Midge (Heggie's Rock)	Diptera
Machimus polyphemi	Gopher tortoise robber fly	Diptera
Bombus affinis	**Rusty-patched bumblebee**	Hymenoptera
Bombus borealis	Northern amber bumble	Hymenoptera
Caupolicana electa	Plasterer bee	Hymenoptera
Dorymyrmex bossutus		Hymenoptera
Dorymyrmex bossutus		Hymenoptera
Pheidole davisi		Hymenoptera
Pheidolie davisi		Hymenoptera
Temnothorax_GA_01		Hymenoptera
Temnothorax_GA_01		Hymenoptera
Amblyomma tuberculatum	Gopher tortoise tick	Ixodida
Acronicta albarufa	Albarufan dagger moth	Lepidoptera
Amblyscirtes alternata	Dusky roadside-skipper	Lepidoptera

Amblyscirtes belli	Bell's Roadside-skipper	Lepidoptera
Amblyscirtes carolina	Carolina roadside-skipper	Lepidoptera
Amblyscirtes reversa	Reversed roadside-skipper	Lepidoptera
Atrytone arogos arogos	Eastern Aragos Skipper	Lepidoptera
Autochton cellus	Golden-banded skipper	Lepidoptera
Callophrys hesselli	Hessell's hairstreak	Lepidoptera
Callophrys irus	Frosted elfin	Lepidoptera
Catocala grisatra	Grisatra underwing moth	Lepidoptera
Chlosyne gorgone gorgone	Gorgone checkerspot	Lepidoptera
Danaus plexippus	**Monarch butterfly**	Lepidoptera
Erora laeta	Early hairstreak	Lepidoptera
Erynnis martialis	Mottled duskywing	Lepidoptera
Euphydryas phaeton	Baltimore checkerspot	Lepidoptera
Euphyes berryi	Berry's Skipper	Lepidoptera
Euphyes bimacula arbogastii	Two-spotted Skipper	Lepidoptera
Euphyes dukesi	**Duke's Skipper**	Lepidoptera
Euphyes pilatka	**Palatka Skipper**	Lepidoptera
Fernaldella georgiana	Ohoopee Geometer	Lepidoptera
Hesperia attalus slossonae	Dotted skipper	Lepidoptera
Hesperia meskei	Meske's skipper	Lepidoptera
Idia gopheri	Gopher tortoise burrow noctuid moth	Lepidoptera
Neonympha areolatus	Georgia Satyr	Lepidoptera
Neonympha helicta	Helicta satyr	Lepidoptera
Phyciodes batesii maconensis	Tawny crescent	Lepidoptera
Pieris virginiensis	West Virginia White	Lepidoptera

Poanes aaroni howardi	Aaron's skipper	Lepidoptera
Polites baracoa	Baracoa skipper	Lepidoptera
Polygonia faunus	Green comma	Lepidoptera
Problema bulenta	**Rare Skipper**	Lepidoptera
Satyrium edwardsii	Edwards hairstreak	Lepidoptera
Satyrium kingi	King's hairstreak	Lepidoptera
Speyeria diana	Diana fritillary	Lepidoptera
Zale perculta	Okefenokee zale moth	Lepidoptera
Aptenopedes apalachee		Orthoptera
Eotettix palustris		Orthoptera
Floritettix borealis		Orthoptera
Hesperotettix floridensis		Orthoptera
Melanoplus acidocercus		Orthoptera
Melanoplus clypeatus	Shield-tailed Spur-throat Grasshopper	Orthoptera
Melanoplus longicornis		Orthoptera
Melanoplus nossi		Orthoptera
Melanoplus sp nov 1		Orthoptera
Melanoplus sp nov 2		Orthoptera
Melanoplus stegocercus		Orthoptera
Melanoplus tumidicercus		Orthoptera
Trimerotropis saxatalis	Lichen or rock grasshopper	Orthoptera

High priority habitats and sites

The range of terrestrial invertebrates is so diverse that they occupy nearly every conceivable niche on the planet. A number of studies have focused on rare or declining habitats (e.g. caves or pocket gopher mounds) and identified threatened or unusual terrestrial invertebrate species associated with those habitats. The SWAP list of priority terrestrial invertebrate habitats includes a number of these rare habitats but also a few more common types that contain exceptional diversity for some taxa.

Coastal Plain (including both Southeastern Plains and Southern Coastal Plain)

Sandhills – Longleaf pine/scrub oak woodlands and xeric Aeolian dunes were identified as high priority habitats in Georgia's 2005 SWAP and they remain so. They are found on excessively-drained sandy soils found along the Fall Line (of Cretaceous age) or in Pleistocene aeolian deposits along rivers (such as Ohoopee Dunes), or Pleistocene marine sand deposits at the site of former barrier islands (such as Trail Ridge). Vegetation is usually dominated by longleaf pine, xeric oak species such as turkey oak, and wiregrass, little bluestem, and other herbaceous groundcover species. Because species have evolved to adapt to the relatively harsh conditions of these habitats, and because the habitats themselves are rather narrowly distributed across the landscape, a large number of high-priority animals and plants are found on sandhill habitats in Georgia and throughout the Southeast.

Lepidoptera and Orthoptera have probably been the best-studied taxonomic Orders of terrestrial invertebrates on sandhill habitats in Georgia, although they are by no means the only high priority taxa. Amongst the Lepidoptera, the following species are typically found on sandhills: *Acronicta albarufa* (Albarufan dagger moth), *Atrytone arogos arogos* (Eastern Aragos skipper), *Callophrys irus* (frosted elfin), *Catocala grisatra* (Catolcala underwing moth), *Chlosyne gorgone gorgone* (Gorgone checkerspot), *Fernaldella georgiana* (Ohoopee geometer, endemic to Ohoopee Dunes Aeolian sandhills), *Hesperia attalus slossonae* (dotted skipper), *Hesperia meskei* (Meske's skipper), and *Polites baracoa* (Baracoa skipper). Amongst *Orthoptera*, the following are associated with sandhills: *Melanoplus acidocercus*, *Melanoplus sp nov 1*, *Melanoplus sp nov 2*, and *Melanoplus stegocercus* (a Georgia endemic restricted to Ohoopee and Canoochee Aeolian dunes with one occurrence at Yuchi WMA). In addition, a number of Coleoptera, *Cicindela nigrior* (Autumn tiger beetle), *Polyphalla donaldsoni* (Donaldson's lined june beetle, restricted to Ohoopee Dunes), *Crossidius grahami* (Ohoopee Dunes endemic associated with woody goldenrod as a host plant), *Geopsammodius ohoopee* (another Ohoopee Dunes endemic), *Hypothyce osburni*, and *Mycotrupes lethroides* are restricted to sandhills, as is the globally rare plasterer bee *Caupolicana electa*. A couple of other priority species are restricted to gopher tortoise burrows (often, though not exclusively, a sandhills associate) and some potential priority species are restricted to pocket gopher mounds (also often, though not exclusively, associated with sandhills). These sub-habitats are discussed below. One more Lepidoptera, *Callophrys hesselli* (Hessell's hairstream), is restricted to Atlantic white cedar swamps, themselves found nearly exclusively (except for one occurrence at Dixon State Forest) in drainages amongst sandhills.

Ants (Order *Hymenoptera*) are of particular interest in sandhill habitats. Many species are restricted to sandy soils and species diversity may be quite high. In particular, 76 species of ants, including some unusual ones, are known from Ohoopee Dunes Natural Area. Although not enough information is available at present to identify many specific high-priority ant species in Georgia, ants undoubtedly serve as excellent site-quality indicators for sandhills. That said, two ant sandhill specialists, *Dorymyrmex bossutus* and *Pheidolie davisi*, have been recommended as high priority. They have been found only at Big Hammock Natural Area and Ohoopee Dunes Natural Area, respectively.

Although these are discussed in more detail under the "Threats" section, sandhill habitats are threatened by conversion to other land uses that may not be compatible with maintaining viable populations of native flora and fauna, including terrestrial invertebrates. Beyond conversion, permanent changes in wildfire regimes necessitating prescribed burning have complicated management for sandhills. Previously wildfires would burn in a patchy manner, leaving canebrakes along drains and some examples of fire-intolerant species such as hawthorn (critical to *Catocala grisatra*, the Grisatra underwing moth) untouched. Patchy burns are more challenging for prescribed burners.

Longleaf pine woodlands – This habitat type might include both dry and mesic upland longleaf pine woodlands as well as lower-lying pine flatwoods (of both slash and longleaf pine). Examples are found throughout both the Southeastern Plains and Southern Coastal Plain, but are particularly noteworthy in the Red Hills around Thomasville, GA (Thomas, Brooks, Grady, and Decatur counties), and on military bases, especially Fort Stewart and Fort Benning. Longleaf pine woodlands are well-known for requiring fire to maintain an open understory, lush herbaceous groundcover, and low-density forest canopy. They may be found on an array of soils from sand to clay, between well-drained and poorly-drained, as distinguished from the excessively-drained sands of sandhill habitats.

High-priority terrestrial invertebrate species found in longleaf pine woodlands includes: *Amblyscirtes alternata* (dusky roadside-skipper), *Atrytone arogos arogos* (Eastern Aragos skipper), *Erynnis martialis* (mottled duskywing), *Aptenopedes apalachee*, *Eotettix palustris*, *Floritettix borealis*, *Hesperotettix floridensis*, *Melanoplus clypeatus* (Shield-tailed spur-throat grasshopper, a Georgia endemic), *Melanoplus tumidicercus* (also a Georgia endemic), and *Mycotrupes cartwrighti* (a flightless scarab beetle). Longleaf woodlands with intact groundcover that have escaped tillage have also been found to be important to a number of ant species, though there is not enough information at present to identify high-priority ants.

Freshwater marsh – A significant number of high-priority Lepidoptera species are associated with fresh- or brackish-water marsh habitats found along coastal rivers (particularly larger examples such as the Altamaha or Savannah), other wet near-coastal environments, and in larger basin swamps, such as the Okefenokee. These marshes are dominated by emergent and submerged herbaceous vegetation of varying species.

Lepidoptera associated with freshwater marshes include: *Euphyes berryi* (Berry's skipper), *Euphyes bimacula arbogastii* (Two-spotted Skipper), *Euphyes dukesi* (Dukes' skipper), *Euphyes pilatka* (Palatka skipper), *Neonympha areolatus* (Georgia satyr), *Poanes aaroni howardi* (Aaron's skipper), and *Problema bulenta* (rare skipper). Dukes' skipper, the Palatka skipper, and the rare skipper have all been petitioned for federal listing.
Although legally protected under the Clean Water Act, freshwater marshes are still under some threats, including sea level rise due to climate change, and potentially due to saltwater intrusion from harber deepenings/dredging.

Pocket gopher burrows – A "micro-habitat" of sorts, these mounds are built by the Southeastern pocket gopher *Geomys pinetis*, itself a high-priority, State Threatened species in Georgia. Pocket gophers tunnel in loose, sandy or loamy soil at scattered locations across the

Coastal Plain. When they surface they push small mounds of dirt to the side. Their burrows are similar to a miniature cave system. A colonial species, Southeastern pocket gophers are often associated with longleaf pine savannas or sandhill habitats, though they are not restricted to these areas – they also often occur in pastures or are distributed along roadsides. They have demonstrably declined in Georgia in recent years, disappearing from a number of localities where they were once known.

A number of invertebrate species may be associated with pocket gopher burrows. At least 11 species of *Aphodius* (scarab, dung-eating) beetles, as well as one *Euphoria* species, are restricted to them, including some that were recently described. These species generally have G-ranks in the G2G3 range, and deserve consideration for high-priority status, especially since declines have been documented for pocket gophers across much of the Coastal Plain.

Gopher tortoise burrows – The gopher tortoise, *Gopherus polyphemus*, is found across the Georgia Coastal Plain in open pinewoods, sandhills, and dry flatwoods. It is a high-priority species, is listed as Threatened by the State, and is an official federal Candidate species for listing under the Endangered Species Act. Populations of tortoises, though still robust in many places, have demonstrably declined greatly from pre-European-settlement levels, and continue to be threatened primarily due to habitat loss. Individual gopher tortoises dig several burrows across their home range. The burrows usually have a wide sandy "apron" nearly devoid of vegetation, and may be up to 40 feet in length (though usually less than half that).

A wide array species are known as gopher tortoise "commensals", being frequently found in association with tortoise burrows. Tortoise commensals include invertebrates, from the wide-ranging camel crickets to several that can be considered obligates. The latter group includes the gopher tortoise tick *Amblyomma tuberculatum*, found on the tortoise itself, as well as a dung-eating scarab *Onthophagus polyphemi polyphemi*, the little gopher tortoise scarab beetle *Alloblackburneus troglodytes*, the gopher tortoise hister beetle *Chelyoxenus xerob Atis*, a gopher tortoise robber fly *Machimus polyphemi*, and the gopher tortoise burrow Noctuid moth *Idia gopheri*. Although these species are at least as rare as the tortoise itself, their distributions are poorly known, and further surveys should be a priority.

Southwestern Appalachians/Ridge and Valley

Caves and rock outcrops – With funding from the Georgia Nongame tag a five year project exploring the caves of Georgia was begun in 1998, following up on previous work conducted by Kurt Buhlman. Some of these caves were previously known to house rare mammals such as Gray Myotis (*Myotis sodalis*) and rare amphibians such as Georgia Blind Salamander (*Haideotriton wallacei*). What was not well known was the invertebrate fauna that would be encountered. By collecting and limited trapping in 43 of the nearly 500 known caves in Georgia, eleven undescribed species of terrestrial invertebrate were encountered (Reeves et al. 2000). Six of these were new to science and one, a centipede, represents a new genus. Distributions and rarities of most invertebrate cave fauna are poorly understood, and vary widely even on very local levels.

Caves and rock outcrops can be completely destroyed by mining activities, which are becoming increasingly common in this region. Forest moisture required by terrestrial invertebrates may be compromised by significant logging or land clearing operations. Water quality of subterranean streams may be threatened by septic tanks and other sources of toxins from upslope developments.

Mountains (including Blue Ridge, Ridge and Valley, and Southwestern Appalachians) and Piedmont

Mesic hardwoods – Hardwood forests dominated by oaks, hickories, maples, yellow-poplar, beech, and other deciduous trees are common throughout Georgia, especially in the northern part of the state. Often they are associated with riparian areas, which affords them some legal protection (stream buffer ordinances), though not always. Some hardwood forests contain stands of river cane. Particularly in metropolitan Atlanta hardwood forests may be threatened by conversion to residential or other urban land use.

Hardwood forests are important habitat for a wide array of high-priority plant animal species in Georgia, including terrestrial invertebrates. High-priority species associated with these habitats include: Amblyscirtes belli (Bell's roadside-skipper), Amblyscirtes carolina (Carolina roadside-skipper), Amblyscirtes reversa (reversed roadside-skipper), Erora laeta (early hairstreak), Euphydryas phaeton (Baltimore checkerspot), Pieris virginiensis (West Virginia white), Polygonia faunus (green comma), Speyeria diana (Diana fritillary), and Melanoplus longicornis. Hardwood forests also have exceptionally high diversity of leaf litter-dwelling Strumigenys ants and likely litter-dwelling beetles.

Piedmont

Granite outcrops – The Piedmont ecoregion of Georgia contains many large exposed areas of granitic rock with sparse vegetation. These granitic exposures are typically flat, though not always. Due to the extremely harsh environments found on the surface of granite outcrops, they have a large number of endemic or nearly endemic species. Granite outcrops do not lend themselves to many land uses, but a very large number of them have and continue to be quarried for gravel, and recreational abuses (including vandalism) and illegal dumping plague many sites. The rock or lichen grasshopper Trimerotropis saxatalis is restricted to granite outcrops across its range. Known from only three locations in Georgia, it may occur on others but has not been adequately surveyed. Recently two very rare species were discovered on Heggie's Rock in Columbia County, GA: a jumping spider Habronattus sabulosus, and a midge Bryophaenocladius chrissichuckorum (only known from Heggie's Rock at present). It is quite likely that a number of other unusual invertebrate species will be found on other granite outcrops with increased surveys.

Threats to Terrestrial Invertebrates

The Terrestrial Invertebrates Taxa Team reviewed threats to high-priority species and habitats. Different species may face somewhat different sets of circumstances, but some of the most important threats overall are summarized below.

Conversion to Agriculture or Silviculture – This threat was mentioned for more species than any other. It is particularly acute for longleaf pine, sandhills, and other natural pine-dominated habitats. Conversion of these communities to agricultural fields or industrial silviculture is still taking place. Although planted pine stands may retain some canopy tree species, the loss of diverse herbaceous groundcover and shrub species may be extremely deleterious for invertebrate species that depend on particular plant hosts. In many agricultural fields application of broad spectrum herbicides eliminates formerly widespread host plants, and insecticides are suspected in declines of a number of bumblebees and other native pollinators.

Altered Fire Regimes – This threat was also mentioned for many priority species, especially those found in natural pine-dominated habitats or sandhills. Before widespread European settlement of Georgia and the Southeastern United States, large wildfires would spread across the landscape at frequent intervals, with a complex patchwork of fire effects, clearing the underbrush and woody shrubs in many areas but leaving others relatively intact. Today wildfires are nearly nonexistent (at least the uncontrolled variety) and the remaining fire-dependent habitats are maintained via prescribed burning. Although fire is absolutely essential to the maintenance of a large number of Georgia's priority habitats (and by extension, species), the complex mosaic of fire effects is equally important to many invertebrate species. This creates a challenge for prescribed burners in ensuring adequate burning to manage for species that require fire maintenance over large acreages, while also keeping that complex mosaic.

Altered Hydrology – This threat was noted for a number of Lepidoptera species associated with freshwater marsh habitats. Significant dredging could result in changes in salinity that could completely alter marsh ecosystems. An even more widespread threat is sea level rise due to climate change. Although marshes may migrate up river systems, the speed of sea level rise and ability of the marshes to migrate is in some doubt. Salinity changes due to sea level rise have the potential to largely eliminate the freshwater marsh ecosystem in Georgia.

Global Warming/Climate Change – As noted above, this threat has the potential to affect species found in freshwater marsh ecosystems (primarily butterflies). In addition, some species found in the Blue Ridge Mountains, especially those near the southern end of their range, may be impacted. Similar to the situation along the coast, communities or host plants may not be able to migrate upslope quickly enough as their current habitat/elevation range becomes unsuitable, or there may simply be no place for them to move up to.

Residential Development – This threat is lower at present than in 2005 due primarily to the economic downturn, but could return at any time. It is particularly acute in the northern part of the state (Piedmont and Blue Ridge especially) and in near-coastal areas. Residential development may not result in complete conversion of a habitat but often renders it unsuitable for priority species.

Incompatible Mining/Mineral Extraction – This threat is most pronounced for sandhills and granite outcrop-obligate species. Sand and kaolin mines along the Fall Line and elsewhere in the Coastal Plain, and gravel quarries on the Piedmont may result in complete alteration of habitats, though they usually cover smaller acreages than some of the other threats.

Poaching or Commercial Collecting – These activities, as well as excessive scientific collecting, have the potential to negatively impact some species, especially butterflies and tiger beetles (both very attractive to collectors). At present terrestrial invertebrates receive no protection from over-collection in Georgia.

High Priority Species Conservation Actions

State Listing of Species – Twelve terrestrial invertebrate species have been proposed by the Taxa Team for state listing as protected species. This list includes nine butterflies, one moth, one grasshopper, and a tiger beetle. These species have been demonstrated to be under significant threat due to overcollecting, habitat loss, or restricted range. At present there are no terrestrial invertebrate protected by state law in Georgia. Protected status would confer some protection to their habitats on state lands, and require permits for their collection.

More Inventory - Although the pace of terrestrial invertebrate work has picked up greatly since 2005, there are still significant gaps and our knowledge of this taxonomic group is still well behind any other being considered in the SWAP. Lepidoptera and Orthoptera have received the most attention in Georgia but all taxa need work. In addition, a broader array of habitats across the state need to be sampled in a somewhat systematic fashion.

Updates to Biotics - Even with recent survey efforts, there is still a lot of information that has been collected that has not made it into Biotics, our rare species tracking database. Our Biotics database allows us to make better conservation planning decisions by bringing rare species knowledge into a spatial format, and at present terrestrial invertebrates are not receiving the consideration they should.

Terrestrial Invertebrates as Indicators of Habitat Quality – A number of taxa, including ants, may as a group make excellent indicators of habitat quality. An Index of Biotic Integrity (IBI) incorporating characteristic, rare, and invasive species could be developed, particularly for sandhill habitats.

Terrestrial Invertebrate Zoologist – There is potentially a large volume of work on terrestrial invertebrate conservation in Georgia. We are a large, diverse state with relatively little previous inventory and a large backlog of data entry/management needs. Currently there are no terrestrial invertebrate experts on the staff of Georgia's Nongame Conservation Section. Adding a Biologist to fill this role would improve our data and survey efforts, and free up other staff to work on other priorities. Funding would need to be secured.

Monarch Butterfly – The monarch butterfly (*Danaus plexippus*) is presented here as a special case. Still relatively common in comparison to the species listed as "high-priority" above, nonetheless the monarch is in trouble, with overwintering populations in Mexico having declined up to 90% from historic population levels (Monroe et al. 2015). It has recently been petitioned for listing under the ESA. The monarch is currently ranked as a G4 species. The importance of monarchs in Georgia to the overwintering populations in Mexico is not known, although at least some make the annual migration. In addition, efforts should be made to identify over-wintering sites for the monarch in Georgia. It is probably deserving of an S4 rarity rank in Georgia.

The monarch has received a great deal of attention in the popular press from a large number of groups across the nation. There is potentially a significant source of funding directed at the monarch to improve habitat for it and other "pollinators." Such habitat improvements could have great benefit for other terrestrial invertebrate species, especially if efforts are directed at native plant species and habitats. Georgia's State Parks Division is considering a number of state lands for pollinator plantings, and the Nongame Conservation Section will provide technical assistance.

Other Native Pollinators – In addition to the monarch, a number of other native pollinators are either known or suspected to have undergone drastic population declines in recent years. One group under particular stress appears to be native bumblebees. The rusty-patched bumblebee (*Bombus affinis*), once common throughout its range across the eastern United States, has apparently disappeared from over 90% of sites (Colla and Packer 2008), and now has a global rarity rank of G1. Its status in Georgia is unknown, although it is thought to be extirpated. Many other native bee species are also thought to have declines, but their status in Georgia is barely known, if at all. Inventory is acutely needed, and eventually a more complete review of the conservation status of the taxa. Reasons for declines are not completely clear, but are thought to include disease, loss of preferred host plants, and overuse of insecticides. Native pollinator habitat efforts for the monarch noted above would no doubt also provide help for bumblebees and other declining species.

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Appendix H. Plants Technical Team Report

Prepared by Tom Patrick and Mincy Moffett, Co-Chairs

Technical Team Members

The Plants Technical Team represents academia, professional and amateur botanical consultants, nurserymen, and a sampling of staff from nature centers and botanical gardens.

Marshall Adams, Nurseryman [woody plants]
Heather Alley, Plant Conservation Program, State Botanical Garden [native plant horticulture, coordinator of Botanical Guardian volunteers]
Joanne Baggs, Botanist, Chattahoochee/Oconee National Forest [rare plants, monitoring]
Wilson Baker, Naturalist [plants of the Coastal Plain; surveys]
Mark Ballard, Botanical Consultant [plants of the Piedmont; surveys]
Steve Bowling, Conservation Assistant Horticulturist, Atlanta Botanical Garden [discovery, horticulture, surveys]
Forbes Boyle, Botanist, Okefenokee NWR [Okefenokee Swamp flora]
Jim Candler, Environmental Supervisor, Georgia Power [powerline management, surveys]
Jaime Collazo, Ecologist, Georgia Dept. of Transportation [roadside management, mitigation]
Richard Carter, Professor of Biology, Valdosta State University [sedges; rare plant surveys]
Jenifer Ceska, Coordinator, Georgia Plant Conservation Alliance, State Botanical Garden
Linda Chafin, Conservation Botanist, State Botanical Garden of Georgia [general flora]
Alan Cressler, Hydrologist, U. S. Geologic Survey [discovery, photography]
Ron Determann, Superintendent, Fuqua Conservatory, Atlanta Botanical Garden [horticulture, discovery, habitat restoration]
Brian Davis, Ecologist, Georgia Dept. of Transportation [surveys]
Paul Davison, Professor of Biology, North Alabama University [bryophytes]
Ben Dickerson, Wildlife Biologist, Georgia Power [powerline management, surveys]
Jim Drake, Georgia Botanical Society [gentians, lilies, discovery]
Lee Echols, Botanical Consultant, North American Land Trust [conservation, blackland prairies]
Debbie Folkerts, Professor of Biology, Auburn University [bog ecology]
Chick Gaddy, Naturalist [rare plants, discovery, surveys]
Tom Govus, Botanical Consultant [vegetation classification, rare plants, discovery]
Malcolm Hodges, Director of Stewardship, The Nature Conservancy of Georgia [natural area management lichens]
Lisa Kruse, Botanist, Nongame Conservation Section, GADNR [general flora, monitoring, natural area management, *Oxypolis canbyi*]
Ron Lance, Land Manager, North American Land Trust [woody plants, *Crataegus*]
Eamonn Leonard, Vegetation Ecologist/Botanist, Nongame Conservation Section, GADNR [vegetation classification, invasives, native plant propagation]
Patrick Lynch, Botanical Assistant, Joseph E. Jones Ecological Research Station [vegetation of limestone forests of the Coastal Plain; general floristics]
Bob McCartney, Nurseryman [woody plants, surveys, discovery]
Ed McDowell, Master Gardener [rare plants, monitoring, networking within conservation multiple conservation organizations]

Max Medley, Naturalist [discovery, general flora]
Mincy Moffett, Botanist, Nongame Conservation Section, GADNR [general flora, natural area management, invasives, mountain bogs, *Xyris*, safeguarding]
Tom Patrick, Botanist, Nongame Conservation Section, GADNR [rare plants, Biotics database, *Trillium*, safeguarding, surveys]
Rich Reaves, Botanical and Wetlands Consultant [general flora, state land inventories, discovery]
Matt Richards, Conservation Coordinator, Atlanta Botanical Garden [orchids, horticulture, habitat restoration]
Frankie Snow, Archaeology Consultant, Science/Computer Lab Technician, South Georgia College [flora of the Altamaha Grit Region, discovery]
Bruce Sorrie, Botanist (retired), North Carolina Heritage Program [Agalinis, endemics of the Southeast, surveys, flora of the Fall Line Sandhills, Lilium]
Matthew Stoddard, Wildlife Biologist, Nongame Conservation Section, GADNR [discovery, natural area management]
Nate Thomas, Wildlife Biologist, Nongame Conservation Section, GADNR [discovery, natural area management, Northwest Georgia rare plant surveys]
Jacob Thompson, Vegetation Ecologist/Botanist, Nongame Conservation Section, GADNR [flora of the Outer Coastal Plain, monitoring. Surveys; vegetation classification]
Richard Ware, Georgia Botanical Society [Floyd County flora, discovery, woody plants]
Brad Wilson, Veterinarian, Herpetologist [orchids, discovery]
Wendy Zomlefer, Professor of Plant Science, Director of the Herbarium, University of Georgia [herbarium access, Georgia flora atlas project, advises grad students in floristic and biosystematics projects]

Approach

Primary information sources for this assessment were the files of the Georgia Natural Heritage Program (GNHP), selected publications (especially volumes published to date in the Flora of North America series) and some internet sources such as the NatureServe website (www.natureserve.org). Other information came from consultations with specialists in large and difficult groups. Examples of reliance on specialists are projects involving two genera with numerous species that are often difficult to separate primarily due to inadequate detailed descriptions and outdated taxonomy.

First, consider the purple foxgloves, *Agalinis*. In 2012 a call for information on ten-lobed purple foxglove, *Agalinis decemloba*, a name under which no specimens were located at the University of Georgia Herbarium, brought to light several taxonomic issues. Botanists from Mid-Atlantic States and published research determined that federally listed sandplain purple foxglove, *Agalinis acuta*, was synonymous with *Agalinis decemloba*. An early monograph showed *Agalinis decemloba* from the Blue Ridge of Georgia and a recent collection was identified as *Agalinis decemloba* from Catoosa Co. in the Ridge and Valley, plus a published picture in Tipularia showed the plant on Lookout Mountain near Cloudland Canyon. Field observations by Rich Reaves, Tom Govus, Max Medley and Tom Patrick confirmed *Agalinis decemloba* extant in Georgia. Meanwhile, Wilson Baker dutifully rediscovered Georgia purple foxglove, *Agalinis georgiana*, from pristine longleaf pine-wiregrass habitat in the Southeastern Plains near

Thomasville. These observations represent new findings in need of herbarium documentation and conservation actions. Bruce Sorrie assisted with determinations of collections made by other members of the Plants Technical Team.

Another conundrum is represented by the hawthorns. Fortuitously, in 2014 Ron Lance published Haws: A Guide to Hawthorns of the Southeastern United States. This provided enough insight on *Crataegus* to allow for identification of most specimens, and, most importantly, it included detailed range maps and rarity status notes at the state level. Some 75 *Crataegus* taxa are known from Georgia, including 22 listed as rare. We include 5 species as High Priority Plants suitable for effective plant conservation activities, plus one known at present only historically. Attention to *Crataegus* has long been overlooked. With the guidance of Ron Lance we now can determine the significance of the many hawthorns found in woodland and prairie habitats that are of conservation concern. Further additions, however, to our rare plant list await more detailed surveys.

A two-day team meeting was held at Valdosta State University on 20-21 March 2014 with selected Coastal Plain botanists. At this time team members and other volunteers were introduced to the new Biotics 5 conservation database by our botany intern, Rebecca Pudner. Richard Carter demonstrated the virtual herbarium project now underway at Georgia's two largest herbaria, Valdosta State University and the University of Georgia. Jacob Thompson discussed vegetation classification in the coastal counties. Tom Patrick reviewed other heritage methodology, including recent rare plant surveys and assignment of state rarity ranks. Some botanically significant sites were noted by the group and a preliminary list of rare plants of the Coastal Plain was presented and critiqued. Similar regional sharing of lists among team members will be undertaken.

Results of Initial Assessments and Discussions

Phase I of the assessment process began with the development of a matrix, in the form of an Excel spreadsheet, that featured, as column headers, various ranking factors (e.g. abundance) and critical data needs (e.g. best sites) and a row down the left side with the names of all the plant taxa in the GNHP database that were designated at the time as "Tracked" or "Watched" by the GNHP. For SWAP (2005) this initial list contained 996 species, but grown to 1085 for this revision, including both vascular and nonvascular plants. Nonvascular plants include lichens, mosses, liverworts and hornworts only. There are no data for the fungi of Georgia at present incorporated in Biotics. Currently, there are ca. 3100 vascular plants and ca. 550 nonvascular plants recorded for Georgia.

The primary ranking factors identified by the team are listed below. Three in bold print at the end of the list are new criteria based on conservation actions taken through coordination with other agencies, primarily as part of decisions made through the Georgia Plant Conservation Alliance with guidance from GADNR botanists.

- Range-wide (global) abundance
- Federal and State protection status
- Narrowness of range in the state

- State rarity ranking
- Overall perceived species trends
- Degree of demonstrable threat
- Number of already protected occurrences
- Statewide abundance
- Importance of efforts in Georgia to overall status of the species
- **Whether petitioned for listing by Center for Biological Diversity**
- **Safeguarding actions already in place**
- **Urgency of overall conservation needs.**

Using the criteria enumerated above, two lists of high priority rare plants were compiled.

First, State Historic (SH) plants, those plants not observed in the wild since the mid-1990s, were compiled in Table 1. The rediscovery of the so-called "Lost Plants" of Georgia is a high priority for SWAP (2015). No conservation actions besides looking for these plants can be undertaken until populations are relocated. There are 48 confirmed "Lost Plants" in addition to the famous Franklin tree (*Franklinia alatamaha*) that is now regarded as extinct in the wild. Of these 48, most were found on the Coastal Plain, especially in areas known as the Dougherty Plain and Tifton Upland primarily in Southwest Georgia on the Southeastern Plains or Inner (Upper) Coastal Plain ecoregion. Several dozen more taxa likely qualify as SH in Georgia, but data are lacking for dates of collection and latest observations of several graminoids, mosses and liverworts. In addition, even basic rarity ranks for nonvascular plants for the most part have yet to be determined.

Second, a revised list of high priority plants, excluding "Lost Plants," was developed. SWAP (2005) listed 435 plants with no other prioritization of urgency. SWAP (2015), Table 2, lists 288 high priority plants. A deliberate attempt to place the rarer plants only in Table 2 resulted in a more reasonable number of plants that feasibly could be worked into projects over the next 10-year SWAP cycle. Such a revised list also resulted in applying the term "URGENT" in Table 2 for those of highest priority (see Column 1 under Scientific Name). The plants designated as "URGENT" are those that are known from few sites, usually under one or two, with little if any permanent protection, *in situ* enhancement or *ex situ* safeguarding. Some well-established safeguarding sites may be underway, but unless viable populations have been established, much additional monitoring and care are needed. One example is the American barberry (*Berberis canadensis*) recently outplanted near Sprewell Bluff along the Flint River, Meriwether Co., in a montane longleaf pine woodland. American barberry in Georgia is known from only one extant natural occurrence and is considered at risk of extinction in the wild without site protection and established viable populations. Another critical species is the Carolina windflower (*Anemone caroliniana*), known from a single clump or two in the wild along a roadside in the Monticello Glades, Jasper Co., but not yet represented in any safeguarding effort.

High Priority Species Summary

The summary tables with high priority plants listed for SWAP (2015) are included in the4 Appendix. There are three tables pertaining to plants. Table 1 includes 48 plants documented from Georgia but not observed for at least 20 years. These plants are commonly referred to as

Georgia's "Lost Plants." A high priority is to relocate as many of these plants as possible by targeted surveys. In addition, some 292 extant species are recognized as those in most need of conservation action within the next 10 years. These plants are listed in Tables 2 and 3. The enumeration differs from the last SWAP (2005) of a decade ago in that several plants are added that are under study as taxa petitioned for possible listing consideration by the U. S. Fish and Wildlife Service. This is a subset of 48 plants that includes 45 vascular plants, 2 liverworts and 1 hornwort. Petitioned plants are indicated in Tables 2 and 3 with a "P" after the common name of the plant in column 2.

Gradually, nonvascular plants (lichens, mosses, liverworts and hornworts) are being considered in Georgia's plant conservation efforts. This requires expertise from academia and/or self-taught experts trained in bryology and lichenology. Other changes include emphasizing additional priority levels within the list of 292 plants. The most critical plants that need attention as soon as possible have a prominent black dot (●) next to the scientific name in column 1 in both Tables 2 and 3. There are 20 plants designated with dots that deserve immediate attention; most of them are known from one vulnerable site with few plants. These critical high priority plants are included within another subset designating 103 plants as a higher priority and these are bolded and numbered parenthetically in column 1.

Species Distribution by Ecoregion

Table 2 shows the high priority plants with an indication of the ecoregions in which they occur. Ecoregions are indicated by the following abbreviations designated in the right-hand columns of the table:

- **SA/RV = Southwestern Appalachians/Ridge & Valley** [includes Cumberland Plateau]
- **BR = Blue Ridge**
- **PD = Piedmont**
- **SP = Southeastern Plains** [Upper or Inner Coastal Plain]
- **SCP = Southern Coastal Plain** [Lower or Outer Coastal Plain and Barrier Islands]

Species Conservation Action Categories

Table 3 (Appendix) identifies appropriate conservation actions needed for each high priority species. The conservation actions are divided into four categories in the columns on the right lettered A, B, C, and D. These categories are defined as follows:

- **Category A – Broad-scale habitat restoration/management**

Criteria include current range, threats, and habitat needs that are well known. The species is considered a habitat indicator, keystone species, or good representative of a plant community of interest. Within appropriate habitat there exist discernible populations that are large enough for monitoring to be feasible. Population size and structure are assumed to be indicators of overall habitat quality. Conservation emphasis will be on broad-scale protection, restoration and management of habitat as well as monitoring of individual populations.

Category B – Protection/management of best populations/critical habitats

Range, threats, and habitat needs are well known, but may the species may not be a good indicator of overall habitat quality (e.g., presence and abundance may be better correlated with microhabitat factors, or may be a eurytopic species that ranges widely over many habitats but that depends on discrete areas with specific soil nutrient, light and water requirements. Plants occur in large enough numbers for monitoring to be feasible. Conservation emphasis will be on monitoring and managing existing populations at best sites within range, protecting critical habitat needs (e.g., hydrology, canopy density, etc.), protection against poaching, and dealing with other threats such as overbrowsing, invasives or disease.

- **Category C – Reintroduction/restoration of populations**

The species has suffered catastrophic declines in the state, to the point of extirpation (or near extirpation). Former range, causes of decline, and habitat needs are generally known, but may require some additional research. Existing populations are clearly imperiled and not likely to persist without intervention. Primary conservation emphasis will be on augmenting existing populations and/or establishing new populations through a variety of methods (e.g., propagation, translocation, small-scale habitat manipulation). For plants, this effort is called safeguarding and is undertaken both in botanical gardens (*ex situ* safeguarding) and in natural habitats (*in situ* safeguarding).

- **Category D – Basic research and surveys**

Evidence of rarity or endemism exists, but significant questions remain as to current range, population status, habitat needs, and/or threats. For some groups, this includes species known historically from the state and not observed in recent years. For plants, selected species known historically from the state are included in a separate (Table 1, Appendix). Species reported from only a few sites, usually less than 5 to 20 locations, but for which adequate surveys have not yet been conducted meet the criteria for this category. Generally, insufficient information exists to develop a specific conservation strategy at this time. Emphasis will be on conducting basic research to determine current status, habitat needs, and threats**.**

While the four categories of conservation actions are listed as distinct categories, in reality many high priority species have life history characteristics or habitat requirements that necessitate a multi-focal conservation approach. Therefore, most plants are assigned to more than one conservation action group.

In summary, a total of 20 plants are in urgent need of attention within the next one to three growing seasons. The primary reason for urgency is the threat of habitat destruction due to development, especially since each of the 19 plants is known from only one or two unprotected sites. There often is no efficient way to insure permanent protection with adequate management for small natural areas before sites are destroyed. Without safeguarding action several of these rarities will disappear from existence in the wild within Georgia.

Another feature of the revised SWAP (2015) list of high priority plants is designation of the top 103 out of the total 292 (numbered parenthetically, Table 2, Column 1). The parenthetically numbered plants have best sites identified that need protection and enhancement and/or restoration action. In many cases, landowner contacts and permissions are needed, protection efforts put into place, and additional safeguarding sites established. For the most part, the parenthetically numbered taxa, exclusive of those marked with prominent black dots, are found in more than three or four sites and some work on propagation and safeguarding is already underway. Establishment and management of viable populations are imminent and should be accomplished within the next SWAP 10-year cycle. The remaining high priority plants require conservation actions but are found in more populations and are not as critically imperiled.

By no means do these lists contain all rare plants in need of conservation action. Listed for SWAP (2015) are 292 high priority plants with an additional 48 “Lost Plants” to relocate. Putting these figures in perspective, the current total number of Tracked rare plants in Georgia is 744. Tracked species are mapped and data on occurrences entered into the conservation database (Biotics). Plants on the Watch List number an additional 345. The Watch List plants lack enough distributional data to determine rarity precisely, but are considered likely to have more than 20 or 30 occurrences, have been observed regularly, and are thought to be in no immediate danger of extirpation, allowing time for a more accurate rarity status determination. Therefore, some 292 + 48 = 340 plants are covered by SWAP (2015) specifically out of a total of 744 + 345 = 1,089 plants for which records are kept and research undertaken as time permits. SWAP (2015) high priority plants account for about one third (31 percent) of the known plants of conservation concern. There are 6,400 rare plant occurrences represented in the conservation database (Biotics); 1,800 were added during the last SWAP cycle (2005-present).

Importance of Collaboration

The Georgia Botanical Society (BotSoc), founded in 1928, continues to make invaluable contributions to plant conservation in Georgia. Some examples that help support and publicize activities supported by the Nongame Conservation Section are briefly summarized here. BotSoc annually publishes Tipularia, a botanical magazine with color photos and articles on field botany and current academic research. BotSoc sponsors field trips to explore sites in all physiographic provinces of the state. Several state lands have been inventoried by teams led by BotSoc members. Rare plants discovered during surveys are routinely added to Biotics.

Another botanical group focused on plant conservation is the Georgia Native Plant Society (GNPS), founded in 1994. Of special importance to the Plants Technical Team efforts are the informative newsletters, the annual Native Plant Symposium, and the plant rescue program. Plant rescues are conducted when a new development will impact native plant populations. Plant rescuers are trained in horticulture and plant taxonomy. Protected Plants, officially designated through provisions of the Georgia Wildflower Preservation Act, when encountered during rescues, are reported to GADNR, Nongame Conservation Section. Permits for transport and sale of rescued plants are then issued. GNPS rescuers were among the first to propagate Georgia aster (*Symphyotrichum georgianum*) and offer it for sale. A native plant propagation garden at Georgia’s Stone Mountain Park serves to promote and make available native plants for landscaping. The plant rescue operation and technical propagation expertise are invaluable services to GADNR whenever coordination or mitigation is required by government agencies and their consultants

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Botanists within GADNR are encouraged to participate in some of the activities of these grass root plant conservation organizations. The volunteer efforts undertaken by members of these groups provide a continuous flow of new botanical information, especially about Georgia's rare species of conservation concern. Our very first SWAP Priority Action Item, elaborated upon below, is to mention the importance of collaborative efforts in plant conservation in Georgia. This effort is best exemplified through the role of the Georgia Plant Conservation Alliance (discussed under Priority 1, Part 2, last section of report).

Additional Assessment Results

Following completion of preliminary lists of rare species for the five ecoregions, more comprehensive lists were sent out for review. One issue became evident as lists of 100s of plants appeared too cumbersome to clearly show objectives and priorities concisely in a SWAP plan. Therefore, more attention was placed on the highest priority plants. This resulted in some additional features of the High Priority Plant List, helpful in focusing on projects that needed attention most, yet not neglecting species of importance in which some progress has already been made. Table 2 contains all plants known from Georgia that are petitioned for federal listing consideration by various groups, including the Center for Biodiversity. Currently, there are 43 plants (1 hornwort, 3 liverworts, 39 vascular plants) so petitioned and designated in either in Table 1 or Table 2 by the symbol "P" after the common name. Since SWAP (2005), 5 vascular plants were designated as Candidates for federal listing by the U. S. Fish and Wildlife Service. These 5 high priority plants, all listed in Table 2, are enumerated below to show most recent developments and needs:

- *Arabis georgiana*, Georgia rockcress – Listed as Threatened in 2014; intensive safeguarding and augmentation efforts underway; needs annual monitoring
- *Dichanthelium hirstii*, Hirst Brother's panic grass – more survey needed in Georgia where one large (the largest currently known) population was rediscovered in 2014; safeguarding initiated
- *Helianthus verticillatus*, whorled sunflower – Listed as Threatened in 2014; Georgia sites mostly protected and managed; needs prescribed fire management
- *Platanthera integrilabia*, monkey-face orchid or white-fringeless orchid – likely to be listed in near future due to poaching, few large populations, and continuous management requirements (protection from browsing, maintaining open understory, herbicide avoidance); augmentation and/or safeguarding efforts being undertaken for all 9 extant Georgia populations; needs annual monitoring and additional safeguarding
- *Symphyotrichum georgianum*, Georgia aster– Signed Candidate Conservation Agreement in effect as of 2014; annual survey and monitoring work conducted; needs 10-year commitment

Important discoveries of plants that appear to be state records, or at least are not well-documented with herbarium specimens or literature accounts with specific Georgia localities, continue to be found. A few representative examples since SWAP (2005) are listed below along with respective ecoregion of occurrence and habitat.

- *Agalinis maritima*, maritime purple foxglove – Southeastern Coastal Plain; tidal marsh of barrier island
- *Calamovilfa arcuata*, Cumberland sandreed – Southwestern Appalachians; boulder gravel bar along high velocity stream
- *Clematis fremontii*, Fremont's leatherflower –Ridge and Valley; calcareous flatwoods.
- *Coreopsis rosea*, pink tinkseed – Blue Ridge; drawdown zone of Lake Chatuge
- *Crocanthemum nashi*, Florida sunrose – Southern Coastal Plain; inland aeolian sand dune
- *Euphorbia purpurea*, glade spurge – Blue Ridge; open seep over serpentine
- *Galium virgatum*, limesrock bedstraw – Southeastern Plains; blackland prairie
- *Gratiola graniticola*, granite hedge-hyssop – Piedmont; granite outcrop
- *Liparis loeselii*, fen orchid– Blue Ridge; open seep over serpentine
- *Rivina humilis*, rouge-plant – Southern Coastal Plain; edge of tidal marsh hammock
- *Scutellaria drummondii*, Drummond's skullcap –Southeastern Plains; blackland prairie
- *Solidago arenicola*, Black Warrier goldenrod - Southwestern Appalachians; boulder gravel bar along high velocity stream
- *Tomostima cuneifolia*, limerock draba - Southeastern Plains; blackland prairie

Examples of High Priority Habitats and Species

Southwestern Appalachians & Ridge and Valley

Limestone glades and barrens

These are open habitats dominated by graminoids and forbs, with scattered eastern redcedars and other trees. These habitats may contain a large number of endemic plant species. Glades occur on thin, rocky soils, and are typically dominated by forbs while barrens are in areas with deeper soils and are dominated by grasses. Although the soil characteristics of remnant prairies retard rapid establishment by trees and shrubs, woody encroachment due to fire suppression must be managed.

- Limerock arrow-wood (*Viburnum bracteatum*) [Legal Status: State Endangered]

The limerock arrow-wood is a deciduous shrub, inhabiting calcareous, rocky bluffs and found in less than six populations in the world. Quarrying operations are one of the primary threats to the species. The only known population in Alabama was destroyed by quarrying and two of the three Georgia populations, including the largest known in the state, were jeopardized by past quarrying. These sites are now protected from active quarrying, protected and safeguarded.

Blue Ridge

Rich mesic hardwood forests

These include a range of forest habitats, all hosting a diverse groundcover. These forests, particularly those over basic soils or cation-rich soils (e.g., serpentine, mafic, ultramafic), harbor a wide diversity of rare plant species. These habitats have been impacted by incompatible forestry practices, forest conversion, disease, invasive exotic species, and residential development. Protection from disturbance is vital to the health of these habitats and the rare species they support.

- Persistent trillium (*Trillium persistens*)
  [Legal Status: State Endangered, Federal Endangered]

The persistent trillium is restricted to extreme northeast Georgia and western South Carolina. In Georgia it occurs mostly in Tallulah Gorge and is associated with several rare plants including the Carolina hemlock (*Tsuga caroliniana*), monkey-face orchid (*Platanthera integrilabia*), and sweet pinesap (*Monotropsis odorata*). It was only recently discovered and described (1971). Because it is not a particularly strong competitor, populations are threatened by invasive species, especially in secondary forests, not only aggressive exotics (e.g., English ivy, Japanese honeysuckle, multiflora rose, kudzu, wild hogs), but also natives (e.g., blackberry, black locust). The species forms fruits with few seeds and seems to have a dispersal problem, resulting in its virtual restriction to a narrow gorge with two downstream disjunct occurrences for a total narrow range of 7 miles along the Tallulah-Tugaloo river system. Moreover, due to its showy nature, this species could become the focus of irresponsible collectors. Increased visitation to the gorge by recreationists requires constant monitoring so that populations are not trampled.

Piedmont

<u>Granite outcrops</u>

Georgia hosts almost 90% of the Piedmont granite outcrops of the Southeast. These habitats host unique microhabitats that are characterized by a granitic substrate with pockets of acidic, nutrient-poor mineral soil. Vernal pools, or solution pits, occurring on the outcrops host high priority species that are severely restricted in their range. Specific threats to these habitats include destruction of proximate habitat or adjacent uplands from quarrying activities, recreational use (e.g., trail bicycles, ORV traffic, littering, vandalism, fire building, unleashed dogs), eutrophication resulting from conversion of habitat to pasture (cattle waste adds nutrients that favor the growth of competitive aquatic species), pollution (e.g., dumping of trash, airborne deposition of granite dust), invasive exotic species, and shading due to tree growth. The highest priority for management is to preserve the habitat and to avoid disturbance.

Since SWAP (2005), special attention to Lithonia gneiss outcrops, a subset of Piedmont granite outcrops, shows that additional protection efforts are is needed to protect selected outcrops in DeKalb, Gwinnett, Rockdale and Walton Cos. A suite of rare taxa have their best populations on the Lithonia gneiss outcrops. Special plants more abundant here than on other granite outcrops include flatrock onion (*Allium speculae*), Louisiana bluestar (*Amsonia ludoviciana*), dwarf hatpins (*Eriocaulon koernickianum*), Wolf's Spikerush (*Eleocharis wolfii*), Alexander's rock aster (*Eurybia avita*), and granite hedge-hyssop (*Gratiola graniticola*).

- Pool sprite or snorkelwort (*Amphianthus pusillus*) [Legal Status: State Threatened, Federal Threatened]

The pool sprite is endemic to granite outcrops of the Piedmont ecoregion in Alabama, Georgia, and South Carolina. It is the only member of the *Amphianthus* genus. Recent studies show the plants to be highly specialized members of *Gratiola* and therein go by the name *Gratiola amphiantha*. One peculiar characteristic is that the small flowers can be found both among the submerged basal rosette leaves and between the paired, floating, emergent leaves. On outcrops, this species is restricted to the shallow flat-bottomed solution pits where rainwater collects. Because its microhabitat is naturally quite stable (very slow to undergo change), the pool sprite is not adapted to withstand any habitat modification. Much of its habitat has been destroyed by quarrying activities or degraded by livestock, vehicular traffic, and eutrophication through sedimentation. Newly discovered populations need protection efforts and further inventory. One such site is along Rocky Comfort Creek, Warren Co. that also harbors high quality pools of federally listed mat-forming quillwort (*Isoetes tegetiformans*).

Southeastern Plains

<u>Fire-maintained wetlands</u>

Some of the unique wetlands in this ecoregion include wet pine savannas and herb and shrub bogs. Wet savannas are often a matrix of an open tree canopy with high groundcover diversity, interspersed with bogs. Threats to these habitats are numerous, and include altered fire regimes, altered hydrology and water quality, invasive exotic species (e.g., particularly wild hogs), incompatible agricultural and silvicultural practices, ORV and heavy equipment traffic, and road and utility construction. These threats often compound one another. For example, conversion to pine monoculture results in a fragmented landscape, which promotes altered fire regimes, which in turn facilitate increased density of woody plants, and degrades the habitat for sun-loving bog and savanna plants.

- Purple honeycomb head (*Balduina atropurpurea*)
  [Legal Status: State Rare, Federal Candidate]

The purple honeycomb head is found primarily in South Georgia and Florida. The genus is endemic to the southern United States. This species thrives in the wetter areas of peaty pitcherplant bogs and pine savannas and is particularly vulnerable to woody encroachment and hydrologic alteration. It is important to maintain an appropriate fire regime through controlled burning and to avoid drainage of the site (i.e., take special care in the placement of firebreaks near these habitats). Controlling the impacts of feral hogs is also critical. *Balduina atropurpurea* is under scrutiny as a petitioned species for federal listing. It has been the object of several studies that demonstrate numeorous populations dependent upon appropriate moisture to bloom regularly, as well as prescribed fire or mowing to maintain an appropriate habitat. Due to irregularity of prescribed fire and the sporadic blooming of small populations, the true rarity of *Balduina* is difficult to ascertain. However, where abundant (dozens of clumps or more) in a properly managed wet savanna/seepage bog habitat, the species appears to hold its own. Due to continued habitat destruction or degradation and the lack of a sufficient number of protected sites, especially in the Southeastern Plains ecoregion, much more survey work and protection efforts are needed. This species also occurs in the Southern Coastal Plain, where some of the more robust populations persist on Ft. Stewart. Since ca. 90% of the nearly 80 occurrences are historic, unprotected, unmanaged, and/or extremely small (less than 30-50 flowering stems in a good year of blooming), much remains to be done to adequately conserve this signature plant of the pitcherplant bogs of Georgia's coastal plain.

Southern Coastal Plain Ecoregion

<u>Longleaf pine-scrub oak woodlands</u>

These habitats occupy the drier portion of the moisture gradient. Drier habitats, such as sand ridges and scrub communities, host several rare plants. The largest threat to these habitats is altered fire regime. This includes fire exclusion, fire suppression, alteration of habitats through unnatural timing, frequency, or intensity of prescribed burns, and other incompatible fire management practices. The result of altered fire regimes includes a shift in species composition (of pines and oaks) and reduced diversity in the groundcover.

- Hairy rattleweed (*Baptisia arachnifera*)
  [Legal Status: State Endangered, Federal Endangered]

The hairy rattleweed is only found in two counties in Georgia. This rare endemic is found on sandy soils in open pine flatwoods and sometimes persists on intensively managed slash pine plantations and power line rights-of-way where invading woody plants are kept under control. Maintaining an open condition through prescribed burning is essential to the viability of this species. Avoiding the drainage of the site is also imperative.

Conservation Actions and Research Priorities

In the following accounts progress on priorities listed in SWAP (2005) are briefly highlighted in Part 1. Newly revised actions and research priorities for SWAP (2015) are given subsequently in Part 2. Each of these conservation actions – old and new - requires attention whether an original SWAP (2005) topic revised and updated, or an additional conservation action with new research priorities. Each represents a broad plant conservation goal.

Part 1
A Review of Old SWAP (2005) Priorities

Old Priority 1. Conduct statewide assessment of significantly rare natural communities.

Assess the status, distribution, and description of significantly rare natural communities. Although there are coarse landcover analyses for Georgia, none have thoroughly assessed many of the rarer (fine-scale) natural community types. Few of these communities have been adequately described using the ecological framework developed by NatureServe. This priority includes GIS coverages, descriptions of natural communities, assessments of threats and status, and addition of community records into Biotics. Also, recommendations for the protection and stewardship of rare natural communities are needed.

Since initiation of SWAP (2005) additional staff hired as vegetation and GIS specialists conducted vegetation surveys, particularly in the coastal and adjoining tier of counties. In addition, several projects beyond the purview of rare plants were completed, such as vegetation of sandhills and monitoring of fire effects. Documentation of occurrences of rare natural communities is now a more prevalent part of Biotics, the conservation database currently used. NatureServe's ecological community classification systems are now integrated into Georgia's vegetation projects. The assessment of rare natural communities now concerns several teams involved with SWAP (2015). Some examples of the Plants Technical Team directly contributing to assessments of rare natural communities are intense mapping and surveys of mountain bogs in the Blue Ridge, investigations of sag ponds and springs in the Ridge and Valley, vegetation and floristic assessments of blackland prairies and limestone forest communities on the Fort Valley Plateau of the Southeastern Plains, oak/pine woodlands on the Piedmont, and inland aeolian sand dunes along the Ohoopee River.

Members of the Plants Technical Team have authored new plant associations approved and now included within the U. S. National Vegetation Classification hierarchy. Examples are the Southern Ridge and Valley Sub-Calcareous Shale Barrens authored by Tom Govus and Max Medley, and the South Atlantic Mixed Oak-Pine Calcareous Flatwoods Forest authored by Jacob Thompson found in the Southern Coastal Plain. Both associations have significant rare plants – Alabama larkspur (*Delphinium alabamicum*) and swamp post oak (*Quercus similis*), respectively.

Old Priority 2. Develop Element Occurrence Rank specifications.

This is particularly important for species that are either endemic to, or primarily within Georgia (plants and animals). Define specifications for ranking the quality of individual element occurrences (i.e., "observation standards" per NatureServe). Element Occurrence Ranks are much needed by the conservation community in order to prioritize conservation efforts. Numerous metrics (e.g.,. population size, distribution, reproductive modes, viability, etc.) would have to be field-assessed.

It is standard procedure now to enter an Element Occurrence Rank based on data provided by the observer. There are 100s of older records that have not yet been ranked and are gradually being updated. Approximately 1,800 new plant records have been entered into the Biotics Database during the last SWAP cycle (2005-present). There have also been nearly 900 additional plant records updated (incl. all edits and deletions) during this same period.

Old Priority 3. Develop protocols and procedures for safeguarding rare plants.

In 2008, a policy statement establishing protocols for an integrated plant conservation strategy combining *in situ* and *ex situ* projects and including habitat restoration and plant population safeguarding was developed and signed by 18 members of the Georgia Plant Conservation Alliance (GPCA). The DNR is both a charter member and leading institution within the GPCA.

The policy/protocols document is informally known as the “GPCA Safeguarding Agreement” and is the de facto membership document for institutional participation in the GPCA. The document served to expand the scope and accelerate the process for determining and approving *ex situ* plant conservation projects in Georgia. There are currently 36 signatories to the Safeguarding Agreement.

Safeguarding, as it applies to plants, refers to all types of propagation and/or outplanting activities that constitute a conservation strategy of last resort. Specifically, safeguarding refers to various propagation and outplanting activities as they relate to *ex situ* or *in situ* efforts, including re-introductions, augmentations/enhancements, and introductions.

In Georgia, the primary vehicle for rare plant safeguarding, as well as rare plant conservation in general, is the Georgia Plant Conservation Alliance (GPCA). The GPCA, is an innovative network of public gardens, government agencies, academic institutions, utility companies and environmental organizations committed to preserving Georgia’s endangered flora. Formed in 1995 its mission is to study and preserve Georgia’s flora through multi-disciplinary research, education, and advocacy; facilitate the recovery of rare, threatened, and endangered plants of Georgia and the southeastern US through collaborative efforts within our state; and communicate the importance of preserving biodiversity worldwide.

Old Priority 4. Conduct surveys for nonvascular species.

One of the groups of plants least understood are the nonvascular bryophytes (mosses, liverworts, hornworts). Little is known about bryophytes in the state including distribution, habitat requirements, and abundance data. It would be important to survey for their diversity, habitat specifics, for rare, threatened, special concern mosses and liverworts.

Since 2005, a few bryological surveys have been conducted primarily by Paul Davison, University of North Alabama, Florence and Ken McFarland, University of Tennessee, Knoxville. These surveys included searches for new populations of the headwaters hornwort (*Megaceros aenigmaticus*), and general moss collections from diverse habitats. During general collecting trips in Blue Ridge and Cumberland Plateau sites of North Georgia, significant mosses and liverworts were documented. A checklist of Georgia liverworts was completed and a few rarities were added to the database. Other bryologists have recently reported their collections from specialized habitats, especially areas of the Altamaha Grit Formation in Coffee and Jeff Davis Cos. This geologic feature within the Southeastern Plains ecoregion resembles outcrops of sandstone often with deep crevices and cliffs and was found to harbor the rare moss *Eccremidium floridanum* in seepy depressions on the exposed bedrock.

Lichenologists have also visited most of Georgia’s 159 counties and made collections, a preliminary atlas of the lichens of Georgia, and conducted lichen workshops. Very few lichens have yet been added to the conservation database as special concern plants. Two high priority lichens, for example, are (1) the federally listed rock gnome lichen (*Gymnoderma lineare*), and, (2) state listed orange fruticose bark lichen (*Teloschistes exilis*), a conspicuous indicator of the blackland prairies, although its distribution in other habitats remains enigmatic. Rarity ranks need to be assigned and support given for the upkeep of a county distribution atlas.

Old Priority 5. Assess conservation status of selected wetlands of Northwest Georgia.

In 2008 and 2009, the Atlanta Botanical Garden was contracted to survey likely habitats in northwestern GA for new occurrences of Tennessee yellow-eyed grass (*Xyris tennesseensis*) and monkey-face orchid (*Platanthera integrilabia*). The botanical survey employed topographic maps, soil surveys, and known locations of *X.tennesseensis* and *P. integrilabia* to help identify areas of suitable habitat for both target species. The counties of focus for *X. tennesseensis* included Bartow, Carroll, Cherokee, Chattooga, Floyd, and Gordon Counties. Stephens County in northeastern Georgia was included in the survey as well, specifically for the monkey-face orchid. The surveys focused on spring heads, spring runs, and their nearby creek channels. Several sites with impoundments were also surveyed that might have historically been springs. In total, nearly 50 sites were surveyed. Surveys were conducted during August through October to coincide with flowering and fruiting.

As a result of the surveys, three new Tennessee yellow-eyed grass populations were discovered (two in Bartow Co. and one in Floyd Co.), including the Clear Creek Lake Springs site which contained over 20,000 flowering stems making it Georgia's largest known population of this species. Much additional suitable habitat was identified for the yellow-eyed grass. While this survey did not locate any new populations of *P. integrilabia*, areas with suitable habitat were identified, most of which were located on protected public property. These sites represent good potential for the establishment of safeguarding populations *in situ*. There is also substantial property left to survey with the hopes of finding new populations.

Some progress has also been made on sag ponds in Northwest Georgia in the Ridge and Valley ecoregion. Two recent exploratory visits revealed several coastal plain disjuncts and rediscovery of one of Georgia's Lost Plants, pale mannagrass (*Glyceria pallida*, now known as *Torreyochloa pallida*). Additional surveys and inventories of the dozen or so remaining, intact sag ponds of Bartow Co. are needed. Atop the Cumberland Plateau additional floristic work is needed on sag ponds, especially those shown to support one of our rare sedges, tussock sedge (*Carex stricta*).

Old Priority 6. Assess conservation status of graminoids.

Very little is understood for this complex group of plants that makes up a large component of our state's diversity (focus on *Rhynchospora* and *Panicum*). Based on the SWAP (2005) evaluation, it is clear that there are numerous globally rare (G1, G2) species in need current status surveys.

Limited work has been accomplished with graminoids, although numerous collections and observations were made. Some examples of rare graminoids are at least safeguarded in propagation and initial steps taken to safeguard *in situ*. Tawny cottongrass (*Eriophorum virginicum*) has successfully been propagated from seed collected from Georgia's single extant site. Autumn Beakrush or Solitary Beakrush (*Rhynchospora solitaria*), known from 3 extant sites, none protected, may be the rarest beaksedge known. It is a Georgia endemic described by Roland Harper in 1901. His type locality is destroyed, all but one remaining site is inaccessible due to uncooperative landowners. The accessible site is an unmanaged, frequently disturbed, roadside seepage bog with a few scattered plants, one of which was salvaged and remains in cultivation. Hirst Brother's panic grass (*Dichanthelium hirstii*) was finally relocated in 2014 after not being found since 1947 – a nearly 67-year absence. The limesink depression pond/wet savanna in which it was found harbors other rarities, including Harper's beaksedge (*Rhynchospora harperi*). Meager sedge (*Carex exilis*), a state record, was discovered since the last SWAP in an Atlantic whitecedar bog on the Fall Line Sandhills. Attention has been given to a few more graminoids of conservation concern that appear to be habitat indicators, such as northern long sedge (*Carex folliculata*) in mountain bogs, and Wolf's Spikerush (*Eleocharis wolfii*) and bog oat-grass (*Danthonia epilis*) of Lithonia gneiss granitic outcrops. At least 6 new species of *Carex* found in Georgia have been described since SWAP (2005), and keys to *Dichanthelium* and *Rhynchospora* much improved by Richard LeBlond in Weakley's revision of his on-line flora (Flora of the Southern and Mid-Atlantic States).

Old Priority 7. Promote markets for the use of native species.

Wildlife Division Biologists have gained valuable insight and developed protocols for the use of native plant species, through the Private Lands Program (PLP), habitat restoration and management of public lands by WRD biologists, and through collaborations and partnerships with other organizations, such as the NRCS, Georgia Exotic Pest Plant Council (GAEPPC), Georgia Plant Conservation Alliance (GPCA), and the Georgia Native Plant Society (GNPS). The use of native plants is inextricably linked to the eradication/control of invasive plant species, and the identification of suitable alternatives for agriculture, horticulture, and erosion control. The GAEPPC has worked to develop a list of alternatives, as has the GNPS. The NRCS and the GPCA actively restore habitats (both large, general-vegetation acreage and small rare plant communities) using native species. These activities are, in turn, helping to increase the markets, both demand for and supply of native species.
The Protected Plants of Georgia can be propagated and sold with proper documentation and permitting. The Plants Technical Team has many horticultural and nursery representatives who promote the use of native plants. Several gardens now feature native plants, especially butterfly gardens and GADNR botanists are involved with recommending native host plants and nectar sources. Recently many of our native plants, including some rarer ones that propagate well and exhibit favorable garden qualities, are being grown at a new facility at the State Botanical Garden in Athens called the Mimsie Lanier Center for Native Plant Studies is a research, education and plant production center that.propagates native Georgia plants for habitat restoration, endangered species recovery and introduction to the gardening community. There is also the Georgia Native Plant Initiative, formed in 2010 that the State Botanical Garden coordinates to bring together commercial growers, horticultural scientists, land managers, landscape architects and restoration ecologists. By working together Georgia's plant conservationist are helping to make some of Georgia's attractive native plants available in the trade. The GADNR botanists rely on botanical gardens and native plant nurseries to propagate high priority plants for habitat restoration and other safeguarding activities.

Old Priority 8. Restore mountain bog habitats.

Mountain bogs are one of the most critically endangered habitats of the Southern Appalachians. The bogs are typically small – from a half-acre to 5 acres – and usually associated with seeps, springs and small creeks. These are early successional habitats that support a variety of unique and imperiled flora and fauna, including the federally threatened bog turtle (*Glyptemys muhlenbergii*) and swamp pink (*Helonias bullata*), possibly the state's rarest reptile and plant species, respectively. Other exceptionally rare and state-protected mountain bog plants include the montane purple pitcher plant (*Sarracenia purpurea var. montana*), which has been petitioned for federal listing, Carolina bog laurel (*Kalmia carolina*), Canada burnet (*Sanguisorba canadensis*) and Cuthbert's turtlehead (*Chelone cuthbertii*).

For 22 years, the Nongame Conservation Section, working independently and as a member of the Georgia Plant Conservation Alliance (GPCA), has engaged in mountain bog restoration. Restoration is on-going at 8 bogs in Rabun and Union counties. The restoration focus is on manual woody competition removal, small scale "hydro-engineering", invasive species removal, introduction of prescribed fire at both landscape and bog-proper levels, and reintroductions of rare flora (see Priority Action Item #3-Safeguarding/GPCA). Mountain Bog restoration within NCS is largely a collaboration between botanists and herpetologists. For additional SWAP accomplishments and issues, see priority actions related to bog turtles and mountain bog restoration in the Reptile and Amphibians Technical Team Report.

A cornerstone of the mountain bog restoration program is the propagation and outplanting of rare mountain bog plants. More than 5,000 individuals of five rare-plant species have been propagated during the last 20 years. During the last 10 years over 1,000 individual plants have been outplanted (*in-situ*) into appropriate habitats. The remaining plants are in conservation holdings (*ex-situ*) at (GPCA) gardens. Seedling recruitment has been documented for swamp pink and purple mountain pitcherplant at three restored bogs – this includes a F2 generation (i.e., grandchildren) in, at least, one bog.

In 2007, the GPCA obtained a Wildlife Action Opportunities Fund (WAOF) Grant from the Wildlife Conservation Society and Doris Duke Foundation. DNR biologists were instrumental in securing this grant. Funds were used, in part, to: a) hire a GPCA Mountain Bog Program Coordinator; b) expand the pace of mountain bog active management/restoration; c) assist in the ground-truthing of 330 potential montane wetland sites identified from a GIS survey prepared by the Natural Resources Spatial Analysis Laboratory (NARSAL) of UGA; and d) contract a detailed (6-inch contour interval) topographic site survey of a portion of Hale Ridge Bog, a necessary first step in the restoration of this bog, which is in need of substantial hydrologic repair.

In 2013, Georgia acquired a new partner in mountain bog restoration, the Bog Learning Network (BLN). The BLN, modeled after the highly successful Fire Learning Network (FLN), is an association of state and federal agencies, NGOs, academicians, and private consultants and land managers who have some responsibility for or interest in mountain bogs. Their mission is to help advance the stewardship and management of Southern Appalachian bogs (GA, NC, SC, TN, VA) by providing a forum for sharing information and resources. Its creation reflects a heightened regional interest in mountain bog conservation and restoration, which includes the recent proposal to create a Mountain Bogs National Wildlife Refuge. Nongame Conservation Section staff was invited to serve on the steering committee of the BLN.

Old Priority 9. Conduct surveys for species historically recorded in the state.

Many globally rare species have only historically been recorded in the state; they have not been seen since prior to the mid-1990s. The standard time since the last observation is 20 years (20-25 years is also practical) for a plant to be assigned a rarity rank of "SH" (State Historic). Consequently, it is imperative that surveys and herbarium work be conducted to assist in locating populations, documenting their abundance and condition, and begin collecting landowner information to initiate conservation measures. Some progress has been made in relocati8ng Georgia's "Lost Plants." Some examples of plants found since SWAP (2005) follow:

An addendum table was prepared to include plants with the state rarity rank of SH. This is a list of plants not seen within the recent past – usually within the last 20 years, or since about the mid-1990s. No conservation action can be taken on the SH plants until they have been relocated. At that time they will be considered high priority species. Since SWAP (2005) important rediscoveries have been made. Some representative rediscoveries of SH plants made since SWAP (2005) are listed below with notes on ecoregion of occurrence and habitat.

- *Agalinis decemloba*, Ten-lobed purple foxglove – Southwestern Appalachians; grassy openings in Virginia pine/scarlet oak forest over sandstone
- *Agalinis georgiana*, Georgia purple foxglove – Southeastern Plains; well-managed, longleaf pine/wiregrass woodland
- *Carya laciniosa*, shellbark hickory – Ridge and Valley; bottomland hardwoods
- *Clintonia borealis*, bluebead lily – Blue Ridge; northern hardwood forest bordering a boulderfield
- *Crataegus aemula,* Rome Hawthorn – Ridge and Valley; opening in calcareous flatwoods
- *Crataegus dispar,* Aiken Hawthorn – Piedmont; xeric, mixed oak-hickory-shortleaf pine forest edge
- *Delphinium alabamicum,* Alabama larkspur – Ridge and Valley; shale barrens with sparse redcedar and dense *Cheilanthes lanosa*, hairy lipfern. Note: Habitat newly classified as a G1
- *Dichanthelium hirstii,* Hirst Brothers' Panic Grass – Southeastern Plains; wet savanna in seasonal depression pond
- *Lonicera canadensis* – Blue Ridge; rocky, forested, north-facing slope at head of cove hardwood forest
- *Parnassia grandifolia* – Blue Ridge; open seep over serpentine.
- *Ruellia noctiflora*, Night-Blooming Wild Petunia - Southern Coastal Plain; mowed roadside and powerline rights-of-way surrounded by remnant slash pine flatwoods.

Old Priority 10. Provide incentives to conserve imperiled plants and habitats.

This priority action item was recognized as a genuine need in the mid-1990s. In 1999, WRD created the Private Lands Program (PLP) through new initiatives and consolidating existing forestry and wildlife stewardship incentive programs. The numerous programs under the PLP "umbrella" (e.g., Bobwhite Quail Initiative, Forestry Stewardship Program, and Forestry for Wildlife Stewardship Program) also provided funding to support wildlife biologists to administer these programs. A useful public document, entitled "A Landowners Guide to Conservation

Incentives" was produced (currently in its 4th Edition [2010]). A central feature of the PLP was, and is, the plethora of Farm Bill programs promoting land protection, management, restoration, and stewardship. Another significant development was the passage of the Georgia Land Conservation Act (2005) establishing the Georgia Land Conservation Program (GLCP) The GLCP works to preserve a statewide network of land and water resources by promoting partnerships between cities and counties in Georgia, state and federal agencies, landowners, and other private sector partners. The NCS biologists supported this effort by conducting plant and vegetation surveys, providing technical support to PLP biologists, and promoting the program during the performance of their duties throughout the state, especially when interacting with private landowners.

Part 2
Updated and New SWAP (2015) Plants Technical Team Priorities

Priority 1. Continue to build the Georgia Plant Conservation Alliance; expand and enhance the rare plant safeguarding program.

The Georgia Plant Conservation Alliance (GPCA) is an innovative network of 36 public gardens, government agencies, academic institutions, utility companies and environmental organizations committed to preserving Georgia's endangered flora. Formed in 1995, with DNR as a charter member, GPCA initiates and coordinates efforts to protect natural habitats and endangered species through biodiversity management, public education, and rare plant safeguarding.

The GPCA has experienced tremendous growth during the last decade. Growth can be seen in the areas of institutional membership, programmatic scope, volunteer network, and resources contributed by member institutions. Institutional membership has doubled, and member institutions are engaged in recovery projects for nearly 80 imperiled plant species. Over 60 of these are in safeguarding programs at botanical gardens, arboreta and seed banks, with close to 50 species being successfully introduced back into the wild. Monetary and in-kind contributions by GPCA member institutions have amounted to an estimated $1.5 million in direct and indirect support for plant conservation since its inception. More than $1.1 million of this was supplied by non-DNR members supporting high-priority species and habitats identified in the SWAP (2005). A significant portion of the contributions have come from the trained GPCA volunteer force known as Botanical Guardians, now numbering in excess of 140, and contributing more than 2,000 hours of conservation work during the last calendar year. The NCS staff has been instrumental in building both the GPCA as an organization, and in building the safeguarding program as a conservation strategy/approach. The NCS resources provided in support of the GPCA and plant conservation were leveraged substantially by GPCA partners (about 5:1).

The growth of the GPCA should continue to be supported robustly with staff resources. Additionally, the continuing development of the GPCA Safeguarding Database (maintained by the Atlanta Botanical Garden) should be supported. The database is designed to keep track of the *ex situ* collections of all GPCA propagation partners, and the *in situ* outplantings across the state. It contains inventory, location, monitoring and survivorship data, and is linked to an ArcGIS geospatial database complementing the Biotics and NatureServe databases. Lastly, some degree of funding support should be provided periodically for GPCA member institutions involved in rare plant propagation, especially for NCS-initiated plant conservation projects.

Priority 2. Conduct statewide assessment of significantly rare natural communities; provide staff to adequately populate the conservation database with natural community data.

The conservation database used by GADNR, Nongame Conservation Section staff contains nearly 6,400 site records for rare plants, but is lacking in detailed data for natural communities. Lacking a full-time vegetation ecologist, the GADNR is handicapped and a serious effort should be made in hiring a full-time vegetation ecologist. Since SWAP (2005), a significant step forward in describing natural communities accessible to the public was taken. The 675-page book entitled The Natural Communities of Georgia was published in 2013. Botanists continue to discover unique natural communities, inventory known ones, and rely on outside. Some of these have been recently described using the ecological framework developed by NatureServe. Although there are coarse land cover analyses for Georgia, none have thoroughly assessed many of the rarer (fine-scale) natural community types.

Priority 3. Develop Element Occurrence Rank specifications and use the Conservation Rank Calculator for revamping state rarity ranks.

The specifications used to determine the overall quality of a rare plant occurrence can be detailed using methodology developed by NatureServe. In this way, states consistently rank occurrences and the better ones can be prioritized for further conservation action. Some of Georgia's special plants need to have specifications developed. This is particularly important for species that are either endemic to, or primarily within Georgia. Element Occurrence Ranks are much needed by the conservation community in order to prioritize conservation efforts. Numerous metrics (e.g,. population size, viability, habitat protectability and condition, etc.) would have to be field-assessed.

The Conservation Rank Calculator is a tool that automates the process of assigning a conservation status rank – an evaluation of the level of risk of extinction of a species, in other words, the use of state rarity ranks. Rarity ranks are used to establish priorities with the rarest species assigned a conservation status or rarity rank of S1 (at the state level) or G1 (at the global level). The most common species are ranked S5 (at the state level) or G1 (at the global level). The Conservation Rank Calculator is used extensively by NatureServe and its member programs and collaborators that collect and evaluate data for species and ecosystems of concern using a common methodology. The Rank Calculator tool facilitates the accurate application of this methodology and promotes greater accuracy and consistency of the assessments. The Rank Calculator tool has not yet been applied to Georgia's plants.

Priority 4. Continue to conduct surveys for nonvascular species.

One of the groups of plants least understood are the nonvascular plants, including bryophytes (mosses, liverworts, hornworts) and lichens. Little is known about Georgia bryophytes, especially concerning distribution, habitat requirements, and abundance. Some recent surveys were for rare liverworts and hornworts, such as headwaters hornwort, *Megaceras aenigmaticus* (*Nothoceras aenigmaticus*) and a suite of gorge liverworts. Special habitats, such as Altamaha Grit outcrops have had preliminary bryophyte and lichen surveys. All of these surveys generally result in state records and occurrences for regionally important nonvascular plants. One example is the state record Florida pygmy moss, *Eccremidium floridanum*, found on exposed, seepy, sandstone-like outcrops of Altamaha Grit. Florida pygmy moss is ephemeral and diminutive, but seems to be a quality habitat indicator of seepy outcrops in the vicinity of other plants of conservation concern. The Altamaha Grit outcrops are nearly unique to Georgia, with perhaps one outlier known from panhandle Florida. Such distinctive habitats and the diverse physiography of Georgia, strongly indicate that Georgia has important nonvascular plant diversity that needs to be documented. Rarity ranks and element occurrence data are needed for nonvascular plants of significance.

Lichens may be better known in Georgia due to volunteer efforts and county record distribution efforts of Malcolm Hodges, Sean Beaching, and Bill Buck. There needs to be an attempt to assign rarity ranks to significant lichens. Also, website resources need to be supported to promote knowledge of county distributions. The federally listed rock gnome lichen, *Gymnoderma lineare*, known from one high quality rock cliff in the Blue Ridge, is in need of further protection efforts. The face of the rock cliff supports numerous vascular plants of significance, but additional nonvascular plant inventory is justified.
Second, is the state record Florida pygmy moss, *Eccremidium floridanum*. Florida pygmy moss is ephemeral and diminutive, but seems to be an good indicator of seepy outcrops in the vicinity of other plants of conservation concern. The Altamaha Grit outcrops are mostly in Georgia, with perhaps one outlier known from panhandle Florida. Conservation actions are being put into place on newly acquired state lands and exemplified already at the Broxton Rocks Preserve, Coffee Co.

Priority 5. Assess the conservation status of selected wetlands, especially isolated wetlands, including the sag ponds of Northwest Georgia, and, the limesink depression ponds of Southwest Georgia.

There are a variety of wetlands in Northwest Georgia (e.g., sag ponds, fens, seeps, spring runs, calcareous flatwoods) that support several rare plant species and communities. These wetland habitats need adequate surveys and appropriate conservation attention. An even less explored area is on the Dougherty Plain, part of the Southeastern Plains ecoregion of Southwest Georgia. Literally 100s of isolated limesink depression ponds exist in this region and dozens need to be thoroughly explored during the entire growing season. Over 25 rare vascular plants are known to inhabit seasonal ponds on the Dougherty Plain. Most lack recent information and it is likely that a few state records and range extensions will be encountered.

Extensive pre-planning using the latest aerial photography and soils data will help select suitable ponds for exploration. Preliminary field surveys confirm that appropriate surveys needs to be conducted throughout the growing season and that each pond has its own seasonal variation in water depth, may or may not have adequate drawdown zones, and variable light conditions due to fire suppression, lowering of the water table, or other disturbances. In the case of Hirst Brothers' panic grass (*Dichanthelium hirstii*), a federal Candidate recently relocated in a pond habitat in Sumter Co., the common maidencane (*Panicum hemitomon*) can overcome the rare grass, shading it out of existence. Furthermore, it appears that fire, often recommended as a management tool for curtailing woody plant invasions in ponds (e.g., establishment of pondcypress thickets in seasonal pond/wet savanna habitats), may increase maidencane to the point of seriously impacting some of the pond rarities. If significant pond vegetation is discovered, management needs will have to be addressed.

These wetland communities are currently under increased threat due to residential and commercial development, pond construction, intensive agricultural demands for water, conversion of hardwoods to planted pine plantations and anything disrupting hydrology. It is important to generate fine-scale GIS coverages (maps) and natural community and rare plant records for the conservation database (Biotics). Also, the number, size and condition of target habitats including an assessment of hydrology, plant communities, threats, conservation opportunities, and ownership are needed.

Priority 6. Continue restoration of mountain bog habitats.

A major accomplishment since SWAP (2005) has been the restoration of selected mountain bog communities. Efforts to reintroduce, augment, or establish rare plant populations must continue. These efforts should work in conjunction with restoration efforts for the bog turtle. Mountain bogs have been historically neglected from a stewardship perspective resulting in the decline or disappearance of many signature species. Restoration of bog habitats would include reduction of woody cover, expansion of *Sphagnum* mats, establishment and augmentation of rare species populations, and restoration of natural hydrology.

Priority 7. Conduct surveys for species historically recorded for Georgia.

Many globally rare species were historically recorded in the state, but have not been observed for 20 or more years and are in need of current status surveys. Consequently, it is imperative that surveys and herbarium work be conducted to assist in locating populations, documenting their abundance and condition, and begin collecting landowner information to initiate conservation measures. Eventually, those found can be evaluated further and may become high priority plants for research and additional conservation actions. Examples of State Historic (SH) plants are given in Table 1. These plants can be popularly termed Georgia's Lost Plants and information distributed to the public.

Priority 8. Identify rare plant populations seriously threatened by invasive exotic species, develop prompt and effective responses; act to eliminate or moderate threats.

Most of the concern, discussion, and focus regarding invasive species usually involve broad-based, landscape-level planning, research, and management schemes. While this macro-approach is appropriate for addressing the larger problem, and building coalitions, enacting legislation, changing public policy, and driving market-based solutions, it tends to ignore problems associated with small sites and/or those in need of an urgent response. In those instances where the focus is on a small sites requiring an urgent response, it is because the invader is one for which there is zero tolerance, such as cogongrass (*Imperata cylindrica*). In this situation, the Georgia Forestry Commission (GFC) will attack any size infestation within 72 hours of discovery and repeat-treat until the infestation is ruled to be eliminated. An aquatic example would be the Asian northern snakehead fish (*Channa argus*), where zero-tolerance is based on the nature of the perpetrator rather than on the imminent threat to potential victims.

Rare plant populations are particularly at risk due to the sessile nature of plants, as well as the low number of individuals and other conditions (genetics, physiology, life history, ecological niche) associated with their rarity. A rare plant population, or an entire rare plant site containing numerous rare plant species, could potentially be destroyed within a few years when under assault by a suite of invasive species. They could certainly be extirpated in less than a decade (before the next SWAP revision in 2025). One example would be the beech-magnolia hardwood forests and ravines along the Flint River at Montezuma Bluffs WMA, where some portions of lush understory understory that includes relict trillium (*Trillium reliquum*) and ovate catchfly (*Silene ovata*) near an abandoned trailer park are rapidly succumbing to competition and shading from English ivy (*Hedera helix*), Japanese honeysuckle (*Lonicera japonica*), Chinese privet (*Ligustrum sinense*), and Kudzu (*Pueraria montana*).

In a situation involving marauding feral pigs, extirpation could potentially happen in the time span of a few days, depending on the circumstances. The range of feral pigs in Georgia has increased by nearly 5-fold in the last 30 years. A conservative estimate of the feral hog population in the U.S. is between 5-10 million animals. Annually, these swine account for environmental and agricultural losses of $1.5 billion across the country. In sites along Big Grocery Creek in the Oaky Woods WMA, hogs are vigorously rooting and causing great damage to the rich assemblage of spring ephemerals associated with the limestone bluffs and floodplain. Within the last two years, more and more invasions of the unique blackland prairies of Oaky Woods have been observed and wild pig encounters are increasing.

Certain populations and sites are so special and contain such rarities as to require immediate corrective action. Sites known to be under imminent threat should be quickly evaluated and a management approach decided upon. Management action should proceed quickly. Rare plant sites impacted by invasive animal species may require the assistance of other sections within the GADNR Wildlife Resources Division (e.g., Game Management and Fisheries). Additionally, the Nongame Conservation Section will survey other special rare plant populations suspected of being at risk from invasive species. If found to be under imminent threat, they will receive the same expeditious evaluation and treatment mentioned above.

Priority 9. Assist the U. S. Fish and Wildlife Service with data collection and implementation of the Conserving At-Risk Species Program.

In the next 10 years the USFWS (SE Region) will evaluate a record number of species for possible listing under the Endangered Species Act (ESA). This is partially a result of successful petitioning for these evaluations by outside public interest groups (Center for Biological Diversity and Wild Earth Guardians). It is the desire of the USFWS not to list these species, but rather to engage in proactive conservation, with public and private partners, that is both voluntary and innovative, thereby precluding the need to list them under the ESA. The five action areas of the Conserving At-Risk Species Program include: (1) prioritizing "at-risk" species for pro-active conservation needs; (2) developing voluntary conservation actions that can be taken; (3) building partnerships with state and other federal agencies; (4) collecting data for listing decisions; and, (5) engaging in outreach to individuals, NGOs, and Congressional staffers.

The Nongame Conservation Section staff will help prioritize at risk species by identifying data gaps and unknowns involving species distribution, population, conservation status, and threats. They will also help determine those species that are "decision-ready" and which are appropriate for pro-active conservation. In the case of data gaps and unknowns, they will conduct status surveys of populations and update the Biotics database accordingly. They may also be asked to provide expert opinion regarding proposed USFWS actions/decisions. They will also assist with the development of practical and biologically appropriate pro-active conservation actions. One of these actions may be the development of a Candidate Conservation Agreement (CCA). See next priority action item.

Priority 10. Assist the U. S. Fish and Wildlife Service with the development of Candidate Conservation Agreements (CCAs) for selected plants of conservation concern; maintain active monitoring and management of plants already covered by established CCAs.

Candidate Conservation Agreements (CCAs) and Candidate Conservation Agreements with Assurance (CCAAs) are two specific instruments for pro-active conservation. CCAs are voluntary conservation agreements between the USFWS and one or more public or private parties. The Service works with its partners to identify threats to Candidate species, plan the measures needed to address the threats and conserve these species, identify willing landowners, develop agreements, and design and implement conservation measures and monitor their effectiveness. CCAAs expand on the concept of traditional CCAs by providing non-federal landowners with additional incentives for engaging in voluntary proactive conservation through assurances that limit future conservation obligations.

A recent example of a CCA with significant involvement from GADNR staff involved the Georgia aster (*Symphyotrichum georgianum*). In 1999, the USFWS made the Georgia aster a Candidate for listing under the Endangered Species Act. The Georgia aster remained on the list for 15 years as the USFWS applied its resources to higher priority species. During this interim, state agencies and conservation organizations continued to survey for new populations and to work on the conservation of the species. In 2014, the USFWS determined listing was not necessary if precluded by a broad-based, range-wide, pro-active conservation plan (i.e., CCA). Georgia DNR was a major contributor to the development of the agreement and to consensus building among the disparate partners across four states (AL, GA, NC, and SC). In particular, Nongame Conservation Section (NCS) staff developed the management approaches and monitoring protocols.

NCS will continue to assist the USFWS with development of CCAs (and CCAAs) for species whose range includes Georgia, and for which these conservation instruments are biologically and ecologically appropriate.

Priority 11. Continue to expand the knowledge base and use of native plants.

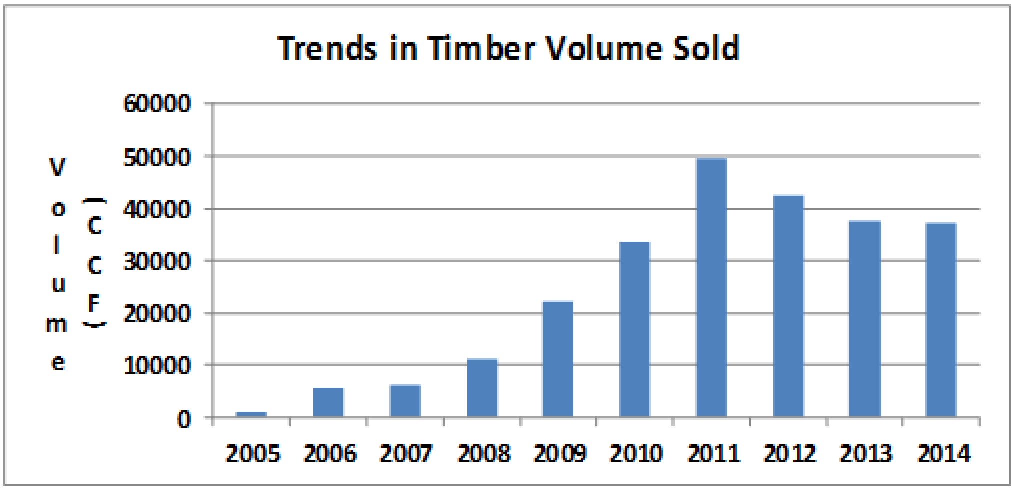
Wildlife Resources Division biologists will continue to improve the state of restoration science using native plants through DNR's many restoration and management initiatives/activities. WRD will continue to work with important partners and collaborators, such as the Natural Resources Conservation Service (NRCS), Georgia Exotic Pest Plant Council (GAEPPC), Georgia Plant Conservation Alliance (GPCA), and the Georgia Native Plant Society (GNPS) to identify native species that could be used in lieu of invasive species for purposes of controlling erosion, landscaping, gardening, etc. There are several native plant nurseries and gardens in Georgia where collaboration is encouraged. GADNR staff presents educational programs, provides permits to sell propagated rare plants and rescued plants, collects seed, and otherwise suggests appropriate native plants for cultivation. Noteworthy efforts are undertaken by several GPCA members, including commercial nurseries, experimental gardens (e.g., Georgia Perimeter College, Decatur; Chattahoochee Nature Center, Roswell; Atlanta Botanical Garden) and the new research propagation facilities at the Mimsie Lanier Center for Native Plant Studies, State Botanical Garden, Athens.

Priority 12. Assist the Private Lands Program biologists with technical support and outreach to private landowners owning significant botanical sites.

The Nongame Conservation Section (NCS) botanists will continue to support the Private Lands Program (PLP) and PLP biologists with technical botanical assistance focusing on general vegetation and rare plant communities, as well as rare plant species information. NCS botanists will continue to promote the various aspects of the PLP, numerous Farm Bill programs (e.g., EQUIP, WHIP, CRP, and PFW), and other options (e.g., conservation easements, GA Conservation Tax Credit Program, and CUVA) to private landowners throughout the state. They will work with the WRD/NRCS Contribution Agreement biologists located in USDA offices to provide outreach regarding the need and potential cost share for conserving rare and declining habitats and plant species. The NCS botanists will assist with botanical training for PLP biologists, NRCS biologists, and landowners, as needed. The NCS botanists will actively promote important sites that deserve permanent protection from development.

Collaboration with land trust organizations and other GADNR staff involved with real estate issues is becoming more and more essential if rare plant habitats are to be conserved. GADNR should consider full support of a biologist whose primary purpose is to work with private landowners to find conservation incentives and protection alternatives for isolated populations of high priority plants for which acquisition is not likely. Small sites, often the last stand for rare plants, need attention as well as large hunting areas and parks. The role of organizations such as The Nature Conservancy in acquisition of small sites (areas under 500 acres down to 10 acres or less) has dramatically decreased over the last decade. The need for land trusts and other holders of conservation easements for botanical sites must be promoted.

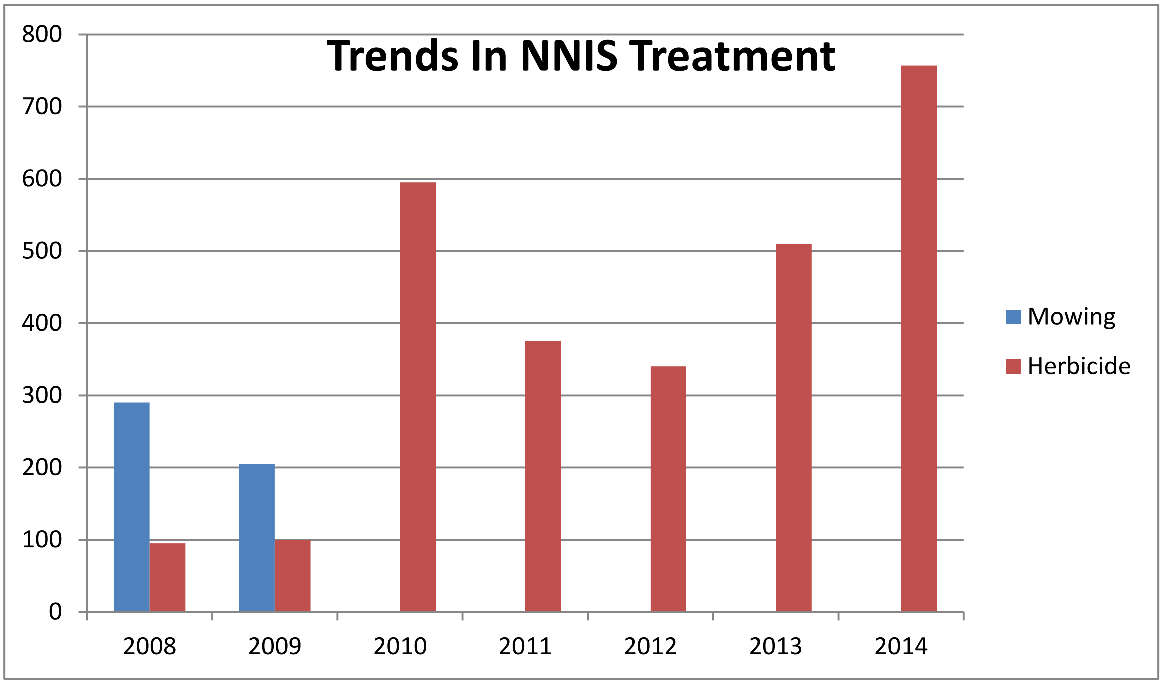
In general, imperiled plants require specific habitat management and, as a consequence, their enhancement and protection should become a part of most programs that fund habitat improvement. Habitat management incentives should at least indirectly serve to conserve known sites of botanical significance. Landowners have responded resoundingly to the availability of incentives for conservation practices. There are incentives to help conserve imperiled habitats and species, but more attention must be placed on protection alternatives for isolated populations of high priority plant species for which acquisition may be the only option for permanent protection.



In cooperation with the Georgia Plant Conservation Alliance (GPCA), the Forest is involved in the establishment and management of safeguarding sites for rare bog flora including mountain purple pitcher plant (*Sarracenia purpurea* ssp. *purpurea* var. *montana*), swamp pink (*Helonias bullata*), and Carolina laurel (*Kalmia caroliniana*). Hand tools and prescribed fire are being used to restore mountain bog habitat in 7 bog complexes, several of which also contain the federally listed bog turtle (*Glyptemys muhlenbergii*). Habitat for woodland plants such as smooth purple coneflower (*Echinacea laevigata*), Georgia aster (*Symphyotrichum georgianum*), and eastern turkeybeard (*Xerophyllum asphodeloides*) also is being managed with prescribed fire and vegetation management. Additionally, safeguarding sites for federally listed smooth purple coneflower and large-flowered skullcap (*Scutellaria montana*) have also been established. The Forest is also working with the Atlanta Botanical Gardens and the University of Georgia compete a habitat assessment, assess the monitoring program, develop a spatial model, and conduct germination trials for the federally threatened small whorled pogonia (*Isotria medeoloides*). In addition to establishing safeguarding sites, the Forest is working with other GPCA partners such as Georgia DNR and Atlanta Botanical Garden, to improve data sharing through development of the safeguarding database. The database tracks the safeguarding program from source material, to outplanting, to monitoring. Increased efforts for survey and monitoring continue to focus on rare bog plants, small whorled pogonia, smooth purple coneflower, and Georgia aster.

As a result of the increased concern due to the effects of white-nosed syndrome as well as recent discovery of an Indiana Bat (*Myotis sodalis*) maternity colony in north Georgia, the Forest has placed additional emphasis on forest bats. In conjunction with Georgia DNR and US Fish and Wildlife Service personnel, the Forest has undertaken acoustical and mist net surveys to establish baseline bat populations. The Forest is also implementing measures to control human access to caves and mines and is developing a Forest Plan Amendment to incorporate additional measures to protect and enhance habitat conditions for forest bats.

The Forest also has a growing program of inventory and treatment of non-native invasive species (NNIS). The early detection and rapid response program continues to identify new invasive plant risks including fig buttercup (*Ficaria verna*) on the Chattahoochee National Forest and Japanese climbing fem (*Lygodium japonicum*) on the Oconee National Forest. The Forest also has an extensive program to reduce the threat of the exotic insect hemlock woolly adelgid (*Adelges tsugae*) on our native hemlocks. This includes the chemical treatment of individual groups of hemlocks and the release of several species of predator beetles produced at labs at Young Harris College, the University of Georgia, the University of North Georgia in Dahlonega, and Clemson University. The invasive species program also includes an effort on the Chattooga River Ranger District to control feral hogs in high priority bog habitats. The Forest has also increased use of native herbaceous species for erosion control and restoration.



For aquatic species, the Forest has installed bottomless arch culverts on several streams to enhance passage for brook trout (*Salvelinus fontinalis*), Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*), and other species. To increase the availability of spawning for the blue shiner (*Cyprinella caerulea*), log spawning structures were installed in portion of the Conasauga River where large woody debris was limited. On the Oconee National Forest, we are working with Federal, State, and private partners in the Robust Redhorse (*Moxostoma robustum*) Conservation Committee to help in the recovery of this species. The Forest has an ongoing effort with Conservation Fisheries Inc. to monitor rare aquatic species. Finally, in the last decade, the Forest's land acquisition program has focused on high priority watersheds including the acquisition of nearly 800 and 400 acres in the Conasauga and Etowah River watersheds, respectively.

Non-Governmental Organizations

Georgia Plant Conservation Alliance

Lisa Kruse (GA WRD) and Contributors

Georgia Plant Conservation Alliance

Jennifer Ceska, Jim Affolter, Heather Alley (State Botanical Garden of Georgia)

X	*Addressed Altered Fire Regimes*
X	*Improved Management Practices*
X	*Combatted Invasive/Alien Species*

The Georgia Plant Conservation Alliance (GPCA) is a professional network of botanical gardens, state and federal agencies, non-profit organizations, universities, and large land-owning companies working together on statewide plant conservation projects. GPCA began its work in 1995 with the goal of preventing plant extinctions in Georgia. There has been real success over the last two decades, expanding to include 36 active organizations, with 80 endangered species in active recovery, and 31 species in safeguarding in wild protected sites. Habitat restoration on these sites is essential for the longterm success of these high priority species.

GPCA was launched by the State Botanical Garden, Callaway Gardens, the Atlanta Botanical Garden, the Georgia Department of Natural Resources Nongame Conservation Section, the U.S. Forest Service, and The Nature Conservancy of Georgia, expanding slowly to create a network for statewide conservation projects. The mission of GPCA is to facilitate partnerships among private and government agencies that have the knowledge, the critical habitat, and the resources to implement high-priority, science-based plant conservation and education projects statewide.

The GPCA goal is to protect all populations of imperiled plant species in Georgia. Horticulture experts store plant material collected from the wild at botanical gardens. While collecting, growing, and storing rare species is an important conservation strategy, safeguarding plant species ex situ (outside of their natural populations) is only part of a recovery strategy for the GPCA. Our priority for endangered plant species conservation is to restore original populations or introduce new populations in situ (at appropriate wild sites) on protected land. The critical work of locating those plants on the land, finding secure sites appropriate to the species' range and habitat, makes our land-holding and land-managing partners essential to the formula of conserving rare plant species' populations in Georgia. Our partners in The Nature Conservancy of Georgia, the US Forest Service Chattahoochee and Oconee National Forest, and the Georgia Department of Natural Resources, particularly the Nongame Conservation Section, help locate and provide sites for safeguarding rare plant populations on protected lands.

Safeguarding Sites State-Wide

Of the 80 species that GPCA has prioritized for conservation safeguarding work, 65 species have material in safeguarding *ex situ* either as plants, seeds, or tissue. Of those 65 species in safeguarding, 49 species have made the horticulture conservation loop and have been returned to the wild to safeguarding sites. A majority of these species have been returned to wild sites that are on lands owned or managed by GA DNR. These 38 species are planted state-wide and include 21 Wildlife Management Areas (WMAs), 7 areas managed as Natural Areas (NAs), and 10 State Parks/Historical Sites.

Several of GPCA's most successful safeguarding projects occur on these state lands. The sites are protected and are under active restoration and management. GPCA has returned a number of critically imperiled plant species to the wild on areas such as Broad River WMA, Ohoopee Dunes WMA, Rock and Shoals Outcrop WMA, and Cooper's Creek WMA. The projects require long term commitments for protection as well as dedicated resources for the land restoration, management, and monitoring until a species begins to take hold in its new safeguarding home.

Because the WMAs are under active restoration and management, they provide GPCA not only with a protected site, but also a team of professionals working to remove invasive species, apply prescribed fire to the land, and to restore hydrological systems to their natural flows. Working with lands already in active management saves the GPCA years of time, enabling us to return plants to wild sites faster than we would if we were working with other lands that are at the beginning of their restoration phase.

Reciprocal work between the Interagency Burn Team and GPCA partners has enabled us to return imperiled plant species and protect Georgia rare plant populations on land held by different parent agencies, including private, state, and federal. This collaboration has allowed working together as a team, leveraging the work, volunteers, and equipment to get land restored and plants back on the ground. GPCA has been proud to support networking on all of these lands and with significant successes.

Safeguarding Highlight on State Land
Dwarf Sumac at Lower Broad River WMA, Mincy Moffett (GA WRD)

Aggressive habitat-level management, coupled with careful "surgically" applied micro-site management has saved one of Georgia's only two natural populations of the federally endangered dwarf sumac (*Rhus michauxii*) from extirpation. Dwarf Sumac is a small deciduous shrub preferring open woodland habitat.

The male population of dwarf sumac in Elbert County occupies a 1-acre knoll within the larger Lower Broad River WMA (LBRWMA). It began a precipitous decline in the late 1990's, and by 2005, the number of visible male stems at the Elbert County site had dwindled to just two. The site had become incredibly overgrown with a nearly closed canopy and rapidly encroaching mid-story. It was at that time that the Georgia Plant Conservation Alliance (GPCA) added the dwarf sumac to its safeguarding work list and began designing the concept of a 40-acre LBRWMA safeguarding area. The GPCA safeguarding model combines landscape-level management/restoration with more intensive micro-site management to achieve amazing results. Landscape-level management includes such things as prescribed fire, as well as chemical and mechanical removal of woody competition with a focus on large acreage. Micro-site management occurs on a scale of square feet and is essentially *in situ* conservation horticulture.

During the last 8 years, the LBRWMA safeguarding area has received three prescribed burns and one mechanical thinning. In addition, the knoll area received a more thorough manual thinning using chainsaws, and benefits from an annual hand-pruning of woody growth where needed. The plants have responded vigorously to this management scheme, producing 750 stems in 2014. A genetics study by a GPCA member institution indicated the presence of at least 10 different genotypes in the male population, meaning that most of the genotypes were just lying dormant beneath the burden of woody competition and shade during those "lean" years. They were rescued from their slowly-senescing dormancy by the intervention of habitat management.

The GPCA undertook another dwarf sumac initiative designed to encourage sexual reproduction. Fifty stems from the female population in Newton County were transplanted into the male population at LBRWMA. The micro-sites for outplanting were carefully selected and prepped, and young plants received stewardship visits on a regular basis during their first year. In 2013, the mixed population produced viable seed that later germinated in conservation greenhouses. This was the first successful sexual reproduction event ever witnessed for this species in Georgia.

The GPCA also maintains numerous *in situ* and *ex situ* safeguarding collections of both populations of this species as a hedge against extinction.

Safeguarding Highlight on Private Land
Coastal Plain Pitcher Plant Bog, Lisa Kruse (GA WRD)

Another GPCA success story lies in southeast Georgia. The GPCA and its partners have restored endangered herbaceous seepage bog habitat in Georgia's Atlantic Coastal Plain in a long-term public-private partnership for monitoring and management. Intact seepage bogs are extremely rare in Georgia, with less than a dozen high quality bog habitats identified in the entire state. This habitat was identified as a high priority habitat in the original SWAP. One of these bogs near Claxton was chosen by the nascent GPCA around 1999 as one of its five top priority initial conservation projects. It is a complex of seepage bogs in 8 discrete swales along a rolling 5-mile stretch of powerline right of way, within a matrix of intact longleaf /turkey oak sandhill and pine plantation. It is important as the only known Georgia location for the Coastal plain purple pitcher plant (*Sarracenia purpurea* var. *venosa*), for having eight other Georgia protected plant species, and for overall high floristic species diversity that includes at least five orchid and seven carnivorous plant species.

Conservation of these bogs is challenging because they are in multiple private ownership, each with differing land management objectives. Further complications arise from management activities by two utility companies in their right-of-ways across the bogs. Significant threats include fire suppression, herbicide and fertilizer use, off-road vehicle intrusion, invasive plant species, and industrial forestry practices.

GPCA's involvement was initiated when a miscommunication within a utility company resulted in herbicide application that destroyed the herbaceous component of one of the bogs. From that low point GPCA took on the role of 1) centralizing communication among land managers, land owners, and conservationist biologists, 2) formalizing a shared management agreement with utility companies, and 3) monitoring the rare habitats through the Botanical Guardians program.

When regular monitoring from 2002-2006 indicated that the bogs were in rapid decline due to off-road vehicle trespass and fire suppression, GPCA coordinated a multi-pronged management effort to counter these threats. Utilizing the Interagency Burn Team (IBT), prescribed fire was conducted at one property in 2006. In 2007, new fences and educational signs were installed at five of the bogs to deter off-road vehicle use. As GPCA had been in contact with landowners and utility companies for years, permission was not difficult to obtain. The management was mutually beneficial to all parties. Subsequently, Coastal Plain purple pitcher plant and one orchid species have been planted at one bog, grown from seed collected at the site. Four additional prescribed burns, including a second landowner, have been conducted by the IBT. The latest, in 2014, was a growing season burn where nearly 35 acres of wiregrass groundcover flowered and set seed. Fences and signs have remained intact and no further damage has been done by off-road vehicles. Pitcher plants, orchids, and incredible herbaceous diversity are flourishing, particularly where prescribed fire has been implemented. The benefits extend to animal species as well, as evidenced by the numerous gopher tortoise burrows on the site. These great successes have provided inspiration to continue maintaining good landowner relations, expand to additional properties in the restoration management activities, and possibly create long-term legal agreements for conservation of this special habitat.

The Longleaf Alliance

Randy Tate (LLA)

X	*Addressed Altered Fire Regimes*
X	*Improved Management Practices*
	Combatted Invasive/Alien Species

The Longleaf Alliance (LLA) was established in 1995 at Auburn University when it became apparent that the interest in the longleaf ecosystem and the tree itself was growing rapidly, but there wasn't an outlet available for ecologists, foresters, wildlife biologists, land owners and land managers seeking information nor was there a means to distribute information they did know.

A growing body of anecdotal information, personal experience, and scientific data was being passed on fitfully, and many groups were not being reached. The LLA was therefore created with the express purpose of coordinating partnerships between private landowners, forest industries, state and federal agencies, conservation groups, researchers, and other enthusiasts interested in managing and restoring longleaf pine forests for their ecological and economic benefits.

The structure of the LLA is simple, with a direct goal, the establishment of a functional longleaf forest ecosystem to the extent feasible in today's Southern forest environment. We understand that the restoration of a fully functioning longleaf ecosystem appeals to landowners in varying degrees. Recognizing that an intact longleaf forest ecosystem is not likely ever again to dominate the southern landscape, we have adopted the philosophy that "better is better." We believe that longleaf in any form is better than a cotton field; that longleaf and native ground cover (like wiregrass) is better than longleaf alone; that longleaf, wiregrass, and gopher tortoises are better than longleaf and wiregrass alone, etc.

The LLA serves as a clearinghouse for information on regenerating, restoring and managing longleaf pine; provide networking opportunities for supporters to connect with other landowners, managers and researchers with similar interests and problems; and coordinate technical meetings and education seminars.

The vast majority of forest acreage in the Southeast is privately owned. For example, of the approximate 24 million acres of forest land in GA, 92% of that is privately owned (*Sustainable Forest Management in Georgia, GFC, 2008*). Consequently, the LLA feels that the greatest opportunity to significantly re-establish longleaf pine forests is on private lands. A primary focus is to provide economically viable and voluntary options for recovery of longleaf on private lands where most of the losses are occurring.

In 2009, the LLA joined several other agencies, organizations and private individuals in creating a range wide plan for the restoration of longleaf pine. That plan became *America's Longleaf Restoration Initiative.* (http://www.americaslongleaf.org/) America's Longleaf Restoration Initiative (ALRI) is a collaborative effort of multiple public and private sector partners that actively supports range-wide efforts to restore and conserve longleaf pine ecosystems. The vision of the partners involved in ALRI is to have functional, viable longleaf pine ecosystems with the full spectrum of ecological, economic and social values inspired through the voluntary involvement of motivated organizations and individuals.

ALRI has recognized 17 Significant Geographic Areas (SGA) for longleaf throughout its range. Five of these are wholly or partly in Georgia. No other state within the range has as many as Georgia. Each of these SGAs has established a Local Implementation Team (LIT) to coordinate and guide restoration and conservation activities within the boundary they have drawn. These are the *Talladega-Mountain Longleaf Pine Conservation Partnership*, the *Chattahoochee Fall Line Conservation Partnership*, the *Fort Stewart/Altamaha Longleaf Restoration Partnership* the *Okefenokee and Osceola Local Implementation Team* and the *Apalachicola Regional Stewardship Alliance*.

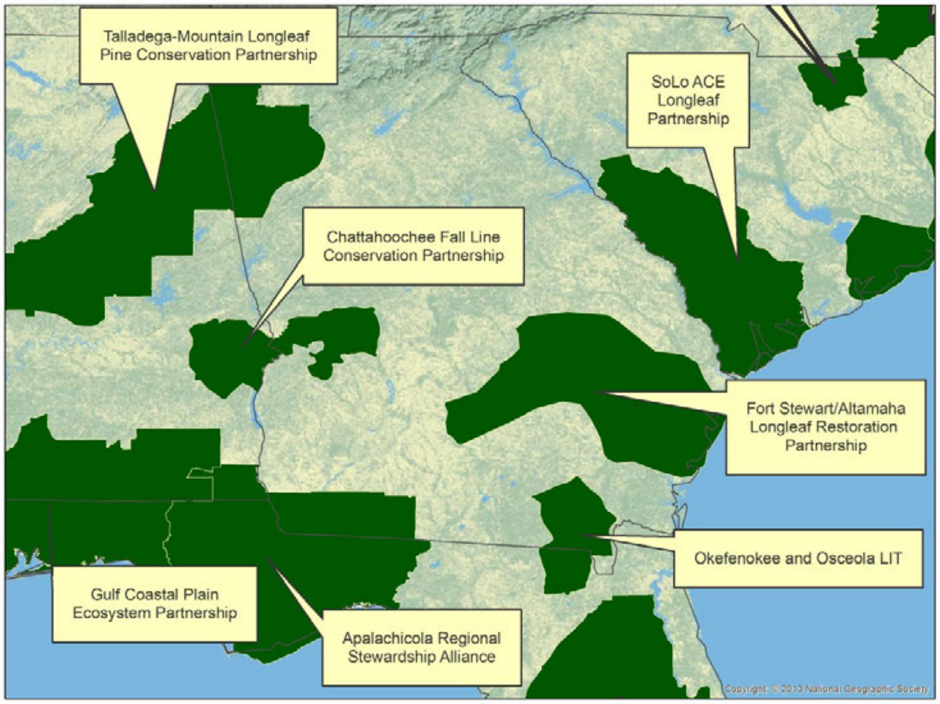
The National Fish and Wildlife Foundation established the Longleaf Stewardship Fund (LSF) in 2012. It is a landmark public-private partnership supported with federal funding from the Department of Defense, the U.S. Forest Service, the Natural Resources Conservation Service, the U.S. Fish and Wildlife Service, and private funding from Southern Company and International Paper's Forestland Stewards Initiative. It is the LSF that has largely funded the establishment and operations of the LITs.

In order to disseminate the best information possible on longleaf establishment and management, the Longleaf Alliance initiated Longleaf Academies in 2008. Longleaf 101 provides the basics of longleaf ecology, establishment and management. They have proved enormously successful and now include Longleaf 201 courses on understory establishment and management and prescribed fire. Several Academies have been held in GA and more are planned in the future.

There has been much work on groundcover restoration in GA. In 2012 the LLA initiated the *Longleaf Understory Common Garden Project*. The project evaluates differences in germination, establishment, phenological characteristics and growth rates among proposed seed transfer zones for six common understory plant species that provide functionality in the longleaf ecosystem. One of the four sites is located in GA at the Joseph Jones Ecological Research Center in Newton, GA. Also, a groundcover seed production plot has been established at K&L Forest Nursery in Buena Vista, GA. Six different common longleaf understory species are being grown for the purpose of seed production. And, in conjunction with the Chattahoochee Fall Line Ecosystem Partnership, 21 acres of native grasses were established on The Nature Conservancy owned Ingram Tract that borders the Ft. Benning Military Installation. Over the next two years (2015-2016), a five acre groundcover restoration demonstration site will be established at Moody Forest Natural Area in Appling County.

Additionally, in collaboration with Trees Atlanta, the LLA established a demonstration planting of longleaf and understory species along the Eastside Trail on the BeltLine in Atlanta, GA, in 2012.

Each LIT within Georgia currently has funding for two more years and anticipates continued work given future funding. These LITs form an infrastructure for longleaf pine restoration and management into the future. Dozens of species of conservation concern will benefit.



America's Longleaf Restoration Initiative recognized 17 Significant Geographic Areas

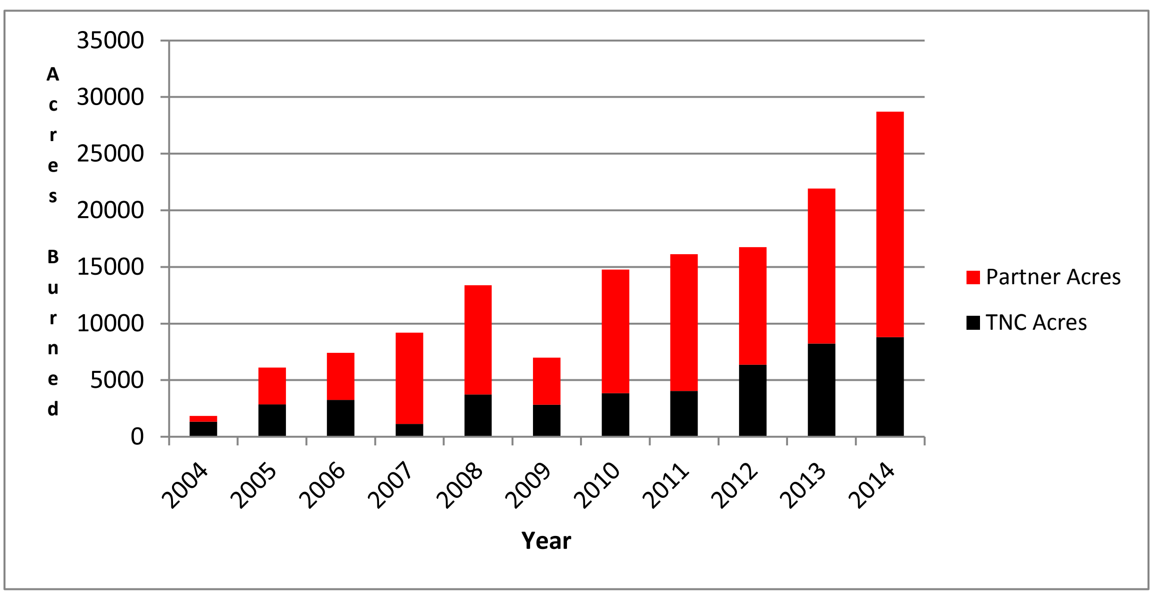
The Nature Conservancy (TNC)

Habitat Restoration Over the Past Decade, Malcolm Hodges and Erick Brown (TNC)

X	*Addressed Altered Fire Regimes*
X	*Improved Management Practices*
X	*Combatted Invasive/Alien Species*

Over the past decade (2004-2014), The Nature Conservancy has increased both its need for habitat restoration and its capacity in Georgia. In general, our conservation staff has declined, but we have gone from three to four full-time land stewards, two site-based and two statewide. Most of the latter half-decade we went without a state-dedicated fire manager, but that was rectified in 2013. TNC-owned lands in Georgia have more than doubled in the past decade, and the conservation easement acres managed by our land stewards have also increased significantly (see Figure 1). To fill the capacity gap, we rely heavily on volunteers, interns, and short-term fire crews, as well as assistance from partners such as GA DNR.

Our habitat restoration strategy places high priority on prescribed fire. In addition, we remove pine plantations and native invasive hardwoods (e.g., water oak, sweetgum) and replant uplands with site-appropriate pine species. We also harvest native plant seed and replant in areas where necessary. Finally, we remove non-native plants and animals negatively impacting natural systems. Over the last decade, we have continued with all these practices, with varying degrees of success. Emphasis on fire, which we believe is the most important single action we can take, has increased outside TNC lands, with our participation in fire on partner lands growing tenfold over the last decade. We began the decade relying on staffing prescribed burns with full time employees militia style and short term Americorps NCCC teams, then moved to a seasonal crew based out of Baxley, and now routinely hire two crews each spring. We believe that we achieve the greatest success at efficiently conserving biodiversity by ensuring our fire program, and the fire programs of our partners, continues to grow and achieve programmatic objectives.



TNC attempts to use its preserves as a testing ground for best habitat restoration practices, and then use that knowledge to assist in restoration efforts and land management undertaken by partner agencies and organizations statewide. Over the past decade, we have experimented with tree and herb planting methodology, fire frequency in xeric habitats, restoration of fire-suppressed mature pinelands with organic soils, and methods for restoring exotic grasslands. Many of these attempts at "adaptive management” are ongoing, and engaging partners has often involved a slow, osmotic transfer of information.

Conservation of biodiversity in conjunction with habitat restoration can sometimes result in surprises, some good and some bad. For instance, over the past decade fire management in remnant prairies in the Coosa Basin has resulted in significant increases in populations of two federally protected plants, Mohr’s Barbara-buttons (*Marshalia mohrii*) and whorled sunflower (*Helianthus verticillatus*). However, two key habitat-indicator plants, prairie dock (*Silphium terebinthinaceum*) and prairie purple coneflower (*Echinacea purpuea*), have declined. Increased fire at sites with populations of Georgia plume has invigorated some populations, while others have suffered setbacks from excessive deer browse on root sprouts. Habitats are complex systems and pushing on one part can cause unanticipated effects in other areas.

Habitat restoration of increasingly isolated tracts begins to look like zoo-keeping in a state with less than 10% of its land area in protected lands. Our manipulation of populations of rare plants and animals has grown, with reintroductions, ex-situ propagation and safeguarding of rare organisms all increasing greatly over the last decade. Examples include the introduction of gopher frog to Williams Bluffs Preserve (Early County), augmentation of green pitcherplants (*Sarracinia oreophylla*) at Reed Branch Wet Meadow Preserve (Towns County), reintroduction of Georgia rockcress (*Arabis georgiana*) from ex-situ cultivation at Black’s Bluff Preserve (Floyd County), and safeguarding of Cooley meadowrue (*Thalictrum cooleyi*) from Dry Creek Swamp Preserve (Worth County) at a nearby conservation easement. Such creative methodology will only increase as we make full use of a weak conservation portfolio to conserve the state’s existing biodiversity.

As large-scale land protection wanes in the face of an increasing human population, careful restoration and management of existing conservation lands becomes more important. Collaboration among conservation-lands managers has increased and will no doubt continue to do so, as we seek best practices for habitat restoration and develop multi-site cooperative projects.

Rapid changes in land tenure, intensification of anthropogenic extraction processes, climate change, declines in government funding, and the shifting structure and mission of non-profit environmental groups create a mercurial environment for long-term land-management practitioners. In particular, the uncertain future of fire management in the face of increasing concern over smoke management and atmospheric carbon inputs places our most important restoration strategy at risk. Prioritization of management practices on those lands most resilient to change is one way to minimize risk. Belief in the ecologically redemptive power of fire can reach an almost evangelical zeal amongst land stewards, but careful evaluation of and experimentation with alternatives to fire would be wise in the coming decades. Examples include close-mowing and rotational grazing schemes.

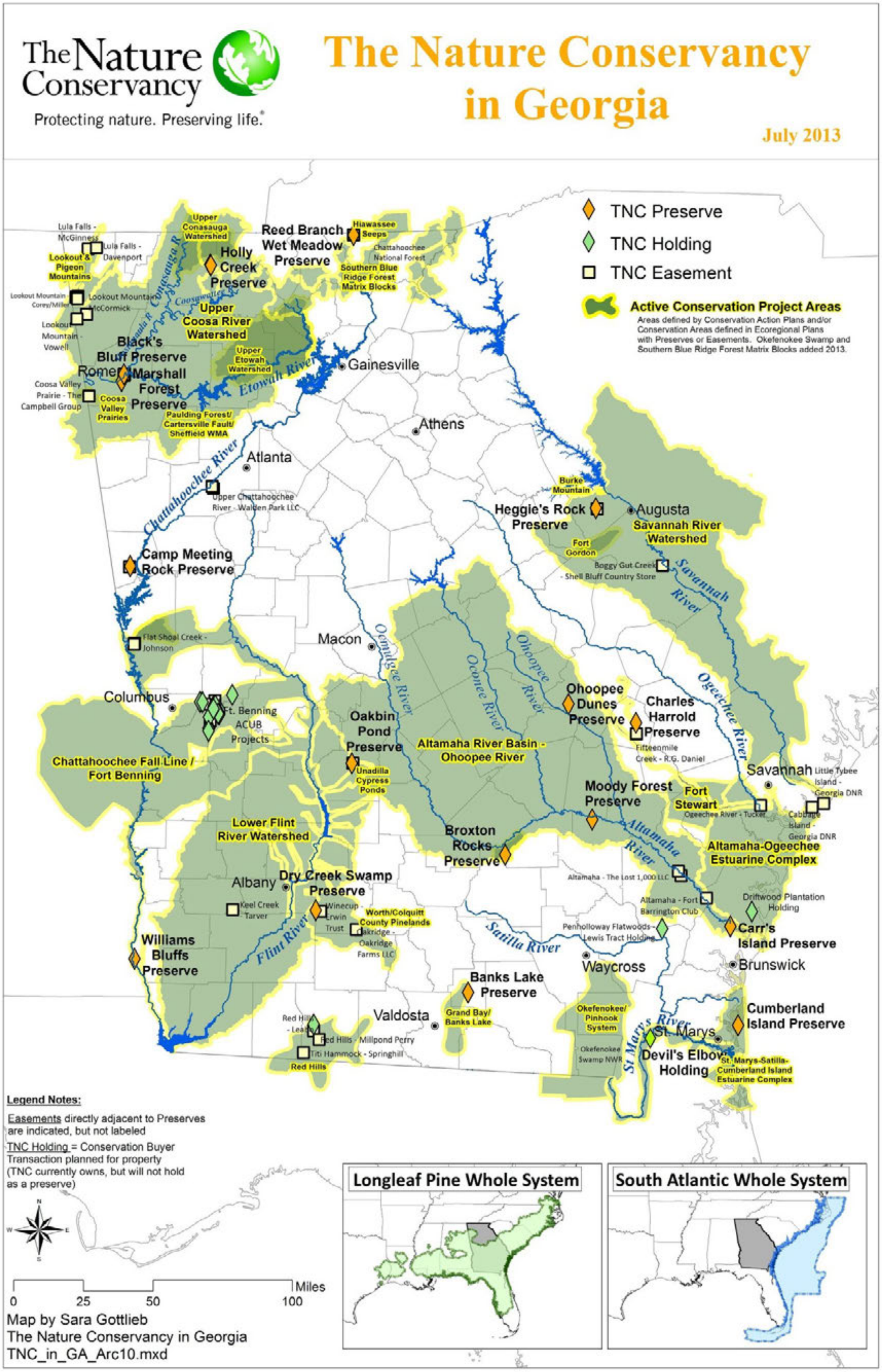


Figure 1. TNC lands in Georgia.

Habitat Restoration and SWAP

Looking Ahead

Shan Cammack and Eamonn Leonard (GA WRD)

The State Wildlife Action Plan was developed by a comprehensive planning team as a conservation strategy to protect and maintain the full complement of species native to a Georgia, especially species of greatest conservation need. The strategy assessed the extent and condition of habitats required by these species, as well as existing and potential problems and conservation opportunities for these habitats. The plan remains as strong and relevant to habitat restoration today as it was when it was published ten years ago.

Recommended Actions and Strategies that were outlined in the original SWAP were addressed in the past ten years.

Address Altered Fire Regimes
• Partnerships continue to grow and increase capacity to conduct prescribed burning and to identify priority areas in need of better fire management. More emphasis is being placed on appropriate timing and frequency. • The Interagency Burn Team (IBT) continues to be successful and will continue with the recent re-signing of the Memorandum of Understanding. • Several programs focused on working with private landowners owning high priority habitat. Technical assistance and incentive programs encouraged prescribed burns in fire-adapted habitats. • NWCG (National Wildfire Coordinating Group) certification standards were adopted by all state and federal practitioners in the IBT.
Encourage Improved Management Practices
• As outlined in this chapter, USFS, NPS, USFWS, and other public land managers worked together at multiple levels to improve habitat management on public lands. Restoration and maintenance of natural habitats was emphasized as well as addressing regional conservation. • IBT partners work to couple habitat management and educational outreach programs to help provide the public with information to inspire sound stewardship for wildlife resources on private lands. • NRCS used SWAP widely to promote the planting of native species through Farm Bill programs. • State agencies worked to improve public familiarity with and use of BMPs for agriculture, forestry, and land development practices.
Combat Invasive/Alien Species
• A strong interagency push was made to work collaboratively on invasive species issues. This included promoting education about exotic species that covered identification, effects, and eradication measures. Efforts were also made to reduce the importation of invasive exotic species. • State, federal and NGOs worked tirelessly to eradicate invasive species on their properties. • Land management agencies worked to initiate integrated control measures that focus on early detection and eradication of alien species.

Thanks to the Georgia State Wildlife Action Plan, land management agencies across the state have been working hard to improve habitats for species of special concern. Perhaps the most useful benefit of the SWAP is heightened importance of habitat restoration and the increased availability of funds. Federal funding entities as well as non-profit organizations relied on the SWAP to set priorities and rank projects. This has funded a lot of on-the-ground management activities that have benefitted a myriad of species.

These priorities remain in place. This, coupled with the momentum that has been generated in the last ten years, suggests that the vision of habitat restoration will continue into the future. Part of this success has been due to the high level of collaboration and cooperation between the various state, federal, and non-profit agencies and groups. The unique landscape of Georgia and the high level of private landownership has forged these alliances and led to creative ways to implement effective land management. Species of special concern in Georgia will experience new challenges in the future in the form of economic, demographic, environmental, and political change that will force land managers to be adaptive. The SWAP will continue to be used as a blueprint to guide the prioritizing of habitat restoration activities for years to come.

Appendix J. Monitoring Technical Team Report

Prepared by Lisa Kruse and Jacob Thompson

Technical Team Members

Team Leaders
Lisa Kruse, WRD, Nongame Conservation Section – Botanist; Ecologist
Jacob Thompson, WRD, Nongame Conservation Section – Botanist; Ecologist

Team Members participating at Monitoring Technical Committee Meeting
Jon Ambrose, WRD – Nongame Section Chief
Mike Byrne, U.S. Park Service – Terrestrial Ecologist
Sim Davidson, GADNR Parks – Wildlife Biologist
Brian Davis, GA Department of Transportation – Ecologist
Matt Elliott, WRD – Nongame Program Manager
Robin Goodloe, U.S. Fish and Wildlife Service - Biologist
Jim Hanula, U.S. Forest Service – Research Entomologist
Steve Holzman, U.S. Fish and Wildlife Service – Data Manager
Dorset Hurley, Sapelo Island National Estuarine Research Reserve – Senior Marine Biologist
Brian Irwin, USGS, Georgia Cooperative Fish & Wildlife Research Unit – Assistant Unit Leader (Fisheries)
Michael Juhan, Fort Gordon Army Base – Wildlife Biologist
Tim Keyes, WRD – Wildlife Biologist; Ornithologist
Kay Kirkman, Joseph Jones Ecological Research Center – Scientist; Plant Ecologist
Joyce Klaus, Gordon College – Assistant Professor; Herpetologist
Patti Lanford, WRD – Stream Survey Team - Biologist
George Matusick, The Nature Conservancy – Forest Ecologist
Clint Moore, USGS, Georgia Cooperative Fish & Wildlife Research Unit – Assistant Unit Leader (Wildlife)
Katrina Morris, WRD – Wildlife Biologist
Rebecca Pudner, Auburn University – Graduate Student
James Tomberlin, WRD – Private Lands Biologist
Susan Walls, U.S. Geological Survey (Amphibian Research & Monitoring Initiative) - Regional Coordinator

Team Members participating through email and correspondence
Analie Barnett, The Nature Conservancy – Landscape Ecologist
Laurel Barnhill, U.S. Fish and Wildlife Service – I&M Chief & Atlantic Zone Coordinator
Richard Chandler, University of Georgia – Assistant Professor
Nathan Klaus, WRD – Wildlife Biologist
Alison McGee, The Nature Conservancy – Coastal Plain Program Director
Joe O'Brien, USDA Forest Service Southern Research Station – Research Ecologist
Rob Sutter, Enduring Conservation Outcomes – Conservation Ecologist
Dirk Stevenson, Orianne Society – Assistant Conservation Scientist; Herpetologist
Jennifer Welte, GADNR Environmental Protection Division – Wetlands Biologist
Jim Wentworth, U.S. Forest Service – Wildlife Biologist

Invited but unable to participate
Bob Cooper, University of Georgia – Professor
Joe DeVivo, U.S. Park Service – Southeast Coast Network I&M Program Coordinator
Chelsy Miniat, USDA Forest Service Southern Research Station – Coweeta Hydrologic Lab Project Leader
Lissa Leege, Georgia Southern University – Professor; Plant Ecologist
Betsie Rothermel, Archbold Biological Station – Assistant Research Biologist
Becky Sharitz, University of Georgia, Savannah River Ecology Lab – Professor Emeritus

Executive Summary

As part of the 2015 Georgia State Wildlife Action Plan (SWAP) Revision, a monitoring technical team was assembled to determine ways to improve monitoring efforts in Georgia. Based on meetings and discussions with monitoring team members, a list of actions to improve monitoring was created and then ranked to create a priority subset of monitoring improvement actions. Other SWAP technical teams gave input on their top ranked monitoring actions, which along with discussions with team leaders, were assessed to determine overlapping monitoring needs and priorities.

Throughout this process, we found that the most consistent theme encompassing actions to improve monitoring was improving coordination state-wide, and regionally, among professionals conducting monitoring and management. Improving coordination involves a variety of actions that were emphasized by the monitoring team and other SWAP technical team leaders. These actions include tying monitoring to adaptive management, hiring a GA DNR monitoring coordinator, improving internal GA DNR communication related to monitoring, using standardized monitoring protocols and data forms when possible, improving sharing of protocols and data, and using technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects. We believe that all of these goals are achievable within the 5-10 year period covered by this SWAP Revision.

Because the monitoring improvement actions promoted by the monitoring team are often related, implementation of one action will often result in the success of another. For example, development of online tools will enable a greater capacity for protocol and data sharing. However, coordinating and improving monitoring statewide would be a significant time and resource commitment. Therefore, meeting the challenge of improving rare species and habitat monitoring likely hinges on hiring a monitoring coordinator. In particular, we find that the concept of tying monitoring to adaptive management requires careful consideration for the optimal level of implementation within GA DNR, mainly because of the necessity for status and trends monitoring in determining rare species status. However, working in an adaptive management framework is important because it is conducive to an institutional culture of constant assessment of monitoring results and communication of management implications.

Monitoring and an adaptive approach to species and habitat management are more important than ever considering uncertain future conditions with potential anthropogenic impacts and climate change. We propose that an adaptive management approach should be integrated throughout state monitoring programs, with results of monitoring informing conservation actions. Advances in technology will be integral to developing more rigorous monitoring/adaptive management programs. Overall, communication and coordination about monitoring and management should be emphasized within GA DNR and should incorporate partners to allow for conservation success.

Introduction

Monitoring is critical to the work of researchers, biologists, and practitioners in the conservation field. From the collection of basic qualitative data by conservation managers to the analysis of complex long-term datasets by statisticians, monitoring can shape conservation and management actions in a significant and positive way. Well-designed monitoring can show status and trends over time in species, natural communities, and ecosystems; document the implementation and efficacy of conservation and management actions; guide decisions regarding conservation and management actions; and provide knowledge about the biology of the species and systems monitored (The Nature Conservancy 2009, Larsen 2013).

Because of its importance in conducting sound conservation and management, monitoring is essential to the implementation of statewide conservation strategies such as the Georgia State Wildlife Action Plan (SWAP). The 2005 SWAP discussed the significance of monitoring and highlighted monitoring in the adaptive management framework (Georgia SWAP 2005), whereby monitoring is designed to indicate whether conservation objectives are being met, and informs whether particular conservation actions should be continued or changed (Elzinga et al. 1998). The 2005 SWAP gave guidance on how to prioritize species for monitoring, and gave a list of actions that would improve efficiency and efficacy of monitoring in Georgia. These actions included recommendations such as improving volunteer networks for monitoring, utilizing available databases of partner agencies, requiring monitoring to be a component of conservation projects, integrating new technologies and GIS resources into monitoring, and working internally and with partners to create efficient, easy-to-use monitoring protocols (Georgia SWAP 2005).

Progress has been made in many of those actions since 2005. An incomplete list of examples follows: To engage citizen scientists, the volunteer network of the breeding bird survey has been expanded, and also used as a model for annual frog and bat monitoring. The Georgia Plant Conservation Alliance has developed a network of trained volunteers who help with rare plant monitoring state-wide, and with research on specific high priority projects such mountain pitcher plant bog restoration. Certain grants, such as the Multi-State Sandhills Restoration Grant, require monitoring for completion, and through this grant management effects on breeding birds, gopher tortoise, and vegetation community of the sandhills ecosystem have been tracked since 2009 on thousands of acres. GA DNR freshwater aquatic biologists have used GIS analysis of survey metadata improve prioritization of watersheds for monitoring. Extensive baseline habitat mapping and classification projects have been completed, focusing especially on sandhills communities, state parks, and the eleven-county coastal region. Monitoring of longleaf pine ecosystem restoration has improved understanding of the effects of GA DNR’s land management, including site preparation methods, timber management, and prescribed fire in extremely fire-suppressed sites, which has subsequently been applied to improving GA DNR strategies for restoration of this critical ecosystem. And, to address the need for a simple, broadly-applied protocol, a fire effects photo monitoring program has been implemented in 25 state parks and natural areas state-wide. For this program, local staff collect data and submit it to a centralized repository of photos, and the data manager organizes chronological documentation of fire effects for each conservation property.

It is clear that across Georgia, monitoring of species, natural communities, and landscapes is conducted at many scales by multiple agencies and organizations. However, knowledge of monitoring programs in Georgia is not yet well-cataloged, nor is there an established mechanism for communicating about monitoring programs and results within the GA DNR nor among its partners. Certain partner agencies have developed rich monitoring programs and networks, such as the Inventory and Monitoring Network of the U.S. Fish and Wildlife Service (http://www.fws.gov/Refuges/NaturalResourcePC/IandM/), the Southeast Coast Network of the National Park Service (http://science.nature.nps.gov/im/units/SECN/), the Forest Inventory and Analysis Program of the National Forest Service (http://www.fia.fs.fed.us/), and the Fire Research and Management Exchange System, or FRAMES (https://www.frames.gov/). These programs provide important examples for monitoring strategies, protocol design, data management, and results reporting. Also over the past decade, rapid development in computer technologies has occurred, making available convenient, reasonably priced and ergonomic tools for digital data collection and management. The need to effectively use and coordinate these resources to improve monitoring is great, as development and other pressures on Georgia's natural resources continue to increase, while simultaneously conservation and restoration programs continue to expand in scope and acreage.

Considering these factors, it was imperative to update and create new monitoring strategies to include in the revision of the Georgia SWAP for 2015. Therefore a monitoring technical team was convened to focus on monitoring issues for Georgia's rare species and habitats. The purpose of the monitoring technical team was to create a synthesis of how species, habitats, and conservation actions are currently being monitored in the state and to develop strategies to monitor more effectively in the future. The goals of the monitoring team were to assess the most significant gaps in monitoring in Georgia, what steps are critical and practical to improve monitoring in the next 5-10 years in Georgia, and how the Georgia Department of Natural Resources (GA DNR) can collaborate with partners to achieve these steps.

This monitoring chapter of the 2015 SWAP revision serves two functions. Primarily we make recommendations on how to improve monitoring in Georgia based on the work of the SWAP monitoring technical team. In addition, we begin the process of summarizing the priority monitoring projects and programs of the Nongame Conservation Section and key partners within the state. Both sections describe the current status of rare species and habitat monitoring in Georgia and provide an initiation point for collaborations and information gathering. We hope that this chapter will encourage new coordination for improved monitoring among DNR and its partners.

Methods

The SWAP Revision monitoring technical team members were selected across different organizations based on their prior experience with monitoring. Professionals who conduct monitoring or have some expertise in monitoring including design, data collection, data storage, data analysis, and results reporting, were contacted to participate. The final team included a range of monitoring experience and was comprised of taxa experts, ecologists, researchers, conservation managers, and statisticians. Each team member submitted information about their monitoring work or monitoring work carried out by their organization.

The monitoring technical team assembled for a single-day meeting at Little Ocmulgee State Park in McRae, Georgia in order to: 1) Learn about existing projects and their objectives; 2) Discover overlapping priorities for monitoring in the next 5-10 years; and 3) To make plans on how to coordinate resources for improvement of monitoring of rare species and communities in Georgia. At the meeting, GA DNR Nongame Conservation biologists gave an overview of past and current Nongame monitoring projects in Georgia. Also, representatives from the National Park Service and U.S. Fish and Wildlife Service Inventory and Monitoring Networks gave presentations on their monitoring projects. In the afternoon, the team split out into five breakout groups to address the following questions:

What steps do you see as most practical and critical to improve monitoring of rare species and communities in Georgia? How can we coordinate resources to implement these steps over the next 5 to 10 years?

- How can we improve protocol design, data collection, and analysis of monitoring projects?
- What suggestions do you have to improve sharing of monitoring results with scientists, land managers, and others who can apply them?
- How can we improve our engagement of citizen scientists in monitoring projects?
- How can we use qualitative monitoring information?

After the breakout group discussions, the team reconvened to review each group’s responses to the questions. Ideas were recorded and placed in a spreadsheet.

After the meeting, ideas were reviewed and overlapping concepts were combined. They were categorized and organized into a monitoring actions table (Table 1). The monitoring actions table was then sent out to the team for review. Team members were asked to rank the importance of each numbered action based on these seven ranking criteria: 1) providing multiple benefits for high priority species/habitats, 2) addressing un(der)funded needs, 3) overall importance of Georgia efforts, 4) timeliness or urgency, 5) connections with other conservation actions, 6) building public support for wildlife conservation, and 7) probability of success. Responses were then used to edit the monitoring action table and determine the most important monitoring actions in the table.

Once we had feedback from the team members, we held individual discussions with various technical team members to refine the highest priority actions and develop insights on how these actions can be applied to rare species and ecosystem conservation. In particular, insight was especially needed on pragmatic application of adaptive management and monitoring in the rare species monitoring context, and on the development of a monitoring coordinator position within GA DNR.

Also, the monitoring team leaders sought feedback from other SWAP technical teams on their highest monitoring priorities and their methods for determining these priorities. We found that this feedback was critical for assessing how the monitoring actions fit within the current context of monitoring conducted by GA DNR biologists, and to refine the prioritization of the monitoring actions. The results of this process are listed in Table 2.

Results

Selection of actions to improve monitoring

The breakout sessions provided monitoring actions that were grouped into five categories. These categories are: ways to improve coordination and communication of monitoring activities, prioritization of monitoring to optimize resource allocation, monitoring design and data collection, data reporting, and citizen and volunteer involvement in monitoring projects (Table 1).

Table 1. Actions to improve monitoring in Georgia

Improve coordination and communication of monitoring activities
1. Improve awareness among scientists about monitoring work that supports conservation in Georgia a. Conduct regular meetings of monitoring biologists in key agencies b. Conduct an inventory of ongoing rare species and habitat monitoring programs in the state. This includes research, surveys, and databases maintained by academic institutions and agencies. Create a database that is easily accessible and updatable 2. Improve internal GA DNR communication related to monitoring a. Conduct regular meetings of DNR Biologists working on similar issues (e.g. land management, species monitoring, freshwater streams) to share monitoring programs and address problems in monitoring. Meetings should include field tours. Include the Environmental Protection Division, Parks Division, and Private Lands Program where appropriate b. Maintain a database of qualitative information regarding land management and land management decisions for high priority properties c. Maintain a database of rare species and habitat monitoring conducted within GA DNR 3. Communicate SWAP priorities to universities and other research institutions for potential collaboration a. Create a concise list of SWAP monitoring priorities to disseminate to universities and other research institutions. b. Relate priorities to potential funding opportunities. 4. Improve sharing of protocols and data a. Develop an easily accessible mechanism to share protocols and data b. Identify current monitoring protocols that work for state objectives. Where no standard protocol exists, work with other agencies and universities to create standardized protocols for species and ecosystems. Move toward greater consistency across state boundaries (e.g., Index of Biological Integrity, National Bobwhite Conservation Initiative) c. Coordinate with agencies that regularly collect rare species data (Department of Transportation, National Park Service, U.S. Forest Service, U.S. Geological Survey) to improve rare species monitoring

5. Hire a GA DNR monitoring coordinator to compile data, increase collaboration, improve and standardize agency protocols, and coordinate funding opportunities

Improve prioritization of monitoring to optimize resource allocation

6. Determine realistic monitoring frequencies for high priority species and habitats
7. Determine data gaps for priority habitats and species to help set monitoring priorities
8. Establish and share clear monitoring priorities to enable greater collaboration with other institutions

Improve monitoring design and data collection

9. Use technology to increase information that can be obtained from photos and to improve access to the data.
   a. Use photo monitoring with simple quantitative data collection for rapid assessment of management effects. Use local personnel or volunteers to expand data collection capacity.
   b. Where applicable, use remote sensing of spatial data to monitor habitats
10. Tie monitoring to adaptive management
    a. Include trigger points in protocols, i.e. design monitoring to include agreed upon actions that are engaged when certain conditions are detected
    b. Identify specific courses of action that would be implemented when monitoring questions are answered
    c. Consider thresholds and variability, rather than only the mean as important measures. Increased variability could indicate a catastrophic event
11. Census important reference sites and relate to management and monitoring
12. Monitor common species along with rare species to prevent rarity
    a. Use strategies such as Index of Biological Integrity (IBI) and Floristic Quality Indices (FQI) that includes both rare and common species
13. Use standardized monitoring protocols and data forms when possible
    a. Collect data on at least one main variable across different monitoring projects.
    b. Include the statistical approach in monitoring designs
    c. Require a standard format for maintaining all metadata relating to monitoring project rationale, objectives, techniques used, data format, and summary of findings throughout the project
    d. Archive protocols and all associated data in a central location
    e. Use protocols for storing qualitative data established by institutions such as the Joseph W. Jones Ecological Research Center, National Park Service, and U.S. Fish and Wildlife Service
14. Capture qualitative data on management results. Compile information from managers; conducting periodic and exit interviews may be a useful way to collect this data

Improve monitoring data reporting; make results accessible to the appropriate end-user

15. Use the outreach capacity of organizations that emphasize public education such as the Joseph W. Jones Ecological Research Center, the Longleaf Alliance, and Rivers Alive to improve monitoring data reporting
16. Provide short-term feedback from monitoring projects to participating landowners and

managers. This will allow for greater future collaboration and adaptive management 17. Develop a website to make reports accessible to land managers and biologists
Involve citizens and volunteers in monitoring projects
18. Use technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects a. YouTube videos to share protocols b. Smart-device apps to engage large numbers of citizens (e.g. EDDMaps for invasive species) c. Recognize contributions of individuals or communities with social media d. Create a mechanism for quick data entry to reduce work load of the coordinating biologist 19. Incorporate monitoring into Master Naturalist programs 20. Use the Environmental Education Alliance to reach teachers with programs for monitoring in school classrooms. 21. Reciprocate monitoring participants' efforts with rewards, both tangible (certificates, badges, books, gift certificates) and intangible (knowledge, accolades)

After the monitoring action table (Table 1) was sent out to technical team members for review, nine team members ranked and/or gave feedback on the monitoring actions. Of the nine, only six members provided ranking for each monitoring action. In addition, we had in-depth discussions with ten scientists, some additional to the original team, regarding their use of monitoring and priorities for improving monitoring. After this process, some of the actions in Table 1 were refined. So although we did not have explicit feedback on the monitoring conservation actions from a majority of the monitoring technical team, we feel that between the detailed information gathered at the meeting and the conversations we held, we have developed a consensus on the most critical actions to improve monitoring. It should be noted, however, that many technical team members felt uncomfortable ranking each of the 21 actions, finding many of the actions to be equally important and also finding it difficult to rank specific actions ahead of others.

There were six actions from the table above which were most frequently ranked as the most important. They are listed here in order of rank: 1) Tie monitoring to adaptive management; 2) Hire a GA DNR monitoring coordinator; 3) Improve internal GA DNR communication related to monitoring; 4) Use standardized monitoring protocols and data forms when possible; 5) Improve sharing of protocols and data; and 6) Use technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects.

Monitoring priorities of other SWAP technical teams

Many of the technical teams included monitoring priorities in their section of the SWAP Revision (Table 2). After discussing how these priorities were selected with technical team leaders and reviewing the priorities, we found that each group included monitoring actions based on different needs, though there were similarities in many of the goals and some teams had overlapping priorities.

Status and trends monitoring is a significant component of the Georgia DNR's species conservation programs. This type of monitoring is necessary to track populations of high priority species over time, and allows biologists to detect potential threats and assess the need for conservation measures. When determining how these types of monitoring projects were prioritized, we found that some were initiated prior to the start of the SWAP Revision process, such as Indigo Snake monitoring on the Altamaha, while others were determined as priority monitoring actions by SWAP Revision technical teams. Some priority species groups, such as sea turtles, have had a long history monitoring and will continue to be monitored while a greater focus can be placed on management strategies to help increase populations. For other programs such as bat monitoring, only recently has there been a higher level monitoring intensity, due to the devastating threat of the disease, White Nose Syndrome. In this case, biologists are still learning about species biology, so the greatest monitoring need is to determine population status and trends, while developing more standardized protocols and increasing information sharing capacity across state boundaries.

Some species are given high priority for monitoring as a result of legal agreements, such as Candidate Conservation Agreements. A Candidate Conservation Agreement (CCA) is a voluntary conservation agreement between the U.S. Fish and Wildlife Service and one or more public or private parties as a way to reduce threats and conserve candidate species. Under these agreements, species populations are monitored to determine the effectiveness of conservation measures. In Georgia, the Gopher Tortoise and Georgia Aster have been prioritized for monitoring to fulfill the requirements of CCAs.

Monitoring response to management, especially prescribed fire, was a significant priority for some teams, including the habitat restoration and bird teams. The Georgia DNR fire management program is central to the conservation of many fire-adapted species and habitats in the state, thus monitoring the effects of fire management is critical to understanding the success of this program. Another shared goal was the need for baseline landcover/habitat data. Both the Ecosystems/Habitat Mapping and Climate Change Adaptation teams expressed the need for this type of information in order to monitor landscape level changes over time and to help model the effects of land use and climate change on species and habitats in the state.

Monitoring priorities for many teams reflect several of the ideas mentioned by the Monitoring Technical Team as actions to improve monitoring (see Table 1). A significant overlapping need is the improvement of standardized protocols and a greater capacity for the sharing of these protocols and monitoring data. This is mentioned as a high priority monitoring action for many taxa, including birds, plants, mussels, and bats. Related to these goals is the improvement of online tools, including methods to collect data and share monitoring information. For example, the habitat restoration team prioritized the use of EDDMaps, an online tool used to detect and monitor infestations of invasive species. Also, the habitat restoration team would like to take advantage of advances in online technologies to improve monitoring protocol and data sharing for photo monitoring in fire-adapted habitats.

Table 2. List of monitoring priorities for each of the SWAP Revision technical teams

Technical Team	**Monitoring Priorities**
Reptiles and Amphibians	1. Gopher tortoise population monitoring using Line Transect Distance Sampling on all inventoried state lands and select private lands at intervals no less than every five years but no

	greater than every 10 years. This is required by the tortoise Candidate Conservation Agreement to which WRD is a party. 2. Occupancy monitoring of eastern indigo snakes at select sites in the lower Altamaha River sandhills region. This effort, contracted out to Orianne Society, has taken place annually for the past three years, but will likely be extended to a greater interval. 3. Continue 3 year occupancy monitoring cycle of eastern hellbender populations at known sites, including disease screening 4. A statewide index of abundance for diamondback terrapins will be developed to determine trends in abundance over time 5. Trends in adult female sea turtle abundance will be assessed through nest monitoring programs and genetic mark-recapture sampling. Sea turtle strandings will be monitored (and necropsies performed to determine cause of death) as an index of threats in coastal marine waters.
Birds	1. Pursue coordinated monitoring and data storage for seabirds across the Southeast states to better understand status and trends. Prioritize using a shared database such as the Avian Knowledge Network to serve as a central clearinghouse for data storage and dissemination for many of our bird conservation efforts. 2. Continue participating in national/international coordinated efforts such as the Breeding Bird Survey, U.S. Nightjar Survey, and International Shorebird Survey. 3. Develop a regional survey/monitoring protocol for wading birds. 4. Develop and implement monitoring protocols for secretive marsh birds. Make these protocols compatible with similar efforts in other parts of the Southeast or the species' range. 5. Monitor the effectiveness of management, particularly prescribed fire, on bird populations.
Mammals	1. Annual monitoring of caves with populations of bats currently affected or likely to be affected by White Nose Syndrome 2. Annual summertime monitoring of gray bats and southeastern bats in caves 3. North Atlantic Right Whale: satellite tagging to study movement and habitat use; seasonal aerial and boat photo-ID surveys and genetics sampling for population monitoring 4. Bottlenose Dolphin: Boat photo ID surveys to assess abundance, vital rates, residency patterns and stock structure; capture-release studies and remote biopsy sampling to assess health of dolphins in Brunswick area 5. Monitoring spotted skunks with camera "traps" 6. Monitoring pocket gophers with mound counts
Fishes and Freshwater	1. Evaluate status and distribution of high priority snails 2. Surveys for petitioned aquatic species

Invertebrates	3. Update GA Dept. of Transportation Mussel Sampling Protocol 4. Continued aquatics species monitoring in high priority watersheds, where numerous high priority species can be targeted in one project.
Terrestrial Invertebrates	1. Inventory to obtain baseline information for priority species and for species habitat associations 2. Develop invertebrate-based Indices of Biotic Integrity [IBI] for specific high priority habitats
Plants	1. Monitor high priority plant species and habitats when scientific uncertainty and/or stakeholder disagreement exists about suitability of management actions (e.g. *Lindera melissifolia* and *Ceratiola ericoides* population response to prescribed fire, and timber harvest for restoration of prairies at Oaky Woods WMA). 2. Monitor select populations for which regulatory conservation agreements exist to document success or failure of the agreements (e.g. *Symphyotrichum georgianum*) 3. Monitor high-priority *in-situ* population augmentation or introductions (e.g. *Arabis georgiana, Echinacea laevigata, Rhus michauxii, Sarracenia* species). 4. Develop a standard DNR-wide protocol for monitoring suites of rare species that occur in specific high priority rare habitats, in particular in coastal plain seepage bogs of the sandhill habitat.
Habitat Restoration	1. Expand and improve DNR's fire photo monitoring program. a. Incorporate simple quantitative data collection methods associated with the photo points for high priority sites, especially where land managers desire more information. b. Include Game Management biologists and Wildlife Management Areas. c. Use technology to improve photos and increase information that can be obtained from then (e.g. vegetation cover, canopy cover). d. Create a geodatabase of the fire monitoring points e. Develop an online mechanism for uploading photos and data points to a centralized system f. Include reference sites of high priority habitats 2. Where there are significant questions related to the management of high priority habitats and/or species, initiate adaptive management vegetation monitoring projects 3. Organize and complete a unified "lessons learned" report that includes the multi-faceted monitoring and research that has been conducted in the longleaf pine ecosystem by DNR Nongame Conservation Section biologists. This compilation could be published by the DNR and made available to landowners and research institutions. 4. Continue incorporating and promoting online tools such as EDDMaps that can be used for early detection of invasive

	species, to track the spread of invasives, and to monitor occurences over time. 5. Foster invasive species working groups such as the Coastal CISMA to help track invasive species at a regional level.
Ecosystems/Habitat Mapping	1. Conduct landcover mapping for the state, particularly the Coastal Plain. This baseline data along with future mapping can be used to track changes in the landscape over time, including land use, climate change, and restoration activities. 2. Incorporate new remote sensing technologies where appropriate to monitor habitats at the local scale. 3. Use field surveys and monitoring to inform habitat mapping and vice versa. Data collected during field surveys can serve as valuable reference points for landcover mapping efforts. Also, habitat maps can be used to inform monitoring by directing surveys and detecting landscape level changes undetectable by fine-scale monitoring programs.
Climate Change Adaptation	1. Similar to the Ecosystems/Habitat Mapping team, the highest priority is to map natural communities throughout the state. Mapping products can be used as a baseline to monitor vegetation response to climate change and to strengthen climate change adaptation models of resiliency, sea level rise, and impacts on species. 2. Establish data loggers in rivers and streams. These loggers can be used to create more accurate models for fish and other aquatic species susceptible to climate change. Engage the Georgia River Network to help establish data loggers throughout the state. 3. Conduct basic plant phenology monitoring to evaluate long-term change related to climate change. Integrate monitoring efforts with those of national phenology monitoring networks. 4. Monitor depressional wetlands, maritime communities, and other habitats sensitive to climate change. Continue monitoring salt marsh transects to determine the effects of sea-level rise on coastal habitats.

Discussion

The Georgia DNR and its partner organizations conduct a wide range of monitoring activities on a regular basis. These actions, including ecological research, species and habitat status and trends monitoring, and management effectiveness monitoring, are critical to our mission to conserve priority wildlife and their habitats. However, during the process of evaluating current monitoring strategies, it became clear that better organization and a more strategic approach would improve the overall value and effectiveness of monitoring in the state. Here we discuss some approaches to improve monitoring of species and habitats in Georgia, and outline the highest ranked priority actions for monitoring improvement based on the work of the Georgia SWAP Revision monitoring technical team. We give emphasis to mechanisms that are feasible on the time frame of 5 to 10 years.

In many ways, each of the monitoring conservation actions listed in Table 1 cannot exist as a single action. All are intertwined, and development of one will facilitate development of another. For example, tying monitoring to adaptive management relies on improving communication about monitoring, as those who are conducting monitoring must successfully coordinate with those who set management objectives, and with those who can change management actions. New technologies subsequently are essential to improving coordination and standardizing protocols, especially for species and habitats whose status is determined across a region that is larger than one agency's purview. This is one reason the monitoring actions were difficult to rank. It is also a strong argument for centralizing the efforts to improve monitoring in one agency with state-wide perspective and networking capacity such as GA DNR, because the actions must occur across many specializations and roles in the conservation arena. Without centralization of efforts, the coordination required to carry out these actions would not likely occur.

Develop a monitoring coordinator position

Therefore, to improve efficiency and efficacy of monitoring in Georgia, our highest priority action is to hire a state-wide monitoring coordinator. Because of the complexity of the biological monitoring network in Georgia and because so many of the priority monitoring actions depend on good communication, having a person dedicated to coordinating monitoring improvement actions is critical to their successful implementation. Biologists who are responsible for conducting monitoring in their specialized fields would not have it in their current job priorities to coordinate among the diverse array of monitoring professionals in Georgia.

Key responsibilities of a monitoring coordinator would include review and compilation of monitoring plans and protocols within Georgia DNR; inventory of monitoring programs outside of GA DNR; facilitate communication between resource management, administrative, and monitoring staff to develop adaptive management protocols that are consistent with GA DNR priorities and policy; development of mechanisms for sharing monitoring programs and data in Georgia; consult on and set standards for protocol development, protocol documentation, data management, and reporting within GA DNR; outreach to academic institutions to develop opportunities for collaborative adaptive management projects; and provide venues for sharing of results, technologies, and ideas across GA DNR, such as in a periodic symposium advertised internally and externally.

Tie monitoring to adaptive management

Tying monitoring to management actions was the highest ranked monitoring action from the monitoring technical team. In contrast, status and trends monitoring without specified management actions is the most commonly listed type of project for GA DNR (Table 2). However, these projects are often tied to management in an informal manner. For example, populations of a shorebird species are monitored annually and have shown a steady decline in the past ten years since monitoring was initiated. A decision is made to burn habitats associated with the species to decrease shrub encroachment and expand the preferred open, grassy habitat. After the prescribed fire, bird populations are monitored to examine response to management.

In a rigorous adaptive management framework, also called "active adaptive management," monitoring is designed not only to determine trends but also to learn about the species or habitat of concern (e.g. Larson 2013, Westgate et al. 2013). Hypotheses are tested about how the monitored system functions, or about which management approaches are optimal (Westgate et al. 2013). It is considered an important strategy because management actions, which are usually time-critical, can be conducted at the same time as research to understand key biological concepts for conservation (Nichols and Williams 2006, Westgate et al. 2013).

There are a number of challenges to implementing adaptive management (see especially Westgate et al. 2013). A primary challenge for GA DNR is the lack of simple institutional control over management options—especially at the landscape or watershed level. At this level, GA DNR staff frequently cannot execute management actions for rare species and habitats even when monitoring indicates management is critically needed for conservation of the resource (B. Albanese, P. Lanford, and T. Morris, pers. com.). Other challenges include difficulties in managing and measuring effects on extremely rare and/or hard to detect species (T. Morris pers. com.), lack of expertise and resources for experimental design and statistical analysis (T. Keyes pers. com. and Kruse and Thompson pers. obs.), and lack of space and resources for replicating management treatments (Kruse and Thompson pers. obs.).

Because they require additional staff resources and expertise, careful prioritization of adaptive management projects is necessary. Active adaptive management is highest priority when there is scientific uncertainty, high risk, and conflict about management actions (Larson 2013), and these projects must be carefully designed to measure only the most pertinent environmental variables to answer the specific high priority questions the monitoring is being implemented to answer (Larson 2013). For GA DNR, opening avenues of collaborations with academic researchers for adaptive management projects could provide an important tool for learning about our high priority biological systems at the same time as we are managing them.

A less rigorous framework, an "adaptive approach" (*sensu* Westgate et al. 2013), is more congruous with rare species and habitat monitoring in Georgia. In an adaptive approach, monitoring is tied to management by incorporating management objectives into specific population indicators that will be measured (Elzinga et al. 1998, The Nature Conservancy 2009). For example, if reduction of shorebird nest failures by 30% is a management objective, measuring nest failures should be the highest priority of a monitoring protocol, rather than measuring any other feature of that shorebird population. The sampling protocol subsequently must be designed so that it is possible to detect the desired amount of change in nest failure rate with a statistical test. The data will then be capable of demonstrating whether the management objective has been met, and therefore whether management actions need to be modified. In this way, specific monitoring results feedback directly into decisions about the status of priority species and habitats, and the management actions that will be taken for their conservation.

An adaptive approach takes place qualitatively in management actions all the time, as managers make skilled observations and implement actions based on their observations. The advantage of tying monitoring of specific variables to specific management objectives is that a focus on the most critical indicators of rare species and habitat status is ensured (Kirkman, pers. com). This approach gives a way to communicate rare element status and the effects of management to a broader audience. Focusing on key management-oriented variables is more efficient than an approach where multiple variables are measured for their general interest, with no clear *a priori* idea of how the data are to be used. Thus monitoring is designed for decision making, producing data that are used for assessing the effectiveness of management actions, ultimately reducing management and conservation uncertainty (Sutter 2014).

Although all monitoring projects conducted by GA DNR will not directly feedback to an immediate management decision, underpinning the monitoring program with an adaptive management philosophy will promote a holistic approach to monitoring projects that utilizes sound science. A monitoring program that emphasizes adaptive management will continually be vigilant for opportunities to improve conservation actions for rare species and habitats. Such a program will prioritize effective monitoring design, constant assessment of monitoring results, and insist that biologists and managers communicate implications for conservation, whether action can be taken now or ideas are being advocated for the future (R. Sutter, pers. com).

Therefore we advocate that a monitoring coordinator work in an adaptive management framework, and develop departmental guidelines as to when, and at what level, adaptive management monitoring should be conducted by GA DNR or through contracts with academic research institutions.

Improve sharing and standardization of protocols and data forms
This action was ranked third highest priority by the monitoring technical team, but was the singular most important action for improving monitoring when discussing monitoring with leaders of the taxonomic technical teams. For some priority species groups, such as bats, monitoring technologies are not developed to the extent that statistically strong data can be collected and there is a lack in available experts to conduct the monitoring (T. Morris, pers. com.). For these types of species, the most important actions to improve monitoring are development of strong regionally standardized protocols and strong data management and sharing. Organized records that are kept systematically, with strong metadata that clearly describe the work flow, protocols, and functioning of the database, can be employed across organizations for generations. This is critical for understanding long-term trends and for eventual development of adaptive management protocols when technology improves.

Other priority species and habitats have relatively well-developed technologies and protocols for monitoring, but have wide ranges such that monitoring is often performed by multiple organizations. Protocols tend to vary within and across state boundaries. Examples include certain high priority shorebirds, the gopher tortoise, and longleaf pine ecosystem restoration that occurs on private lands. Standardization and sharing is equally important for monitoring these entities so that efforts are not duplicated and that data can be compared across their geographic ranges.

One mechanism for sharing protocols suggested by the monitoring technical team is a searchable internet database that partners could use to post and access information related to their specific monitoring projects. As an example, the National Biological Information Infrustructure (NBII) was an online database that provided access to monitoring information as one of its components (Wikipedia 2014). Funding for NBII was discontinued in 2012, but information about its development and structure could be accessed as a model for a simpler project focusing only on sharing protocols.

Another mechanism is for biologists to reach out directly to partners who already collect rare species data to work together to modify and standardize protocols to meet joint objectives. This mechanism is already recognized as critical for improving monitoring. For example, working with GA Dept. of Transportation to standardize their mussel sampling protocol is a high priority conservation action for the updated Georgia SWAP. In particular, the monitoring team noted the need for standardizing monitoring of the vast longleaf pine ecosystem restoration projects occurring on private lands throughout the state.

Improve internal GA DNR communication related to monitoring
Internally, GA DNR exemplifies similar challenges to coordination of monitoring that exist state-wide. Among the divisions of the agency, there is lack of awareness of monitoring projects and associated challenges, even among biologists studying the same ecological systems. For example, the Private Lands Program, Game Management Section, and Nongame Conservation Section conduct longleaf pine restoration but there is little opportunity for communication regarding results of their restoration projects and how they are monitored. As GA DNR is a large agency, good communication can be difficult to achieve. In particular, those coordinating monitoring often work separately from site managers, or may have different philosophical approaches to management. In an adaptive management framework communication is especially critical to facilitate standardization of management objectives, prioritize management activities, and enable managers to adapt management actions based on monitoring results.

Improving coordination of monitoring within GA DNR will serve as a model for coordination of monitoring among partners state-wide. Therefore we rank this as the fourth highest priority monitoring improvement action. Two mechanisms for communication will be used in combination, by developing a department-wide online database of monitoring projects, and special-interest topics presented at department-wide meetings.

The objective of the online database is not only to share monitoring reports, but to provide a standardized system to store protocols, data, qualitative information regarding land management results, and metadata about projects. Metadata provide the documentation necessary for a project to be carried on regardless of staff and resource availability, and should be required for all monitoring projects. Important metadata include project rationale, objectives, techniques used, data format, sampling dates, and summary of findings throughout the project. Implementation would likely occur in a two-phase process, with the first phase to develop the system for posting project reports and qualitative management results, and the second to develop the system for storing and accessing protocols, data, and metadata.

The objective of GA DNR monitoring meetings is to share ideas on how to meet monitoring goals in an environment where peer-review of projects is cultivated. Peer-review provides an internal mechanism for improving monitoring and conservation projects. The meetings can be informal or structured, but should include all disciplines that use monitoring and staff of Wildlife Resources, Environmental Protection and State Parks Divisions. The meetings will provide a venue to discuss monitoring issues, share protocols and results, demonstrate new monitoring technologies, and to coordinate monitoring with management staff. Staff who monitor overlapping ecological systems should meet separately, either concurrently or at another time in the field. Due to the effort required to establish these meetings, we envision that a monitoring coordinator is essential to their success.

Incorporate technology and citizen-scientist networks to improve monitoring
With the ubiquity of smart phones, tablets, and other electronic handheld devices, there is increasing opportunity to collect valuable field data electronically for survey and monitoring projects. Many of these devices can use cellular phone service or GPS to give accurate location information. Also, the ability to take and store field notes electronically and take pictures with a camera on the same device greatly simplifies field data collection. It is critical to incorporate this technology into monitoring work in ways that will be useful and efficient. Furthermore, because so many citizen scientists and volunteers already own these types of devices, there are great possibilities to create networks of people collecting valuable data for conservation. An excellent example of such a network is the invasive species detection application EDDMaps. EDDMaps is an easy to use web-based mapping system for documenting distributions of invasive species. This application allows smart phone users to collect field data on an invasive species occurrence and track infestations through time. These remote data collection technologies should be considered for other monitoring programs, particularly where volunteers can be engaged.

Another improvement in technology is a greater ability to share information online. Online tools can now be used for easy data entry and for the rapid transfer of data to others. Improving online tools to allow for easier access to protocols, simple data entry, and sharing of data and reports with others should be a high priority for the DNR and other agencies. Social media and video-sharing websites can be used to make monitoring more transparent, by alerting people or groups about monitoring or for sharing protocols. They can also be used to improve training, coordinating, and data sharing for citizen scientist and volunteer networks involved in monitoring habitats and species.

Some other technologies have advanced in recent years and can now be considered when collecting field data. For example, a University of Georgia graduate project is currently using unmanned aerial vehicles, also known as drones, to assess vegetation recovery after prescribed fire in dune grasslands on Little Saint Simons Island. Only recently have these vehicles become more affordable and readily available for monitoring applications, although new regulations and potential privacy issues should be taken into account. GIS technologies and online mapping tools such as Google Earth are making community and landscape level changes easier to track. The availability of high resolution aerial imagery and detailed elevation data such as LiDAR allows for more detailed habitat mapping. It is necessary to continue promoting aerial imagery and LiDAR flights in Georgia to help improve mapping and monitoring efforts over the next 10 years.

In recent years, the DNR's photo-monitoring program has been greatly expanded to help monitor the effects of prescribed fire in fire-adapted habitats on State Parks and other state lands. Camera technology should be researched to determine if simple quantitative data can be derived from photos taken at these established photo-points. The photo points could also be used for additional quantitative data collection for assessing whether broad management goals have been met.

Conclusions

Improvement of monitoring statewide is a challenging topic, particularly for the breadth of disciplines that must be involved. Across Georgia's diversity of species and habitats, there are varied obstacles to successful monitoring. Aside from resource limitations for monitoring, these obstacles include species detection difficulties, populations that range far outside state boundaries, and the inability to enact adaptive management. Monitoring professionals have approached solutions in multiple ways, often without a collaborative process. Despite these difficulties, monitoring has become more important in natural resource management institutions for documentation of conservation actions and whether these are successful—for accountability, learning, and public education objectives.

The monitoring technical team provided an abundance of ideas for improving monitoring. All members of the monitoring technical team were adamant that, first and foremost, coordination of efforts is critical to improving monitoring in Georgia. Most of the monitoring actions that were ranked highest include steps toward meeting that broad goal, including hiring a monitoring coordinator, developing an online database to share protocols region-wide, holding regular GA DNR monitoring symposia, and creating an internal database for standardized metadata relating to all GA DNR monitoring projects.

For the monitoring technical team, working in an adaptive management framework was also high priority. There are clear reasons why strict adaptive management is not appropriate for all rare species and habitat conservation actions. However, we advocate that working in an adaptive management framework will encourage sound science and protocol design in monitoring and timely incorporation of monitoring results into conservation actions.

Finally, it is clear that new technologies are abundant and provide many exciting opportunities to facilitate all of the priority monitoring actions developed here, by increasing accessibility to protocols, data, and results that can be used by volunteers, scientists, managers, and administrators alike.

From the ideas documented in this chapter, and from the enthusiasm for sharing monitoring projects and ideas we witnessed during this project, it is clear that conservation professionals are passionate about the quality of rare species and habitat monitoring in the state. We are eager to work together to increase effectiveness of this important aspect of conservation biology.

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Table 3. Conservation partner organization monitoring priority table (to be developed)

Partner Organization	Monitoring nexus	Types of projects and available resources
U.S. Fish and Wildlife Service – Ecological Services (USFWS ES):	Track results of management and special programs on rare species and habitats; provide data for rare species conservation and regulation as required by federal legislation	1. Changes in populations and habitat after management implementation, esp. for aquatic habitat restoration, plant or mussel population augmentation; 2. Trends in rare or special concern plant and wildlife populations, and in their habitats, especially freshwater aquatics, birds, bats, and rare plants; 3. Success of stream restoration for mitigation; 4. Development of protocols and supervision of their implementation
U.S. Forest Service (USFS) – Chattahoochee and Oconee National Forest	In Georgia the USFS manages approximately 865,000 acres of federal lands for many purposes, and is required by law to protect and monitor rare species and habitats on these lands	1. Monitors or assists GA DNR in monitoring of rare plants, rare freshwater aquatic species, migratory and rare birds, and bats on National Forest lands; 2. Database of rare species occurrences on the National Forest
U.S. Forest Service (USFS) – Southern Research Station	Forest ecology research	Conducts research relevant to forest threats, disturbance regimes, and fire ecology; research questions are developed both in response to management and basic science needs
U.S. Forest Service (USFS) – Forest Inventory and Assessment (FIA)	Assesses condition of forests in the U.S. and projects future conditions for the next 5-10 years	Monitors status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership
Enduring Conservation Outcomes, LLC	Consulting on and development of monitoring and adaptive management protocols	Consults on establishing monitoring objectives, identifying indicators, developing study and sampling designs, analyzing, interpreting and communicating results, including qualitative data, and integrating monitoring results into adaptive management

GA Dept. of Transportation	Tracks rare species occurrences related to transportation projects. Minimizes impacts to rare species and habitats within proposed road construction corridors	Conducts surveys for rare species located with proposed road projects. Monitors potential transportation impacts to rare species located within transportation corridors or DOT lands. Works with GA DNR, USFWS, and other conservation organizations to minimize impacts to rare species in proposed or current transportation corridors.
U.S. Geologic Survey – Cooperative Research Unit, University of Georgia, Athens	Facilitates research between natural resource agencies and universities, provides technical assistance and consultation on natural resources issues	Current staff have expertise in: 1. Consultation on how to connect monitoring to decision making and reducing critical uncertainties 2. Connecting management questions to monitoring objectives, for example, as in evaluation of harvest policies; 2. Quantitative models of population responses to natural and anthropogenic influences; 3. Design of adaptive management frameworks for agencies
Dept. of Defense – Fort Benning, Gordon, and Stewart Army Bases	Protects and conserves rare species and their habitats on military bases in accordance with Dept.of Defense's military missions	Monitors rare species located on military bases. The primary focus of monitoring are federally listed and candidate species such as the Red-cockaded Woodpecker and Eastern Indigo Snake. However, state-listed or special concern species are also tracked. Restoration activities such as prescribed fire are emphasized to improve and maintain habitats for rare species.
Natl. Park Service – Southeastern Inventory and Monitoring Network	Facilitate collaboration and information sharing for monitoring and management among National Parks; establish a region-wide integrated program for natural resource monitoring	1. A long-term biological monitoring program, called "Vital Signs Monitoring" is in place to track key indicators of ecosystem integrity at National Parks. Biological components are land bird, vocal anuran, and vegetation community monitoring, with standardized protocols for each. 2. Grants are available for studies that apply to the parks and adjacent lands.
Georgia Dept. of Natural Resources – Coastal Resources Division	Manages and monitors coastal marshes, beaches, waters, and marine fisheries in Georgia	Monitoring of various marine fisheries, oyster reefs, salt marsh plant and animal communities, and marsh dieback. Some specific marine fisheries monitoring projects include trawl surveys of finfish and invertebrates in estuaries, eel surveys, and important recreational finfish monitoring. CRD also monitors oyster reef restoration and living shoreline projects. Regular "drop ring" sampling is used to monitoring plant and animal communities associated with tidal river levees.
Georgia Dept. of Natural Resources – State Parks Division	Helps restore and maintain natural communities on state parks, including conducting prescribed burns in fire-adapted habitats	With assistance from WRD Nongame Conservation Section, photo monitoring of fire-adapted habitats have been established on the majority of Georgia's state parks. Local parks staff conduct the monitoring annually or biennially.

Georgia Dept. of Natural Resources – Environmental Protection Division (GA EPD)	Monitoring of environmental quality to inform condition of natural resources and their regulation	An example project with close ties to Wildlife Resources is EPD's wetland monitoring program. The goal is to assess wetland quality and function throughout the state. As part of this work, various indicators of wetland condition are being investigated for development of a rapid wetland assessment method.
Sapelo Island National Estuarine Research Reserve	Research, stewardship, and sound management of coastal resources	1. High resolution mapping of marsh vegetation; 2. Detection and monitoring of invasive animal and plant species and their ecosystem effects; 3. Reproductive success of wading shorebirds; 4. Oyster reef ecology
Project Orianne	Conservation of the Indigo Snake and its habitat; conservation of high priority reptile species	1. Monitors Indigo Snake populations throughout S. GA; 2. Monitors Gopher Tortoise on select properties; 3. Monitors high priority snake species throughout GA; Surveys for spotted turtles throughout GA.
The Nature Conservancy – Georgia Field Offices	Biodiversity conservation and land stewardship	Monitor rare species and community responses to management on Nature Conservancy lands. Conducts inventories and monitoring on military bases and Army Compatible Use Buffer (ACUB) lands. Coastal priorities include monitoring critical maritime forests, living shorelines, wetlands, and oyster reefs.
The Nature Conservancy – Eastern Science Division	Develops spatially explicit data on natural habitats and communities at the regional level, beyond state boundaries, for conservation planning	1. Resilience of terrestrial communities to climate change; 2. River and stream habitat classification; 3. Protected lands database; 4. Floodplain assessments
Joseph J. Jones Ecological Research Center	Understand and demonstrate excellent natural resource management and conservation in the southeastern U.S. coastal plain	Ecology of longleaf pine woodlands and their wildlife, including wetlands and aquatic resources; research on the problem of natural resource management and environmental quality

U.S. Fish and Wildlife Service – Refuges Inventory and Monitoring Network	Monitor the status and trends of fish, wildlife, and plants in each refuge; integrate the monitoring system with the broader scientific community; provide data to inform adaptive management and conservation planning	1. Developing standard protocols across all refuges (e.g. amphibian community monitoring); 2. Developing an integrated data management system for storage of protocols, reports, management plans, and historical data; 3. Baseline data to evaluate impacts due to climate change and other long term environmental stressors in coastal and marine habitats; 4. Monitoring of federally listed species in the refuge system; 5. Fire risk, fire ecology, and prescribed fire monitoring; 6. Invasive species monitoring; 7. Bird surveys

Appendix K. Education Technical Team Report

Technical Team Members

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Paul Medders, DNR Coastal Resources Division
Joseph Mendelson, Zoo Atlanta
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Robert Phillips, Georgia Wildlife Federation
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Lisa Weinstein, Turner Foundation
Karan Wood, Captain Planet Foundation

Purpose of this Report

In 2005, the Wildlife Resources Division of Georgia Department of Natural Resources (DNR) with various partner agencies and organizations completed a comprehensive statewide plan for conserving Georgia's wildlife. The best available data on the distribution and abundance of wildlife in the state was used to create this conservation strategy, now referred to as the State Wildlife Action Plan (SWAP). It examined the extent and condition of habitats required by these species and threats to these habitats, as well as addressed research and survey needs, habitat restoration needs and monitoring needs. The original SWAP also included an assessment of current regulations, policies, and programs for wildlife conservation in Georgia. Several technical teams were formed to address specific elements of this plan, including a group to strategize how environmental education could be used as an effective tool for conservation.

The GA DNR made a commitment to review and revise the SWAP every ten years. Therefore, the technical teams reconvened to produce an updated wildlife conservation plan for Georgia. In Fall 2013, thirty environmental educators from various agencies and organizations were invited to serve on the SWAP Education Revision Team. Twenty-five of them agreed to help with updating the statewide strategy for wildlife conservation education, offering their time and expertise in-kind. At their first meeting in January 2014, since many of the team members were new to this effort, DNR staff familiarized the group with the SWAP and the original education report. The team then determined which of the 2005 recommendations were still relevant and in need of implementation, which could be revised and consolidated, and which would best be addressed by the SWAP Communications Team. The Education Team also added a few conservation actions to complete their revised list of recommendations below:

1. Assess the current level of wildlife conservation literacy among Georgia citizens;
2. Create educational core concepts with key messages that support the main SWAP themes;
3. Identify and develop targeted educational materials to facilitate the delivery of SWAP conservation messages
4. to the public;
5. Improve communication of SWAP messages to regional education networks and community groups; and
6. Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in
7. Georgia.

Based on areas of expertise, the SWAP Education Team divided into five subcommittees (one per conservation action) to further develop these recommendations. They were charged with writing a more detailed description with justifications as well as determining funding sources, lead organizations, partners, and other variables required for successful implementation. The group reconvened in March 2014 to review each subcommittee's work. For the entire group to access and further develop the five conservation actions, sharable files were created via Google Docs. In May 2014, the Education Team's revision was complete and ready for review by the SWAP Advisory Board.

Environmental Education in Georgia

The health and well-being of Georgia's plants, wildlife, and people depends on the quality and integrity of the environment. Loss, degradation, and fragmentation of habitat are the greatest problems facing fish and wildlife. To effectively protect Georgia's natural heritage, the public must be aware of and engaged in conservation.

More than 400 organizations including private non-profit and for-profit entities, universities and governmental agencies provide environmental education programs for the citizens of Georgia. A statewide network of about 400 environmental educators, the Environmental Education Alliance (EEA) of Georgia, supports these organizations through their annual conference, an outdoor learning symposium, an accredited environmental education certification program, and networking opportunities. EEinGeorgia.org, the online guide to environmental education in Georgia, makes information about environmental education resources readily available. This comprehensive website is a collaborative effort of the Environmental Protection Division (EPD) of the Department of Natural Resources (DNR), the Department of Community Affairs, the Department of Education (DOE) and EEA. It includes EE lesson plans for all grades and subjects based on the state education standards, a searchable directory of EE organizations and their resources, facts about Georgia's environment, and a calendar of EE events.

SWAP Environmental Education Team Recommendations

1. Assess the current level of wildlife conservation literacy among Georgia citizens.

A statewide survey to measure environmental literacy of Georgia residents has never been conducted. We recommend that a survey be developed and conducted to establish a baseline of wildlife conservation knowledge and to measure the effectiveness of environmental education initiatives in Georgia. While many examples of environmental literacy surveys exist, a subcommittee of the Environmental Education Technical Team reviewed the following surveys and recommends them as suitable models for Georgia:

- National Environmental Education and Training Foundations report – Understanding Environmental Literacy in America: And Making it a Reality (http://www.neetf.org/roper/ELR.pdf)
- The First Pennsylvania Environmental Readiness for the 21st Century Survey Report by the Pennsylvania Center for Environmental Education (http://www.pcee.org/Research/research_1main.asp)
- Report Card on Minnesotan's Environmental Literacy (2003-04) by the Wilder Research Center (http://www.seek.state.mn.us/eemn_b.cfm)

The major steps required to implement a statewide survey include:

- Determine the key conservation and environmental issues affecting Georgia's wildlife resources today.
- Partner with a local university or independent research firm to develop survey questions that will assess the knowledge, attitudes, and behaviors of Georgians regarding these key issues.
- Determine how to best collect data from various ages and audience types.
- Conduct a statistically valid phone survey of Georgia citizens, legislators and community leaders to determine their knowledge of key conservation issues.
- Work with the SWAP Communications team to post these questions on the GA DNR website and/or via software like Survey Monkey, and encourage citizens to take this quiz (with the understanding that the web instrument lacks statistical independence between survey respondents, so this survey would only be an index of understanding of these issues).
- Create some an incentive for participating in the survey (ie., random drawing for a gift certificate).

Funding required for this project may be minimal. Graduate students may be utilized for analysis and reporting, and DNR Wildlife Resources already has a Survey Monkey account. Partners to help promote survey participation include various environmental education groups, Georgia Public Broadcasting, Parent-Teacher Associations (PTAs), colleges, nature oriented groups. Ideally, we would like to receive at least 250,000 responses to effectively analyze and summarize the results of this wildlife literacy survey.

2. Create educational core concepts with messages that support the main SWAP themes.

Under the leadership of the Georgia DNR Wildlife Resources Division, a team of partners including content experts, educators, and public affairs experts will create a SWAP logo with 'slogan' as well as a set of educational core concepts with key messages. The content experts will provide expertise in science and natural resources, and the educators and public affairs experts will provide guidance related to the readability and effectiveness of message construction. The focus will be on conserving all of Georgia's natural resources including plants, wildlife and their habitats, while calling every Georgia citizen to responsible action.

The core concepts will be fairly broad and simple, while the key messages supporting each core concept will address the SWAP themes more specifically. The implementation committee should strive to convey that every species matters, that everyone's actions impact our natural resources, and that we can all have a share in protecting the quality of our environment and maintaining biodiversity. The results of the environmental literacy survey (if completed) will provide a valuable resource for developing core concepts and message content.

We recommend limiting the list to five core concepts with associated key messages that tie back to the main SWAP themes, as most people are capable of processing only five to nine different pieces of information at a time (George Miller, 1956 "Magical number seven plus or minus two," http://www.musanim.com/miller1956/). Key messages can be adapted to fit the conservation concerns in specific ecoregions and for particular audiences. We not only need to focus on what we want people to know, but also what we want them to do and how they can help with specific calls to action.

The Conservation Education Core Concepts developed by the Association of Fish & Wildlife Agencies (AFWA) provides a national example of core concepts with supporting messages, which may serve as a good reference for this Georgia SWAP Education initiative: http://jjcdev.com/~fishwild/?section=conservation_education_core_concepts

Another helpful reference is a toolkit for creating engaging messages, developed by the Audubon Society in partnership with the U.S. Fish and Wildlife Service and the Environmental Education and Training Partnership: http://web4.audubon.org/educate/toolkit/pdf/section-c.pdf

Funding for this work could be minimal with in-kind donations of staff time. Indicators of success include agreement on the core concepts and supporting messages by partner agencies and organization, as well as their cooperation by incorporating these themes into their communications, materials, and conservation work. A future wildlife literacy survey, when compared to a baseline survey, could reveal if these message have impacted the behavior of Georgia citizens.

3. Identify and develop targeted educational materials to facilitate the delivery of SWAP conservation messages to the public.

To help Georgia's environmental educators promote the SWAP's core concepts and key messages, easy-to-use resources should be identified and produced. The goal is to make available exemplary and innovative resources, tools, materials, and models consistent with the goals, priorities, and technical expertise in the SWAP. Materials should be tailored to the general public as well as formal and informal educators, property owners, land managers, recreationists, businesses, faith communities, and students who will grow up to be the next generation of caretakers of Georgia's natural environments. SWAP materials and models should:

Promote opportunities to engage Georgians outdoors where they can connect with nature, learn about the environment, and/or engage in environmental stewardship and conservation actions.
Include effective curricula in science and other STEM fields, technical references, hands-on materials, website information, and opportunities for environmental stewardship through citizen science and service learning projects.
Be disseminated via DNR websites, EEinGeorgia website, and other partner websites.
Be accessible through an organized, online database that links education programs and resources with SWAP priorities. So that users can easily identify conservation materials that pertain to them, such a database should offer search and filter functions that allow users to sort information by:

- geographic area/ecoregion within the state
- particular habitats or plant/animal communities
- conservation threats
- key conservation actions identified in the SWAP
- audience
- gaps in resources, where new materials and models need to be created.

EEinGeorgia.org is the most comprehensive source of environmental educational materials for K-12 students and teachers. The effectiveness of this tremendous resource could be enhanced by adding search filters specific to SWAP and stewardship. In addition, an EEinGeorgia link or button should be prominently displayed on GA DNR Division websites (such as www.georgiawildife.com), GA DOE websites, and other websites used by Georgia educators. GA DNR and partners' web pages should be updated with resources and opportunities for stewardship, citizen science and environmental education. SWAP brochures, in the style of EEinGeorgia's one-page summary of Farm to School resources (http://growing-minds.org/lesson-plans), are needed for various target audiences.

Funding possibilities should be investigated, including through The Environmental Resource Network (TERN), to enhance the search and filtering functions of the EEinGeorgia website so that it's easier to find SWAP-consistent educational resources related to priority species and/or habitats for any part of the state. Other funding sources or grants may need to be pursued to enhance the DNR/SWAP website so that it can offer more educational content for landowners and other stakeholders, market educational messages, and analyze website usage.

Many of Georgia's natural resources are managed by public agencies, but since most wildlife lives on private land, landowners play an important role in sustaining habitat and protecting biodiversity. Sustainable natural resources depend on the support of an informed and responsible citizenry. The public must be aware and supportive of conservation actions necessary to protect Georgia's natural heritage.

4. Improve communication of SWAP messages to regional education networks and community groups.

SWAP educational messages and materials will best be disseminated through existing ecoregional networks. Working with EEA, EEinGeorgia, Georgia Science Teachers Association (GSTA), DNR Nongame Conservation, DNR Hunter Education, Natural Resources Conservation Service (NRCS) and other agencies/organizations, leaders/moderators within each ecoregion first need to be identified. Virtually or via in-person workshops, representatives could network with each other, learn about the unique features and issues of their ecoregion, discover easy-to-use materials for teaching about high priority conservation issues, and incorporate the SWAP messages into their programming.

To infuse SWAP themes and messages into current practices, educators could work with various SWAP technical team members (namely Communications) to identify good stories that can be used to hook learners on issues in that ecoregion. In addition to the general public, target audiences will include school children, teachers (including pre-service), and community groups that affect land use (private property owners, business leaders, government officials, etc.). To encourage buy-in by these groups, community gatherings could integrate SWAP strategies with local issues, thereby creating a common educational strategy.

We also suggest developing a GovDelivery bulletin to better disseminate SWAP messages. For two-way communication, a Facebook page should be developed. Also consider creating a SWAP clearinghouse website, separate from or part of the GA DNR Wildlife Resources Division website (www.georgiawildlife.com).

The effectiveness SWAP communications may be evidenced by the following performance indicators:

- # of downloads of educational materials and other website analytics
- # of additional open online environmental education resources and technical information available through eeingeorgia.org or Georgia DNR web pages
- # of requests for information resulting from personal interaction at festivals, meetings, training
- Tracking the distribution of printed materials
- Results of click rates and other web analytics, as well as short, instant surveys at targeted websites and outdoor places where people visit, to measure awareness of SWAP-related educational materials such as GA DNR's e-newsletter, Dragonfly Gazette (Project WET), Junior Rangers (DNR State Parks), and EEinGeorgia.org
- Development of new materials to fill gaps, as needed

5. Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in Georgia.

Many citizens enjoy our state's rich cultural and natural heritage, and they cherish outdoor memories from childhood. Therefore, Georgia's parents tend to be passionate about their children's education and the environment in which they are raised. They also are concerned about their health and the future of the economy. These concerns are justified, because our quality of life is threatened. Our energy practices are not sustainable, our schools are struggling to meet national standards, and many of the fields and forests we once explored have disappeared. Today's youth spend their time in front of electronic screens. All of these issues are inextricably linked to environmental literacy. To reverse this trend, citizens must understand the conservation issues we face in order to make informed decisions about our state's environmental health. We must increase our state's environmental literacy in order to sustain and improve our way of life.

According to the North American Association for Environmental Education (NAAEE), creating an environmental literacy plan (ELP) provides the framework for school systems to expand and improve their environmental education programs. A state environmental literacy plan ensures that environmental education is integrated into formal education systems, that a consistency and accuracy in environmental content knowledge is established, and that underserved communities are engaged.

The SWAP Advisory board should support the Georgia Department of Education in creating an ELP. In partnership, the Department of Natural Resources' Wildlife Resources Division can advise the Georgia Department of Education on how to best address wildlife conservation concepts in the ELP. Currently, no federal funds are available in regards to the No Child Left Inside Act. Private and local sources must be sought. However, in the meantime, the SWAP Advisory Board could become involved in the development of the Next Generation Science Standards as a near-term goal. http://www.nextgenscience.org/Georgia

The actual development of the ELP could be accomplished with no additional funds other than gifts in-kind, by allowing employees to serve on a writing committee. Success would include a resolution signed by the Governor, a functioning Georgia Partnership for Children in Nature (GPCN), a completed ELP, and annual assessment of progress towards becoming an environmentally literate adult. To measure effectiveness, we need a method of measuring baseline knowledge and health data, increased time spent in nature by children, and how exposure to the outdoors affects test scores and health (perhaps via a survey to assess literacy upon graduation).

Conclusion

The State Wildlife Action Plan presents us with an opportunity to: 1) educate the citizens of Georgia about natural communities and the conservation priorities within their ecoregions; and 2) measure the effectiveness of the campaign. These goals can be accomplished by establishing a baseline of knowledge through a wildlife literacy survey, incorporating those findings into SWAP core concepts and messages, identifying and creating teaching resources that target specific audiences, and taking advantage of Georgia's strong and diverse network of environmental educators and other conservation organizations to effectively communicate how we can all play a role in protecting biodiversity. Future surveys and studies can aim to measure the long-term effectiveness of these efforts.

Georgia Wildlife Education Providers

This list was compiled with contributions from the Environmental Education of Georgia website (www.eeingeorgia.org) and other sources. Audiences served are arranged by Level III Ecoregions in Georgia (www.hort.purdue.edu/newcrop/cropmap/georgia/maps/GAeco3.html), as well as organizations that offer wildlife education statewide.

Blue Ridge (Ecoregion 66)
Amicalola Falls State Lodge Park, Dawsonville, Dawson County
Anna Ruby Falls/U.S. Forest Service, Helen, White County
Birding Adventures Inc., Atlanta, DeKalb County
Blue Ridge Outdoor Education Center, Toccoa, Stephens County
Camp Toccoa/Camp Fire USA Georgia Council, Toccoa, Stephens County
Dalton-Whitfield Solid Waste Authority, Whitfield County
Fort Mountain State Park, Chatsworth, Murray County
Medicine Bow, Ltd., Dahlonega, Lumpkin County
Northeast Georgia Youth Science & Technology Center (GYSTC), Clarkesville, Habersham County
Rolling Thunder Enterprises, Jasper, Pickens County
Smithgall Woods-Dukes Creek Conservation Area/DNR, Helen, White County
Soque River Watershed Association, Clarkesville, Habersham County
Tallulah Gorge State Park, Tallulah Falls, Rabun County
Tellus Science Museum, Cartersville, Bartow County
Unicoi State Lodge Park, Helen, White County
Upper Etowah River Alliance, Canton, Cherokee County
Wahsega 4-H Center, Dahlonega, Lumpkin County
Wildlife Rehab Sanctuary & Outdoor Educational Program, Ellijay, Gilmer County
Wildlife Wonders - ZOO TO YOU, Cleveland, White County

Southwestern Appalachians/Ridge & Valley (Ecoregions 67 and 68)
Arrowhead Environmental Education Center (GA DNR Wildlife Resources), Armuchee, Floyd County
Birding Adventures Inc., Atlanta, DeKalb County
Cloudland Canyon State Park, Rising Fawn, Dade County
Dalton-Whitfield Solid Waste Authority, Whitfield County
Georgia Girl Guides, Rising Fawn, Dade County
Georgia WildTalk, Armuchee, Floyd County
Red Top Mountain State Park, Acworth, Bartow County

Piedmont (Ecoregion 45)
Altizer Lab, Athens, Clarke County

Anna Ruby Falls/U.S. Forest Service, Helen, White County
Arabia Mountain Nature Preserve, Lithonia, DeKalb County
Athens-Clarke County Recycling Division, Athens, Clarke County
Atlanta Audubon Society, Atlanta, Fulton/Dekalb County
Atlanta Reptile Connection, Atlanta, Fulton County
Autrey Mill Nature Preserve, John’s Creek, Fulton County
Bear Hollow Wildlife Trail, Athens, Clarke County
Birding Adventures, Inc., Atlanta, DeKalb County
Blue Ridge Outdoor Education Center, Toccoa, Stephens County
Callaway Gardens Education Department, Pine Mountain, Harris County
Camp Toccoa/Camp Fire USA Georgia Council, Toccoa, Stephens County
Cane Creek Farm, Cumming, Forsyth County
Charlie Elliott Wildlife Center (GA DNR Wildlife Resources), Mansfield, Jasper County
Chattahoochee Nature Center, Roswell, Fulton County
Chattahoochee-Oconee National Forests, Gainesville, Hall County
Chattahoochee River Environmental Education Center (National Park Service), Alpharetta, Fulton County
City of Alpharetta Department of Engineering/Public Works, Alpharetta, Fulton County
City of Roswell Environmental Protection Unit, Roswell, Fulton County
Cobb County Adopt-A-Stream, Cobb County
Cochran Mill Nature Center, Palmetto, Fulton County
Dauset Trails Nature Center, Jackson, Butts County
Dunwoody Nature Center, Inc., Dunwoody, DeKalb County
EcoAddendum, Decatur, DeKalb County
EcoReach (UGA Odum School of Ecology), Athens, Clarke County
Elachee Nature Science Center, Gainesville, Hall County
F. D. Roosevelt State Park, Pine Mountain, Harris County
Fernbank Museum of Natural History, Atlanta, DeKalb County
Fernbank Science Center, Atlanta, DeKalb County
Forty Oaks Nature Preserve, Clarkston, DeKalb County
Georgia Aquarium, Atlanta, Fulton County
Georgia Museum of Natural History, Athens, Clarke County
Georgia Wildlife Federation - Alcovy Conservation Center, Covington, Newton County
Georgia Wildlife Federation - Mill Creek Nature Center, Buford, Gwinnett County
Gordon Georgia Youth Science & Technology Center (GYSTC at Gordon College), Barnesville, Lamar County
Greening Youth Foundation, Atlanta, Fulton County
Gwinnett Adopt-A-Stream, Buford, Gwinnett County
Gwinnett Environmental & Heritage Center, Buford, Gwinnett County
Hard Labor Creek State Park, Rutledge, Morgan County
Hightower Educational Forest, Dawsonville, Dawson County
Homestead Atlanta, Atlanta, Fulton County
John Tanner State Park, Carrollton, Carroll County
Keep Forsyth County Beautiful, Cumming, Forsyth County
Lazy B Farm, Statham, Barrow County
Mistletoe State Park, Appling, Columbia County

National Wildlife Federation--Southeastern Natural Resource Center, Atlanta, Fulton County
Nature Corners, Peachtree City, Fayette County
Newman Wetlands Center, Hampton, Clayton County
Oconee River Georgia Youth Science and Technology Center (GYSTC), Winterville, Clarke County
Outdoor Activity Center (West Atlanta Watershed Alliance), Atlanta, Fulton County
Oxford Institute for Environmental Education, Oxford, Newton County
Panola Mountain State Conservation Park, Stockbridge, Henry County
Piedmont National Wildlife Refuge, Round Oak, Jones County
Reynolds Nature Preserve, Morrow, Clayton County
Rock Eagle 4-H Center, Eatonton, Putnam County
Sandy Creek Nature Center, Athens, Clarke County
Science Excitement Inc., Marietta, Cobb County
Serenbe Farms, Chattahoochee Hills, Fulton County
Southeast Institute for Place-Based Education, Palmetto, Fulton County
Spring Valley EcoFarms, Athens, Clarke County
State Botanical Garden of Georgia, Athens, Clarke County
Stone Mountain Park, Stone Mountain, DeKalb County
Sweetwater Creek State Conservation Park, Lithia Springs, Douglas County
Trees Atlanta, Atlanta, Fulton County
Victoria Bryant State Park, Royston, Franklin County
Warm Springs National Fish Hatchery (US Fish & Wildlife Service), Warm Springs, Meriwether County
Warnell School of Forestry and Natural Resources, Athens, Clarke County
Watson-Brown Foundation, Thomson, McDuffie County
Wild Intelligence, Athens, Clarke County
Wylde Center, Decatur, DeKalb County
Zoo Atlanta, Atlanta, Fulton County

Southeastern Plains (Ecoregion 65)
Albany Audubon Society, Albany, Dougherty County
Bartram Forest, Milledgeville, Baldwin County
Birdsong Nature Center, Thomasville, Thomas County
Bond Swamp National Wildlife Refuge, Round Oak, Jones County
Coastal Rivers Water Planning and Policy Center, Statesboro, Bulloch County
Flint RiverQuarium, Albany, Dougherty County
Florence Marina State Park, Omaha, Stewart County
General Coffee State Park, Nicholls, Coffee County
George T. Bagby State Park, Fort Gaines, Clay County
Georgia College & State University Outdoor Education Programs, Milledgeville, Baldwin County
Go Fish Education Center (GA DNR Wildlife Resources), Perry, Houston County
Grand Bay Wetland Education Center (GA DNR Wildlife Resources), Valdosta, Lowndes County
Keep Tift Beautiful, Tifton, Tift County
Leaders in Environmental Action for the Future (LEAF - The Nature Conservancy), Atlanta,

Fulton County
Little Ocmulgee State Park, McRae, Wheeler County
Magnolia Springs State Park, Millen, Jenkins County
McDuffie Environmental Education Center (GA DNR Wildlife Resources), Thomson, McDuffie County
Middle Georgia Youth Science & Technology Center (GYSTC), Warner Robbins, Houston County
Museum of Arts and Sciences, Macon, Bibb County
Oxbow Meadows Environmental Learning Center, Columbus, Muscogee County
Parks at Chehaw, Albany, Dougherty County
Phinizy Swamp Nature Park (Southeastern Natural Sciences Academy), Augusta, Richmond County
Providence Canyon State Park, Lumpkin, Stewart County
Reed Bingham State Park, Adel, Colquitt County
Spirit Creek Educational Forest (Georgia Forestry Commission), Hephzibah, Richmond County

Southern Coastal Plain (Ecoregion 75)
Bull River Cruises, Savannah, Chatham County
Burton 4-H Center on Tybee Island, Tybee Island, Chatham County
Coastal Ark (GA DNR Coastal Resources), Brunswick, Glynn County
Coastal Georgia Audubon Society, Brunswick, Glynn County
Coastal Audubon Society, Brunswick, Glynn County
Coastal Resources Division (GA DNR), Brunswick, Glynn County
Coastal Rivers Water Planning and Policy Center, Statesboro, Bulloch County
Crooked River State Park, St. Mary’s, Camden County
Driftwood Education Center, St. Simons, Glynn County
Georgia Sea Turtle Center, Jekyll Island, Glynn County
Jekyll Island 4-H Center, Jekyll Island, Glynn County
Leaders in Environmental Action for the Future (LEAF - The Nature Conservancy), Atlanta, Fulton County
Mary Kahrs Warnell Forest Education Center, Guyton, Effingham County
Oatland Island Education Center, Savannah, Chatham County
Ogeechee Audubon Society, Savannah, Chatham County
Okefenokee Education and Research Center, Folkston, Charlton County
Okefenokee National Wildlife Refuge, Charlton County
Okefenokee Swamp Park, Waycross, Ware County
Sapelo Island National Estuarine Research Reserve, Darien, McIntosh County
Skidaway Island State Park, Savannah, Chatham County
St. Catherines Island Sea Turtle Conservation Program, St. Catherines Island, Liberty County
Stephen C. Foster State Park, Fargo, Charlton County
Taylor Schoettle, Author and Naturalist, Darien, McIntosh County
Tidelands Nature Center, Jekyll Island, Glynn County
Tybee Island Marine Science Center, Tybee Island, Chatham County
University of Georgia Marine Education Center and Aquarium, Savannah, Chatham County

Serve a Statewide Audience

A-Z Animals, Fayetteville, Fayette County
Discover Life, Athens, Clarke County
Environmental Education Alliance of Georgia
EEinGEORGIA.org (GA DNR Environmental Protection)
Garden Club of Georgia, Athens, Clarke County
Georgia 4-H Environmental Education Program
Georgia Adopt-A-Stream (GA DNR-EPD), Atlanta, Fulton County
Georgia Botanical Society, Marietta, Cobb County
Georgia Department of Natural Resources - Environmental Protection Division
Georgia Department of Natural Resources - State Parks and Historic Sites (65 sites)
Georgia Department of Natural Resources - Wildlife Resources Division
Georgia Native Plant Society, Atlanta, Fulton County
Georgia Organics, Atlanta, Fulton County
Georgia Parent Teacher Association (PTA), Atlanta, Fulton County
Georgia Power, Atlanta, Fulton County
Georgia Project Learning Tree (Georgia Forestry Foundation), Forsyth, Monroe County
Georgia Project WET (GA DNR Environmental Protection), Atlanta, Fulton County
Georgia Project WILD (GA DNR Wildlife Resources), Mansfield, Newton County
Georgia Reptile Society, Dry Branch, Twiggs County
Georgia River Network, Athens, Clarke County
Georgia Wildlife Federation - Alcovy Conservation Center HQ, Covington, Newton County
Georgia Youth Science & Technology Centers (GYSTC)
Monarchs Across Georgia (Environmental Education Alliance), Atlanta, Fulton County
Nature Conservancy (Georgia Chapter), Atlanta, Fulton County
Southeastern Reptile Rescue, Orchard Hill, Spalding County
US Department of Agriculture - Forest Service

Appendix L. Communications and Outreach Technical Team Report

Prepared by Rick Lavender, team leader

Technical Team Members

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Ron Morton, USDA Natural Resources Conservation Service
Pete Pattavina, U.S. Fish and Wildlife Service
Rob Pavey, Augusta Chronicle (retired)
Stacy Shelton, U.S. Fish and Wildlife Service
Sandra Spivey, U.S. Fish and Wildlife Service
Judy Toppins, USDA Forest Service
Marshall Williams, U.S. Department of Defense

Regrettably, during the revision Stacy Shelton of the Fish and Wildlife Service and Marshall Williams of the Defense Department moved on to other responsibilities and could not continue with the committee. Susan Gibson volunteered to serve in Williams' stead.

Approach

Georgia's Comprehensive Wildlife Conservation Strategy, finalized in 2005 and now referred to as the more digestible State Wildlife Action Plan, was built on reports from teams of experts who researched conservation of specific aspects of Georgia wildlife and natural habitats, such as birds and plants. As part of that initial effort, one team tackled environmental education, an already vast realm made larger by including communications. When revising the plan in 2013 and 2014, as required every 10 years, DNR decided to form a team centered solely on SWAP communications. This group would also work with the Environmental Education Technical Team on common ground and goals.

Made up of representatives from 12 state and federal agencies, private organizations and companies that participate in conservation around the state, the Communications Team met in December 2013, and then and through follow-up in 2014 explored ideas and issues about SWAP communications. Work included a survey of members' opinions concerning communication objectives, target audiences and outreach tools; a survey of other technical team leaders regarding their top communication objectives and audiences; a brief strengths-weaknesses-opportunities-threats analysis of SWAP communications; the beginnings of contact lists for priority audiences; and drafts of generic, high-level messaging.

The missions of members' organizations and agencies were also compared to identify areas where those missions intersect with SWAP values. The four core touchstones revealed mark where partners would be more motivated to promote the SWAP, a critical point in communicating by network. The four areas:

- Conserve and enhance native Georgia wildlife, plants and habitats on public and private lands.
- Promote land uses via farmers, forest owners and others that ensure healthy woods and waters.
- Identify natural habitats and wildlife species that need conservation attention in Georgia.
- Pursue effective wildlife conservation that allows for public recreation and military training.

Such legwork led to the discussion and recommendations that follow.

Conservation Communications

The original SWAP included at least five priority actions tied specifically to communications. The one with the longest reach called for developing a statewide campaign to increase public support for wildlife conservation. That general effort has included many facets of outreach, including SWAP-specific elements such as a 2010 DNR article series (www.georgiawildlife.com/SWAPArticle) and lineup of events celebrating the 10th anniversary of the State Wildlife and Tribal Grants Program (www.georgiawildlife.com/node/2321), and a 2009 photo contest led by the Georgia Conservancy and called the Great Georgia Photo SWAP (www.flickr.com/groups/greatgeorgiaphotoswap).

Other recommendations called for developing educational materials to promote conservation to the public (items have included brochures such as "Is It a Water Moccasin?" produced by DNR and the University of Georgia's Savannah River Ecology Laboratory), targeted messaging about natural resources conservation, and technical educational materials – examples of the latter include "The Breeding Bird Atlas of Georgia" (UGA Press , 2010) and "Amphibians and Reptiles of Georgia" (UGA Press, 2008).

Of course, the world of communications is far different than when the SWAP was completed a decade ago. Social media is now the go-to source for engagement (for comparison, in 2005 YouTube launched and Myspace ruled led social networking in the U.S.). More than two-thirds of Americans use online devices most frequently for news, second only to television (American Press Institute). In response, agencies, nonprofits and companies have plunged into social media, overhauled websites and revamped communications.

But, arguably, the goals for wildlife conservation communications remain the same: raise awareness, rally support, engage supporters, advance conservation. Communicating the revised SWAP will build on the foundation laid by the original, if with new tools and a renewed focus.

Recommendations

The messaging, products and other outreach efforts that result from the following three recommendations will be shaped by a) the SWAP revision themes determined by the Advisory Committee and b) outreach needs identified by other technical teams. Also, in all a robust communications network of SWAP partners will be vital.

1. Increase stakeholders' support for wildlife conservation; awareness of the SWAP, its importance, themes and successes; and, awareness of the partnership effort involved in SWAP.

As used here, "stakeholders" refers to five audiences that team members deemed most critical to reach with SWAP messaging. Those audiences: conservation and outdoor sporting organizations; state and federal lawmakers; private and corporate forestland owners; agencies that regulate or are otherwise significantly involved with wildlife and land uses that affect wildlife in Georgia; and, wildlife watchers.

The recommended action is written in stair-step fashion: Greater support for wildlife conservation leads the pack. But this action is obviously a tall order. As noted, messaging, including calls to action, will flow from the SWAP revision themes and technical team needs. The communication options used and items produced will be suited to the targeted group, be it providing a social media post with video to conservation/outdoors organizations, informing wildlife watchers through DNR's Georgia Wild e-newsletter (circulation, 43,000) and the partners network, or connecting with private landowners through a Georgia Forestry Today article and by supporting landowner days with brochures explaining forest management practices that benefit gopher tortoises and native groundcover.

Audience contact lists will be further developed. Online surveys will help measure before-and-after opinions on support and awareness. Analytics can be used to gauge traffic to related websites.

2. Increase awareness of the SWAP among partner organizations.

In-reach is important, considering that partners are the face of the SWAP. Raising awareness and understanding of the plan among our staffs will better prepare them to address the topic with constituents and fellow workers, and can widen the base of support for the SWAP.

Work with partners will identify best ways to reach their staffs on specific messaging. Online surveys of willing partner organizations can set benchmarks to monitor changes in knowledge of the SWAP. Partners' use of messaging can also be reported.

3. Work with the Education Team where needed to achieve its recommendations.

Specifically, this could involve creating an online survey supporting the assessment of Georgians' wildlife conservation literacy; helping shape the content of core educational concepts, related messaging and educational materials; and, helping identify SWAP stories per eco-region for use in regional education networks and community groups.

Conclusion

The analysis of SWAP communications strengths, weaknesses, opportunities and threats (SWOT for short) noted that a significant opportunity – a sustained, active network of communicators can benefit SWAP and other conservation priorities in Georgia – is faced by an equally significant threat: Workloads and changing priorities and staff can undermine any communications network focused on the plan.

Maintaining a strong communications network will be the key in following the course suggested in this report. While not expansive, that course is achievable and – because of the SWAP's focus – will help conserve Georgia wildlife and raise awareness of the plan and the conservation actions it emphasizes.

Appendix M. Database Enhancements Technical Team Report

Prepared by Greg Krakow and Anna Yellin, Team Leaders

Technical Team Members

Team Leaders
Greg Krakow, WRD
Anna Yellin, WRD

Team Members participating in Database Enhancement Meeting
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Joanne Baggs, U.S. Forest Service
Chuck Bargeron, UGA, Bugwood Network
Larry Carlile, DOD
Jamie Collazo, GDOT, Ecology Section
Sonny Emmert, GA DNR, Coastal Resources Division
Sara Gottlieb, The Nature Conservancy
Tom Govus, Independent Contractor
Alex Jaume, U.S. Forest Service
Greg Krakow, WRD, Wildlife Biologist
Thom Litts, WRD, Fisheries Management Section
KC Love, Edwards-Pitman, Consultant
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Carrie Straight, U. S. Fish and Wildlife Service
Jacob Thompson, WRD, Nongame Conservation Section
Deb Weiler, WRD, Nongame Conservation Section
David Whitehouse, International Paper
Anna Yellin, WRD, Nongame Conservation Section

Team Members available to participate through e-mail and correspondence
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Brad Dethero, Geo-Source
Matt Elliott, WRD, Nongame Conservation Section
Trina Morris, WRD, Nongame Conservation Section
Cristin Walters, UGA, Herbarium

Invited but unable to participate:
Shawna Babin, Rocky Branch Elementary School
Pete Pattivina, U. S. Fish and Wildlife Service,
Dirk Stevenson, The Orianne Society
Wendy Zomlefer, UGA Herbarium

Objectives

The primary objectives of the Database Enhancement Team are to address the strengths and weaknesses of the Georgia DNR biodiversity database, how the data are used, how the data can be improved, and what additions or changes are needed to make the database a more valuable conservation tool. Participants were invited from a diverse group of organizations (above) that use biodiversity data in a variety of ways.

Technical team members were asked what their needs are and where the database has proven to be difficult to use or does not meet expectations. A meeting was held at the Charlie Elliott Conference Center on March 4, 2014. Twenty-two members of the team were in attendance.

Data for Input

Increase Data Sources

Data are obtained from contributors in many forms. This is sometimes done by submission of reports of individual sightings through the U.S. mail or e-mail. More common sources of data are e-mailed or digitally submitted data (through the website) from surveys conducted by contractors (who submit environmental reports due to NEPA requirements), DNR biologists, federal agency biologists, or staff of cooperating organizations, such as The Orianne Society and The Nature Conservancy.

There are certainly more surveyors that continue to collect valuable information regarding Georgia rare species than WRD staff are aware of. Identification of new data sources (and obtaining data from) these individuals and organizations is essential. Underutilized data sources identified by the group included the Tennessee Valley Authority, utility companies, timber companies, the National Park Service, and biological staff on military bases. These organizations and more should be contacted to help fill data gaps that have been identified.

Standardize How Large Amounts of Biodiversity Data Are Provided To Georgia DNR

Given the number of records that are submitted, maintaining the timeliness of EO entry is a challenge. One of the identified problems is that data are submitted in many different formats. These include, but are not limited to, the following: anecdotal e-mails, historic records, museum records, rare species submission datasheets, literature, shapefiles (with varied projections), Google Earth images, points / polygons on satellite imagery, points/ polygons on topographic maps, tax records, and survey reports. Although all forms of records will continue to be accepted, standardizing the format to will lead to greater efficiency by decreasing the amount of time spent interpreting the data.

One solution is to insist that DNR employees and contractors hired by DNR to perform surveys submit records using a standard format or template. The WRD staff has developed an EXCEL spreadsheet that should be completed and submitted with each report. Shapefiles that link to the locations to the entries in the spreadsheet should also be submitted.

This EXCEL sheet is available on the WRD website at the following location: (http://www.georgiawildlife.com/conservation_data_electronic_submission). Publicizing the preference that data is turned in on this sheet will be necessary. Requesting frequent cooperators to use these standard data forms in their submissions (such as GDOT contractors) should be encouraged.

Add Methods As Technology Improves

Many wildlife organizations are encouraging the use of 'apps' on smart phones to aid in data submission. It is recommended that WRD staff and cooperators utilize this technology. Different methods of internal data collection are also being developed through the use of tablets, which may be used by contractors in certain cases. This could be made available on the WRD website for others to utilize for rare species reporting.

In order to gather data with the use of 'apps' we need forms. Currently under development is the use of ODK (Open Data Kit) XForms for gathering data. ODK XForms (formally known as OpenRosa XForms) is an open standard for making entry forms that is currently used by many related technologies. What distinguishes these forms is that they can be used from remote areas without internet connection, they are easy to develop and they have little or no cost for usage. Apps and Web pages have been developed to utilize this technology on IPhones, Android phones and tablets as well as other devices like laptops and desktops.

Because ODK XForms is a standard, forms can be created using one technology and then implemented by any other related technology. The aggregated data can then be viewed and used by those who administer the server site.

Schedule Information Requests

One identified cause of data not reaching the WRD databases is the lack of an established schedule for obtaining data. Without deadlines, it is easy for a task to be overlooked. Although WRD staff inputs data that are submitted, they don't recognize the lack of data when we are not sent reports. A simple method that can be used to remedy this is to create a Google Calendar with 'go-to' people that should be contacted to request data. Staff will need to obtain assurances that these people that they will send us data and they will follow up with their organization when it does not come. This will need to be done for requests of information within Georgia DNR as well.

Coordinate With Special Permits Unit Of Georgia DNR

In the past, scientific collecting permits for special concern animals and plants were reviewed only by the Special Permits office of the Georgia DNR Law Enforcement Division. In many cases, insufficient information was submitted by scientific collection permit holders to determine or confirm rare species occurrences. In addition, these survey reports were rarely seen by staff of the Nongame Conservation Section. This situation has been remedied by updating the permit reporting form to include all of the necessary data fields for developing an element occurrence record, and by coordinating with staff of the Special Permits office to extract useful data from collection reports. Nongame Conservation Section staff now review the collection reports and identify useful location information on special concern species. The relevant data are then extracted for development of element occurrence information in the Biotics database.

Obtain Data From Smartphone Applications Utilized By Other Wildlife Organizations

Citizen science applications such as *e*bird and *i*naturalist can be used for obtaining data. Biologists within NCS and cooperating organizations will need to review the records to verify that the species is correctly identified and the location information is from a reliable source. Staff will work with cooperators to identify priority sources for data acquisition.

Expand Collection And Use Of Negative Data

Typically only positive occurrence data are entered into Biotics, not updates from surveys in which the species surveyed for was not observed. It is planned that this will change. The Nongame Conservation Section is awaiting the development of the Georgia Natural, Archaeological, and Historical GIS (GNAHRGIS) https://www.gnahrgis.org/gnahrgis/index to provide the technology for this improvement. This reporting tool is being developed at the University of Georgia and meetings are ongoing.

WRD aquatic zoologists that conduct periodic field surveys for fishes and mollusks maintain databases that are used to track the results of these efforts. Negative data can be inferred by results of these periodic surveys when species don't show up in the surveys. Such negative data can be very valuable for conservation assessments. Similar survey databases for plants and other groups should be developed.

Data Provided to Others

Improve Accessibility of Species Profiles on the Web

The Database Enhancements Team made the following recommendations to improve the accessibility of species profiles on the WRD website:

1) Convert the rare species profiles from pdf format into a web based application that stores treatments locally on mobile phones, tablets, and computers for viewing offline.
2) Make the species profiles accessible from links embedded in lists of special concern species. (Note: the ability to click on species in lists on the web was implemented in early 2015 and the same is being done to quickly link to range maps.)

Ensure That All Species in Georgia Are Acknowledged As Present in the Biotics Database

This is particularly necessary in the case of invertebrates. According to the National Wildlife Federation website (http://www.nwf.org/wildlife/wildlife-library/invertebrates.aspx), there are over 140,000 species of invertebrates in the United States. Because of a lack of baseline species data, a very small percentage of terrestrial invertebrates are tracked. If a particular species isn't tracked (or even if it is), relatively few have been entered into Biotics as 'present.' However, we do not need to know the status of these species to put them on the map as being present in

Georgia. Of all species entered into the database as present in Georgia, just 1000 of them are terrestrial invertebrates. Getting these species into Biotics as present is a necessary action item.

Create A Profile For Every Tracked Species

The Nongame Conservation Section maintains a set of rare species profiles that can be referenced for information on habitat, distribution, rarity, seasonality, and photographic identification. This page (http://www.georgiawildlife.org/rare_species_profiles) is utilized by students, educators, biologists, ecologists, etc. The profiles are of state protected species and some other rare species that are tracked in the Biotics database. A recommendation of the Database Enhancements Team is to increase the number of profiles to eventually include all species tracked in the Biotics database. Identification information is essential if we expect contractors to be able to identify tracked species in the field.

Add Range Maps to Species Profiles

Predicted range maps should be included with our species profiles. The team expressed significant interest in having these maps downloadable from the WRD website to a shapefile. There have been a number of attempts at creating species range maps. For aquatic species it is often enough to list species by HUC10 (USGS ten digit hydrologic unit code) watersheds. Terrestrial species are sometimes a problem, especially with some plant species that have disjunct ranges or that can persist under variable environmental conditions. For these species, range extensions and new disjunct populations are frequently showing up.

Downloadable information and instructions to make range maps of known locations of species are available on the WRD website. Information is provided by HUC8, HUC10, Georgia county and quarter quads (1/4 of USGS 7.5 minute quadrangle maps). Fishes, crayfishes and mollusks already have links to range maps from their species profiles.

Aquatic biologists in the Nongame Conservation Section have developed a methodology for developing Conservation Status Maps that display occurrences of a given species within a HUC10 watershed. Date ranges of the last documented occurrences of a species are color-coded, and indicate areas in which additional surveys may be needed to confirm the continued existence of the species in a watershed. This method and similar methods can be used to show areas of the data that could be improved by further field work or data scrutiny.

QC (Quality Control) of Data

Currently WRD staff uses an established methodology to QC rare species and natural community occurrence (EO, element occurrence) data. This usually works well for newly entered or revised data, but occasionally errors get through this process. There are many older records that have not gone through the current QC process. These records as well as errors in newer records could be addressed by using adjunctive QC methodologies. One such method would be to run special QC queries against Biotics data to find fields that aren’t filled in or contain lower quality data. The team recommends including a link on the website to report data errors or website problems.

Appendix N. Ecosystems and Habitat Mapping Technical Team Report

Prepared by Jason Lee

Wildlife conservation measures such as land acquisition on a statewide level are challenging due primarily to the scale and complexity of issues regarding prioritization, especially for a state as biologically diverse as Georgia. With a limited budget, how does a state assess wildlife value on one property versus another? A good decision process is one that accounts for the complexity of the issues while producing an easy to understand result, typically a map. The SWAP Habitat Mapping process attempts to compile current biological knowledge, current land conditions, predicted future impacts, and biological opinions in a transparent and objective way to better define areas of biological importance.

This report details the cumulative efforts of DNR to initiate and plan for this process, and is intended to be both an internal blueprint for SWAP Habitat Modeling and also a public resource. It our hope that federal, state, local government and private partners can utilize this prioritization process to promote and conserve wildlife in Georgia.

Technical Team Members

Team Members participating in the meeting
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Dr. Nate Nibbelink, UGA
Dr. Jeff Hepinstall-Cymerman, UGA
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Christi Lambert, TNC
Chris Canalos, DNR
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Dr. Liz Kramer, UGA
Dee Pederson, NRCS
Dr. Ken Myer, ARC
David Gregory, DNR
Brent Womack, DNR
Thom Litts, DNR
Andrew Szwak, GEFA
Fuller Callaway, GEFA

Approach

On December 12, 2013, Team members assembled at Ocmulgee State Park in McRae, Georgia to discuss goals and plans for SWAP habitat mapping and modeling. Nongame DNR presented a general outline of preferred approaches based on SWAP needs, singular and overall goals, and processes to achieve them. This overall goal can best be described as a comprehensive modeling and mapping approach, and was approved by the team. The team then discussed the status of individual components such as landcover products or species models in terms of availability, potential importance, and accuracy. After review of available datasets and budgetary limitations it was obvious to the group that only portions of that overall objective could be achieved by the 2015 SWAP deadline.

In spite of this and after subsequent internal Nongame DNR deliberation and research and approval by the Habitat Team, it has been determined that steps toward the overall goal of an exhaustive modeling approach will be appropriate. Although not all individual datasets will be incorporated due to lack of availability, those will be developed and included in the near future. We consider this a dynamic modeling process that will be useful by 2016, but continue to build on current available data and eventually produce the desired comprehensive model.

In the following draft report, the process proposed and deliberated for SWAP Habitat modeling is presented, as well as future goals and opportunities, and merits of individual components that will contribute to the overall goal.

Identified Overall Needs

- To update the original SWAP Conservation Opportunity Areas map with a thorough prioritization process that is based primarily on the habitat needs of rare species and landcover maps, answering the question of 'What areas do we need in conservation to sustain Georgia's biodiversity'?
- To create a dynamic process that allows for improving the map over time as new information becomes available.

- A public website to display the prioritization and engage public and partners.

Identified Products

Final products that will need to be developed for the SWAP to achieve identified needs are the specific goals. The final opportunity map will be a single integrated composite index based on ranked component input data (the individual components will also be made public). Some of these data are not available currently, so an essential part of this process is to identify data needs (which will then be listed as goals). Occasionally a placeholder may be used until an improved dataset can be developed. Products identified as goals are (Goals 2-5 will form the composite Conservation Opportunity Map):

1. Landcover maps & status and trends over past decade
2. Landcover derivatives (urban projections, Landscape Suitability, Habitat Richness, etc)
3. Wildlife Corridor Opportunities (Greenways)
4. Priority Watersheds
5. Conservation Lands, status and trends
6. Species Habitat Models

With each of these products, a list of goals and data needs for improving the Opportunity map components will also be produced if necessary.

The following Sections discuss these individual products in more detail.

1. Landcover Mapping

The basis of all habitat prioritization modeling is landcover. Most importantly it is used as the building block for all species models, and for landcover status/trends. For some types of analysis, general landcover is adequate. Analysis related to urban projections, agriculture land changes, or acres of silviculture for example are best done at a coarse scale.

<u>Status and Trends for General Landcover:</u>
Below are spatial and tabular representations of general landcover trends per Ecoregion from 2006 to 2011 (the most recent NLCD landcover map). Although this only covers half of the time period since the 2005 SWAP, it covers the time period from 2006-2008, a very intense period for development in the State. The trends are presented in percentage increase per landcover class (so, for instance Agriculture in the Southeastern Plains decreased by 2.7%, from 6,603 total square miles to 6,423 total square miles).

Overall, the 2006-2011 period appears to be relatively stable from a general landcover perspective. The most notable overall trends for these 6 years are a substantial increase in ‘Early Successional’, a significant increase in ‘Developed’, mostly stable ‘Wetland” trends and significant ‘Forest’ and ‘Agriculture’ loss.

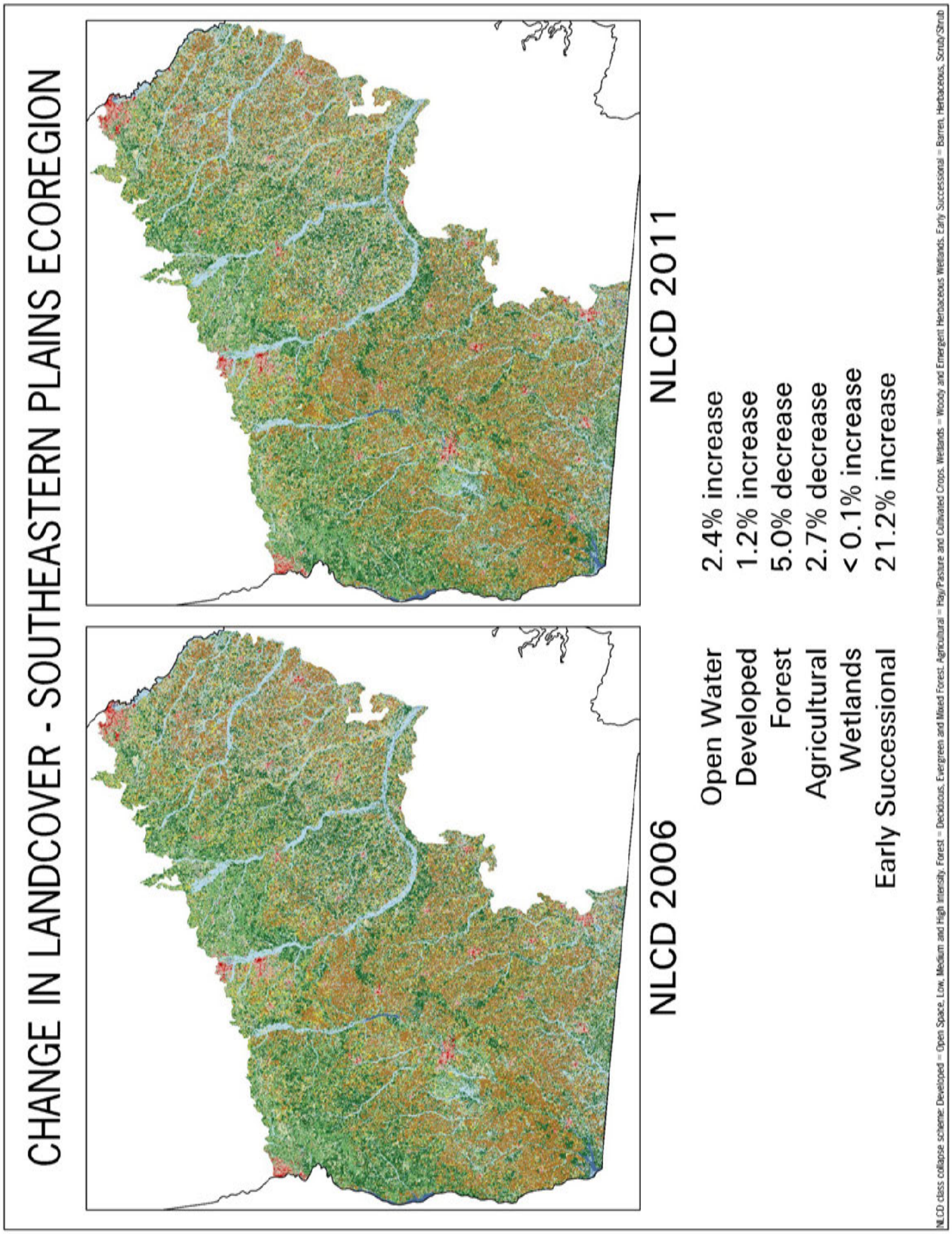
The forested loss, spread evenly across Deciduous, Evergreen and Mixed Forests types (see table below), is primarily into Herbaceous and Scrub/Shrub (shown in figures below as Early Successional) and Development. Herbaceous and Scrub/Shrub can represent conversion to another landuse or can represent the early reforestation phase. Some of this loss from forest could also be explained from timber revenues declining after 2007, and silviculture becoming substantially less lucrative relative to other landuses, but most likely represents substantial clearcuts from 2006-2008 when timber prices were significantly higher, and cut areas are in the early, more open phase of silviculture reforestation. Presumably neither of these are an overall forest loss as those areas will return to forest. Hay/Pasture and Cultivated Crops appeared to be stable overall in the State. The increase in Development is likely to have been due to larger forested and agriculture properties being subdivided, sold and converted to suburban type developments during the growth period (2006-2008). This loss of forest and agriculture to development is significant and concerning.

Importantly, virtually no wetland loss may signal good news statewide as the trend of wetland loss seems to have abated for now. Coastal and Southeastern Plain wetlands, which have been drained and heavily converted to pine plantation over the past few decades appear to be stable from 2006-2011. Perhaps this is due to more marginal, easily converted, wetlands being exhausted and decreased timber revenues not justifying further hydrologic modifications.

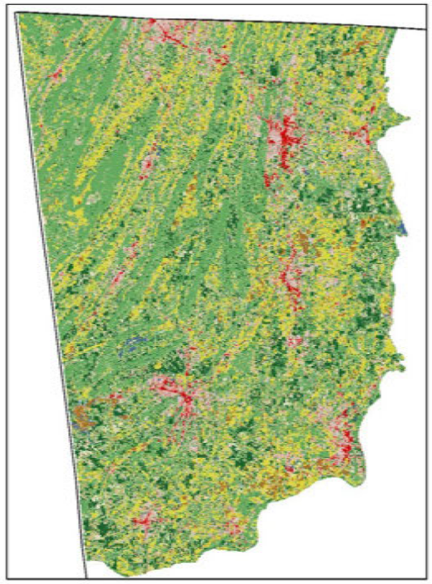
NLCD Classes	**Square Miles 2006**		**Square Miles 2011**	
Open Water	856		872	
Developed, Open Space	3524		3588	
Developed, Low Intensity	1580		1564	
Developed, Medium Intensity	453		522	
Developed, High Intensity	211		230	
Total Developed	5767		5904	
Deciduous Forest	10788		10350	
Evergreen Forest	12933		12326	
Mixed Forest	2079		1914	
Total Forest	25801		24590	
Hay/Pasture	4740		4634	
Cultivated Crops	5766		5631	
Total Ag	10506		10265	
Woody Wetlands	8162		8018	
Emergent Herbaceous Wetlands	1111		1270	
Total Wetland	9273		9288	

Barren Land	180		199	
Shrub/Scrub	2705		3835	
Herbaceous	3562		3711	
Early Successional	6446		7746	

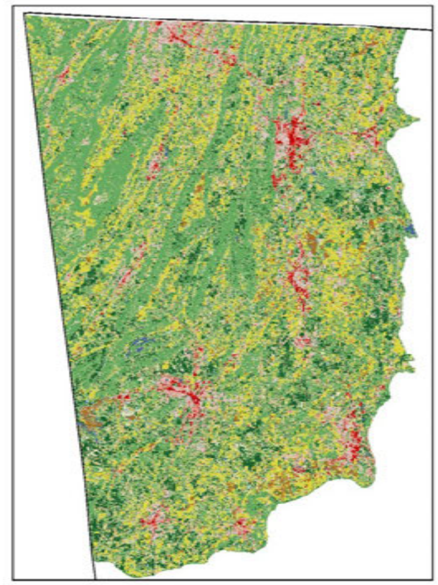
Table of overall landcover status and trends for Georgia per the National Landcover Dataset. Figures below are generalized further and described in maps (figures generated by Chris Canalos)


CHANGE IN LANDCOVER - SOUTHEASTERN PLAINS ECOREGION
NLCD 2006
NLCD 2011
Open Water 2.4% increase
Developed 1.2% increase
Forest 5.0% decrease
Agricultural 2.7% decrease
Wetlands < 0.1% increase
Early Successional 21.2% increase
NLCD class collapse scheme: Developed = Open Space, Low, Medium and High Intensity; Forest = Deciduous, Evergreen and Mixed Forest; Agricultural = Hay/Pasture and Cultivated Crops; Wetlands = Woody and Emergent Herbaceous Wetlands; Early Successional = Barren, Herbaceous, Scrub/Shrub

CHANGE IN LANDCOVER - SOUTHWESTERN APPALACHIANS AND RIDGE & VALLEY ECOREGIONS



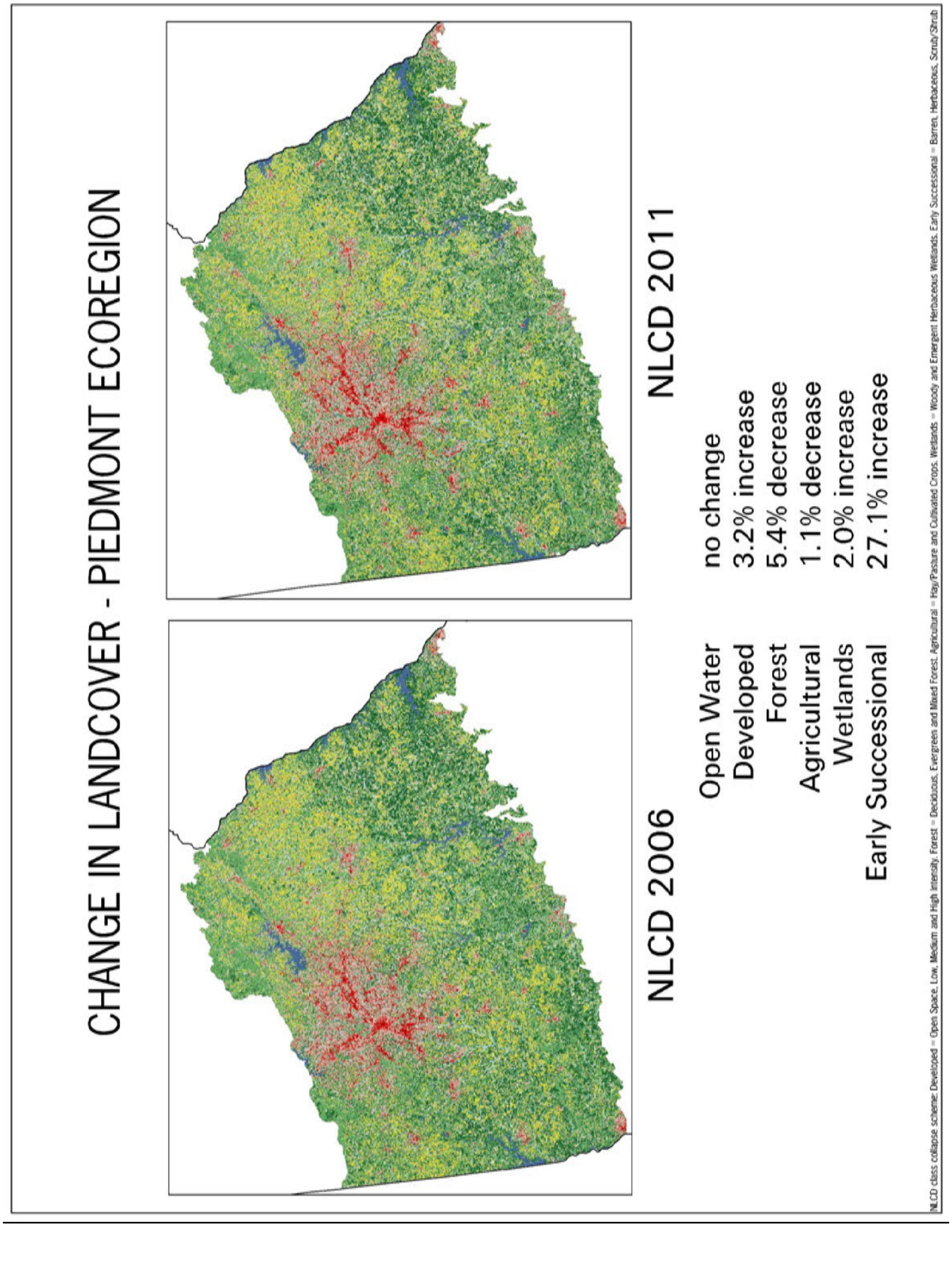
NLCD 2006

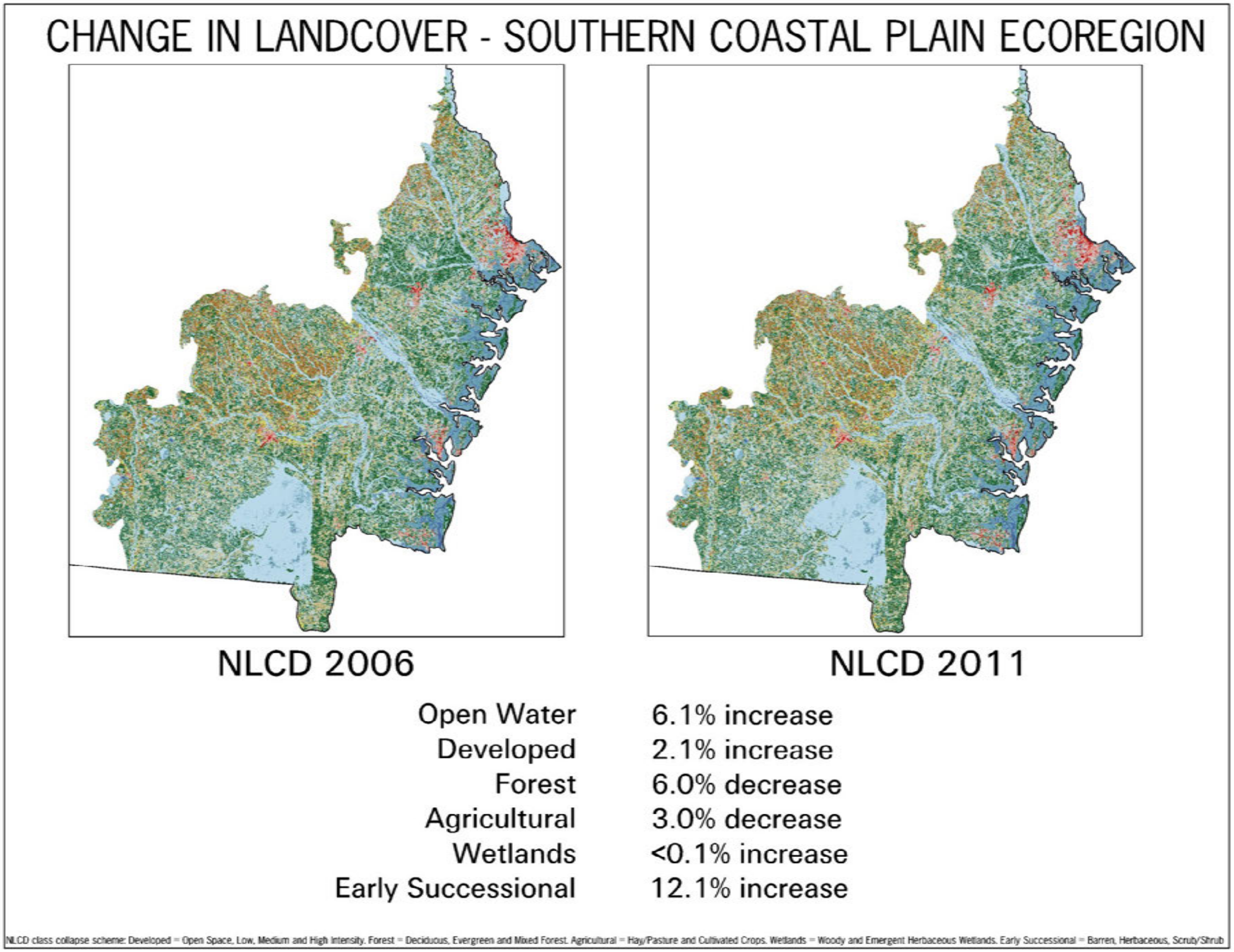


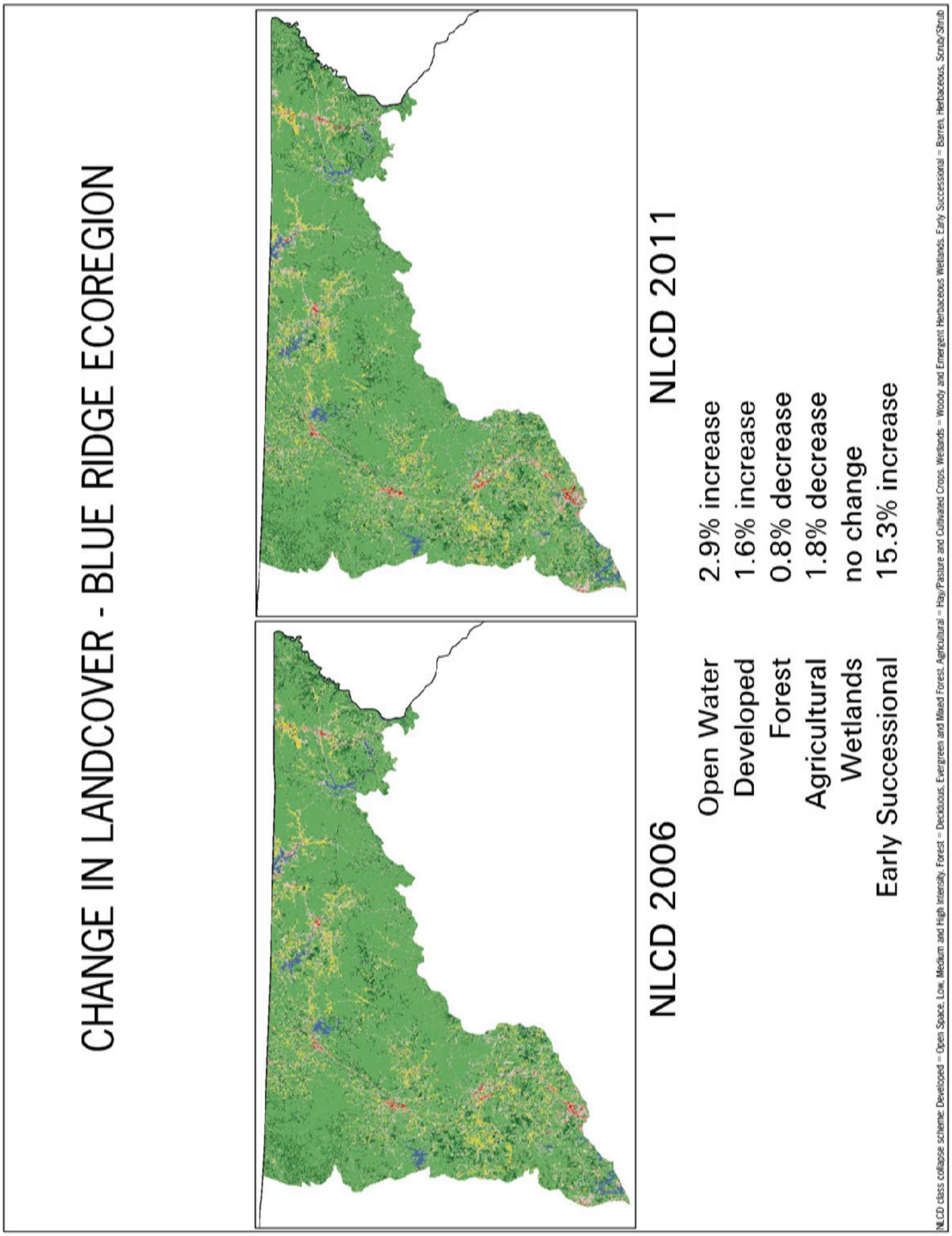
NLCD 2011

Open Water	no change
Developed	2.4% increase
Forest	1.5% decrease
Agricultural	1.1% decrease
Wetlands	no change
Early Successional	11.2% increase

NLCD class collapse scheme: Developed = Open Space, Low, Medium and High Intensity. Forest = Deciduous, Evergreen and Mixed Forest. Agricultural = Hay/Pasture and Cultivated Crops. Wetlands = Woody and Emergent Herbaceous Wetlands. Early Successional = Barren, Herbaceous, Scrub/Shrub


CHANGE IN LANDCOVER - PIEDMONT ECOREGION
NLCD 2006
NLCD 2011
Open Water no change
Developed 3.2% increase
Forest 5.4% decrease
Agricultural 1.1% decrease
Wetlands 2.0% increase
Early Successional 27.1% increase
NLCD class collapse scheme: Developed = Open Space, Low, Medium and High Intensity. Forest = Deciduous, Evergreen and Mixed Forest. Agricultural = Hay/Pasture and Cultivated Crops. Wetlands = Woody and Emergent Herbaceous Wetlands. Early Successional = Barren, Herbaceous, Scrub/Shrub


CHANGE IN LANDCOVER - SOUTHERN COASTAL PLAIN ECOREGION
NLCD 2006
NLCD 2011
Open Water 6.1% increase
Developed 2.1% increase
Forest 6.0% decrease
Agricultural 3.0% decrease
Wetlands <0.1% increase
Early Successional 12.1% increase
NLCD class collapse scheme: Developed = Open Space, Low, Medium and High Intensity. Forest = Deciduous, Evergreen and Mixed Forest. Agricultural = Hay/Pasture and Cultivated Crops. Wetlands = Woody and Emergent Herbaceous Wetlands. Early Successional = Barren, Herbaceous, Scrub/Shrub



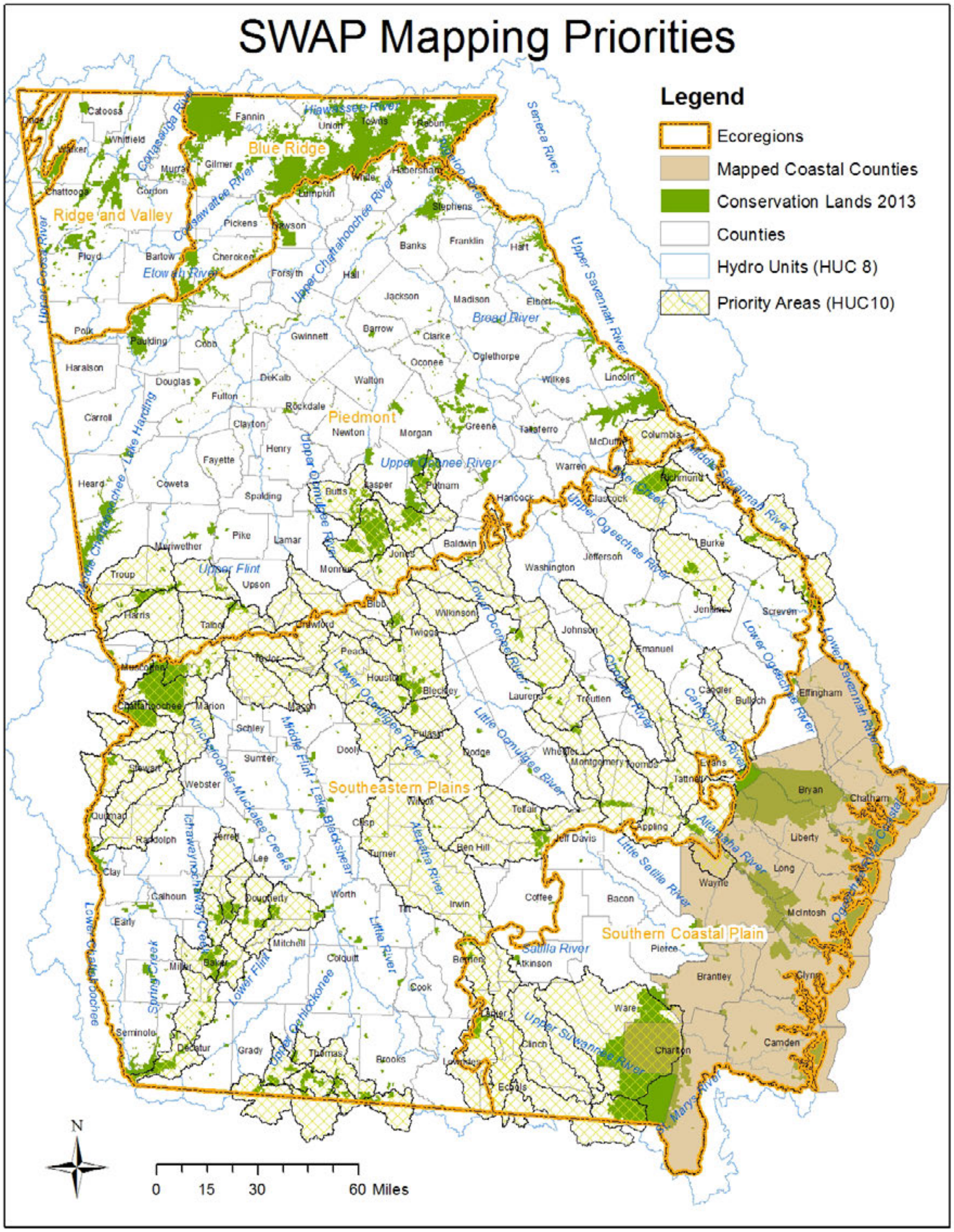
Maps are generated from NLCD; for percentages, Developed classes are merged, Forest classes are merged, Hay/Pasture and Cultivated Crops are merged into Ag, Wetland Classes are merged, Barren Land, Shrub/Scrub and Herbaceous are merged into Early Successional and Open Water stays Open Water.

However, there is much diversity of habitats within the more natural landcover types that are important for individual species use. For example, upland longleaf pine and pine flatwoods may both be called natural pine in a general landcover, but usually consist of very different flora species(and attract different fauna).

Due to this, it is crucial that landcover maps be as accurate and details as possible. From 2007 to 2010, Nongame staff mapped vegetation for much of the Southern Coastal Plain of Georgia to a precise level based on the National Vegetation Classification System developed by NatureServe. This field-based inventory and fine-scale mapping approach has yielded great benefits for coastal conservation, specifically in the ability to analyze habitat priorities. With the coastal habitat map, we are able to clearly ascertain the relative abundance plant communities and refine our priorities accordingly. This ability has led DNR to the conclusion that precise inventory mapping is worth the investment statewide, as it allows us to remove considerable uncertainty and refine our priorities.

To that effect, and considering budgetary limitations, we have drafted a prioritization for the State for future fine-scale mapping efforts (see map below). Natural systems, (not overly affected anthropogenic ones such as agricultural and urban classes) will be the primary targets for mapping, decreasing the mapping extent considerably. The target classification system will be determined later, but the Natural Communities of Georgia is our current goal, with Natureserve Ecological Systems/Associations also possibilities depending on budget factors and needs for specific areas.

The Habitat Team agreed that the Southeastern Plains stands out as the biggest landcover gap. The Team also agreed that for many needs, the Piedmont, Appalachians, Ridge and Valley and Cumberland Plateau Ecoregions can be currently served by 2002 Southeast GAP Landcover data. Although 10 years old, some change detection from current GLUT/NLCD maps can accurately incorporate major changes and so can still be useful until further fine scale mapping is completed.

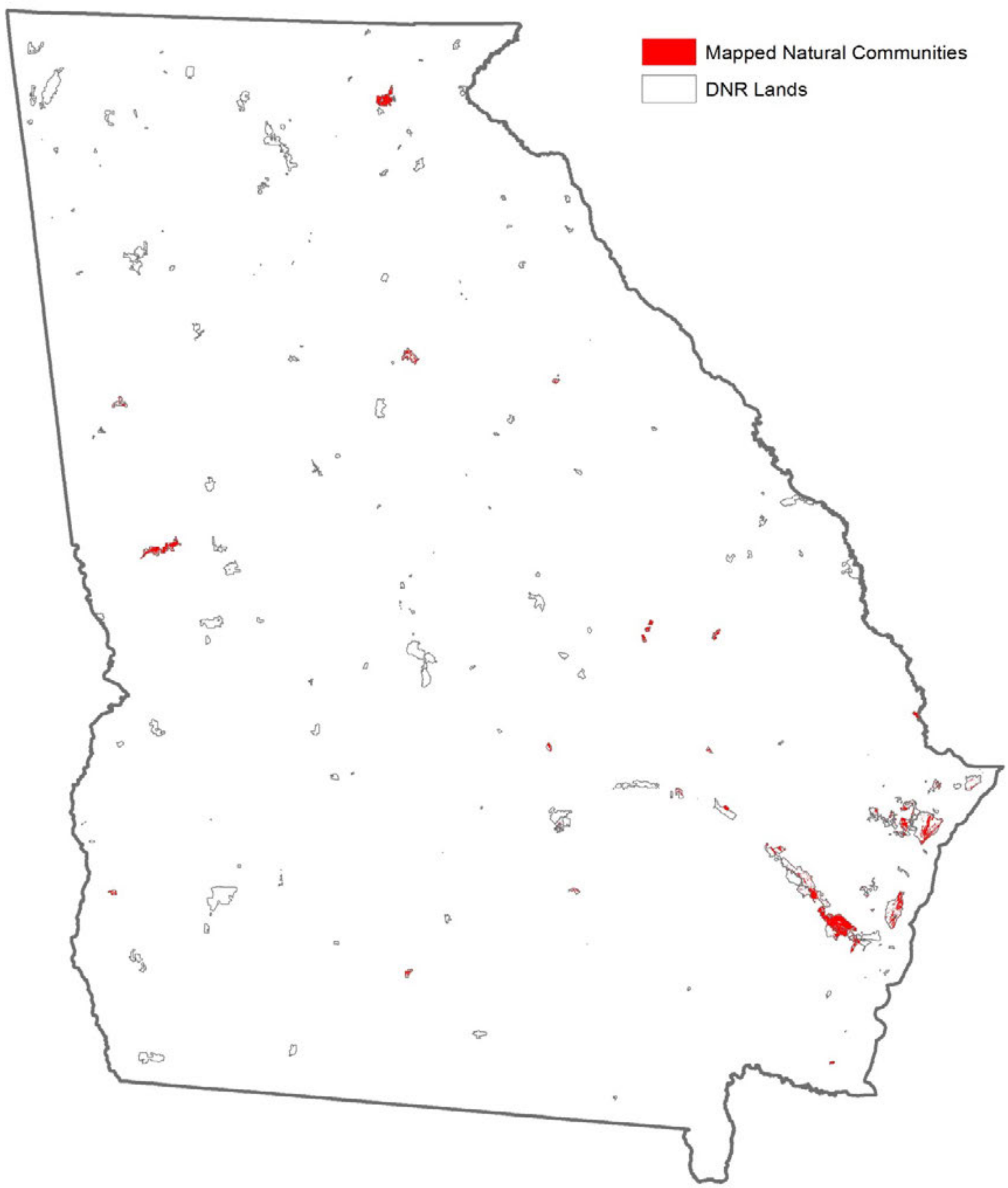


The Southern Plains is our largest landcover gap as it does not have a reliable landcover map (of finer scale than general landcover) since 1998. The draft Priority Areas above show areas of conservation interest and without recent landcover, and the coastal areas (in brown) previously mapped.

In addition to the above spatial prioritization, DNR has identified some Southeastern Plain priority habitats that need to be inventoried and mapped. These include high quality longleaf pine- savannas and woodlands, wet pine flatwoods, pitcherplant bogs, cypress savannas (limesinks), mesic slopes, calcareous bluffs, Altamaha grit outcrops and associated wetlands, remnant black belt prairies, canebrakes, calcareous flatwoods, river shoals, granite outcrops, ultramafic glades, and Florida scrub. Two more important habitats to map at finer resolutions are saltmarsh and brackish marsh and associated components such as high marsh, low marsh, levees and oyster beds. Although we have the extent of each well mapped, there is much biodiversity within each that should be better studied, classified and mapped accordingly.

DNR has completed fine scale mapping for Sandhills, Carolina Bays, sagponds, Doughtery Plain isolated wetlands, and wet oak flats. Having these and the above areas mapped to the Natural Communities level will help answer the question: 'What natural habitats are present in Georgia, and what is their extent and abundance?'

DNR has also completed fine scale landcover maps for most State Parks, Natural Areas and a few Wildlife Management Areas. These are currently being compiled and crosswalked (status below) to a standardized, single map, to begin to answer the question: 'What natural habitats, and how many and how much of, do we have protected?' To completely answer that question, fine scale mapping for ALL conservation lands including federal and private conservation lands, so this is a SWAP high priority.



Lands in red denote fine scale mapping, all others are DNR lands that are priority mapping areas. Most DNR and other protected lands are not mapped to a fine scale. Map and data below generated by Jacob Thompson and Jason Lee, NCS.

From our initial crosswalk, acreages of Natural communities currently protected are:

Natural Communities	**Acres**
Acidic glades, barrens, and rocky woodlands	13
Bottomland hardwoods	4635
Coastal wet oak flats	51
Cove forests	109
Cypress-gum ponds	1911
Cypress-tupelo river swamps	3037
Depression marshes and cypress savannas	2
Dry deciduous hardwood forests	1192
Dry evergreen oak woodlands	3236
Dry upland longleaf pine woodlands	469
Floodplains, bottomlands, and riparian zones	1389
Freshwater and oligohaline tidal marshes	2789
Granite outcrops	19
Interdunal wetlands	1225
Intertidal beaches, sand bars, and mud flats	669
Low- to mid-elevation oak forests	2135
Maritime dunes	456
Maritime forests	12729
Mesic forests	1265
Mesic slope forests	830
Montane longleaf woodlands and forests	1326
Mountain bogs	1
Oak-pine-hickory forests	7568
Pine flatwoods	5552
Pine-oak woodlands and forests	3563
Riverbanks and levees	240
Sandhills and river dunes	2973
Seepage slope swamps and shrub bogs	1544
Seepage wetlands	16
Small stream floodplain forests	60
Tidal swamps	13906
Total	74910

The total acreage mapped to the classification level we need is 74,910 acres. Georgia DNR owns over 475,000 acres, so more mapping needs to be accomplished to complete all state lands to a fine-scale level (although many of these lands are mapped accurately to a coarser level such as

Ecological Systems) that is often necessary for decision making. Again, a comprehensive, fine scale inventory of all habitats in protection will be very useful in analyzing conservation needs. Although we have not developed a schedule for fine scale mapping these and other priority habitats, we will seek funding for this work and set timelines and goals in 2015. The SWAP Monitoring team will have overlapping and complimentary efforts, and will be consulted with.

Landcover Updates

A crucial component of landcover mapping is regular updates that reflect changes in extent, type or quality of habitat. This is an approach that may not be cost effective if the original method is re-employed for fine-scale mapping (which is considerably expensive). Therefore, change-detection methods are the preferred solution for updates. This consists of an automated process that identifies areas of substantial change, and the remapping process is then a more manageable and less costly process.

In addition to change detection methods, advances in automated landcover classification are showing promise for fine-resolution vegetation mapping. Of particular note are methods successfully pioneered by the Missouri Resource Assessment Partnership (MoRAP) for Missouri and Texas landcover mapping utilizing high quality point data to inform customized classification models. This option needs to be properly vetted for usefulness and application to the Georgia landscape, and may have applications in areas where fine-scale mapping is not possible. The option of mapping the entire Southeastern Plains with a MoRAP-type methodology will also be considered. Urban, silviculture and agricultural and areas can be updated with coarser scale landcover datasets such as GLUT or NLCD.

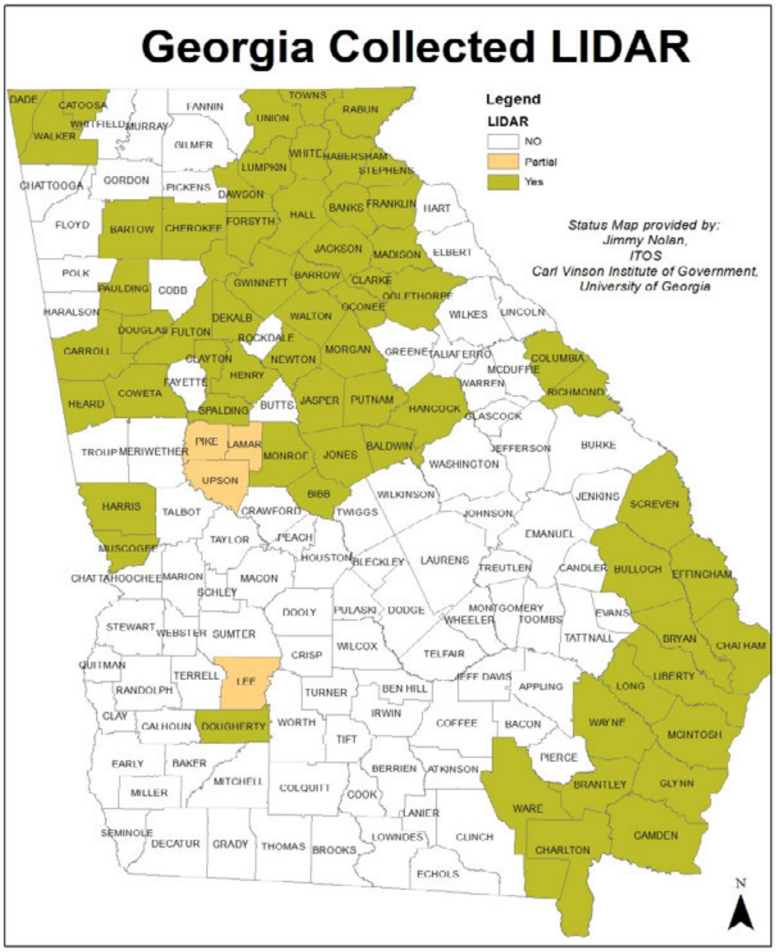
Restoration of ecosystems, especially of longleaf pine systems, needs to be accounted for in future mapping efforts. The reintroduction of prescribed fire is improving habitat across the state, and monitoring fire frequency is an important goal. The Landfire program is actively pursuing monitoring and mapping fire history in Georgia, and collaboration in this effort would be beneficial. Hydrologic restoration will be important to account for as well. The SWAP monitoring Team will be engaged for collaboration to achieve this goal.

Soils Maps

NRCS SSURGO (soils) digital maps have been completed for the entire State. This is an extremely beneficial dataset that will offer us a chance to increase landcover mapping accuracy and detail significantly. Vegetation responds closely to soil types, and some fauna such as the keystone species gopher tortoise inhabit only certain soil types.

Identified data needed to facilitate landcover mapping

One of the most significant needs to support landcover mapping is higher resolution digital elevation data produced by Lidar. Accurate elevation models derived from lidar data are capable of refining the vegetation mapping process greatly, producing more accurate and more detailed landcover datasets. The Lidar status map below shows current availability of Lidar for Georgia. (Note that not all data are publicly available; some are the property of individual counties.)



Counties that have acquired Lidar in Georgia as of December 2014.

Also important to landcover mapping is timely, high resolution imagery. There are multiple ways to acquire high resolution imagery, and cost is usually the determining factor in how that acquisition takes place. Working with federal partners and local governments is commonly the most productive way forward. Another alternative that has the added benefit of repeatability is DNR aerial mapping capabilities such as onboard helicopter sensors.

When prioritizing land for conservation, it is often advantageous to include ecosystem services (or function of habitat) for landcover types. Future mapping efforts should consider modifiers to help with this task. Attention should be paid to species present or other important components.

2. Landcover Derivatives and Landscape Condition Models

Data layers that qualify and quantify lands for habitat purposes can help prioritize land for conservation. These layers are mostly derived from general landcovers using metrics that describe landcover attributes such as patch size (how large a homogenous landcover area such as a forest is) or contiguity. Other complementary layers (such as number of inventoried species per area) are often added to increase functionality. *The overall goal for our landscape conservation initiatives is to target biologically and topographically diverse, well connected, large areas*. Given that, our identified layers needed are:

- Species Richness for Vertebrates Landscape Suitability (Patch/parcel size & Natural landcover)
- Wetlands, Floodplains & Recharge areas
- SLEUTH model of projected urban development
- Landscape Resilience concept: landform/connectivity/fragmentation. For the Coast and the Southeastern Plain, these datasets need reworking with higher quality elevation data.

Of these, the SLEUTH and Floodplains/Recharge Areas datasets are currently available.

3. Wildlife Corridors

Habitat connectivity provides benefits for most species, including plants, insects and mobile vertebrates. To foster connectivity between existing and future conservation lands, and to further provide corridors for species movement, a Greenway/corridors layer has been drafted for input into our prioritization process. *Please note that this is only one input of the final Conservation Opportunity Map*. Due to the complex issues that determine the feasibility of establishing and maintaining wildlife corridors, the actual drafting is mostly a manual process that utilizes multiple datasets. *Many of the corridors shown below exist and function currently as wildlife corridors, and so the primary goal is to retain that current landuse, and to promote a matrix of restored and working lands, (not necessarily publicly owned).*

The following are important themes and priorities we considered when developing the draft map of potential wildlife corridors:

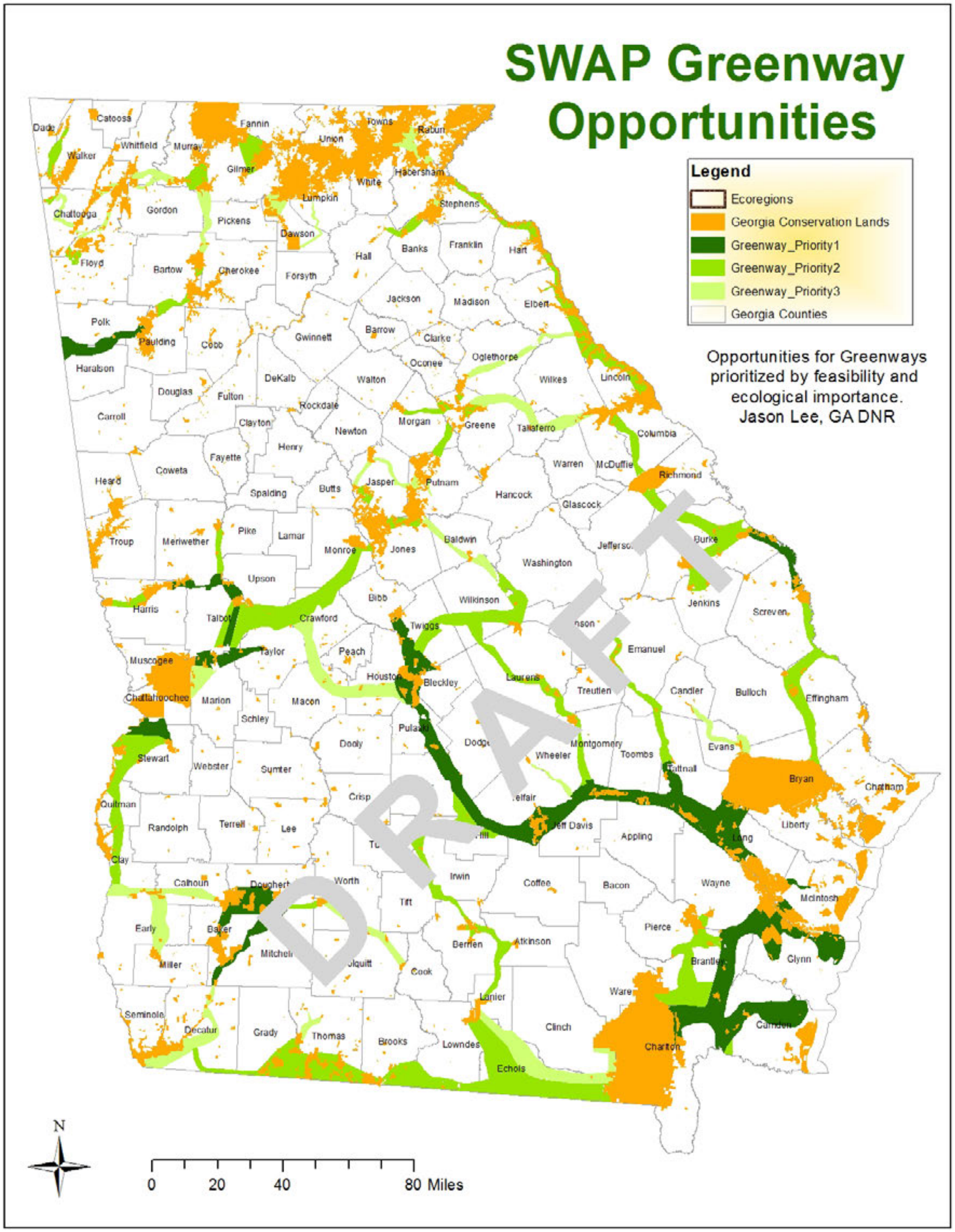
- Different species require different corridor types and sizes. Therefore, the best corridors will be large with diverse topography and landcover. Practically, this often means having significant adjacent uplands with riverine based corridors.
- Wetlands have layers of protection, both natural and regulatory (that must be accounted for in allocating limited conservation dollars.* Although wetlands are being converted to uplands (primarily ditched and drained, permissible under CWA), overall they do have more protection than upland sites.
- High Connectivity values per modeled landcover metrics (Local Connectedness model from TNC, SALCC Circuitscape Black Bear and Pine Snake models.)

- Connectivity between areas with priority species that require large habitat patches (e.g., RCW, gopher tortoise, eastern indigo snake). This usually indicates that the areas are currently functioning as corridors.
- Areas of high biodiversity are a priority for connections.
- Existing landuses (agriculture/forestry) provide some connectivity. A designated corridor within a matrix of more compatible landuses is superior to one that is not.
- High priority streams and watershed delineated by the Fishes and Freshwater Invertebrates Team
- Coastal areas that provide migration routes for species and habitats affected by sea level rise
- Coastal and Southeastern Plain areas with diverse topography (landforms).
- Adjacent states' conservation lands and plans are important to further enhance connectivity at a regional scale.

**A significantly impactful piece of wetland protection, the Biggert-Waters Act of 2012, rolls back federal flood insurance subsidies for new development in flood prone areas. This lack of subsidy will substantially increase costs for flood insurance, and will undoubtedly have a dampening effect on construction in wetlands. This Act, combined with Clean Water Act regulations and the No Net Loss federal policy, could be a powerful deterrent to development in wetlands.*

It is worth noting that, in Georgia, habitat connectivity is highest in the Blue Ridge Ecoregion. New corridors are needed primarily in other parts of the state, with the Fall Line region, Southeastern Plain and Coast as optimum targets due to ample affordable and available opportunities, priority species requirements and projected impacts from sea level rise. Ideally, all major conservation areas within the State should be connected eventually.

There are multiple ways to achieve a biologically effective corridor, depending on the target species, landuse, land condition, land prices, and other factors. At minimum, development should be avoided in these areas via easements, at maximum the land should be acquired by the state and restored to a natural condition. The range of options for between these two extremes should be considered carefully for any potential property. The Draft Greenway Opportunities map below reflects all of these considerations. Please contact jason.lee@gadnr.org with any questions.



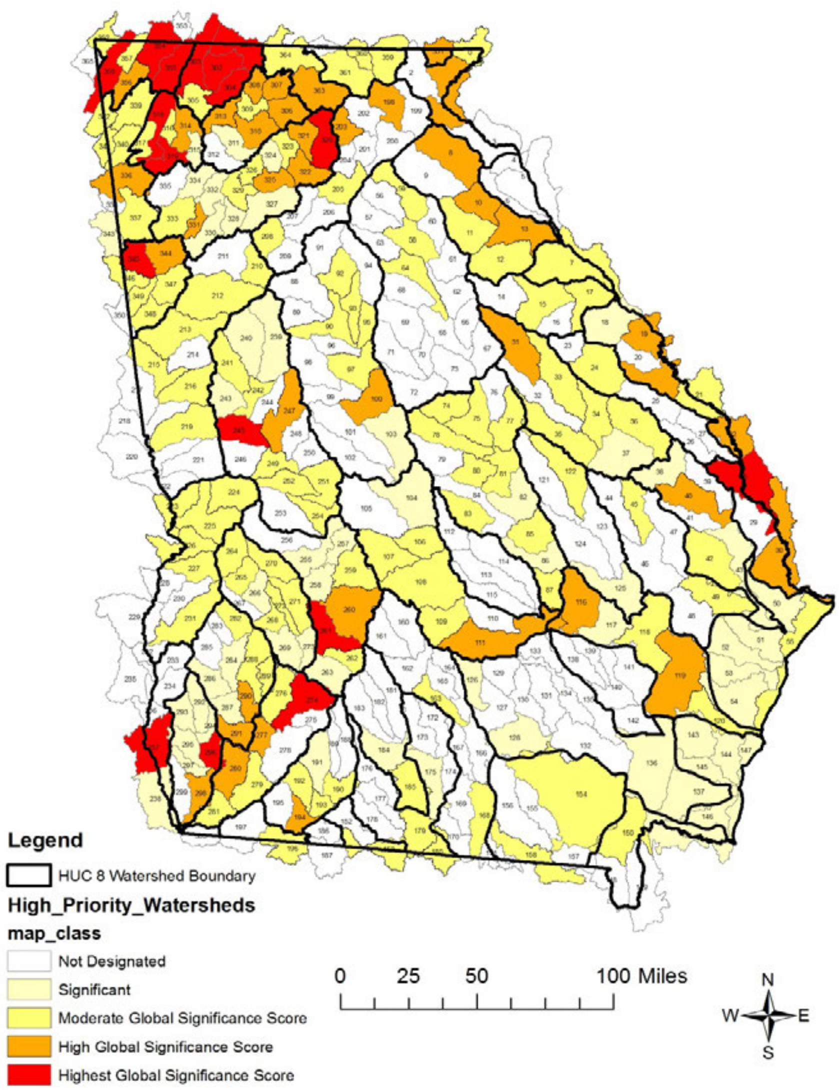
*Note that these do **<u>not need to all be acquired and restored</u>**; fully functioning natural landscapes, but could be a matrix of natural and working lands (forest) including some agriculture. Many of these exist and function currently as wildlife corridors, and so a primary goal is to retain that current landuse. The Priority 1 area totals approximately 1 million acres.*

Thanks to Wade Harrison, Brett Albanese, Jon Ambrose, Matt Elliott and Brent Womack for edits and guidance.

4. Priority Watersheds

The SWAP Fishes and Freshwater Invertebrates Technical Team and the SWAP Aquatic Habitat Technical Team have developed and implemented a prioritization method for watersheds at the Hydrologic Unit Code 10 watershed scale based upon the number of important populations of high priority aquatic species they support, as well as the global rarity of each species. Important populations of high priority species were designated in watersheds based upon the date of species occurrences, existing protection (e.g., conservation lands), existing condition (e.g., landuse) and future threats (e.g., projected urbanization).

The Habitat Modeling Team has assessed the results and intends to incorporate this valuable information into the overall conservation priority process. Please refer to the SWAP Aquatic Habitat Team report for more details or contact Brett Albanese at Brett.Albanese@dnr.state.ga.us



High priority watersheds identified during the 2015 revision of Georgia's State Wildlife Action Plan.

5. Conservation Lands

In order to efficiently strategize for conservation, a comprehensive inventory of current protected areas is essential. In addition to current locations and acreages of conservation lands, it is also necessary to know the level of protection (how permanently protected) and the type of protection (is it managed primarily for wildlife, for silviculture, or other uses?).

Currently, there are substantial gaps in obtaining all of these parameters in a timely fashion. Below is a description of the level of reporting by land acquisition partners:

State of Georgia (Georgia DNR, GA Forestry Commission)

- Per the Georgia Land Conservation Act, GA DNR is required to maintain the State Land Conservation GIS
- Maintains an accurate, up to date GIS inventory of State of Georgia acquisitions and conservation easements acquired by the State or facilitated through the Georgia Conservation Tax Credit Program.
- Determines and records level of protection
- Partially successful in defining and recording the type of protection (often this is variable and dependent on uncontrollable variables)

Federal (Fish and Wildlife Service, Department of Defense, Forest Service, National Park Service)

- Maintains accessible, accurate, up to date GIS inventory of acquisitions.
- Determines and records level of protection
- Partially successful in defining and reporting the type of protection.

Land Trusts

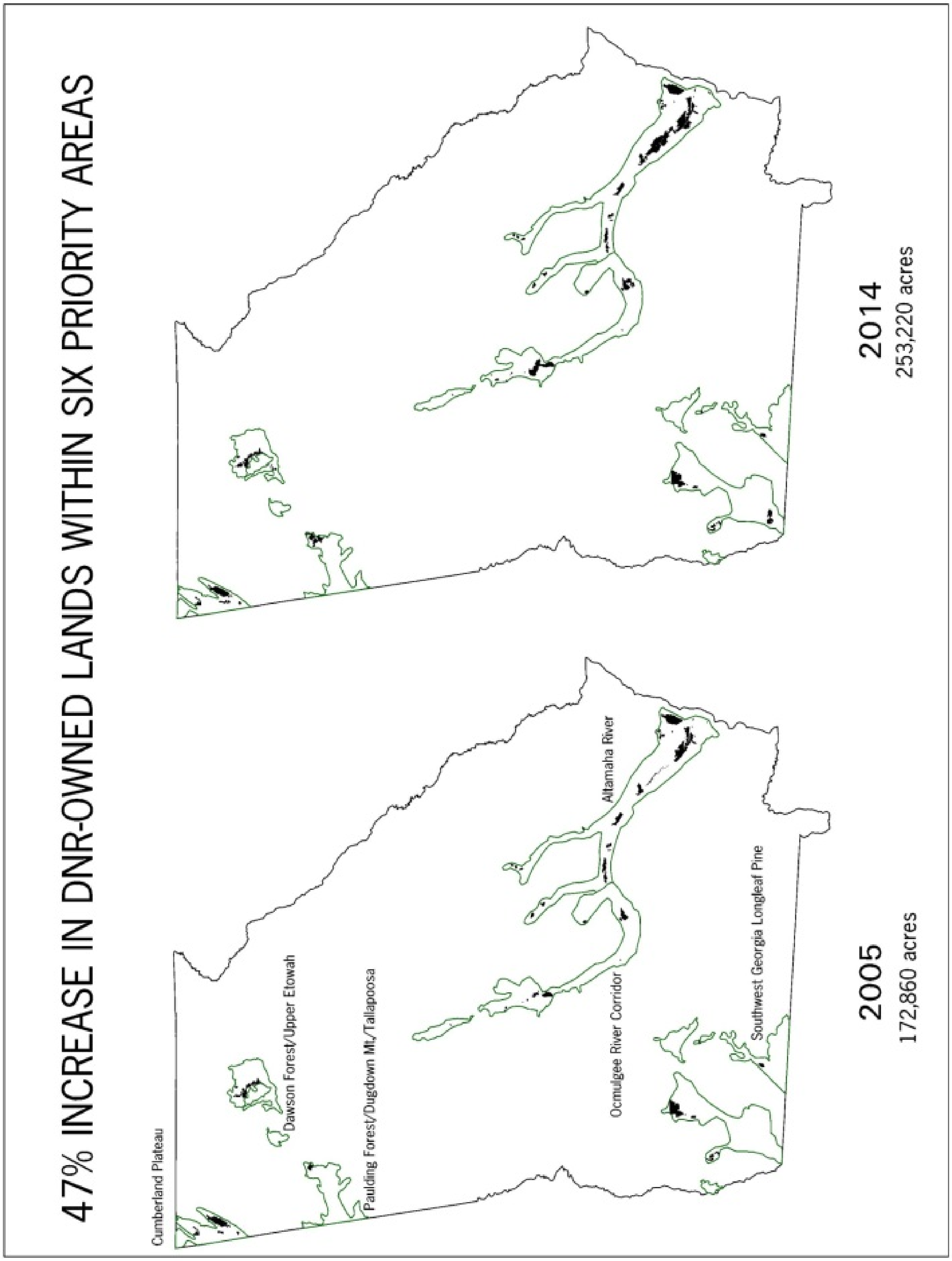
- Some maintain accessible, accurate, up to date GIS inventory of acquisitions. Some updates are provided to GA DNR.
- Determines and records level of protection
- Partially successful in defining and reporting the type of protection.

Local Governments

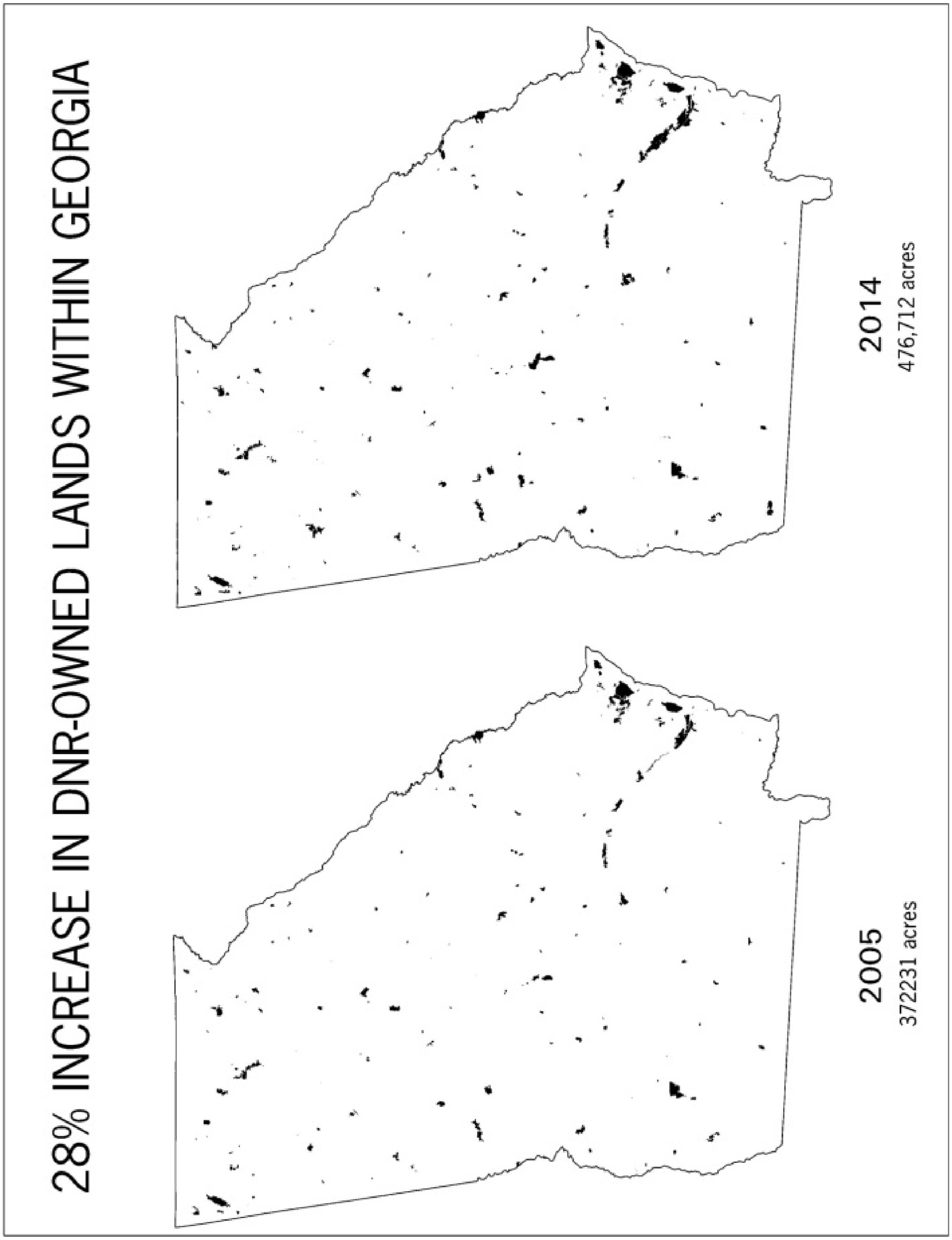
- Some maintain accessible, accurate, up to date GIS inventory of acquisitions, but none regularly provide updates to a statewide layer
- Do not generally determine and record level of protection
- Not generally successful in defining and reporting the type of protection.

As evidenced by the above, it would be beneficial to have statewide coordination for conservation acquisition inventorying. It is also important to understand the impact of more marginal conservation lands such as wetlands and areas zoned for non-urban uses (local land use zoning may be an important attribute for conservation lands, and currently, this is not accounted for in a statewide conservation lands database.) To that effect, spatial representations of both protected wetlands and zoning would also be helpful.

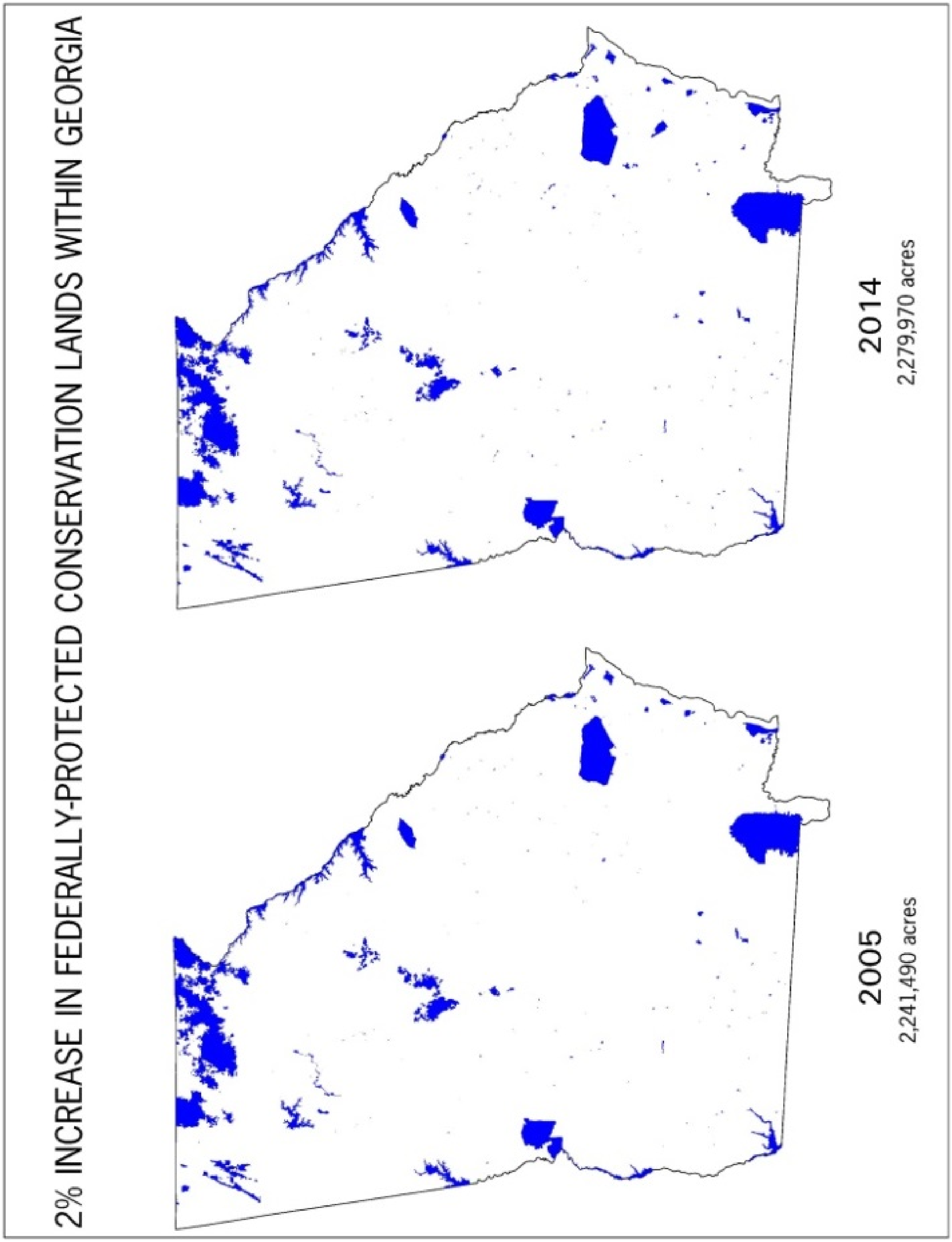
Progress of conservation acquisitions can be measured with several metrics. Below are maps showing accomplishments in Georgia land conservation over the past decade, encompassing 9 of the 10 years since the 2005 SWAP (all but the current year). Note that the Six Priority Areas shown in the following maps will be built upon, amended and ultimately supplanted by the overall results of the SWAP Habitat prioritization process.



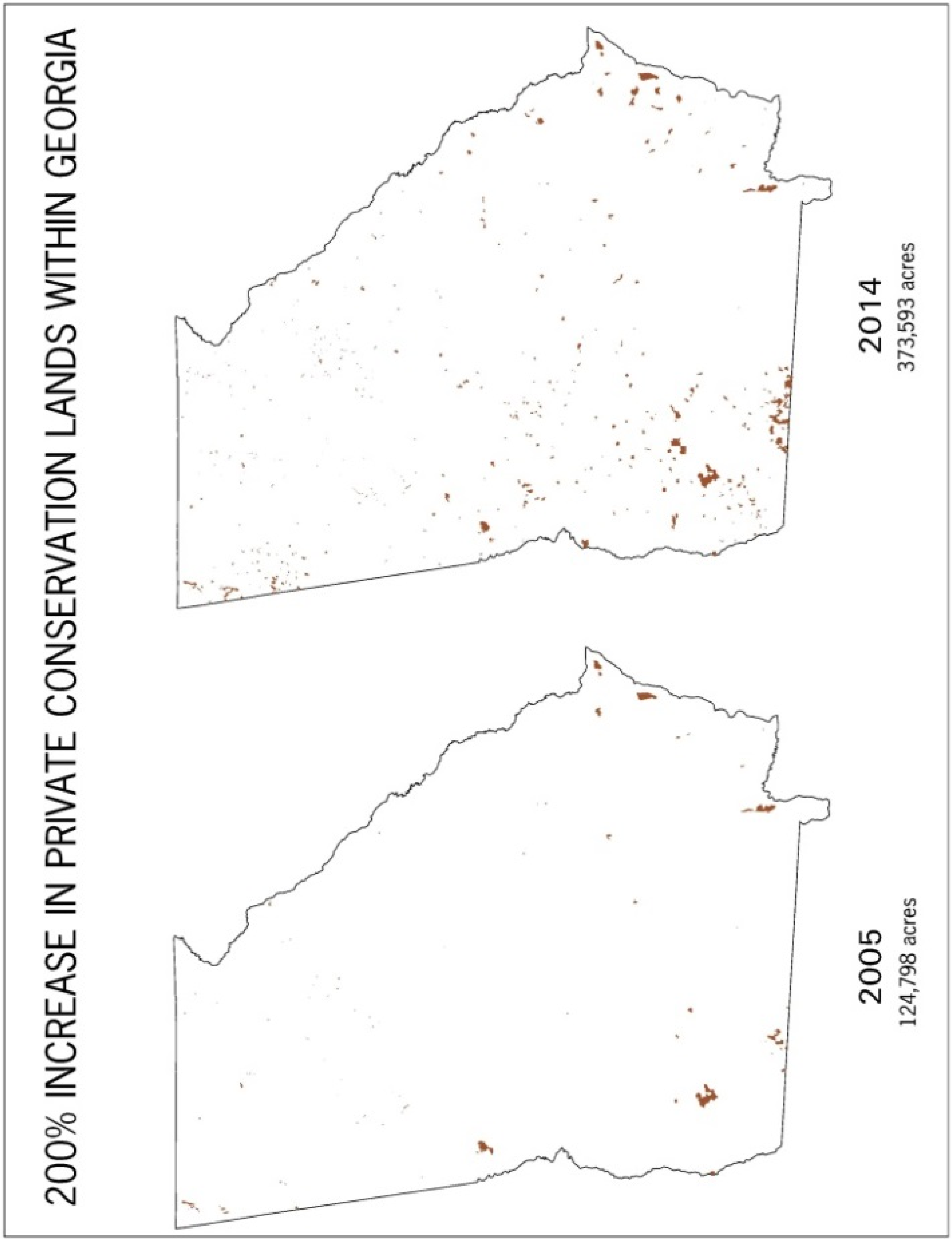
2005 Priority areas were defined using the 2005 SWAP Opportunity Map as a guide. These do not include easements. Figures generated by Chris Canalos, NCS DNR.



Statewide acquisitions since 2005 SWAP. 6% of our acquisitions were in non-priority areas.



Federal land protected in Georgia over past decade.



Private land protected in Georgia over past decade.

In the past 5 years alone, there have been 245,000 total acres (federal, state, land trust, local) protected. That totals 0.7% of the 37 million acres in Georgia.

As noted in the landcover section of this report, it is important to map which habitats are protected in the state, so that we can understand better where to focus our conservation efforts.

6. Species Habitat Modeling

To manage for individual high priority species, habitat requirements must be well understood. The function of the habitat modeling process is to translate those requirements into a spatial representation (a map) that accounts for current and potential habitat to identify areas for conservation targeting.

These models should be accurate and updatable and account for all Georgia species of concern. Our proposal in regards to this is three-fold:

First, we want to encourage a dynamic modeling process wherein researchers maintain models through time. As modeling assumptions shift, as landcover and climate changes, or as conservation lands are added, these changes should be incorporated into the model and new results produced. Although not always feasible, we intend to support this approach in a variety of ways to ensure that the habitat models stay current.

Secondly, these models should incorporate climate change and sea level rise projections where applicable. This would create a future habitat component to habitat models that will be beneficial for long term planning.

Thirdly, we are operating with limited budgets, and in order to produce more immediate, valuable results we have and will initially pursue species habitat models focused on "umbrella" or indicator species. These umbrella species have been chosen as representative of suites of species that associate with priority habitats, and are conducive to the modeling process (we have species occurrence data, we understand habitat requirements, and the species responds predictably to landcover data we have access too).

Our current umbrella list includes (*models/maps we currently have or are in development by researchers):

- Mammals
  - Yellow Bat
  - Summer Range of the Indiana Bat
  - *Black Bear *(SALCC)*
- Plants
  - Georgia aster
  - Relict trillium
  - Sandhills rosemary
  - Fringed campion

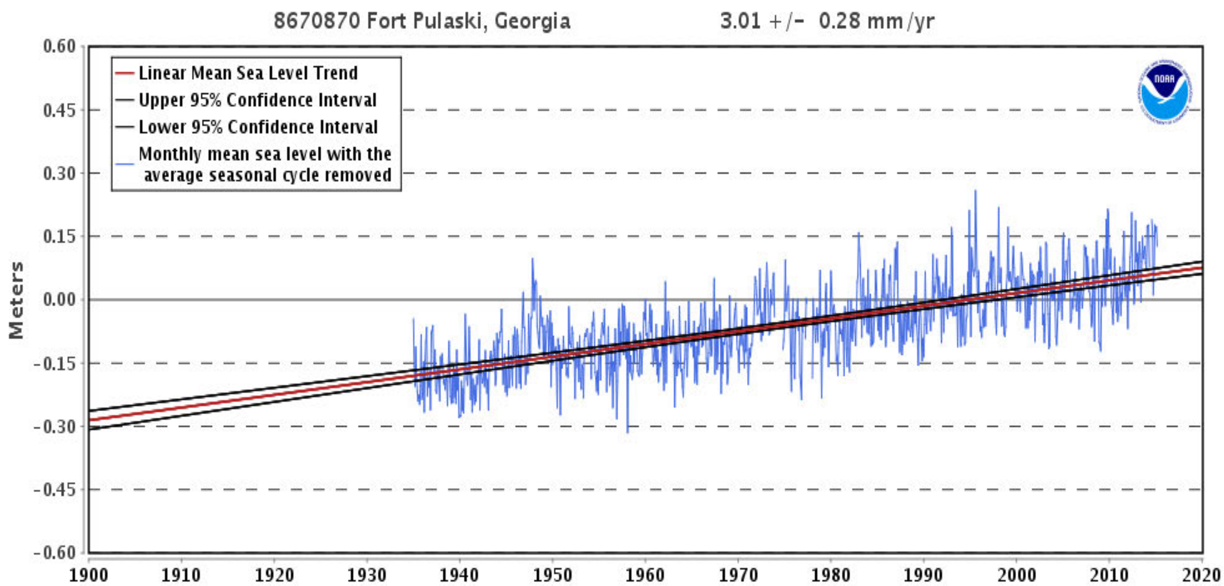
  - Georgia plume
- Reptiles/Amphibians
  - Green Salamander
  - *Bog Turtle
  - *Gopher tortoise *(Clint Moore)*
  - *Pine Snake *(Jeff Hepinstall-Cymerman)*
  - *Indigo Snake
  - *Striped Newt
  - *Flatwoods Salamander
  - *Southern hognose Snake *(Jeff Hepinstall-Cymerman)*
- Birds
  - *Swallowtailed Kite *(Ken Myer)*
  - Henslow's Sparrow
  - Red Headed Woodpecker
  - *American Kestrel
  - American Wood Stork
  - *Birds of Pine Savannas/Woodlands (Northern Bobwhite, Red Cockaded Woodpecker, Bachman's Sparrow; *SALCC*)

As stated, over time we will add important species to the above list and begin to fill in species that may not be covered under any of these categories.

Sea Level Rise & Climate Change

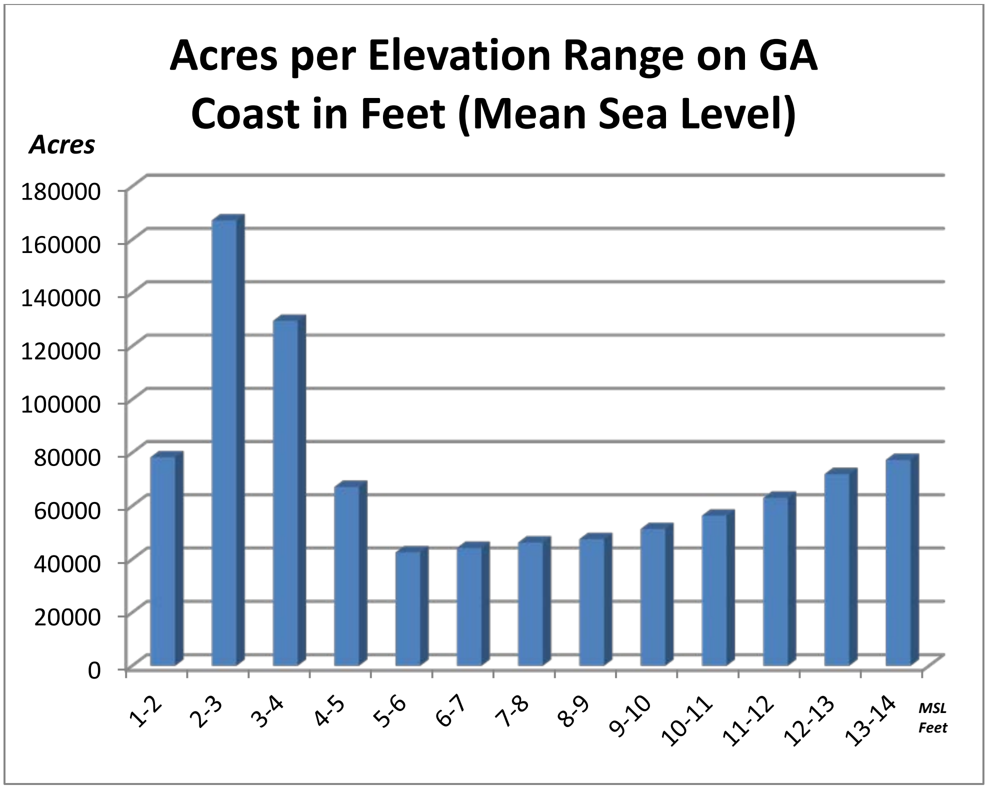
Climate change and sea level rise (SLR) are difficult to incorporate into the planning process. In addition to the uncertainty associated with understanding projections that reach far into the future, there is also considerable uncertainty inherent to the models themselves. However, it is important that the SWAP process begin to account for changes that may occur so that we are prepared.

Recent Sea Level Rise on the Georgia Coast:



The past 80 years has seen 10 inches of recorded rise per the NOAA Fort Pulaski tidal gauge near Savannah. Most sea level rise models predict this to accelerate sharply over the next decade.

From a planning perspective, we have the Sea Level Rise Affecting Marshes Model (SLAMM) based on high accuracy, lidar derived elevations. This dataset projects various scenarios of SLR over the coming 100 years, and should be utilized whenever considering coastal habitats response to SLR. Of note is that much of the coast of Georgia is well situated for the next 30 years due to the predominance of high elevations. However, the vast expanses of saltmarsh will begin fragmenting substantially over that period, and will be followed by marsh drowning on a large scale.



Distributions of elevations on the Coast of Georgia, per Lidar.

Other useful coastal datasets for understanding potential SLR impacts are Historical Shoreline Change (Chester Jackson, Georgia Southern), Hardened Shoreline dataset (Clark Alexander, SKIO) and the Coastal Habitat Map (GA DNR).

Based on our current understanding of projected trends, the four most significant habitat concerns for the Georgia coast are:

- Marsh drowning creating significant habitat degradation
- Volatile extreme tides through rising sea level (frequent flooding of marginal upland habitats and associated species)
- Long-term coastal habitat migration (ample conservation lands and time for habitats to shift upland to new optimal areas)
- New and expanding populations of invasive species

As mentioned previously, an optimal way to approach land conservation on the coast that accounts for sea level rise is to target diverse topographical areas on the near coast. This approach should also be biased towards land with substantial areas above 13 Foot Mean Sea Level, which is the initial zone of elevation in which we have the least protection. For areas below 13'MSL, there is adequate protection in various ways (considerable wetlands, floodplains and near coast areas that are somewhat undevelopable or are already in conservation). 13' MSL is the first missing link in the chain of habitat migration that is necessary for coastal habitats to respond to SLR.

One possible exception to the protection level of areas below 13' MSL is highlighted by the lack of mitigation options for areas that will become marsh in the future. Mitigation is an important conservation tool that is legally designed to account for current impacts to wetlands primarily by restoring other impacted wetlands. Unfortunately, in order to satisfy requirements that mitigation credits be scored between the time of impact and the time of restoration (i.e., lost years of wetland function), mitigating for current impacts with future marsh areas is not easy to quantify. When will that upland area become marsh, and what type of marsh will it become are central questions. Nevertheless, there are significant ecological gains to be realized if future marsh areas can be used in the mitigation process.

It is also important that climate predictions be incorporated into species models as future scenarios. The SWAP Climate Change committee will provide guidance for these purposes, including other areas of the State that may be affected.

Data Needs

Identified data needs in addition to landcover:

- Lidar (statewide)
- Statewide tax parcel database
- Invasive species locations and projections
- Ecosystem services spatial layer

Summary

In summary, Georgia DNR's plan for implementation of SWAP Habitat Modeling goals is to build a comprehensive, dynamic modeling process that will result in a weighted priority index to be utilized for land acquisition by DNR, federal, state, local and private partners for wildlife conservation. Our final prioritization inputs will be:

- Priority Vegetation Communities
- Habitat Richness Vertebrates
- Landscape Suitability (Patch/parcel size & Natural landcover)
- Floodplains & Wetlands & Recharge areas
- SLEUTH (future development)
- SLR and climate change impacts
- Focal Species Habitat Suitability models
- Priority Watersheds
- Connectivity Corridor potential

Our immediate action items to reach our goals are:

- Compile and crosswalk existing high resolution mapping for the State
- Initiate mapping Priority Areas and Communities
- Create and/or commission Landscape Suitability derivations

- Build Species Habitat Models for selected species
- Develop and implement a plan for expansion and improvement of the Conservation Lands database
- Compile existing datasets into priority index (map)
- Construct mapping web portal to show primary inputs and results

Appendix O. Climate Change Adaptation Technical Team Report

Prepared by Mary Pfaffko and Jon Ambrose

Technical Team Members

Team Leaders
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Mary Pfaffko, GADNR-Nongame Conservation Section

Team Members participating in the meeting
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Fuller Callaway, Georgia Environmental Finance Authority
Dr. Ronald Carroll, University of Georgia
Dr. Jenny Cruse-Sanders, Atlanta Botanical Garden
Megan Desrosiers, One Hundred Miles
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Wade Harrison, The Nature Conservancy
Dr. Jeffrey Hepinstall Cymerman, University of Georgia
Elizabeth Herbert, Indiana University
Elizabeth Hunter, University of Georgia
Dr. Donald Imm, U.S. Fish and Wildlife Service
Dr. Kay Kirkman, Joseph W. Jones Ecological Research Center
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Jason Lee, GADNR-Nongame Conservation Section
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Robert Ramsay, Georgia Conservancy
Dr. Joshua Reece, Valdosta State University
Will Ricks, GADNR-Game Management Section
Todd Schneider, GADNR-Nongame Conservation Section
Randy Tate, The Longleaf Alliance
Jacob Thompson, GADNR-Nongame Conservation Section
Dr. Seth Wenger, University of Georgia

Invited but unable to participate in the meeting
Clark Alexander, Georgia Southern University
Andy Carroll, University of Tennessee at Chattanooga
Chris Craft, Indiana University
Kimberly Hayes, U.S. Fish and Wildlife Service
John Hiers, U.S. Air Force
Chester Jackson, Georgia Southern University
Amy Keister, U.S. Fish and Wildlife Service

Christi Lambert, The Nature Conservancy
John Charles Maerz, University of Georgia
David Mixon, GADNR-Game Management Section
Robert Sutter, Enduring Conservation Outcomes

Approach

As part of the 2015 revision of Georgia's State Wildlife Action Plan (SWAP), the SWAP Climate Change Adaptation Technical Team was assembled to address the impact of climate change on fish, wildlife, and habitat, and identify research and conservation needs to address it. Understanding and adapting to the impacts of climate change is a process inherent with uncertainty and therefore requires a multi-jurisdictional, regional, partnership approach. The team was comprised of representatives from government agencies, nongovernmental organizations, and universities.

Team communications occurred electronically and through one in-person meeting in January 2015. The format of the two-day meeting was presentations followed by two hours of general discussion on both days. Presentation topics included:

- Overview of the SWAP and Climate Change Adaptation Technical Team goals
- Effects of climate change on migratory birds
- Coastal vertebrate susceptibility to sea level rise
- Role of safeguarding in rare plant conservation
- Integrating uncertain futures into conservation management
- Landscape resilience
- SIVVA: a tool for assessing the synergistic impacts of climate change, land-use change, sea-level rise, and other factors on species prioritization and conservation
- Freshwater fish responses to climate change
- Amphibian and reptile climate change vulnerability assessment
- Incorporating temperature/precipitation predictions into models

Discussion topics included:

- What do we know right now at the species and ecosystem levels to help us respond to climate change and sea level rise?
- What do we need to know?
- Where should research be focused to inform our responses?
- Where and how should we focus conservation efforts?

The impact of climate change reaches beyond state boundaries, exacerbates existing threats to wildlife, and affects each species differently. Consequently, climate change warranted being addressed in the 2015 revision of the Georgia SWAP as an emerging issue in Section V. Below is a list of research and conservation needs for climate change adaptation identified by the Climate Change Adaptation Team. This is not intended to be a stand-alone "Climate Change Action Plan," but rather an acknowledgement of climate change as an important issue to be dealt with as part of the implementation of the SWAP, which includes continuing working with researchers, agencies, and organizations to elucidate potential impacts and implement climate smart conservation.

Research and Conservation Needs

Amphibian Responses to Climate Change
Identify priorities using models of amphibian response to climate change and structured decision making. Study the impacts of climate change on the flatwoods salamander and other species dependent on isolated wetland habitats. Use amphibian and reptile climate change vulnerability assessments to prioritize species, habitats, and sites. Identify protected areas that could provide management opportunities. This could be achieved by partnering with the University of Georgia and expert elicitation.

Analyzing Moving Boundaries Using R (AMBUR)
Use the AMBUR package for analyzing and visualizing historical shoreline change. The baseline and transect method is the primary technique used to quantify distances and rates of shoreline movement, and to detect classification changes across time. A forecasting function also allows estimation of the future location of the shoreline.

Coastal Incentive Grants
Apply for grants from the Coastal Resources Division for disaster resiliency and management to fund infrastructure and transportation on the coast.

Conservation Blueprint
Use the South Atlantic Landscape Conservation Cooperative Conservation Blueprint, which is a spatially-explicit plan that describes the places and actions needed for the regional conservation community to respond to climate change and other changes.

Freshwater Fish Response to Climate Change
Monitor water temperature to inform the understanding of freshwater fish response to climate change. Partner with Adopt a Stream, University of Georgia, Riverkeepers, and citizen science groups such as the Metro Atlanta Amphibian Monitoring Program. Develop a map of prioritized watersheds for temperature modeling. Start with Adopt-a-Stream areas, and then find gaps. Consult the Georgia River Network. Address this topic at the regional level to engage the Southeast Aquatic Resources Partnership (SARP), Landscape Conservation Cooperatives (LCCs), and Climate Science Centers (CSCs).

Guide Land Protection
Identify conservation corridors informed by sea level rise projections. Use land acquisition mechanisms including fee simple acquisition or easements, as well as voluntary set-asides and local ordinances. Work with local county governments.

Guide Policy
Inform wetland and salt marsh mitigation in the context of sea level rise. Provide policy guidance on how to protect future conditions. Partner with the NOAA Natural Resource Damage Assessment.

Migratory Species Response to Climate Change

For some species (e.g., painted bunting and ruby-throated hummingbird), Georgia may be their first significant landfall during spring migration. Georgia may contribute to rebuilding the monarch butterfly population, which is being considered for federal listing at the time of this writing. Conduct research and habitat management for transmission rights-of-ways (ROWs), which can provide a corridor of habitat that could accommodate major shifts in climate. Conduct pilot projects in partnership with University of Georgia (UGA) and Georgia Power Company to assess the feasibility of low-cost, low-maintenance Safe Passage management on ROWs. The two pilot projects include creating detention ponds and plantings in ROWs near UGA/Oconee River. Habitat would be managed and wildlife would be monitored by students. If the pilot projects are successful and effective, this action could be expanded to include other ROWs owned by the GA Power Company.

Safeguard Rare Plant Species

The Safeguarding Database is a centralized, standardized, and updated repository for data pertaining to collaborative plant conservation projects. The database is a tool for tracking rare species in safeguarding and landscape management, and for communicating successes, methods, threats, and needs. Safeguarding sites are correlated to Element Occurrences (EO) so the database can be used to update the Biotics database, which is used by state natural heritage programs to track sensitive species and conservation actions. Reports (e.g., prescribed fire habitat management report) can be generated to facilitate communication across high-profile restoration and recovery projects. Safeguarding can help rare plants species cope with the effects of landscape change. The database provides details relevant to habitats that can serve as indicators for responses to climate change. The Georgia Plant Conservation Alliance (GPCA) keeps genetic material for rare plants should assisted migration become necessary. The database was developed by Atlanta Botanical Garden in conjunction with the Georgia Department of Natural Resources, the State Botanical Garden of Georgia, and the Chattahoochee-Oconee National Forest. The GPCA has coordinated safeguarding efforts since 1995, and restores and introduces rare species into native habitat. Member organizations establish and maintain collections for rare plant species that represent invaluable genetic resources.

Sea Level Rise Affecting Marshes Model (SLAMM) and Species Niche Modeling

The coast of Georgia has SLAMM models based on high accuracy, LiDAR-derived elevations. This dataset projects various scenarios of sea level rise over the next 100 years. Use SLAMM when considering coastal habitat response to sea level rise. While much of the coast of Georgia is well situated for the next 30 years due to the predominance of high elevations, the vast expanses of saltmarsh will begin fragmenting substantially over that period, and will be followed by marsh drowning on a large scale. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

Southeast Resilient Landscapes Model

The Southeast Resilient Landscapes Model, developed by the Nature Conservancy (TNC), identifies key places for conservation in the face of climate change and other factors. The model is based on conserving complex landscapes that increase diversity and resilience. An estimated resilience score is assigned based on scores of landscape diversity and local connectedness, and ranked relative to the geophysical setting and ecoregion. Landscape diversity refers to the number of landforms, the elevation range, and the wetland density. Topographic diversity buffers against the impacts of climate change by providing a variety of microclimates. Local connectedness refers to the number of barriers and the degree of fragmentation within a landscape. A highly permeable landscape promotes resilience by facilitating range shifts and the reorganization of communities.

Using Doris Duke Charitable Foundation funds, TNC plans to implement Resilience 2015: Southeast Resilient Landscapes Model with the purpose of identifying a network of resilient sites and linkages for the eastern U.S., and communicating the results to agencies and partners. The model provides regional context for conservation actions. Some of the data from this model has been incorporated into the GADNR draft "Greenways" map.

The current and revised products of the project may continue to inform climate change adaptation going forward. Connect TNC's models with niche models. Work with TNC and others to evaluate the model outputs and recommend improvements. Integrate uncertain futures into conservation management.

TNC invited the Georgia Department of Natural Resources (GADNR) to join the Steering Committee to identify resilient coastal areas impacted by Hurricane Sandy. Information from the project has been incorporated into the South Atlantic Landscape Conservation Cooperative's datasets. Information has also been incorporated into a land conservation funding project coordinated by the Open Space Institute and supported by the Doris Duke Charitable Foundation. The initiative is designed to help land trusts and public agencies focus their conservation efforts on climate priorities. The initiative includes priority areas within Georgia.

Standardized Index of Vulnerability and Value (SIVVA)

The Standardized Index of Vulnerability and Value (SIVVA) is a tool for assessing the synergistic impacts of climate change, land-use change, sea-level rise, and other factors on species prioritization and conservation. It is a standardized system for assessing extinction risk, vulnerabilities to threats, and values. Potential partners include Valdosta State University (VSU) to modify SIVVA for application to ecosystems of Georgia. This would be modeled after the approach used by VSU, Florida Natural Areas Inventory, University of Central Florida, and the University of Florida to assess the conservation value and vulnerability of 300 species to interacting threats for the Florida SWAP (Reece et al. 2013).

Statewide Landcover Map

Develop a statewide landcover map. Fine-scale mapping facilitates habitat prioritization and conservation planning, as was demonstrated with the mapping of habitats of 11 coastal counties in the Southern Coastal Plain of Georgia. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

Statewide Light Detection and Ranging (LiDAR) Coverage

Obtain statewide LiDAR coverage to inform habitat mapping. LiDAR is a remote sensing method that generates precise, three-dimensional information about the shape of the Earth and its surface characteristics. LiDAR produces high resolution digital elevation data that supports landcover mapping needs through refining the vegetation mapping process. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

Statewide Map of Priority Habitats and Landscape Features

Develop a habitat data layer to provide a detailed picture of the status of habitats across the state and inform conservation actions at multiple scales. Update these data periodically to detect change. Full coverage of the Coastal Plain of Georgia is a priority for habitat mapping. The current map of 11 counties took three years to complete so the approach needs to be modified in order to achieve mapping goals over a reasonable timeframe. The current map has been used widely by local governments, conservation organizations, and private landowners. Over the longer term, the map would enable strategic conservation, and partners would apply for grants from public or private sources to assist with mapping. Create an ecosystems services spatial layer.

Trophic Asynchrony Models

Incorporate temperature and precipitation predictions into trophic asynchrony models. Incorporate phenology into existing monitoring efforts. Standardize phenology monitoring with partners over time. Identify a network of sampling sites to monitor phenology. Inform Atlanta Botanical Garden's monitoring program on what to monitor to capture climate change data in terms of phenology.

Urban Wildlife Conservation

Improve forage quality, minimize mortality due to predation and disease, and link stopover sites in cities to broader greenspace campaigns (e.g., Gwinnett County park easements, Atlanta Beltline) to provide food resources for migrants and reduce storm water runoff, and educate the public about keeping bird feeders clean. Build partnerships for urban wildlife conservation. Build on the existing urban conservation programs of the Nature Conservancy and the Georgia Forestry Commission. Build on existing Georgia Power Company programs such as 1) the Species Management Areas program which helps protect endangered birds, and 2) Power of Flight. Partner with Atlanta Botanical Garden to work with Atlanta schools on urban pollinator gardens. Incorporate urban areas into the Georgia SWAP. Include urban areas when modelling potential habitat. Urban areas may be on migration corridors, and are home to voters and potential citizen scientists and rain gardens. Revitalize the Georgia Department of Natural Resources backyard habitat program or collaborate with other organizations that can help in this effort, such as the Georgia Wildlife Federation and garden clubs. Implement public education programs. Provide easy access to a list of recommended nurseries for native plants. Understand habitat connectivity; model the aggregate impact of smaller greenspaces that could enhance the impact of larger greenspaces. Address fish passage in urban areas. Encourage use of the SWAP to guide grants to do urban conservation work. Work with local governments to establish recreational corridors that also provide wildlife habitat. Include urban areas in a statewide landscape resiliency to engage city dwellers. Use the SLEUTH Projected Urban Growth mapping to present data that represent the extent of urbanization predicted by the model.

Vulnerability Assessments

Evaluate existing vulnerability assessment tools to determine potential priorities for conservation actions.

Wildlife Conservation on Private Lands

Work with private landowners to make better use of funds from Farm Bill conservation programs (e.g., Working Lands for Wildlife for Gopher Tortoise).

Appendix P. High Priority Conservation Actions

The SWAP technical teams and other stakeholders initially identified over 200 high priority conservation actions. These were sorted into the following twelve categories, which represent generally stated conservation goals or themes:

- Assess status of high priority habitats
- Assess status of high priority species
- Conserve high priority habitats
- Conserve high priority species
- Improve environmental education
- Improve private land management
- Improve public land management
- Improve SWAP communications
- Increase capacity for wildlife conservation
- Reduce impacts from development and other activities
- Implement climate change adaptation
- Engage in regional partnerships

The identified conservation actions included research and survey, habitat/species management, education, outreach, regulation, database, administrative, and funding efforts. For each conservation action, focal species/habitats, ecoregions, watersheds, funding sources, lead organizations, and partner organizations were identified. In addition, a brief description and comments/justification were outlined for each project. Finally, relevant data to be collected and performance indicators were identified for each project as a first step toward developing monitoring programs to facilitate adaptive management.

Each conservation action on the list was evaluated and assigned an importance score using the following seven criteria:

1) Providing Multiple Benefits for High Priority Species/Habitats
   The conservation action provides direct, measurable benefits for several high priority species and/or globally rare natural communities.
   (Rating =1 to 3; Weight: = 2)

2) Addressing Un(der)funded Needs:
   The conservation action represents a significant improvement or advance in wildlife conservation in that it provides support for a conservation effort that is not addressed by other funding sources, programs, or organizations.
   (Rating =1 to 3; Weight = 1)

3) Overall Importance of Georgia Efforts

The conservation action addresses wildlife conservation needs that are unique to Georgia (e.g., endemic species) or for which Georgia serves a key role geographically or strategically.
(Rating =1 to 3; Weight = 3)

4) Timeliness or Urgency
The conservation action addresses a problem that is particularly urgent. If this specific action is not implemented or continued in the next ten years, Georgia will experience a significant loss of biological diversity or habitat quality.
(Rating =1 to 3; Weight = 3)

5) Connections with Other Conservation Actions
The conservation action serves as a critical component that enables or facilitates one to several other important conservation measures. Without this component, other efforts will be crippled or made ineffectual.
(Rating =1 to 3; Weight = 2)

6) Building Public Support for Wildlife Conservation
The conservation action is likely to increase overall public support for wildlife conservation. The benefits of the action will be readily apparent to the public, or the project itself will focus on increasing public support for conservation.
(Rating =1 to 3; Weight = 2)

7) Probability of Success
The conservation action is likely to succeed because it employs tested methodologies, has strong support from stakeholders, and has clearly identified and readily achievable objectives.
(Rating =1 to 3; Weight = 2)

[NOTE: Rating reflects relative contribution or significance of a conservation action for a particular factor (1 = Low; 2 = Medium; 3 = High). Weight is a multiplier of the rating and indicates relative contribution of that criterion to the total score. Maximum total score = 45 points.]

The technical teams assessed the contribution of each conservation action for each of these criteria and assigned scores based on those assessments. The resulting point totals were used to sort the conservation actions into three categories: very high priority (41-45 points), high priority (36-40 points), and medium priority (27-35 points). Conservation actions scoring less than 27 points were deleted from the list.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
1	Assess Status of High Priority Habitats	Implement statewide habitat mapping effort and conduct assessments of rare natural communities and habitats that support species of conservation need.	Survey	Proposed	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants other federal sources, private foundations	DNR, contractors	NatureServe, TNC, public and private landowners
2	Assess Status of High Priority Species	Conduct surveys for rare plants known historically from Georgia	Survey	Proposed	Numerous	All	All	Nongame Wildlife Fund, USFWS	DNR	Contractors and taxonomic specialists
3	Assess Status of High Priority Species	Conduct surveys for undersampled high priority mammals (e.g. spotted skunk, humpback whale) and assess conservation needs.	Survey	Proposed	Spotted skunk - essentially statewide in a variety of habitats; Humpback whale - marine habitats	All	All	State Wildlife Grants, USFS, UGA, NMFS	DNR	USFS, UGA, NMFS, Provincetown Center for Coastal Studies

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
1	Implement a statewide habitat mapping initiative to inform conservation efforts at multiple scales. Assess the status and distribution of natural communities using revised natural community classification system. Survey known existing, historic, and probable locations of rare natural communities, assessing conservation status and conducting botanical and zoological surveys	VH	Although there are coarse landcover analyses for Georgia, none have thoroughly assessed fine-scale natural community types at a state level. Few of the rarest natural communities in Georgia have been adequately described using the ecological framework developed by NatureServe. In particular, very little is known about the current distribution and abundance of rare wetland habitats in NW Georgia. These wetland communities are currently under increased threat due to residential and commerical development. Systematic surveys and assessments of these and other high priority habitats are needed to better determine the distribution and condition as well as protection and management priorities. A statewide habitat data layer is needed to inform local, state and regional land conservation efforts.	GIS coverages and descriptions of natural communities, assessments of abundance and condition, addition of natural community records into Biotics.	Statewide GIS coverage and descriptions of natural communities; assessments of threats and status, addition of community records into Biotics, recommendations for protection and management of high proirity natural communities
2	Conduct field surveys for rare plants known to occur in Georgia but not observed in recent years.	H	Many of these species have not been observed in the state for more than 25 years and are in need of current status surveys to determine whether they have indeed been extirpated.	Distribution, habitat, and abundance data; documentation of sites visited and species observed; reports of status and condition of observed rare plant species populations and associated habitats; management recommendations	Number of updated records on the distribution and condition of globally rare plants in Georgia. Specific recommendations for protection and management of these populations.
3	Spotted skunk -- document occurrence using camera traps (citizen science effort). Humpback whales - document spatial and temporal extent of occurrence in Georgia waters	M	Spotted skunk -- there are growing recent concerns about this species throughout its range; very few records from Georgia, rarely encountered. Humpback whale - small numbers of humpback whales are observed in Georgia waters annually; need to assess whether numbers are increasing and if there are potential impacts that need to be managed; most of this work can be done opportunistically during existing right whale surveys	Spotted skunk -- occurrence locations, habitat and landscape data. Humpback whales - photo-identification data, genetics and effort-corrected aerial sighting data.	Spotted skunk -- occurrence records and survey effort coverage. Humpback whales - identification of whales utilizing Georgia waters seasonally, threats, identification of stock these whales belong to through photo-ID and genetics by cooperating with NMFS and Provincetown Center for Coastal Studies.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
4	Assess Status of High Priority Species	Assess Middle Georgia black bear population and habitat conservation needs; develop conservation plan for Ocmulgee River corridor	Survey, Conservation planning	Ongoing	*Ursus americanus/* Ocmulgee River floodplain	SP	Ocmulgee	DNR	DNR	UGA, NPCA, USFS, USFWS, Georgia Land Conservation Center, local governments, land trusts
5	Assess Status of High Priority Species	Assess populations of high priority terrestrial birds in the Coastal Plain (e.g. swallow-tailed kite, southeastern American kestrel, painted bunting, Henslow's sparrow).	Survey	Ongoing	*Elanoides forficatus,* bottomland hardwood forests *Falco sparverius paulus; Passerina ciris/scrub-shrub,* maritime forest, interdune scrub; *Ammodramus henslowii* , *Aimophila aestivalis* , other grassland birds; various early successional habitats	SP, SCP	Numerous	Nongame Wildlife Fund, USFWS, State Wildlife Grants, Altamaha River Cooperative for Stewardship & Research (ARCSR), USGS, UGA	DNR, USGS	Avian Research & Conserv. Institute; ARCSR; UGA; University of Georgia, Georgia Southern University, Georgia Power; University of Georgia, USFWS, Georgia Southern University, USGS-Patuxent, private barrier islands, SC DNR, NC Museum, NCWildComm , FL WCC
6	Assess Status of High Priority Species	Assess status of high priority bryophytes, lichens, and graminoids in Georgia.	Survey	Proposed	Numerous (all high priority bryophytes and graminoids)	All	All	Nongame Wildlife Fund, USFWS	DNR	University System of Georgia, contractors, taxonomic specialists

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
4	Periodically assess black bear population size and habitat utilization. Utilize model of habitat suitability and use to develop a conservation plan for this and associated species in the Ocmulgee River corridor.	H	This small, isolated black bear population is being pressured by surrounding development, resulting in loss of habitat. Opportunities to protect habitat for this species should be assessed in the context of providing protection to a broader complex of habitats in this portion of the Ocmulgee River corridor.	Numbers of bears, locations of home ranges and utilized habitats. Locations of other high priority species and habitats that could benefit from conservation efforts in this area.	Bear numbers, acreage used; estimates of amount of habitat needed to maintain population. Conservation objectives for Ocmulgee River corridor.
5	Use aerial/ground surveys and sightings to determine distribution and abundance of STKIs in GA., and identify critical nesting, roosting, and foraging areas. Monitor nests and radio-tag birds to evaluate nesting success, habitat use, site fidelity, threats, etc. Assess population of southeastern American kestrels nesting along powerline corridors and evaluate replacement nest structure. Conduct a status assessment of the Atlantic Coastal population of the painted bunting exploring factors affecting its survival and how to best manage habitat for it on public lands. Assess importance of Georgia as a wintering area for Henslow's Sparrow. Evaluate factors critical to sustaining populations of Bachman's Sparrow during the breeding season and winter.	H	Swallow-tailed kite surveys were initiated in 1997, and the data collected are instrumental in working toward the conservation and management of Georgia’s STKI population, and the long-term protection of this imperiled species. The southeastern American Kestrel is a species of high conservation concern, having lost much of its original nest habitat. This project explores various population parameters and use of various artificial nest cavities in a population nesting in power poles along a powerline in south Georgia. The Coastal Plain of Georgia may be a critical wintering area for Henslow's Sparrow and represents the center of the Bachman's Sparrow range. Evidence suggests that the Atlantic Coast population of Painted Bunting is very likely a separate species or subspecies from the interior breeding population. Both populations have undergone tremendous declines over the last few decades, particularly the Atlantic Coast population. This population likely numbers in the low 100,000s making it highly vulnerable to extirpation.	Swallow-tailed kites - sightings, nests and site fidelity, estimates of productivity, nesting and foraging habitats, movement patterns, diet. Kestrel - nesting success and fecundity, preferences in nesting structures. Painted bunting - abundance, levels of predation, parasitism; habitat parameters; Henslow's Sparrow - presence, abundance, habitat preferences; Bachman's Sparrow - relative abundance, density, population size, and habitat quality.	Swallow-tailed kites - distribution, abundance, productivity, and survival, identification of nesting and foraging habitats, land-use or habitat associations. Southeastern American kestrel - number of nest sites surveyed, nesting success with replacement structures. Painted bunting - estimated number of breeding pairs or population size, population trends, effects of habitat management efforts. Henslow's Sparrow - Number of sites surveyed and relative abundance/density. Bachman's Sparrow - breeding population size estimate, micro-habitat feature determination.
6	Survey known existing and historic sites, as well as likely habitat for high priority mosses, liverworts,lichens, and graminoids. Conduct field surveys for recognized rare species and herbarium work to determine historic locations. Consult with taxonomic experts and knowledgeable field botanists on range, habitat needs, and conservation status of these species.	H	Little is known about the current distribution and abundance of mosses, liverworts, lichens, and graminoids in the state. Based on the SWAP evaluation of rare plants, it is clear that there are numerous globally rare species in need of current status surveys.	Distribution, habitat, and abundance data. Documentation of sites visited and species observed; reports of status and condition of observed rare plant species populations and associated habitats; management recommendations	Updated data on the distribution and condition of globally rare plants in Georgia. More specific recommendations for protection and management of these populations.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
7	Assess Status of High Priority Species	Conduct aerial surveys for federally listed birds (bald eagle nesting surveys; wood stork nesting and roosting surveys).	Survey	Ongoing	*Haliaeetus leucocephalus, Mycteria americana*	All	All	Nongame Wildlife Fund, ESA Section 6	DNR	USFWS, University of Georgia, Others
8	Assess Status of High Priority Species	Conduct Armuchee Creek aquatic species surveys	Survey, Monitoring	Proposed	Numerous	SA-RV	Oostanaula	State Wildlife Grants, other Federal Funds	DNR or USFWS	TNC
9	Assess Status of High Priority Species	Conduct assessments of federal petitioned and candidate species, as well as undersampled high priority species not currently under federal review. Work with other state agencies in the region to implement the Southeast At-Risk Species Plan	Survey, Database	Ongoing	Numerous	All	All	Section 6, State Wildlife Grants, other federal grants, Nongame Wildlife Fund.	DNR, USFWS, other Southeastern states	UGA, Joseph Jones Ecological Research Center, private contractors
10	Assess Status of High Priority Species	Conduct disease testing of vulnerable amphibians and reptiles	Research, Survey	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Section 6	DNR	SCWDS, University of Tennessee
11	Assess Status of High Priority Species	Conduct Gulf Slope mussel surveys	Survey, Monitoring	Proposed	Suwanee Moccasinshell, Ochlockonee Mocassinshell, Suwanee Pigtoe, Oval Pigtoe, and Shinyrayed Pocketbook.	SP	Numerous	State Wildlife Grants	DNR, USFWS	

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
7	Conduct statewide monitoring of nesting bald eagles, relyiing primarily on helicopters surveys. Conduct aerial surveys for wood storks each spring to identify and monitor nesting colonies; develop techniques for aerial estimates of colony productivity using low altitude digital photography. Work with landowners to manage nest sites.	H	These survey projects are needed for monitoring recovery efforts for federally listed species nesting in Georgia. The bald eagle survey efforts have been deemphasized in recent years, but wood stork survey efforts continue to be an important component of WRD's recovery efforts.	Bald eagles - nest occupancy, specific nest site locations, fledglings per nest. Wood storks - number of nests, nest and chick survival to fledging, productivity estimates, number of colonies.	Number of active colonies (wood storks); number of nests constructed; number of birds hatched and fledged per year. Productivity estimates for wood storks developed regionally to give U.S. Wood Stork productivity for Recovery Plan goals.
8	Survey for fishes, mussels and crayfish in the Armuchee Creek system. The goal would be to document full diversity and establish a baseline for long-term monitoring	M	Armuchee Creek is a high quality tributary in the Coosa drainage, with the potential to support several high priority aquatic species. It has only been surveyed at a few sites. The system is threatened by nutrient pollution, development, and the development of springs for water supply.	Species presence at survey sites	Number of high priority species persisting in the watershed; number of new high priority species discovered during survey.
9	Georgia is home to over 100 species that are under federal review by USFWS as candidate species or species that have been formally petitioned for listing. We will be assisting the Service by conducting status surveys, providing status reports, and providing input into range-wide conservation plans for these at-risk species.	VH	The current status of many of these species is unknown or poorly known. To properly inform any listing decisions, status surveys on these species are necessary.	Various, including population estimates, catch per unit effort, relative abundance, threats to viability.	Information on distribution, overall abundance, and viability of populations in state; number of species listings precluded and conservation plans implemented.
10	Potentially or known-to-be vulnerable high priority amphibians and reptiles will be sampled for emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.	H	Newly emerging diseases are a growing conservation concern for many of our priority species, some of which are known to be highly susceptible while others have been unchallenged thus far but are potentially vulnerable. Diseases and disease-causing pathogens include Snake Fungal Disease (potentially harmful to all snake species), Upper Respiratory Tract Disease (affects gopher tortoises and box turtles), ranavirus (affects many amphibians and some turtles; gopher frogs are highly vulnerable based on laboratory trials), and amphibian chytrid fungi (Batrachochytrium dendrobatidis and B. salamandrivorans).	Positive and negative detections, health status	Number of positive detections per species sampled, population effects
11	Survey mussels in poorly sampled stream reaches in the Ochlockonee, Withlacoochee and Suwanee basins. Species of interest include Suwanee Moccasinshell, Ochlockonee Mocassinshell, Suwanee Pigtoe, Oval Pigtoe, and Shinyrayed Pocketbook.	H	There are many streams in Gulf Slope drainages of Georgia with the potential to harbor unknown populations of high priority mollusks. Documenting new or updated occurrences of these species is needed for status assessment and to plan conservation efforts. This area has been much less surveyed than the	Species presence, species relative abundance, habitat quality	Number of species with completed surveys and status assessments

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
12	Assess Status of High Priority Species	Conduct midwinter waterbird survey and piping plover winter survey; conduct research and surveys on southeastern red knot and whimbrels; investigate American oystercatcher ecology and demographics	Survey	Ongoing	33 species of outer barrier beach affiliated wintering waterbirds, emphasis on *Charadrius melodus, Calidris canutus, Limosa fedoa, and Haematopus palliatus*	SCP	Atlantic Coastal Plain	Nongame Wildlife Fund	DNR, Audubon, NC State University	USFWS, ACOE, St. Catherines Island Foundation, Sapelo Estuartine Research Reserve, Ogeechee Audubon, Coastal Audubon, TNC, Sea Island Company, Cumberland Island Homeowners Association., NPS
13	Assess Status of High Priority Species	Conduct surveys for Black Rails in high marsh areas of saltmarsh and possibly other shallowly flooded freshwater habitats	Survey	Ongoing, Proposed	Black Rail	SP, SCP, PD	All SP, SCP, and PD drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	Black Rail working group, Little St. Simons Island, U.S. Fish and Wildlife Service, Center for Conservation Biology
14	Assess Status of High Priority Species	Conduct surveys for high priority bats	Research, Survey	Ongoing	*Corynorhinus rafinesquii,* All *Myotis* spp., *Lasiurus intermedius, Perimyotis subflavus*	All	All	State Wildlife Grants, GDOT, UGA	DNR	USFS, USFWS, GDOT, UGA, GA Museum of Natural History, Eco-Tech, Ecological Solutions

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
12	Complete winter beach survey conducted in late January, over a period 1.5 hrs. before and after high tide. Also, continue red knot surveys by researchers from Manomet, USFWS, volunteers and DNR, as well as surveys of whimbrels conducted by DNR staff. For American oystercatcher - promote, support, coordinate local and regional studies examining migration patterns, life history parameters, recruitment, longevity, age and sex ratios and identify important range-wide population centers.	VH	Annual midwinter survey incorporates International Winter Piping Plover Survey conducted by the USFWS every 5 years. Georgia is the only state to conduct this type of survey targeting shorebirds. The Altamaha River Delta is the only major fall staging area for Red Knots on the Atlantic coast. Although the Eastern Arctic population of red knots has declined by more than 50% in the last ten years, the entire SE population (12,000) stages on the Altamaha prior to dispersal to other SE states. This group is showing insular qualities and appears to be more stable. Continued studies are needed to determine the ecological and biological parameters that support this unique group of knots. American oystercatcher is a high profile estuarine inhabitant and beach nester. Management protocols for this species will have implications for large assemblage of beach nesting obligate species.	Distribution of wintering shorebirds and seabirds; location data for shorebird roosts. Red knot - numbers, habitat use, age ratios, band resight data, sex ratios, body weights, physical condition, temporal use and turnover, contaminant exposure, forage species, feeding rates. Whimbrel - flock counts at Gould's Inlet. American oystercatcher - life history, population demographics, disturbance and depredation, migration, wintering, nesting ranges, health parameters.	Reports from each island are generated with regional priority species highlighted. Peer review of manuscripts and publication expected. Data made available to the public through the GOS website and used toward species trend assesment in Program for Regional and International Shorebird Monitoring Program (PRISM)
13	Continuation and possible expansion of survey work started recently under Imperiled Species funding from USFWS. This would include vocalization playback surveys in appropriate high marsh habitats and possible expansion of these surveys to shallowly flooded freshwater habitats inland in the Coastal Plain and Piedmont.	VH	This species has been decline for over a century. More recent surveys in the mid-Atlantic indicate that it may have declined by as much as 75-90% over the last two decades. This bird is considered one of the highest priority bird species in need of conservation action in the U.S. Sea level rise and other factors are the most significant threats.	Presence and abundance data over several years.	Number of sites where Black Rails are present as well as number of individual birds present.
14	Survey within suitable habitat for presence of species of concern, track individuals to roost sites, formulate conservation strategy	H	More information is needed to better determine the range and abundance of these high priority species. Better distribution information will allow for more targeted sampling and a focus for potential mitigation efforts in high priority bat habitats.	New locations of occurrence, identification of important foraging and roosting sites, threats, movements, document declines from WNS	Number of new occurrence records, number of roost sites, number of threats addressed

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
15	Assess Status of High Priority Species	Conduct surveys for Yellow Rail in pine flatwoods and similar sites as well as other shallowly flooded habitats	Survey	Proposed	Yellow Rail	SP, SCP	All SP and SCP drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	
16	Assess Status of High Priority Species	Conduct Upper Coosa mollusk surveys	Survey, Monitoring	Proposed	Numerous	RV, BR	Numerous	State Wildlife Grants	DNR, USFWS	TNC, Kennesaw State University
17	Assess Status of High Priority Species	Conduct Upper Nottely River aquatic species surveys	Survey, Monitoring	Ongoing	Sicklefin Redhorse	BR	Hiwassee	State Wildlife Grants	DNR	Young Harris College, USFWS-Asheville
18	Assess Status of High Priority Species	Continue calling frog survey routes as part of the North American Amphibian Monitoring Program	Survey, Monitoring	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants	USGS-Patuxent, DNR	USGS-Patuxent, DNR, volunteers
19	Assess Status of High Priority Species	Continue Conasauga River fishes monitoring	Survey, Monitoring	Ongoing	Numerous	RV, BR	Conasauga	USFWS, Nongame Wildlife Fund	DNR	GMNH
20	Assess Status of High Priority Species	Continue Etowah River aquatic species and water quality monitoring	Survey and Monitoring	Ongoing	Numerous	PD, BR	Etowah	Section 6	DNR, USFWS	GMNH

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
15	This would be a preliminary effort to assess where Yellow rails occur in the state and in what numbers. Most effort would be concentrated in shallowly flooded to mesic pine flatwoods and similar habitats at night. Researchers in Alabama and Mississippi have developed a technique similar to the one we use for Henslow's Sparrow surveys (flush netting) that is effective at night for Yellow Rails. They have captured many birds in areas similar to those where we catch Henslow's Sparrows during the daytime.	H	This would be the first attempt in the state to quantify Georgia's importance to wintering habitat of this rare and declining species. At several sites survey logistics could be piggy-backed on those for Henslow's Sparrows, basically running Henslow's surveys at a site during the day and then a Yellow Rail survey at the same site at night.	Presence and abundance data over several years.	Number of sites where Yellow Rails are present as well as number of individual birds present.
16	Implement occupancy sampling for freshwater mussels and snails in the under sampled reaches of the upper Coosa, including Coosawattee, Oostanaula, and Chattooga rivers. We will use our Conservation Status Assessment Maps, and other data sets, to identify under-sampled reaches in the Coosa system.	H	There are many stream reaches in the upper Coosa system in Georgia with the potential to harbor unknown populations of high priority mollusks. Documenting new or updated occurrences of these species is needed for status assessment and to plan conservation efforts.	Species presence/absence at sites throughout the Coosa. Estimate of species occupany, corrected for incomplete detection.	Number of new or updated occurrences documented.
17	Survey for rare fishes, mussels, and crayfishes in Nottely River mainstem, upstream of Lake Chatuge. This reach has not been thoroughly surveyed for rare aquatic species. Assess potential for stream to support Sicklefin Redhorse.	M	The Upper Nottely River still maintains moderate to high quality moutain river habitat. It has not been extensively surveyed anc could support undocumented populations of rare aquatic species. It is within the historic range of the Sicklefin Redhorse, and the upper Nottely could be a potential reintroduction site.	Lists of species at multiple sites on the mainstem Nottely River, habitat data	Number of new populations documented, report documenting habitat quality for Sicklefin Redhorse
18	Continue coordinating NAAMP in GA and recruit new surveys in an effort to increase the number of routes.	H	NAAMP is the primary source for information on population trends of frog species on state, regional, and national scales. Increasing the number of routes run each year will improve the statistical power to detect significant changes in frog populations, allowing quicker and more accurate detection of changes thereby speeding up subsequent conservation actions.	5-minute point counts at 10 stops per route.	Number of volunteers and routes added.
19	Continue Conasauga River mainstem monitoring of fishes and water quality. Expand project to include mussels and other rare aquatic species as appropriate. Integrate results with ongoing water quality and contaminant studies in this watershed.	H	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. Long-term monitoring of high priority aquatic species is needed to ensure that species persist and are responding positively to management actions. The GMNH has been monitoring fishes in this watershed since the late 1990s and we plan to continue this monitoring with Section 6 funds	Species occupancy, habitat and water quality data, estimates of abundance, etc.	Proportion of native species with stable or increasing occupancy rates across sites
20	Continue Etowah River mainstem monitoring of fishes and water quality. Consider expansion of project to include other rare aquatic species (such as the Etowah Crayfish) as appropriate.	M	The Etowah River System is one of the richest drainages in Georgia (and the US) and provides habitat for several globally imperiled species. Long-term monitoring of high priority aquatic species is needed to ensure that species persist and are responding positively to management actions. The GMNH has been monitoring fishes in this watershed since the late 1990s and we plan to continue this monitoring with Section 6 funds	Species occupancy, habitat and water quality data, estimates of abundance, etc.	Proportion of native species with stable or increasing occupancy rates across sites

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
21	Assess Status of High Priority Species	Continue Flint River and Sawhatchee Creek mussel monitoring	Survey, Monitoring	Ongoing	Numerous	SP	Lower Flint, Lower Chattahoochee	State Wildlife Grants	DNR, USFWS	Flint Riverkeeper
22	Assess Status of High Priority Species	Continue Line Transect Distance Sampling (LTDS) of gopher tortoise populations	Survey, Monitoring	Ongoing	*Gopherus polyphemus*	SP, SCP	Numerous	State Wildlife Grants, Section 6	DNR	Joseph Jones Ecological Research Center
23	Assess Status of High Priority Species	Continue long-term monitoring of Pigeon Mountain salamander and other cave-inhabiting salamander populations; conduct surveys for other high priority cave and outcrop species.	Survey, Monitoring	Ongoing	*Plethodon petraeus* ; other cave and outcrop inhabiting salamander species, including *Aneides aeneus*	SA-RV	Tennessee	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6	DNR	Piedmont College
24	Assess Status of High Priority Species	Continue monitoring hellbender and eastern indigo snake occupancy	Survey, Monitorng	Ongoing	*Cryptobranchus alleganiensis, Drymarchon couperi*	SA-RV, BR, SP, SCP	All Coastal Plain watersheds, Tennessee drainage	State Wildlife Grants, Section 6	DNR	The Orianne Society
25	Assess Status of High Priority Species	Continue to explore use of eDNA sampling to survey for cryptic amphibian and fish species	Research, Survey	Ongoing, Proposed	*Eurycea aquatica, Urspelerpes brucei, Gyrinophilus palleucus, Ambystoma cingulatum, Ambystoma bishopi, Enneacanthus chaetodon,* others	All	All	State Wildlife Grants, Section 6	DNR	DOD, USFS, USGS, The Orianne Society, Warm Springs Fish Technology Center, Charles H. Wharton Conservation Center

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
21	Continue monitoring freshwater mussel populations in key sites in the lower Flint River Basin and Sawhatchee Creek (lower Chattahoochee). This work has been ongoing by WRD and partners since the mid 2000s	H	Mussel populations in this part of the state are impacted by low stream flows associated with drought and human water use. Monitoring is necessary to ensure that species persist and also to identify the flows needed for mussel survival and recruitment	Mussel survival, growth, recruitment and occupancy rates	Number of mussels with stable or increasing populations
22	LTDS is the standard rangewide method for estimating gopher tortoise population sizes and age distribution. The Candidate Conservation Agreement (CCA) that WRD is a party to requires periodic (every 7-10) population monitoring of tortoises on state lands using this methodology	VH	This is required by the CCA and will allow us to evaluate the reponse of our habitat management and conservation efforts for the tortoise on state lands and select private lands over time.	Number of tortoises detected per site, burrow occupancy rates, burrow widths as a refernce for age class distribution, population estimates, high priority burrow commensal presence	Stable or increasing population sizes, representation of all size classes indicating good recruitment
23	Seasonal counts of salamanders at Pigeon and Lookout mountains will provide information on species stability over time.	H	The Pigeon Mountain Salamander is a very restricted species and thus is especially vulnerable to endangerment or extinction in the event of significant, localized disturbance. Monitoring known populations will allow for detection of status changes and permit timely conservation actions to be implemented if necessary.	Time or area constrained counts of individual salamanders, habitat quality evaluation	Relative abundance of Pigeon Mountain and other cave-inhabiting salamanders between sites and over time; changes in habitat quality
24	Eastern indigo snake occupancy monitoring has been employed at selected sites in the sandhills of the lower Altamaha River basin and will be periodically (every 2-3 years) continued here and expanded to other areas (likely Alapaha and Satilla river sandhills). Similarly, occupancy modeling has been used to monitor eastern hellbender populations in select mountain streams and will be continued every three years.	H	A critical component of successful conservation efforts involves monitoring to evaluate the population stability of the target organisms. Eastern indigo snakes and hellbenders are relatively easy to sample for and lend themselves well to this approach	Observations/captures per site, per year	Stable or increasing occupancy trends
25	Many amphibians and fishes are difficult or unreliable to detect with standard techniques. DNA from sloughed skin cells can be filtered from water, run through PCR, and identified to species.	M	eDNA analyses allow easy detection of species presence for species that are difficult to catch, occur in inhospitable habitats, or only spend a limited time in a site of interest. This technology has the potential to discover new populations of rare species that are otherwise difficult to document. We are currently attempting this with Blackbanded Sunfish in southwest Georga	Number of positive eDNA detections in known (control) and new locations; number of eDNA samples required for a high probability of detecting the species when present	Number of new populations discovered

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
26	Assess Status of High Priority Species	Determine population demographics (size, nesting success, productivity, etc.) for MacGillivray's Seaside Sparrows	Research, Survey	Ongoing, Proposed	Seaside Sparrow	SCP	All Atlantic drainage watersheds	State Wildlife Grants, Nongame Wildlife Fund	DNR	UGA, other universities, U.S. Fish and Wildlife Service, SE saltmarsh bird working group, possibly National Audubon
27	Assess Status of High Priority Species	Evaluate status and distribution of high priority snails	Survey, Monitoring	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR	USFWS, Kennesaw State University
28	Assess Status of High Priority Species	Expand Breeding Bird Survey routes	Survey	Ongoing	Numerous	All	All	Nongame Wildlife Fund	USGS-Patuxent, DNR	USGS-Patuxent, DNR, GOS and Audubon volunteers
29	Assess Status of High Priority Species	Explore use of detection dogs to survey for cryptic reptile species	Research, Survey	Proposed	*Heterodon simus, Ophisaurus mimicus* , others	SP, SCP	Numerous	State Wildlife Grants, Section 6	DNR	DOD, The Orianne Society, private contractors
30	Assess Status of High Priority Species	Implement Altamaha mussel monitoring	Survey, Monitoring	Proposed	Altamaha Spinymussel	SP, SCP	Numerous	State Wildlife Grants or other federal funds, Nongame Wildlife Fund	DNR	USFWS, Academia, Altamaha Riverkeeper
31	Assess Status of High Priority Species	Implement Tallapoosa aquatic species monitoring	Survey, Monitoring	Proposed	Numerous	PD	Tallapoosa	State Wildlife Grants	DNR, USFWS	TNC, Kennesaw State University, GMNH, Auburn

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
26	This would be a study to look at key demographics for nesting MacGillivray's Seaside Sparrow in the Georgia saltmarsh. Preliminary work is being done by a UGA graduate student using a special Imperiled Species allocation. This work should be expand to include additional sites and look at additional demographics that affect the long-term productivity and survivorship of this saltmarsh obligate bird.	VH	This work would allow us to better understand the factors that limit Seaside Sparrow reproduction along the coast and would be a key piece of information aiding long-term efforts to mitigate the affects of sea level rise on this species as well as other species that use the saltmarsh for all or a portion of their life cycle.	Annual population estimates. Nesting success and productivity at several index sites.	Breeding population numbers.
27	This project would examine historic and potential new sites for high priority snail species, documenting information on species presence, relative abundance and potential threats.	VH	Survey needs for 16 globally imperiled (G1-G2) snails were identified during the SWAP revision. Many of these species occupy unique habitats and may not necessarily be conserved due to co-location with other imperiled species.	Species presence, species relative abundance, habitat quality	Number of species with completed surveys and status assessments
28	Expand number of BBS routes and maintain at roughly 85-90 implemented per year. Utilize network of citizen scientists to provide data that will inform conservation efforts for birds.	M	The BBS is the major source for information on population trends of bird species. By increasing the number of routes to about 100, we could reasonably expect to have 85-90 run each year. With this many routes run each year the statistical power to detect significant changes in bird populations would be increased to a level that would allow quicker and more accurate detection of changes thereby speeding up subsequent conservation actions.	3-minute point counts at 50 stops per route. Adding about 40 routes would give us 2000 more sampling points per year with very little effort invested.	Number of routes added and maintained.
29	Some reptile species are very difficult to detect because they spend much of their time under cover or below the ground. Specially trained dection dogs have been useful for determining presence of rare animals and plants.	M	Detection dogs can be trained to smell the presence of species that are difficult to find by standard techniques. Positive detections will inform biologists of areas where to concentrate more standard survey efforts.	Positive and negative detections; habitat at detection sites	Presence of high priority species documented
30	Continue Altamaha mussel occupancy surveys that were carried out in mid 2000s, focusing on the Altamaha Spinymussel.	M	The Altamaha Spinymussel has an extremely restricted range and is Federally Endangered. In addition to monitoring, this study could also find specimens needed for host-fish trials.	Proportion of sites occupied, corrected for incomplete species detection	Proportion of sites occuppied by Altamaha Spinymussel and other co-occurring mussel species.
31	Continue Tallapoosa aquatic community surveys that were carried out in the 1990s and early 2000s by UGA and Auburn. Continuing this decadal monitoring data set will help WRD track the status of a large number of imperiled aquatic species	M	Continuing this decadal monitoring data set will help us track the status of a large number of imperiled aquatic species	Proportion of sites occupied by each target species	Number of species with stable or increasing proportion of sites occupied

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
32	Assess Status of High Priority Species	Implement the 2013 Georgia White Nose Syndrome Response Plan.	Monitoring, Research, Management	Ongoing	Bat species	SA-RV, SP, BR	Numerous	State Wildlife Grants, USFWS, USFS, Nongame Wildlife Fund	DNR, USFWS, USFS	USFWS, USFS, other federal agencies, GFC, other state agencies, GA Museum of Natural History, BCI, Eco-Tech, Ecological Solutions, SCWDS, universities
33	Assess Status of High Priority Species	Monitor populations of gray bats and southeastern bats in caves	Monitoring	Ongoing	*Myotis grisescens, Myotis austroriparius;*	SA-RV, SP	Numerous	State Wildlife Grants, Southern Wildlife Consultants, UGA	DNR	Southeastern Cave Conservancy, Joseph Jones Ecological Research Center, UGA, Clemson, Southern Wildlife Consultants
34	Assess Status of High Priority Species	Monitor reproductive activity at known,recently extant ponds used by pond-breeding amphibians	Survey, Monitoring	Ongoing, Proposed	*Rana capito, Notophthalmus perstriatus, Ambystoma cingulatum, A. bishopi, A. tigrinum*	SP, SCP, SA-RV	All Coastal Plain watersheds, Tennessee, Coosa	State Wildlife Grants, Section 6	DNR	DoD, Joseph Jones Ecological Research Center
35	Conserve High Priority Habitats	Conduct Aquatic Conservation Planning Meetings for Coosa, Tennessee, Atlantic Slope and Gulf drainages	Conservation Planning	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR	USFWS, TNC, River Basin Center, stakeholder groups in each region
36	Conserve High Priority Habitats	Conduct aquatic species outreach in high priority watersheds	Outreach, Education	Proposed	Numerous	All	Numerous	State Wildlife Grants, private foundations	DNR, USFWS, Georgia River Network	Local governments and watershed groups

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
32	Conduct white nose syndrome monitoring and research. Annual monitoring of caves with populations of bats currently affected or likely to be affected by WNS. Count bats and coordinate with researchers studying the disease and potential treatment options. Other actions may include increase awareness, prevent spread of disease, early detection, increase baseline information on bat populations, management and regulatory actions, and communication.	H	WNS is causing significant declines in cave dwelling bats in N. GA. The disease is continuing to spread south and may eventually move into caves in S. GA. It is critical to document the spread, declines and help with research to study and potentially treat this disease. The 2013 WNS Response Plan outlines a coordinated multi-agency response to WNS in the state.	Numbers of and species of bats at cave sites, samples of fungus, documentation of condition of survivors, temperature and humidity data, estimates of mortality from WNS	Documentation of numbers of surviving bats, successful treatment of WNS, population trends over time, recommendations from the plan relevant to the next 10 years implemented
33	Annual summertime monitoring of known caves that serve as regular summer roosts	H	Small disturbances at cave sites could result in large changes in populations of bats.	Numbers of bats of these two species in each cave, potential threats	Estimated population sizes and trends of these bats
34	These species have been reduced to few sites within the state that provide adequate habitat. All or a subset of the breeding sites for each species will be annually sampled to assess persistence.	H	Because the number of sites where these species persist are few, it is important that they be monitored regularly to evaluate their status and continued suitability and to identify any conservation actions that may be needed to better ensure persistence	Number/presence of egg masses, number/presence of calling frogs, number/presence of larvae or aquatic adults	Number of sites sampled that continue to harbor target species
35	Host regular aquatic conservation planning meetings for major basins in the state, similar to the Coosa Summit. Workshops would include presentations on major research and conservation projects as well as a meeting to discuss future conservation priorities. Meetings would be held at least once every 5 years in each basin. The initial meeting could review results of SWAP and help identify specific actions for high priority watersheds. Participants would include agencies, watershed groups, and other stakeholders. Smaller meetings with key partners could take place annually to stay coordinated on active projects.	VH	If you include all of the partners in the state, there is substantial capacity for aquatic conservation. However, there is no framework for deciding which group will take the lead on a particular issue. In addition to increased coordination, these meetings will provide an opportunity to share SWAP priorities and projects with a broader group of stakeholders and gather input for future projects	None	One major meeting every five years in each basin.
36	Hold at least one aquatic species and habitat outreach event in the top 10 high priority watersheds in the state before the next SWAP revision. Events would target government officials, watershed groups, and children. Present live animals to the public.	H	Most people have no idea what is swimming in their backyard. If we can get people excited about native aquatic species, then they are more likely to become stewards of aquatic resources and support efforts to protect rivers	Number of outreach events, number of attendees	Level of understanding of native species conservation needs in local watersheds.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
37	Conserve High Priority Habitats	Conduct aquatic species stressor study	Research	Proposed	Numerous	All	Numerous	State Wildlife Grants	USFWS or DNR	USGS, UGA, River Basin Center
38	Conserve High Priority Habitats	Conduct field inventory and landowner outreach to conserve coastal plain seepage bogs	Research, Survey, Management, Habitat Protection	Proposed	*Sarracenia spp., Balduina atropurpurea, Hypericum erythreae, Macranthera flammea, Rhynchospora solitaria, Sporobolus teretifolius* , others	SCP	Numerous	Nongame Wildlife Fund, State Wildlife Grants, ESA Section-6, other USFWS funds	DNR	GPCA and its member institutions
39	Conserve High Priority Habitats	Conserve key Swallow-tailed Kite nesting habitat along the Satilla River.	Habitat Protection	Proposed	Swallow-tailed Kite and suite of bottomland forest species that would benefit from habitat conservation	SCP	Satilla	State Wildlife Grants, Nongame Wildlife Fund	DNR	Satilla RiverKeeper, Plum Creek Timber, Ivanhoe Hunt Club
40	Conserve High Priority Habitats	Construct artificial isolated wetlands or improve existing ones by increasing hydroperiod	Management	Ongoing, Proposed	Pond-breeding amphibians/ isolated wetlands	SP, SCP	All Coastal Plain watersheds	State Wildlife Grants, Nongame Wildlife Fund	DNR	Private contractors, private landowners
41	Conserve High Priority Habitats	Continue Conasauga River water quality and contaminants study	Research	Ongoing	Numerous	RV	Conasauga	USFWS, State Wildlife Grants	USFWS	UGA, USGS

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
37	Examine relationships between stressors identified by SWAP aquatic habitat committee and conservation targets. For example, could examine relationship between landuse variables and occurrence probability of high priority species or groups of sensitive species such as fluvial specialists. The purpose of this project would be to identify key drivers of changes in aquatic diversity. It may also help identify the best groups of indicator species for monitoring of biotic integrity.	H	Understanding the landscape scale factors that affect aquatic communities is necessary for both preservation and restoration of aquatic communities. For example, if a goal is to improve biotic integrity of an impaired stream, this project could help identify which aquatic stressor should be addressed.	Extensive fish community data for this project has already been collected by the Georgia DNR Stream Survey Team. USFWS-Athens has already compiled data on landscape scale stressors.	A complete report documenting key stressors in different ecoregions. An interactive tool that can show how aquatic communities will change as stressors increase or decrease within a watershed
38	Develop a protocol for inventory of coastal plain herbaceous seepage bogs. Work in collaboration with biologists of other taxonomic groups, especially herpetofauna, birds, and terrestrial invertebrates to procure funding for an inventory of this high priority habitat and associated landowners within the longleaf pine sandhill ecosytem. Follow up with management of select high quality examples found during the survey.	VH	Coastal plain herbaceous seepage bogs are a high priority habitat for conservation. High or even medium quality examples of these bogs are few in the Atlantic and Gulf Coastal Plains of Georgia. Most are privately owned. Systematic inventory of known sites, strategic survey for new sites, and associated landowner contacts are essential components of this project. Collaborative surveys to meet needs of other taxonomic groups with priority species from the longleaf sandhill ecosystem would increase survey efficiency, funding opportunities, and learning among biologists. A standardized biological sampling protocol would be developed in collaboration with other biologists.	Location, plant community characteristics, species lists, habitat condition, threats, landowner contact, rare species data for Biotics	Number of bogs surveyed, number of landowners contacted
39	Work to conserve important stretches of the Satilla River based upon known long term nesting clusters for Kites, as well as important roosting areas through easements, WRP, purchase, working forest easements.	H	The Satilla River is one of the most important rivers in the state for nesting STKI. Because of their social structures (semi-colonial) and long term site fidelity, protecting known nesting areas is the most important step in the conservation of STKI in Georgia	Currently have years of nest location data on the river, as well as 3 years of roost data	Maintenance of breeding clusters. Stable to increasing state-wide population.
40	Excavate short-hydroperiod depressional wetlands and/or install flexible plastic liners to increase hydroperiod	M	Prolonged drought has been implicated in local extirpations of several high priority pond-breeding amphibians and declines in other pond-breeders. Climate models suggested increased duration and frequency of droughts. Increasing the hydroperiods of breeding wetlands, or creating new ones with long hydroperiods, will help mitigate against the loss of available natural breeding sites.	Hydroperiod of created and improved wetlands; species use and recruitment rates	Successful annual breeding and increased recruitment
41	Continue assessment of water quality and contaminants in the Conasauga River system. Identify major toxicological stressors and the tributaries or mainstem reaches that provide the greatest concentrations of stressors. Continue evaluation of ditches as a source for nutrients and herbicides (e.g., Round-Up)	VH	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. Species are declining in reaches impacted by agricultural activities, but precise mechanisms are unknown. Identification of stressors will help identify the best management practices to reduce water quality impacts associated with agricultural activities.	Concentrations of contaminants in water and sediment at sites along the length of the river, rates of intersex condition, growth and survival of species exposed to contaminants	Report documenting key stressors and suggested bmps

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
42	Conserve High Priority Habitats	Continue cooperative management for golden-winged warbler and other species requiring mid- to high-elevation early successional habitats in the Blue Ridge	Management	Ongoing, Proposed	*Vermivora chrysoptera*	BR	Tennessee, Savannah, Conasauga, Chattahoochee	Nongame Wildlife Fund, NCWC, USFS	USFS	DNR, NCWC, Cherokee National Forest
43	Conserve High Priority Habitats	Continue oyster reef restoration and enhancement	Research, Management	Ongoing	Eastern Oyster	SCP	All Coastal	State and Federal Funds, Private donations	CRD	EPA, NOAA, SFR, CCA, SARP, Oatland Island Wildlife Center, Americorps, UGA, CCGA, Isaak Walton League
44	Conserve High Priority Habitats	Continue Raccoon Creek Watershed Project	Habitat Protection	Ongoing	Etowah Darter, Cherokee Darter	PD	Etowah	Recovery Land Acquisition Grants, Local Governments, Partners for Fish and Wildlife	TNC	USFWS, WRD (NCS, GM), Paulding County, Georgia Power
45	Conserve High Priority Habitats	Control populations of feral hogs to conserve high priority habitats and species.	Management	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Funds	DNR	NPS, USFS, USFWS, DoD, private landowners, hunting public

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
42	Implement habitat management including burning regime to create and maintain breeding habitat (open oak woodlands as well as young forest stands interspersed with open, grassy patches) for golden-winged warblers. Conduct surveys to determine metapopulation status and response to management activities.	M	The golden-winged warbler is quickly losing its breeding habitat in the Southern Appalachians due to lack of a natural fire regime. Creation of suitable habitat through prescribed fire and timber harvest is necessary to conserve this unique metapopulation assemblage which occurs at very localized sites in Georgia and North Carolina.	Data on fire intensity, periodicity, and response of vegetation to prescribed fire. Response of golden-winged warblers to habitat manipulations through point counts and surveys that determine productivity and fecundity.	Number of acres of suitable breeding habitat restored and maintained. Estimates of population sizes for golden-winged warbler and other habitat associates.
43	Continue restoring and enhancing oyster reef communities along the coast through targeted restoration efforts outside of shellfish harvest areas, enhancements within shellfish harvest areas, and living shoreline implementation to restore oyster communities as well as salt marsh plant species.	VH	Oysters are a keystone species in tidal systems on the Georgia coast. It is believed that reefs have been negatively impacted over time for various reasons. CRD's Habitat Workgroup is focused on oyster restoration through various efforts such as living shorelines, restoration in public harvest areas and restoration for fish habitat.	Areal extent of oyster reef, areal extent and composition of vegetation, fixed benthic faunal composition, oyster recruitment availability, water quality metrics	Acreage of successful restoration efforts.
44	Continue land acquisition, restoration, and conservation actions in the Etowah River's Raccoon Creek basin. Continue to monitor target species populations as needed.	H	Raccoon Creek occurs within a high priority watershed in the current SWAP (high global significance score) and contains important populations of Etowah and Cherokee Darters. This project has been very successful at watershed-level conservation in an urbanizing landscape.	TNC has compiled information on fish passage problems, stream bank and channel stability, and other threats. We have been monitoring populations of Etowah and Cherokee Darter since 2009.	Number of stream miles restored, number of acres protected through easement and acquisition, persistence of target species throughout system
45	Increase hunting pressure on public and private lands and implement trapping and shooting programs in especially sensitive sites (e.g., barrier island beaches).	H	Feral hog depredation is a significant threat to sea turtle hatchling production. In addition, feral hogs can significantly impact herbaceous species composition in many natural communities and cause substantial declines in rare plant populations.	Number of hogs removed, effort data (hogs/trap night, hogs/hunting hrs.), sex, location of capture, age. Herbaceous species composition of selected natural communities.	Number of hogs removed. Amount of sea turtle nest depredation, Amount of hog sign in sensitive wildlife habitats. Herbaceous species composition and rare plant population size.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
46	Conserve High Priority Habitats	Develop a comprehensive action plan to control invasive exotic species on public and private lands. Increase public awareness of problems caused by invasive exotic plants; reduce use of exotic species and increase use of native plants in erosion control and landscaping	Conservation Planning, Education, Outreach	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, USGS, NPS, NFWF, NRCS	DNR, GFC, UGA, USFS, USFWS, NPS, NRCS	DoD, Georgia Exotic Pest Plant Council, TNC, APHIS, USGS, GDA, GDOT, Georgia WaterWise Council, Georgia Power, GSWCC, NatureServe, local volunteers
47	Conserve High Priority Habitats	Develop and implement water conservation measures to reduce need for new water supply reservoirs	Regulation, Education	Ongoing	Numerous	All	All	State and Federal Funds, Private donations	USFWS	EPA, EPD, WRD, USACE, private conservation organizations
48	Conserve High Priority Habitats	Develop environmental flow recommendations	Regulation, Policy	Proposed	Numerous	All	Numerous	Unknown	Unknown	USGS, USFWS, DNR, SIFN, UGA
49	Conserve High Priority Habitats	Develop Little Tennessee River System Watershed Plan	Conservation Planning	Ongoing	Greenfin Darter, Fatlips Minnow, Eastern Hellbender, Sicklefin Redhorse, Silver Shiner	BR	Tennessee	319 Grant Program, administered by EPD	EPD, City of Dillard	DNR, USFWS, Rabun Gap Nacoochee School, Orianne Society, Broadfork Environmental, Land Trust for the Little Tennessee, private landowners

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
46	Assess threats from invasive exotic species on public lands and prioritize specific sites and habitats for control efforts. Conduct field assessments on public lands. Coordinate control efforts with other land managing agencies and adjacent landowners where feasible. Work with partners to develop protocols for assessing, documenting, and addressing invasive exotic species on conservation lands. Provide training to public land managers and seek funding for specific exotic species control efforts. Work with local volunteer groups to implement control and monitoring programs for exotic species on conservation lands. Develop educational messages focusing on regional examples of problems caused by invasive exotic species. Work with nurseries to reduce trade in invasive exotic plants and develop recommendations for use of native plants in erosion control and landscaping. Review and update agency guidance on E&S control to remove references to noxious exotic plants and emphasize use of native plants or noninvasive exotics.	VH	Invasive exotic species represent one of the most serious threats to habitat quality and native species viability statewide. Control efforts for these species are generally expensive and/or labor-intensive. This problem must be addressed in a strategic manner to maximize local benefits to native species and natural habitats and avoid costly delays or excessive expenditures of limited resources. Emphasis should be placed on control efforts that will benefit high priority species and natural habitats (especially globally rare species and communities). Sharing technical expertise between managing agencies is another important objective of this effort. Establishing baseline data on existing exotic species populations and assessing relative threats based on best available data is the logical first step.	Exotic species occurrence data; size and extent of populations. Information on life history characteristics, control methods, etc. Assessments of threat and likelihood of control based on experiences in other states or locales. Impacts on natural habitats and rare species populations; control measures and alternatives to exotic species in landscaping, wildlife habitat enhancement, and erosion control.	Reduction in overall range or impacts of highest priority (most noxious) exotic species. Improved species composition of habitats on public lands and reduced impacts on native species populations. Increased awareness of exotic species control techniques by conservation land managers. Number of educational messages (brochures, web site links, FAQ sheets, etc.) provided to educational facilities, land managers, nurseries, and the general public. Number of projects utilizing native plant species for erosion control and landscaping.
47	Protect aquatic connectivity by finding alternatives to new reservoir construction, emphasizing water conservation measures and protection of high quality free-flowing streams.	VH	Reservoirs destroy lotic habitat and fragment populations of aquatic species.	Water conservation measures, purpose and need evaluation, alternative sites, and models of downstream and cumulative impacts.	Per capita water consumption rates; implementation of water conservation measures; number of new water supply reservoirs
48	Support development of environmental flow recommendations for southwest Georgia and other regions throughout the state. Identify the magnitude and timing of flows required to sustain ecosystems and humans.	VH	Stream flow has an overriding influence on water quality, aquatic habitat, and the availability of water for human uses. Low stream flows in southwest Georgia threaten the persistence of several globally imperiled freshwater species.	Various hydrological indicator variables	Maintenance of stream flows through drought, other indicators need to be developed
49	The city of Dillard has contracted with Jenny Sanders (Broadfork LLC) to develop a 319 Watershed Plan for the Little Tennessee River system in GA. The goal of the plan is to identify on-the-ground conservation projects that will improve water quality for people and aquatic species. USFWS and GADNR are serving on the Technical Advisory Committee for the plan.	H	The Little Tennessee Watershed provides habitat for a large number of aquatic species in GA and NC. Intensive planning and conservation efforts are ongoing in NC, but their success depends upon protection and restoration of the headwaters, which are in Georgia. Completing the plan will make the watershed eligible for additional 319 grant funding.	GIS layers of recent landuse, conservation lands, etc. Visual observations of potential impacts to water quality, such as cattle access, ditching, and reduced riparian buffers.	Number of on the ground conservation projects identified, Number of local stakeholders actively participating in the project.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
50	Conserve High Priority Habitats	Develop stream geomorphology database for Cherokee darters	Database, Conservation Planning	Proposed	Cherokee Darter	PD	Etowah	USFWS	USFWS	Stream Geomorphologists, Consulting Firms
51	Conserve High Priority Habitats	Experiment with sand fencing to increase elevation on key offshore bars	Research, Management	Proposed	Beach nesting birds that utilize off-shore bars to nest. Least Tern, Black Skimmer, Gull-billed Tern, American Oystercatcher and Wilsons Plover	SCP	Several	State Wildlife Grants, Nongame Wildlife Fund	DNR	
52	Conserve High Priority Habitats	Implement Conasauga River habitat conservation	Habitat Protection	Ongoing	Numerous	RV, BR	Conasauga	Recovery Land Acquistion Grants	USFWS	DNR, NRCS, TNC, Land Trusts
53	Conserve High Priority Habitats	Implement Lower Altamaha River habitat and water quality study	Research	Proposed	Numerous	SCP	Numerous	State Wildlife Grants	DNR	Academia, Altamaha Riverkeeper
54	Conserve High Priority Habitats	Implement Shoal Creek Watershed Project	Habitat Protection	Ongoing	Etowah Darter, Cherokee Darter, Etowah Crayfish	PD	Etowah	USFWS	USFWS	TNC, DNR
55	Conserve High Priority Habitats	Implement Smithwick Creek Watershed Project	Habitat Protection	Ongoing	Cherokee Darter	PD	Etowah	USFWS	USFWS	TNC, DNR
56	Conserve High Priority Habitats	Implement strategic habitat conservation in high priority watersheds to maintain aquatic diversity;	Conservation Planning, Habitat Protection	Ongoing	Numerous	All	Numerous	Recovery Land Acquisition Grants, Local Governments	USFWS, DNR, TNC	Local governments, conservation organizations, land trusts, private landowners

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
50	Develop a baseline database of stream geomorphic characteristics in high quality Cherokee Darter streams. Use these data to revise stream restoration methods commonly used in the Etowah basin. Ensure that development of habitat for benthic shoal-dwelling fishes is a primary restoration project component (where applicable).	H	There are substantial opportunities and required mitigation throughout the range of the Cherokee Darter. There is a need to ensure that stream restoration projects are effective.		
51	Low off-shore bars provide important nesting habitat for many beach nesting birds die to the lack of mammalian predators. These sites are often prone to flooding however. Short biodegradable sand fencing may be effective at building the elevation enough during the non-breeding season that nesting birds have less chance of losing their nests to flooding.	H	With sea level rise and the increased frequency of high tide events, off shore bars are threatened with higher flooding rates, leading to greater nest loss among some of our highest priority birds	Compare elevations of similar off-shore bars with and without fencing over time. Evaluate use of these bars by beach-nesting birds	Nest success on treatment sites vs. control sites
52	Protect critical reaches of the Conasauga River system through targeted acquisition and easements with willing landowners. Provide targeted outreach and technical transfer to farmers to help minimize agricultural impacts to river.	H	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. There are historic and emerging threats (e.g., contaminants) associated with agriculture, but these can be minimized through implementation of best managment practices		Area of land protected through easements and acquisition, area of land utilizing best practices to minimize impacts to streams.
53	Evaluate fish and mussel habitat and water quality in the lower Altamaha River.	M	This reach of the river has historically supported important populations of fishes and mussels. The discovery of juvenile Robust Redhorse in the lower Savannah River raises prospects that the lower Altamaha River could also be supporting this species. This reach has been well surveyed for sport fishes.	Water quality, fish and mussel density, and physical habitat data	Report or publication
54	Continue land acquisition, restoration, and conservation actions in the Etowah River's Shoal Creek basin (Dawson County), upstream of the City of Atlanta's Dawson Forest.	VH	Shoal Creek occurs within a high priority watershed in the current SWAP (Highest Global significance score). It contains important populations Cherokee and Etowah Darters and Etowah Crayfish. It is a direct tributary to a critical reach of the Etowah River where several high priority species occur. It is threatened by urbanization	USFWS has been working in this watershed for several years. Not sure what data already exists.	Number of stream miles restored, persistence of target species throughout system.
55	Continue land prioritization, acquisition, restoration, and conservation actions in the Etowah River's Smithwick Creek basin.	H	Smithwick Creek occurs within high priority watershed in the current SWAP (High Global significance score). It contains an important population of Cherokee Darters	USFWS has been working in this watershed since 2009. Not sure what data already exists.	Number of stream miles restored,, persistence of target species throughout system.
56	Following model used in Raccoon Creek Basin, protect critical parcels of land by acquiring land or conservation easements from willing sellers in high priority watersheds	VH	Targeted land acquistion, particularly in areas threatened by development, can avoid impacts to aquatic systems that can be difficult to reverse	GIS coverages of species locations, existing landcover, and conservation lands	Proportion of watershed protected; number of local populations conserved at viable levels

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
57	Conserve High Priority Habitats	Protect high priority species and habitats through the Statewide Water Planning Process	Conservation Planning	Proposed	Numerous	All	Numerous	State and Federal Funds, Private donations	DNR (EPD and WRD), GSWCC, Local governments, ARC, Metropolitan North Georgia Water Planning District, industries, county governments	River Basin Center, USFWS, TNC, numerous stakeholders
58	Conserve High Priority Habitats	Resolve the current difficulty in protecting newly created or emerging beach nest bird habitat	Management, Regulation	Ongoing, Proposed	All beach nesting birds. Least Tern, Gull-billed Tern, Black Skimmer, Royal Tern, Sandwich Tern, Brown Pelican, American Oystercatcher, Wilsons Plover	SCP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	DNR LED, Nongame, other coastal partners	St Catherines Island, Little St Simons Island, Little Cumberland Island, Cumberland Island National Seashore
59	Conserve High Priority Habitats	Restore mountain bogs; restore or enhance populations of rare bog plants; continue bog turtle headstart and population establishment efforts; monitor bog turtle populations	Management, Research, Education	Ongoing	Mountain bogs; *Glyptemys muhlenbergii; Helonias bullata*, *Sarracenia purpurea* ssp. *venosa* var. *montana*	BR	Ocoee, Hiwassee, Tugaloo, Upper Little Tennessee	ESA Section 6, Nongame Wildlife Fund, State Wildife Grants	DNR	USFWS, USFS, Chattahoochee Nature Center, Tennesee Aquarium, Atlanta Botanical Garden, State Botanical Garden of Georgia, other GPCA members, Charles H. Wharton Conservation Center, volunteers

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
57	A substantial effort was made to highlight rare aquatic species in each of the water planning regions of the state, with rare species information included in the state water plan. However, its not clear how this information will be used. We need to find additional opportunities for engagement and provide the councils with information on high priority watersheds for aquatic conservation.	VH	The development of water resources will have a large impact on high priority species and habitats as Georgia continues to grow into the future. The extent of the impact will depend on what practices are implemented by the water planning councils (e.g., reservoirs, withdrawals, conservation measures. Conservation goals for high priority species and habitats should be taken into consideration in the development of water resource plans.	Meetings and correspondence with water councils. Information and datasets provided.	Number of councils that can be briefed on SWAP goals to protect high priority watersheds and species.
58	While the Bird Island Rule protects several important nesting sites for beach nesting birds, there are newly created sites (Brunswick Dredge Island, Hupps Bar) that have become highly important to beach nesting birds, but since they are not listed in the Bird Island Rule, closures on these sites is difficult to enforce.	H	These sites are highly vulnerable to a number of threats. Natural sites tend to be very low, and prone to over wash. Since these sites are isolated however, they are free of mammalian predators, which means that productivity can be very high if human disturbance can be controlled.	Colony monitoring, posting and roping.	Increased productivity for beach nesting birds.
59	Restore mountain bog communities, augment or establish rare bog plant populations and continue restoration efforts for the bog turtle. Objectives include the headstarting of bog turtles and the restoration and maintenance of mountains by woody plant control and removal. A long-term goal of releasing approximately 20 juveniles per year is realistic and within the range necessary to successfully establish a population over a five to ten year period of releases.	H	Many of the characteristic species of mountain bogs have declined significantly due to lack of active management. The bog turtle is currently known from less than 10 sites in the state, only two of which are on public land and capable of sustaining a long-term viable population (with continued restoration and management). Few high-quality mountain bogs remain in Georgia, and most of these are in private ownership. Ensuring the continued survival of bog turtles and other bog species in Georgia may depend on protection and enhancement of the few remaining mountain bogs on public lands. If opportunities emerge to enhance bogs on private lands, these landowners will be offered regulatory relief and financial incentives.	Measures of vegetation structure and composition; population estimates for rare bog species; genetic samples of wild Georgia bog turtles; radio telemetry data on turtle movement, habitat utilization, and microhabitat preference at both recipient and donor sites; size and weight of turtles released and recaptured at recepient sites.	Restoration of mountain bog habitats including reduction of woody cover, expansion of Sphagnum, establishment / augmentation of rare species, and restoration of natural hydrology. Number of turtles released and maintained in restored habitat.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
60	Conserve High Priority Species	Conserve estuarine bottlenose dolphin stocks	Management, Research, Survey	Ongoing, Proposed	Bottlenose dolphins; estuarine and nearshore marine waters	SCP	All estuarine and nearshore marine waters	Nongame Wildlife Fund, NMFS, Additional Funding Needed	NMFS, DNR	NMFS, NOAA NOS, UGA, Savannah State University, Georgia Sea Turtle Center, etc.
61	Conserve High Priority Species	Implement manatee recovery plan	Management, Research, Survey	Ongoing	Manatees, Estuaries, Tidal Freshwater Rivers, Nearshore Marine	SCP	All tidal waters	USFWS ESA Section 6, U.S. Navy	USFWS, DNR	USFWS, DNR CRD & LED, USGS, Florida FWC, Navy, Sea to Shore Alliance, Georgia Aquarium
62	Conserve High Priority Species	Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of eastern diamondback rattlesnakes, and develop appropriate regulations.	Regulation	Proposed	*Crotalus adamanteus*	SP, SCP	N/A	N/A	DNR	PARC

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
60	Monitor estuarine dolphin stocks (estimate abundance, distribution, stock boundaries and population vital rates; document causes of mortality and serious injury by maintaining stranding network; assess health of Brunswick stock with biopsy sampling and capture health assessments); reduce and manage anthropogenic impacts (persistent environmental contaminants; commercial and recreational fisheries, dolphin feeding and harassment; implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities); conduct targeted research (satellite telemetry); educate stakeholders and user groups	M	Brunswick stock is high monitoring priority due to high levels of persistent environmental contaminants and potential ecosystem-level effects; New funding, additional staff and/or cooperative partnerships will be needed to implement Brunswick and coast-wide monitoring; Maintaining the stranding network is critical for monitoring human impacts to estuarine and coastal stocks; Maintaining the stranding network will indirectly benefit other marine mammal species that strand in Georgia	Photo-identification, effort-corrected boat-based surveys, genetics from live and dead animals, stranding and necropsy data, entanglement and fishery effort data, telemetry, blubber contaminant concentrations and health parameters of free-swimming animals	Abundance of estuarine stocks estimated to support NMFS management; impacts of contaminants on Brunswick dolphins determined to support stock restoration efforts and ecosystem-level monitoring; dolphin feeding and harassment identified and reduced; human-related mortality and injury at historic and low levels; stranding data collected and submitted to NMFS databases; Stranding network maintained with cooperation from barrier island managers and other cooperators throughout coastal Georgia
61	Monitor manatee population (estimate abundance, distribution and population vital rates; document causes of mortality and serious injury); reduce and manage anthropogenic impacts (assess impacts of watercraft, fishery entanglements and artificial warm water outfalls, implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities); conduct targeted research (satellite telemetry); educate stakeholders and user groups	M	GPS telemetry data are needed to identify high use habitats and movement corridors to manage watercraft impacts; The Atlantic manatee subpopulations was increasing during the 2000s, but recent mass mortalities and future uncertainties regarding warm water refugia and climate change may reverse this trend; Georgia monitoring data are of limited value on their own, they are most valuable when contributed to existing USGS, USFWS and FL FWC databases	Varies according to task; Photo-identification, effort-corrected aerial surveys, individual genotyping, necropsies, entanglement and fishery effort data, outfall data, recreational and commercial watercraft data, satellite telemetry	Continued use of Georgia waters during warm season; Identify high-use areas and movement cooridors; Human-related mortality remains low and similar to historic levels; Monitoring data submitted to USFWC, FL FWC and USGS; Recovery efforts coordinated with governmental, non-governmental and private groups
62	Existing state law does not require permitting, reporting, limits, seasons, or anything useful to monitor impacts and regulate take of this declining species. However, it does allow for promulgation of regulations relating to take. The best long-term solution would be to amend the state law to exclude this species. In the short term, DNR should promulgate regulations requiring permits and harvest records for rattlesnake roundups and prohibiting the take of venomous snakes without a permit.	M	Eastern diamondback rattlesnakes are harvested for "sport", the skin trade, the venom trade, and entertainment at rattlesnake roundups. In order to assess the impact of this take and trade, and adjust regulations accordingly, permitting and harvest reporting is necessary.	Number of rattlesnake take permits issued and number of rattlesnakes taken/sold.	Estimated population changes over time.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
63	Conserve High Priority Species	Address the lack of regulation regarding the use of set-lines ("bush-hooks") and the indiscriminant shooting of basking freshwater turtles in waters of the state	Regulation	Proposed	All freshwater turtles, other wildlife	All	All	N/A	DNR	PARC
64	Conserve High Priority Species	Apply the North American Model for Wildlife Conservation to herpetofauna	Regulation, Policy	Proposed	All reptiles and amphibians	All	All	N/A	DNR	PARC
65	Conserve High Priority Species	Assess the need and feasibility of extending disease testing of vulnerable species to taxa other than amphibians and reptiles.	Research, Monitoring	Proposed	Numerous	All	All	TBD	DNR	SCWDS, UGA, APHIS, CDC, SEAFWA, GWF
66	Conserve High Priority Species	Assist USFWS with development and implementation of Candidate Conservation Agreements (CCA) CCAs with Assurances (CCAA), and other conservation strategies under the Southeast At-Risk Species Program.	Research, Survey, Regulation, Habitat Protection	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, ESA Section-6, other USFWS funds	DNR, USFWS, GPCA, other conservation organizations and agencies	Private and public landowners
67	Conserve High Priority Species	Conduct *Elliptio* taxonomic studies	Research	Proposed	Numerous	All	Numerous	Multi-State State Wildlife Grants	DNR (for GA component of project)	Agencies, Museums
68	Conserve High Priority Species	Conduct Gulf Slope mussel physiology study	Research	Proposed	Numerous	SP	Numerous	State Wildlife Grants	DNR	Academia
69	Conserve High Priority Species	Conduct Halloween Darter status assessment	Research	Proposed	Halloween Darter	PD, SP	Upper Flint, Lower Flint, Middle Chattahoochee, Upper Chattahoochee	State Wildlife Grants, other USFWS or USGS funds	DNR or USFWS	UGA, GMNH

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
63	Existing state laws or rules do not address the attendance, placement, labelling, and immediate removal following fishing efforts of set-lines. Existing state law also does not prohibit the shooting of non-listed freshwater turtles. However, it does allow for promulgation of regulations relating to take.	M	Unattended set-lines incidentially capture or snag, and often kill, untargeted turtle species, including several state-listed species. Those that shoot basking turtles in waters of the state do so indiscriminately. State-listed map turtles, especially, are unfortunate victims of this practice, which has been identified as a threat to map turtles	Information on take of turtles by set-lines and shooting.	Reduction in take of protected and other turtles by set-lines and indiscriminant shooting.
64	The North American Model of Wildlife Conservation is a set of principles that has guided wildlife management and conservation decisions in the United States. The North American Model of Wildlife Conservation rests on two basic principles – fish and wildlife are for the non-commercial use of citizens, and should be managed such that they are available at optimum population levels forever.	M	This model has guided conservation of game species for decades, but in 2014 AFWA formally approved the application of this model to all amphibians and reptiles to ensure their sustainable use.	N/A	Regulatory changes that will eliminate commercial use of herpetofauna and guide their management with the goal of maintaining optimum population levels.
65	Determine whether potentially or known-to-be vulnerable high priority species of taxa should be sampled for emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.	M	Emerging wildlife diseases may require additional testing of species that may be vulnerable. Priority will be given to species that are currently imperiled and for which disease susceptibility has been reported.	Reports of new disease outbreaks in other states; literature on susceptibility of rare or imperiled taxa to diseases.	Determination made about the need and feasibility of extending testing to additional high priority taxa.
66	Assist the USFWS with data collection, coalition/concensus-building among potential CCA signatories , development of management and monitoring protocols for the CCA , and drafting of the CCA.	H	The USFWs will be exploring the use of CCAs and CCAAs as a conservation action, in-lieu of listing under the ESA, with regard to the species being evaluated as part of the At-Risk Species Program. The USFWS must rely heavily on the expertise of DNR staff and the wealth of information in the Biotics database to accomplish this task. DNR will assist as resources allow. Additional funding provided by the USFWS would allow for greater DNR involvement.	Collect and /or update Biotics database information on new and existing rare plant EOs, populations, sites. Gather locational and status info from other sources (experts and herbariums).	Successful development and execution of CCA/CCAAs.
67	Complete taxonomic revision of the mussel genus Elliptio. Management of this group is difficult given current taxonomic uncertainties.	M	Management of this group is difficult given current taxonomic uncertainties. Some species may actually be more widespread than currently recognized while others may be more imperiled	Standard genetic and morphological characters to diagnose species, synonyms	Publication documenting results
68	Evaluate temperature, dissolved oxygen, and desiccation tolerance of high priority mussels (and host fish) from the ACF – Ochlockonee Basin.	M	Understanding the physiological limits of species is necessary when identifying appropriate stream flows for survival and recruitment	Measures of survival and growth for each parameter in controlled lab studies	Report or publication detailing findings on survival and growth parameters
69	Assess Halloween Darter population and genetic status in all four population areas (Lower Flint, Upper Flint, Middle Chattahoochee, Upper Chattahoochee)	M	The Halloween Darter is petitioned for listing, but only limited data is available to assess the status of each population. Genetic data is needed to assess genetic health of each population and to eliminate confusion with cryptic congeners. Mary Freeman has drafted a proposal for this study	Number of sites with recent occurrences of species, comparison of recent vs. historic distribution where data is available	Completed Status Assessment Report

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
70	Conserve High Priority Species	Conduct museum mussel identification project	Research	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR (for GA component of project)	Other state wildlife agencies, natural history museums, natural heritage programs
71	Conserve High Priority Species	Conduct outreach to decision makers and the public about the impact, transmission, and prevention of diseases. Propose regulations to address wildlife diseases as needed.	Education, Outreach	Ongoing	Numerous	All	All	TBD	DNR, SCWDS	GWF, APHIS, CDC, sportsmen's groups, legislators
72	Conserve High Priority Species	Continue Georgia marine mammal stranding network	Management	Ongoing	Cetaceans/estuarine and marine habitats	SCP	All coastal estuarine and nearshore marine waters	Nongame Wildlife Fund, NOAA Prescott Grant	DNR	NOAA Fisheries, UGA, USFWS, Tybee Is. Marine Science Ctr., Cumberland Is. Museum, NPS, Skidaway, et al.
73	Conserve High Priority Species	Continue sea turtle stranding and salvage network.	Survey	Ongoing, Proposed	*Caretta caretta, Chelonia mydas, Dermochelys coriacea, Lepidochelys kempii, Lepidochelys olivacea, Eretmochelys imbricata*	SCP	All Coastal Plain estuaries and offshore waters	ESA Section 6, Nongame Wildlife Fund; Jekyll Island Authority, Caretta Research project, USFWS, Sea Island Co, the Lodge at Little St. Simons Island, Little Cumberland Homeowners Assoc., Cumberland Island National Seashore	DNR	USFWS, NMFS, NPS, UGA, Caretta Research Project, St. Catherines Foundation, Sea Island Co., Jekyll Island Authority, L. Cumberland Island Homeowners Assoc., The Lodge at Little St. Simons Island, Tybee Marine Science Center
74	Conserve High Priority Species	Continue Waterbird Conservation Initiative	Research, Management	Ongoing	67 species of waterbirds	SP,SCP	Coastal Plain	Nongame Wildlife Fund	DNR	Federal and Private land owners, NGO's

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
70	Inventory and validation of museum records for high priority mussel species. This would involve visiting museums with significant mussel collections and may be coordinated with other southeastern states. A grant proposal for this study has already been developed	M	Records of high priority mussel species may have been entered into distributional databases without proper verification. In addition, unsorted material in some collections could contain new distributional records.	Characteristics of specimens used to confirm identifications, locality data	Number of confirmed records of high priority mussel species
71	Continue to conduct outreach to the public and decision makers about activities that contribute to disease transmission. Monitor commercial animal trade and translocation of wildlife to determine potential impacts. Propose regulations as appropriate to reduce risks of importation or transmission of wildlife diseases.	M	Commercial pet trade, transport of native wildlife, and the deliberate or accidentaly introduction of invasive species may contribute to outbreaks of diseases that can result in significant mortality. Outreach is needed to minimize human activities that will cause or exacerbate disease outbreaks.	Information on messages developed and distributed and number of organizations and individuals contacted.	Number of decision-makers, organizations, and people contacted
72	Coordinate response to live and dead stranded marine mammals; collect data on stranded marine mammals, document human/cetacean interactions; assess cause of death if possible	M	DNR is only organization in Georgia with a Letter of Authorization from NOAA to perform task; level of priority may decrease over time if other organizations increase involvement	Species, life history, physical measurements, histopathology, virology, serology, parasitology, human interaction, etc.	Long-term data collection mandated by Marine Mammal Protection Act; data reported to NOAA within 30 days of each stranding event.
73	Conduct standardized surveys for sick, injured or moribund sea turtles. Conduct gross necropsies to determine cause of death.	H	Shrimp trawling is the largest known source of mortality in Georgia. The Georgia coast has consistently recorded some of the highest stranding densities in the U.S. Stranding totals have increased over the last 16 years. Strandings are the primary index of nearshore moratlity for sea turtles. Stranding totals will be used to assess the effects of human activities (commercial and recreational fishing, environmental contamination, recreational boating) on sea turtle populations and react quickly to minimize sources of mortality.	Spatial and temporal distribution of strandings, species composition, size frequency, sex ratios, cause of death, human interactions.	Stranding trend data will be used in management decisions.
74	Identify population trends, stresses, nesting areas, staging sites, and wintering habitat. Work within North American Waterbird Conservation Plan and U.S. Shorebird Conservation Plan recommendations to promote recovery and maintain waterbird populations.	H	Worldwide declines in waterbirds have prompted international and national efforts to stem population losses and maintain regional population stability.	Population bottlenecks identified. Georgia's role in long-term maintenance and recovery of waterbirds recognized. Individual studies encouraged and supported.	Partnerships with academic institutions, NGO's, other state agencies, federal agencies and programs, are established. Population goals met.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
75	Conserve High Priority Species	Determine the demographic patterns and habitat use of juvenile sea turtles in coastal waters.	Research	Ongoing, Proposed	*Caretta caretta, Chelonia mydas, Dermochelys coriacea, Lepidochelys kempii, Lepidochelys olivacea, Eretmochelys imbricata*	SCP	All Coastal Plain estuaries and offshore waters	ESA Section 6	DNR	UGA
76	Conserve High Priority Species	Develop aquatic species field guides	Outreach, Education	Proposed	Numerous	All	Numerous	Private donors?	DNR, GMNH	
77	Conserve High Priority Species	Develop guidelines for captive propagation, reintroduction, and translocation of rare aquatic species	Research, Policy	Proposed	Blue Shiner, Sicklefin Redhorse, possibly others	All	Numerous	State Wildlife Grants, Nongame Wildlife Fund	DNR, USFWS	Conservation Fisheries, Tennessee Aquarium
78	Conserve High Priority Species	Develop Sicklefin Redhorse Conservation Agreement	Conservation Planning	Ongoing	Sicklefin Redhorse	BR	Tennessee	State Wildlife Grants	DNR (for GA component of project)	USFWS-Asheville/Atlanta, Cheorkee Tribe, Young Harris College, NCWRC
79	Conserve High Priority Species	Enforce and monitor trawl fisheries for impacts to sea turtles	Regulation	Ongoing, Proposed	*Caretta caretta, Chelonia mydas, Dermochelys coriacea, Lepidochelys kempii, Lepidochelys olivacea, Eretmochelys imbricata*	SCP	All Coastal Plain estuaries and offshore waters	Section 6	DNR	NMFS
80	Conserve High Priority Species	Identify Altamaha Spinymussel host	Research	Proposed	Altamaha Spinymussel	SP, SCP	Numerous	State Wildlife Grants	DNR	UGA

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
75	Develop an in-water index of abundance to assess spatial and temporal patterns of sea turtle abundance. Assess adult survival using a mark-recapture model.	H	Understanding patterns in seasonal abundance of juvenile sea turtles is critical for assessing the impacts of coastal offshore development projects and other activities such as vessel interactions.	Number and location of turtles recaptured. Survival of adult turtles	Monitoring juvenile abundance and survival is critical for assessing population status and modeling exercises.
76	Support development of field guides and comprehensive books to document the state's aquatic fauna, such as fishes and mussels. Guides would include photographs, keys, range maps, and species accounts and would be published in collaboration with websites such as Fishes of Georgia, Crayfishes of Georgia, and Rare Species Profile pages.	H	Comprehensive distributional guides have been published for fishes and mussels in all surrounding states, but are not available for Georgia. This information is needed for accurate identification and as reference for biological information. These books would be of interest to students, anglers, consultants, professors, and natural history enthusiasts.	Information compiled and formatted for production of guides; completion dates, publication dates, sales	Number of guides produced and purchased
77	Following the steps outlined by George et al (2009), guidelines will require development of a written plan that considers habitat, genetics, source populations, conservation benefit and other factors.	H	There are some habitats that could support reintroduction of aquatic species into portions of their native range in Georgia and would help reduce the overall risk of extinction/extirpation of the species. Examples are Sicklefin Redhorse in the Nottely River and Blue Shiner into the upper Coosawattee/Talking Rock Creek	Genetic diversity and abundance of source populations, MaxEnt model of suitable habitat, monitoring of survival and recruitment of new population	Number of self-sustaining populations restored
78	Support development and actively participate in a multi-partner effort to conserve the Sicklefin Redhorse. The U.S. Fish and Wildlife Service has already drafted a memorandum of agreement for this project.	H	Georgia provides important spawning habitat for the Hiwassee population of Sicklefin Redhorse, which we have been monitoring since 2005. The species could potentially be reintroduced into the Nottley River system and the Little Tennessee River system. The rest of this project will take place in NC	DNR has funded Young Harris College to monitor this population in 2013-2014 will support additional monitoring in the future.	Linear extent of spawning habitat used each year, effective population size, survival and recruitment in any populations that are reintroduced
79	Shrimpers are required to use Turtle Excluder Devices (TEDs) in all trawl nets to reduce incidental capture and drowning of sea turtles. In addition, a limited-entry system for the shrimp trawl fishery should be developed. other trawl fisheries (whelk, jellyfish) should be monitored for sea turtle mortality and conservation measures should be put in place if mortality is observed.	H	The shrimp trawl fishery is the primary source of mortality for sea turtles in Georgia. Poor TED compliance rates have hampered sea turtle recovery efforts in Georgia. Assuring high compliance with TED regulations is necessary for population recovery. The impact of other trawl fisheries may also be significant and thus needs monitoring.	TED use compliance; number of turtles captured and killed in trawls	Reduction in the number of drowned sea turtles
80	Re-attempt host fish research for Altamaha Spinymussel. This work could be completed in conjunction with the proposed Altamaha Mussel monitoring study	M	Identification of the host fish will help us understand why the Altamaha Spinymussel has declined. This information could also be used for propagation	Glochidia transformation rates on potential host fishes	List of suitable host fishes

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
81	Conserve High Priority Species	Implement diadromous fish restoration projects	Research, Survey	Ongoing	Shortnose sturgeon, Atlantic sturgeon, American shad, Alabama shad, hickory shad, blueback herring, American eel, striped bass	PD, SP, SCP	All but Tennessee and Coosa	State Wildlife Grants, FM Section, others	DNR	USFWS, NOAA-Fisheries, ASMFC, GCMFC, SC DNR, AL DNR, FL FWCC,
82	Conserve High Priority Species	Implement red-cockaded woodpecker conservation on private lands	Management	Ongoing	*Picoides borealis*	PD, SCP, SP		Nongame Wildlife Fund, USFWS, Tall Timbers Research Station, Turner Endangered Species Fund, Georgia Power, Joseph W. Jones Ecological Research Center	DNR	USFWS, TTRS, Joseph W. Jones Ecological Research Center

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
81	Evaluate existing population status, commerical and recreational fisheries, and habitat limitations. Look for opportunities to enhance habitat through suite of alternatives.	H	Current diadromous fish populations are greatly reduced compared to historic levels.	American shad harvest statistics, American eel population measures, striped bass population estimates, Alabama shad population estimates, Atlantic and shortnose sturgeon population estimates and telemetry studies	Population stability as measured by reproduction/recruitment. Restoration of species to historic ranges.
82	Implementation of statewide HCP including safe harbor management agreements and mitigated take from small, isolated populations. Also, administration of landowner incentive program for safe harbor participants, participation in consortium for conservation of RCW in Red Hills region; establishing mitigation populations at Ichauway and Moody Forest; providing management assistance to landowners and managers.	H	Recovery plan for this species includes efforts on private lands. However, very few private tracts still suitable. Red Hills population is largest private land population in world and exists in best remaining habitat. Conservation of this RCW population and its habitat will benefit many other species as well.	Nestling RCWs are banded each spring. Some birds are translocated in the fall to help establish potential nesting pairs within this population and within other populations. Other data include number of groups and amount of habitat enrolled in safe harbor agreements, incentive funding utilized, acres impacted by incentive payment contracts.	Number of nests monitored, number of nestlings banded, number of nestlings translocated, number of recruitment clusters installed, number of groups in population, number of recruitment sites occupied, number of acres burned under contract.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
83	Conserve High Priority Species	Implement right whale recovery plan in the Southeast U.S.	Management, Research, Survey	Ongoing, Proposed	Right Whales, marine habitats	SCP	Atlantic Ocean waters	NMFS ESA Section 6	NMFS, DNR	NMFS, DNR CRD & LED, Florida FWC, Sea to Shore Alliance, New England Aquarium, Center for Coastal Studies, Southeast Implementation Team and North Atlantic Right Whale Consortium members
84	Conserve High Priority Species	Improve citizen and volunteer involvement in monitoring projects	Monitoring, Outreach	Ongoing and Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants, other USFWS funds	DNR	Numerous volunteers and citizen science groups
85	Conserve High Priority Species	Incorporate Henslow's Sparrow habitat management into management plans on all WMAs that have confirmed wintering sites	Management	Proposed	Henslow's Sparrow. Habitats often used by other high priority species, so management activity (e.g. prescribed fire) will likely benefit many other species of concern	SP, SCP	All SP and SCP drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	The Nature Conservancy, Plum Creek Timber Company, U.S. Fish and Wildlife Service

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
83	Monitor right whale population (estimate abundance, distribution and population vital rates; document causes of mortality and serious injury); reduce and manage anthropogenic impacts (assess impacts of watercraft and fishery entanglements, implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities such as energy development); conduct targeted research (satellite telemetry, passive acoustic detection, photogrammetry, assess ambient and anthropogenic noise and impacts); educate stakeholders and user groups	VH	This conservation action includes a variety ongoing and proposed recovery activities in accordance with the right whale recovery plan; Ship strike reduction efforts appear to be working; Future activities should focus on reducing entanglements and protecting wintering habitat; Most Georgia monitoring data are of limited value on their own, they are most valuable when contributed to existing cooperative databases using data from Canada, Northeast U.S., mid-Atlantic and other Southeast U.S. states	Photo-identification, effort-corrected aerial and boat-based surveys, individual genotyping, necropsies, entanglement fishing gear analysis, fishery effort data, recreational and commercial watercraft data, telemetry, acoustic recordings (whale vocalizations, ambient ocean noise, anthropogenic noise), whale behavior data, photogrammetric images	Population trends; use of Southeast habitat for calving and overwintering; mortality, low injury and entanglement rates in Southeast U.S.; questions about right whale movement, distribution and migration addressed; Assess cumulative impacts of ocean noise, watercraft and other anthropogenic impacts on whales and Southeast wintering habitat; Habitat remains protected from existing and emerging threats; Monitoring data submitted to NMFS and North Atlantic Right Whale Consortium partners; Recovery efforts coordinated with governmental, non-governmental and private groups via the North Atlantic Right Whale Consortium and Southeast Implementation Team for Right Whale Recovery;
84	Technology should be used to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects. This includes using online tools, social media, and smart-devices to aid training, share protocols, and collect data. Monitoring needs should be shared with Master Naturalist programs and K-12 teachers. A reward program should be initiated for participants' monitoring efforts.	H	DNR has helped organize or has been a key partner in many citizen-science or volunteer-based monitoring projects in the past ten years. In particular, successful programs have involved monitoring of bats, frogs, birds, and invasive species. These projects have been useful in tracking species populations and have allowed for public involvement in DNR conservation projects.	Monitoring data collected by citizen scientists and volunteers	Increase in volunteer-based monitoring programs and participants, successful use of online tools and other technology for monitoring, successful implementation of a monitoring rewards program
85	Work with partners to include habitat management for Henslow's Sparrows in 50-year and annual management plans for WMAs where they are known to occur (Paulk's Pasture, Moody Forest, Townsend WMAs) or likely to occur. This could be extended to national wildlife refuges, other agency lands, and private lands. Much of the management could be conducted on power line right-of-ways and similar areas.	H	Habitat management for this species is relatively straight forward and mostly includes prescribed fire at the appropriate time and occasionally other management tools. Often grassy power line corridors can provide suitable habitat with appropriate management. Damp flatwoods and pitcher plant bogs also can provide habitat.	Number of WMAs and other conservation lands with prescribed burning and other land management activities that benefit Henslow's Sparrows.	Percentage of suitable WMAs and other conservation lands with Henslow's management incorporated into long-term land management plans.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
86	Conserve High Priority Species	Incorporate Swallow-tailed Kite management into management plans on all WMA's that have confirmed or probable nesting STKI	Management	Proposed	Swallow-tailed Kite and suite of bottomland forest species that would benefit from habitat conservation	CP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	Nongame, Game management, Forest Resources	ARCI, Swallow-tailed Kite working group
87	Conserve High Priority Species	Maintain Robust Redhorse Conservation Committee	Conservation Planning, Management	Ongoing	Robust Redhorse	PD, SP	Numerous	State Wildlife Grants	DNR	All RRCC members
88	Conserve High Priority Species	Manage coyote populations on barrier islands to reduce impacts to beach nesting birds	Management	Ongoing, Proposed	All beach nesting birds that nest along beach fronts on Georgia islands. Least Tern, Gull-billed Tern, Black Skimmer, American Oystercatcher, Wilsons Plover	SCP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	Cumberland Island, Little St. Simons Island, DNR, USFWS	Cumberland Island, Little St. Simons Island, DNR, USFWS
89	Conserve High Priority Species	Propose a list of species to supplement the list of wild animals set forth in Georgia Code for which a permit or license, or both, is required.	Regulation	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	GWF, GFC, UGA
90	Conserve High Priority Species	Reduce impact of crab-pot fisheries and vehicle-induced mortality on diamondback terrapins; develop a statewide index of abundance for terrapins	Research, Management, Education	Ongoing, Proposed	*Malaclemys terrapin*	SCP	All Coastal Plain estuaries and offshore waters	State Wildlife Grants, Nongame Wildlife Fund, TERN, GDOT	DNR	Diamondback Terrapin Working Group, GDOT, county road departments, crabbers, landowners, UGA

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
86	Known nesting areas on state lands need to be protected from timber harvest and fire. Buffers need to be set up around these sites. Silvicultural prescriptions can be generated to leave some trees along hard wood edges to produce future nesting habitat for STKI. (details through Plum Creek). artificial nest platforms may be useful in some cases.	H	A tremendous amount of work has been conducted on the Altamaha river to conserve land. We know need to insure that these protected lands are managed in a way to protect one of our highest priority bird species	Years of nest site location data. 3 years of roost data,	Longevity of STKI nesting clusters on state lands.
87	Continue participation in the RRCC. Nongame Conservation has agreed to provide a representative to the RRCC. Our role includes monitoring GA populations, managing contracted studies, and workign with stakeholders to conserve the species.	H	While much has been accomplished through the RRCC, the Robust Redhorse still has significant conservation needs. Successful recruitment of stocked populations has not yet been documented. The Oconee population has declined considerably. Only the Savannah population is considered currently stable.	Visual observations at spawning sites, genetic data to document recruitment, surveys for juveniles in lower reaches of river/reservoir habitats	Number of self-sustaining populations
88	Once coyotes discover beach nesting birds they rapidly and significantly reduce nest productivity. Coyote predation on Cumberland Island National Seashore has transformed this site from one of the highest productivity American Oystercatcher beaches to a site that rarely produces a single chick. Coyotes have also decimated beach nesting birds on Little Cumberland Island, and are now significantly reducing productivity on Little St Simons Island. Recently they have been sighted on Blackbeard Island.	VH	Coyotes on Cumberland and Little St Simons Island are likely the highest threat to nesting American Oystercatcher on the coast.	Nest loss and nest productivity data for Oystercatcher, Least Tern and Wilson's Plover.	Reduction in predation and increased nest productivity for beach nesting birds
89	The list could include non-native invasive species used in the pet trade and likely to impact Georgia native species or natural habitats. Suggest recommendations for specific restrictions or guidelines for issuing permits.	M	Some nonnative invasive species, such as the Cuban treefrog, are in the pet trade and can be legally sold in Georgia. DNR can promulgate rules to add species to the list of wild animals for which permits or licenses, or both, are required.	Information on nonnative species currently sold online that represent threats to native species or natural habitats in Georgia.	Supplemental list developed and submitted for approval by DNR Board.
90	Drowning in crab traps is perhaps the single greatest threat to diamondback terrapins. Develop and implement a terrapin conservation plan for commercial and recreational crab pot fisheries. The terrapin conservation plan should include the use of Terrapin Excluder Devices (TEDs), pot soak time requirements, closure areas, removal of abandoned pots, and monitoring of effectiveness of conservation efforts.The shoulders of causeways and roads through and adjacent to coastal marshes are attractive nesting sites for diamondback terrapins. Develop management guidelines to reduce mortality of terrapins on coastal roadways including techniques for installing seasonal barrier fences (< 10”).	M	Commercial crab fishermen capture and drown large numbers of diamondback terrapins. In some areas, terrapin populations have declined precipitously due to crabbing activity. Requiring use of appropriate BRDS and excluders is necessary to reduce incidental take of terrapins. It is also necessary to determine if such devices should be required on both commercial and recreational traps. Vehicle-induced mortality of nesting female and hatchling diamondback terrapins is a seasonal problem in several areas along the coast. Population sustainability depends on high female survivorship and successful recruitment.	Number of terrapins lost to crab pots or on roadways over time; Index of abundance should be designed to assess trends over time (e.g. occupancy model using terrapin head counts from randomly selected tidal creeks).	Reduction in the number of roadkilled terrapins. Reduction in terrapin capture rates in pots without influencing the blue crab size or abundance. Established protocol for assessing terrapin abundance

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
91	Conserve High Priority Species	Review recovery plans for all federally listed species known to occur in Georgia and identify state-specific objectives	Research, Management	Ongoing	All federally listed species in Georgia	All	All	USFWS Section 6, NMFS, Nongame Wildlife Fund	USFWS, NMFS, DNR	NWF, others
92	Conserve High Priority Species	Update and complete the Fishes of Georgia website.	Outreach, Education	Proposed	Numerous	All	Numerous	State Wildlife Grants	GMNH, WRD	Other Museums and Data Contributors
93	Conserve High Priority Species	Complete taxonomic descriptions of high priority fish species	Research	Proposed	Coosa Madtom, Sicklefin Redhorse, Holiday Darters, Coosa Chub	All	Numerous	Unknown	Academia	GMNH, FLMNH, Roanoke College
94	Conserve High Priority Species	Conduct surveys of southwest Georgia isolated wetlands	Survey	Proposed	*Dichanthelium hirstii, Lindera melissifolia, Croton elliottii, Fimbristylis perpusilla, Lythrum curtissii, Scirpus hallii,* others	SP	Ochlockonee, Kinchafonee/Muckalee Flint Middle, Flint Lower, Ichawaynochaway, Spring, Chattahoochee Upper South	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6, other USFWS funds	DNR	Various academic institutions, private contractors and botanical specialists, GPCA and its member institutions
95	Conserve High Priority Species	Coordinate terrestrial invertebrate surveys and conservation efforts in Georgia	Research, Survey, Monitoring	Proposed	Terrestrial invertebrates in various high priority habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund, USFWS, private foundations,	DNR	Academia (nationwide specialists),TNC, NatureServe, USFWS, other state wildlife agencies.

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
91	Review and assess adequacy of recovery plans for all federally listed species	M	Recovery plans for some listed species (e.g., loggerhead turtle) are known to be out of date. Recovery objectives and methods should be reassessed in the light of recent of research and conservation efforts.	Extensive literature review and individual research findings.	Number of recovery plans reviewed.
92	Some maps need to be completed for taxonomically problematic species. There is also a need to update maps with new distribution records since the website was completed in 2007. Finally, development of a web application could generate conservation funding and broaden use of the application	H	This website has remained about 90% done since 2007. Maps for taxonomically problematic species have never been developed. Additional resources (funding and staff time) are needed to complete this effort.	Information needed for completion of species maps; number of maps completed	Number of distribution maps updated, number of new distribution maps completed
93	Complete taxonomic description of imperiled aquatic species, such as Coosa Madtom, Sicklefin Redhorse, Holiday Darters, Coosa Chub, and other high priority species as needed.	M	Accurate recognition of species diversity is necessary for the prudent investment of conservation resources and will also determine what conservation actions are appropriate for each taxon. For example, if Coosa populations of the Frecklebelly Madtom are distinct, then there is only a single source population that could be used for re-stocking the Conasauga River population if it is declared extinct.	standard morphological and genetic data used in species descriptions	Number of species described
94	Work in collaboration with biologists of other taxonomic groups, especially herpetofauna, birds, and terrestrial invertebrates, to procure funding for an inventory of this high priority habitat and associated landowners. Use GIS resources and aerial imagery to prioritize ponds to visit. Assess sites for potential suitable habitat for high priority species of conservation concern. Obtain landowner contacts and conduct rare species survey at sites with high potential.	VH	Southwest Georgia depressional wetlands are critical habitat for numerous species. Most are privately owned and they are numerous on the landscape; therefore they are undersurveyed. Collaborative effort among biologists of various specializastions would increase survey efficiency, funding opportunities, and learning among staff.	Location, vegetation community characteristics, species lists, habitat condition, threats, landowner contact, rare species data for Biotics	Number of wetlands surveyed, number of landowners contacted
95	Coordinate and encourage terrestrial invertebrate research and conservation efforts in Georgia and in the SE. Bring together various experts across major taxonomic groups and coordinate survey efforts, monitoring, and research.	M	There is currently no coordinated research and conservation effort for terrestrial invertebrates in Georgia, and little or no contact between various experts on conservation of terrestrial invertebrates	Ranges and occurrence of rare terrestrial invertebrates of concern	New or updated occurrence records of rare terrestrial invertebrate populations and invertebrate communities associated with high priority habitats; prioritized lists of species and habitats for conservation.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
96	Conserve High Priority Species	Monitor effects of climate change on sea turtles and their nesting habitat; Monitor trends in adult female sea turtle abundance through nest monitoring programs and genetic mark-recapture sampling.	Research, Monitoring	Ongoing, Proposed	*Caretta caretta, Chelonia mydas, Dermochelys coriacea*	SCP	N/A	ESA Section 6, Nongame Wildlife Fund; Jekyll Island Authority, Caretta Research project, USFWS, Sea Island Co, the Lodge at Little St. Simons Island, Little Cumberland Homeowners Assoc., Cumberland Island National Seashore	DNR	USFWS, NMFS, NPS, UGA, Caretta Research Project, St. Catherines Foundation, Sea Island Co., Jekyll Island Authority, L. Cumberland Island Homeowners Assoc., The Lodge at Little St. Simons Island, Tybee Marine Science Center
97	Conserve High Priority Species	Support research on life history, natural history, taxonomic status, etc. of high amphibians and reptiles	Research	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Section 6, Nongame Wildlife Funds	DNR	Private and university contractors
98	Conserve High Priority Species	Update State-protected species list and work with partners to improve management for these species.	Regulation, Management	Proposed	All state protected animals and plants	All	All	Nongame Wildllife Fund	DNR	SWAP technical teams, other experts on status and distribution; state, federal, and local government land managers.
99	Conserve High Priority Species,	Conduct floristic inventories of undersurveyed state-owned conservation lands with high potential for high priority plant species occurrences	Survey	Ongoing	All	All	All	Nongame Wildlife Fund, State Wildlife Grants	DNR	Private contractors and botanical specialists

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
96	Monitor the length of incubation for all sea turtle nests in the state. Additionally, continue periodic qualitative surveys of sea turtle nesting habitat on all barrier island beaches, categorizing each 100 m section as erosional or depositional based on beach and dune morphological characteristics. Nest counts provide an index of abundance for adult female sea turtles. Genetic sampling can provide robust estimates of female abundance as well as important reproductive parameters such as clutch frequency, remigration intervals, and site fidelity.	H	Sea turtles exhibit temperature-dependent sex determination, so increasing temperatures during nest incubation resulting from climate change may skew sex ratios. Length of incubation is significantly correlated with incubation temperature and thus sex ratios. Another consequence of climate change is sea level rise, so annual surveys will be compared to determine changes in the erosional state of sea turtle nesting habitat. The collection of trend data and estimates of reproductive parameters are critical for assessing population recovery.	Length of incubation; characterization of beach dynamics. Spatial and temporal distribution of nests, hatch success, hatchling production, nest relocation, nests washover, incubation durations, nest depredations, hatchling disorientation, sex ratios, habitat use.	Changes in length of incubation as a correlate for skewed sex ratios; amount of available nesting habitat; numbers of nesting turtles and successful hatches are prime indicators of conservation success.
97	In many cases, such research will be a component of survey and monitoring efforts, but dedicated research may be required to answer important questions that will help guide conservation efforts.	M	Research is an integral part of many amphibian and reptile conservation efforts, in-part because for many of these species we still have more questions than answers about aspects of their life history, natural history, taxonomic status, etc.	Various	Increased knowledge on priority species needs that will improve conservation efforts
98	Conduct a review of Georgia's protected species list at least once every five years. Engage key partners to improve management for state protected species.	H	The state list of protected species was last revised in 2006. Because the list influences conservation priorities for many key partners, it should be based upon the most-up-to-date and scientifically reliable information	Up to date status information on all state protected species and species that should be considered for addition to the list. Number of species added to the list; number of species removed from the list.	Number of times the list of State-protected species is reviewed and revised over the next ten years.
99	Prioritize specific state conservation lands for targeted survey for rare plant occurrences. Examples of high priority properties include Silver Lake WMA and Chickasawhatchee WMA. Determine locations for high potential habitats to target by topographical map and aerial photo. Develop a standard format for submitting results digitally so data can be entered efficiently into the rare species database. Conduct survey with DNR staff or by contracting with qualified botanists. Share data and consult with local site managers to ensure management needs of any high priority rare species and habitats are incorporated into management plans.	H	Certain state conservation lands have high potential for rare plant species occurrences, but have not yet been surveyed. Local site managers need better information about locations of high priority rare plants and habitats for management planning.	Rare species data for Biotics, plant species lists, plant community types and locations	Number of conservation lands surveyed, number of high quality habitats located, number of management plans amended with rare species management needs

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
100	Engage in Regional Conservation Partnerships	Help implement the Southeastern At-Risk Species (SEARS) program.	Conservation planning, Management, Outreach	Ongoing	At-risk species	All	All	State Wildlife Grants, other federal grants, Nongame Wildlife Fund	WMI	SEAFWA Wildlife Diversity Committee (WDC), USFWS, other regional wildlife conservation organizations
101	Engage in Regional Conservation Partnerships	Help revise and implement the South Atlantic Conservation Blueprint.	Conservation Planning, Management	Ongoing	Numerous	PD, SP, SCP	Numerous	USFWS	South Atlantic LCC	DNR, USFS, GFA, others
102	Engage in Regional Conservation Partnerships	Support secure funding for regional conservation efforts.	Funding	Ongoing	At-risk species	All	All	State Wildlife Grants, other federal grants	DNR	AFWA, SEAFWA, federal agencies (e.g., USFWS, DOD), neighboring state fish and wildlife agencies
103	Implement Climate Change Adaptation	Create an updated map to help guide land acquisition and identify future greenway projects. Acquire LiDAR and other data to enhance conservation planning and management.	Conservation Planning, Habitat Protection, Management	Ongoing, Proposed	Numerous	All	All	TBD	DNR, USFWS, DoD, USFS	TNC, GDOT, RDCs, local governments, land trusts, Georgia Land Conservation Center, Oconee Rivers Greenway Commission, land trusts
104	Implement Climate Change Adaptation	Develop a comprehensive, dynamic habitat modeling process that includes projected landscape changes and demographic patterns. Incorporate climate change into landscape and species models and use these to inform conservation plans.	Research, Conservation Planning	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR, USFWS, DoD, USFS	UGA, other research institutions, TNC, land managers

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
100	Includes actions needed to addressed petitioned and candidate species to help minimize the need for federal listings under the Endangered Species Act. Develop and promote data sharing procedures between state fish and wildlife agencies and the U.S. Fish and Wildlife Service so that the best available data is used in listing decisions during the critical points in the decision making process. Identify the highest priority species, coordinate data, and identify funding mechanisms.	VH	Implement the Southeast At-Risk Species Plan by compiling and analyzing data from field surveys, conducting range-wide status assessments of petitioned species, developing proactive conservation plans to address threats, collaborating on data sharing and outreach activities, and providing technical assistance that will inform the listing process. Reach out to stakeholder groups, including private landowners, sportsmans groups, civic groups, and legislators to help them understand the goals and objectives of the SEARS program.	Data from surveys, status assessments and habitat models, etc. Information from datasets shared with other states, meetings, and reports.	Level of participation in the program; number of status assessments completed; number of conservation plans completed and implemented; number of species removed from petitioned list.
101	Help revise and implement the regional plan that describes the places and actions needed to meet conservation objectives in the face of future change. Provide data on Georgia conservation priorities, identify research and conservation needs, solicit new regional partners, and test ecological indicators and species/habitat models.	H	The SALCC Conservation Blueprint provides a regional context for implementation of the Georgia SWAP and plans of other participating states and agencies. This blueprint will be tested, revised and implemented in a series of iterative steps involving input from state and federal agencies and other conservation organizations.	Data provided to SALCC database; interactions with SALCC staff; number of projects implemented using the Conservation Blueprint	Level of participation in the revision and implementation of the blueprint; number of state and regional projects that benefit from the Conservation Blueprint.
102	Assist with applying for competitive and other grants to secure greater funding for conserving species of shared responsibility. Provide input to and support for the efforts of the Blue Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources (BRP) to identify a dedicated source of funds for nongame fish and wildlife conservation.	H	Additional resources are needed for completion of SEARS program and other regional conservation initiatives. Competitive grant programs and funds from private foundations may be needed. In addtion, federal funding must be increased in order for the SEARS program and similar regional conservation efforts to be successful.	Funding initiatives pursued by state, federal and nongovernmental organizations in support of regional conservation programs such as SEARS.	Number of appropriate funding initiatives pursued; funding received and applied to SEARS program and related regional conservation efforts.
103	Refine the existing draft greenways map and state wildlife habitat map by incorporating information from sources such as the Southeast Resilience Landscapes Project and DNR species distribution models. Create new conservation opportunities map to guide land protection. Use LiDAR data to help create the statewide map of habitats, show topography, delineate wetlands, and develop strategies for protection and management of coastal plain wetlands. Prioritize management practices on those lands projected to be most resilient to change to minimize risk.	VH	An updated conservation opportunities map that reflects current distribution information on high priority species, habitats, and landscape features as well as outputs from species distribution models and models of landscape diversity and permeability is needed to inform future conservation efforts in Georgia. This will be an iterative process informed by new data from field surveys and modeling approaches that take into account projected climate change, developement, and demographic changes in Georgia and the Southeast.	Updated information on all priority species; data from species distribution models and landscape resiliency models; projected trends in climate change, development patterns, demographic changes, and land use.	Statewide LiDAR coverage acquired. Updated conservation priorities map developed. Management priorities developed with potential climate-related changes incorporated.
104	Changes can be incorporated into the model as modeling assumptions shift, land cover and climate changes, and conservation lands are added. This would create a future habitat component to habitat models that will be beneficial for long term planning. Final prioritization inputs will include sea level rise and other climate change impacts. Review data from Southeast Resilient Landscapes model and other models to identify resilient landscapes. Emphasize management actions that maintain and enhance connectivity in priority areas and avoid fragmenting habitats.	H	Dynamic habitat and landscape models that take into account projected trends in urbanization, demographic changes, and direct and indirect impacts of climate shifts are needed for prioritization of conservation and habitat management efforts.	Data from Southeast Resilient Landscapes Project, SLEUTH, SLAMM, and other models of landscape change; updated coverage of high priority species and habitats	Dynamic models for species distribution that incorporate landscape changes, including projected climate change, development, demographic changes, and land use changes

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
105	Improve Environmental Education	Assess the current level of wildlife conservation literacy among Georgia citizens.	Education	Proposed	All	All	All	Could be minimal - possibly utilize graduate students for the analysis and reporting. DNR has Survey Monkey account.	DNR with a university	EE groups, colleges, PTAs, nature oriented groups, GPB, SWAP Communications Team
106	Improve Environmental Education	Create educational core concepts with key messages that support the main SWAP themes.	Education	Proposed	All	All	All	In-kind or part of current organization budgets.	DNR	For Content: SWAP technical teams, EPA, EPD, GFC, NRCS, USFWS, USFS. For Readibilty: SWAP Communications Team, EEA of Georgia, Georgia Dept. of Education, Georgia Science Teachers Association,and higher education professionals.

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
105	Assess the current level of Georgia citizens' awareness about native wildlife and wildlife conservation needs. Data collection to be done online possibly using Survey Monkey or like software. Includes a baseline survey of various ages and audience types (possibly separated as 15 & older vs. 15 & under) as well as subsequent measuring of efforts by DNR & partners to promote SWAP themes/messages (Measure = Collect, Analyze, & Report).	VH	A survey of wildlife conservation literacy is needed to establish baseline data for future assessments of progress in current environmental education programs and the creation of new programs. To get the number of responses needed to accurately reflect GA citizen's knowledge, attitude and behavior we will need to work with the SWAP Communications team to conduct a massive email campaign through numerous organizations. We also recommend there is an incentive for participants completing the survey (ie., entered into a random drawing for gift certificates).	Various measures of current public knowledge, attitudes and behaviors regarding wildlife conservation issues and challenges in Georgia.	Ideally 250,000 responses received; analysis and summary of evaluation results.
106	Develop a SWAP logo with 'slogan' and five educational core concepts with key messages that support the main SWAP themes and are geared toward all Georgia citizens (messages can be tailored for specific audiences through educational materials). The messages will focus on conserving all of Georgia's natural resources including plants, wildlife and their habitats, prompting awareness, appreciation and responsible action -- not only for the resources' benefit but for human needs.	VH	Common, consistent messaging shared by all conservation agencies and other stakeholders more effectively reaches and resonates with all Georgians. Messages will stress that everyone can be involved in improving and protecting the quality of their environment, realizing that human actions impact all natural resources.	No new data will be collected. The messages will be created using existing information from partners.	Messages are agreed upon and approved by partners. Stakeholders have incorporated these messages into their communications, materials, and conservation work. A future environmental literacy survey, when compared to a baseline survey, could reveal if these messages have had an impacted the behavior of Georgia citizens.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
107	Improve Environmental Education	Improve communication of SWAP messages to regional education networks and community groups.	Education	Proposed	Numerous	All	All	Mostly in-kind or part of current organization budgets, but may need assistance from TERN or other grants.	DNR Wildlife Resources (Public Affairs and Education Staff)	Nature centers, regional education centers, partner agencies and organizations. Utilize partners who have public affairs staff and can include SWAP messages in their own communications when consistent with their mission (EEA in Georgia, EMCs, Georgia Power, GWF, sportsman organizations, etc.)
108	Improve Environmental Education	Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in Georgia.	Education	Proposed	All	All	All	Private and local sources must be sought. Possible hunter education funding.	Office of the Governor, GA Dept. of Education, DNR	Relevant Governmental and Non-Governmental Environmental Education Organizations

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
107	SWAP educational messages are best disseminated through leaders/moderators in each ecoregion and via existing networks. Virtually or in-person, ecoregion representatives spread the word by incorporating SWAP messages and materials into their programming and current communications. Use the DNR Nongame e-newsletter and/or develop a GovDelivery bulletin to better disseminate SWAP messages. For two-way communication, a Facebook page should be developed. Also consider creating a SWAP clearinghouse website, separate from or part of the GA DNR Wildlife Resources Division website. In addition to the general public, target audiences include school children, teachers (including pre-service), and community groups that affect land use (private property owners, business leaders, government officials, etc.). To encourage buy-in by these groups, community programming could integrate SWAP strategies with local issues, thereby creating a common educational strategy.	VH	Conservation issues vary between ecoregions. Having groups and contact lists from each ecoregion can make dissemination of information more productive. This delivery would be done in the sense of long-tail marketing by getting the most relevant, popular, newsworthy and interesting topics to leaders/moderators for them to relay to community members. Partners will be asked to endorse the SWAP as evidence of outreach to a broad group of stakeholders.	Contact lists will be compiled through the SWAP working group and EEinGA.org. Leaders/moderators will be a representative of the GA DNR or from a partner agency/organization.	Downloads of educational materials and other website analytics; additional open online environmental education resources and technical information available through eeingeorgia.org or DNR webpages; requests for information resulting from personal interaction at festivals, meetings, trainings; results of short instant surveys at targeted websites and outdoor places where people visit, to measure awareness of SWAP-related educational materials such as GA DNRs e-newsletter, Dragonfly Gazette (Project Wet), Junior Rangers (state parks) and eeingeorgia.org; development of new materials to fill gaps as needed.
108	The SWAP Advisory Committee should support the Georgia Department of Education in creating an Environmental Literacy Plan (ELP). Through a partnership, the Department of Natural Resources, Wildlife Resources Division can advise the Georgia Department of Education on how to best address wildlife conservation concepts in the ELP. Since no federal funds currently are available in regards to the No Child Left Inside Act, the SWAP Advisory Board could become involved in the development of the Next Generation Science Standards as a near-term goal.	M	Georgia's citizens must have a basis for understanding the environmental issues we face if we are to make informed decisions about our state’s environmental health. Creating an environmental literacy plan will provide the framework for school systems and other organizations to expand and improve their environmental education programs in order to improve environmental literacy for Georgia's citizens.	Devise a method of measuring baseline data and increased time spent in nature by children. Devise a method of measuring baseline children’s health data and explore correlations between time spent in nature by children and children’s health. Survey to assess literacy upon graduation.	Resolution signed by the Governor, a functioning Georgia Partnership for Children in Nature (GPCN), a completed ELP, and annual assessment of progress towards becoming an environmentally literate adult.

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	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
109	Improve Environmental Education	Educate beachgoers and boaters about the plight of beach nesting birds and passage migrants that use Georgia beaches and offshore bars	Education	Ongoing/Proposed	Beach nesting Birds, as well as migrants and overwintering species that build up critical energy reserves foraging on our coast during spring and fall. Include Red Knot, and Piping Plover	SCP	Several	State Wildlife Grants, Nongame Wildlife Fund	DNR	USFWS, Little St. Simons Island, Cumberland Island, St. Catherins Island, Audubon chapters, American Bird Conservancy
110	Improve Environmental Education	Identify and increase awareness of existing educational materials to facilitate delivery of SWAP conservation messages to the public. Provide resources and promote opportunities to engage people in the outdoors.	Education	Ongoing, Proposed	All. To be specified by users.	All	All	Possible TERN grant as well as exisitng resources	DNR	Captain Planet Foundation, EEA of Georgia, Flint Riverquarium, Georgia Aquarium, Georgia 4-H, Georgia Dept. of Education, GDOT, GFC, GDA, Georgia Forestry Foundation, GWF, NPS, Project WET, Project WILD, Project Learning Tree, State Botanical Garden of Georgia, Turner Foundation, USFWS, UGA, Zoo Atlanta
111	Improve Private Land Management	Assist DNR Private Lands Program biologists with technical support and outreach to private landowners owning significant botanical sites	Education, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, NRCS and USFWS funds	DNR (PLP) will lead; DNR (NCS) will assist	GPCA and its member institutions

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
109	Develop a strategic outreach and education plan to reach beach users and boaters about the challenges faced by beach nesting/foraging/roosting birds. Combination of signage, outreach programs, PSAs, press releases, and other methods.	H	Human disturbance is a major threat to beach nesting birds. Human and canine presence can keep adults off nests where they become vulnerable to exposure and depredation.	Levels of human and canine use in beach nesting habitats.	Increased nest success due to less human disturbance, dog closures on certain beaches
110	Enhance environmental education through development or increased awareness of innovative resources, tools, materials and models incorporating the knowledge, expertise, and resources contained in the SWAP. Correlate SWAP's main themes to core concepts (to be developed), and then tailor educational materials to specific ecoregions and audiences. Disseminate SWAP info via DNR websites, EEinGeorgia website, and other partner websites.	VH	The health and well-being of Georgia's plants, wildlife, and people depends on the quality and integrity of the environment. Loss, degradation, and fragmentation of habitat are the greatest problems facing fish and wildlife. To effectively protect Georgia's natural heritage, the public must be aware of and engaged in conservation.	Collect data on use of EEinGeorgia and other partners' websites.	Click rates, downloads of education materials and other website analytics; number of print-outs of files containing lesson materials; results of short instant surveys at targeted websites and outdoor places.
111	NCS botanists will continue to support the Private Lands Program (PLP) and PLP biologists with technical botanical assistance focusing on general vegetation and rare plant communities, as well as rare plant species information. NCS botanists will continue to promote the various aspects of the PLP, numerous Farm Bill programs (e.g., EQUIP, WHIP, CRP, and PFW), and other options (e.g., conservation easements, GA Conservation Tax Credit Program, and CUVA) to private landowners throughout the state. In addition to the "standard" duties listed above, NCS botanists and PLP biologists will work for the protection of special botanical "small sites".	H	The PLP has a need for technical botanical assistance and NCS botanists will continue to provide it. However, rare plant conservation frequently requires a focus on small isolated populations, sites, and EOs. The PLP typically focuses on larger acreages that have a broader, mixed-use focus that includes agriculture, silviculture, recreation, and historic/cultural preservation. Efforts need to be made to identify special small botanical sites and to work with the private landowners to ensure their protection. This may require special collaborations between NCS botanists and PLP biologists, new training for PLP staff, and/or the hire of a designated PLP botanical professional.	Lists and descriptions of properties and landowners, and rare plant species/communities inhabiting these properties. PLP biologists will be collecting additional data.	Number of at-risk, threatened botanical sites protected, acquired, or put under easement.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
112	Improve Private Land Management	Coordinate utilization of and training for implementation of Georgia's Best Management Practices for Agriculture and improve wildlife conservation guidelines	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	GSWCC, DNR	UGA Cooperative Extension Service, Georgia Cattlemen's Association, Georgia Dept. of Agriculture, Georgia Farm Bureau, GWF
113	Improve Private Land Management	Coordinate utilization of and training for implementation of Georgia's Best Management Practices for Forestry and improve wildlife conservation guidelines	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	GFC, DNR	GFC, PARC, PIF, GFA, Forestry for Wildlife Partners, UGA, Southeastern Wood Producer's Association, SFI Implementation Committee, Master Timber Harvester Program
114	Improve Private Land Management	Develop guidelines for wildlife habitat management for high priority species	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	USFWS, GFC, PARC, PIF, Forestry for Wildlife Partners, UGA, GDA, NRCS, SFI Implementation Committee, Georgia Power, other corporate landowners

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
112	Provide information and technical assistance to develop a wildlife conservation component for agricultural BMPs that addresses needs and opportunities for wildlife habitat protection. Provide assistance with development of educational outreach and training programs relating to existing BMPs as well as more specific guidance on conservation or enhancement of wildlife habitat and protection of sensitive sites.	H	Georgia's Best Management Practices (BMPs) for Agriculture address specific water quality issues. However, specific impacts of certain land management practices on wildlife and sensitive habitats are not adequately addressed, nor are opportunities to avoid or minimize these impacts. A multidisciplinary review team should assess current BMPs and develop additional guidance for wildlife conservation that can be incorporated in the next version of Georgia's BMPs for agriculture, or included in a separate document for a wide variety of landowners and managers.	Comparison of other state BMP's for agriculture; development of a wildllife conservation component that addresses needs and opportunities for conservation or enhancement of wildlife habitat and protection of sensitive sites.	Number of high priority habitats and species protected through enhanced BMPs
113	Review wildlife management, protected species, and sensitive sites components of existing BMPs (Section 7 of forestry BMPs) and recommend improvements for the next revision of Georgia's BMP's. Recommend monitoring protocol for existing BMPs. Develop educational outreach programs and training programs relating to existing BMPs as well as more specific guidance on conservation or enhancement of wildlife habitat and protection of sensitive sites.	M	Georgia's Best Management Practices (BMPs) for Forestry address specific water quality issues and generally address wildlife habitat conservation. However, specific impacts of certain land management practices on wildlife and sensitive habitats are not adequately addressed, nor are opportunities to avoid or minimize these impacts. A multidisciplinary review team should assess current BMPs and develop additional guidance for wildlife conservation that can be incorporated in the next version of Georgia's BMPs for forestry, or included in a separate document for a wide variety of landowners and managers.	Comparison of other state BMP's for forestry; recommendations from Master Timber Harvester Program, SFI, and similar programs. Development of an "Elements of Wildlife Conservation" component that addresses needs and opportunities for conservation or enhancement of wildlife habitat and sensitive sites.	Number of high priority habitats and species protected through enhanced BMPs.
114	Develop habitat-specific management guidelines to address conservation needs of high priority species in each ecoregion of the state and provide these to landowners and managers. Develop educational programs and materials emphasizing opportunities for receiving technical support and/or financial incentives to maintain or enhance rare species populations and significant natural communities.	VH	There are few land management guidelines for the various landowners/managers in the state (county departments of transportation, mining, agricultural, and forestry interests) that satisfactorily address wildlife habitat conservation objectives. Commonly used land use practices that affect high priority species are not adequately addressed in existing Forestry or Agricultural BMPs or other management guidelines. Improved guidelines that address general wildlife conservation objectives as well as recovery objectives for listed species and other high priority species would be a significant improvement.	Comparison of other state wildlife management guidelines and recovery objectives for listed and other high priority species. Development of management guidelines that address conservation of significant natural communities and high priority wildlife species, techniques for habitat restoration or enhancement, and opportunities to receive technical or financial support to undertake these activities.	Number of high priority habitats and species protected through management guidelines. Number of landowners provided technical guidance for conservation of high priority habitats and species.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
115	Improve Private Land Management	Encourage use of prescribed fire as a habitat management tool on private lands. Provide information and technical assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats.	Management, Education, Outreach	Ongoing	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, National Fish & Wildlife Foundation, USFWS, NRCS	DNR, GFC, NRCS, TNC, USFWS	Joseph W. Jones Ecological Research Center, GWF, PARC, PIF, UGA-WSFR, GFA, Prescribed Fire Council, Longleaf Pine Alliance, private landowners and managers.
116	Improve Private Land Management	Collaborate on the revision and implementation of the Georgia Forest Action Plan.	Conservation planning	Ongoing	Numerous	All	All	GFC, DNR	GFC	DNR, USFS, GFA, others
117	Improve Public Land Management	Continue to implement rare plant restoration, enhancement, and safeguarding program. Identify needs, develop horticultural guidelines, and initiate rare plant propagation efforts; continue to develop/improve and implement Safeguarding protocols; continue monitoring populations.	Research, Management, Monitoring	Proposed	Numerous	All	All	Nongame Wildlife Fund, ESA Section-6, GPCA and its member institutions	GPCA, DNR, USFWS, USFS, SBG, ABG	GPCA member institutions

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
115	Provide information and technical and/or financial assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats. Work with EPD to maintain reasonable burning windows to allow proper management of fire-dependent habitats while meeting air quality standards. Utilize Interagency Burn Team approach to share expertise and costs associated with prescribed burns on ecologically significant sites.	VH	Many of Georgia's high priority habitats and species are fire-dependent. The long-term viability of these species and habitats hinges on increased emphasis on prescribed burns conducted under conditions that mimic natural fire regimes. Significant opportunities exist to restore or enhance fire-dependent habitats on private land, but landowners and managers need information, technical support, and in many cases, financial support to initiate and maintain these management efforts.	Location and condition of high priority sites and habitats for prescribed burns. Number of landowners willing to undertake habitat restoration or enhancement projects. Presence and condition of populations of high-priority species.	Improved structural and compositional characteristics of fire-dependent habitats. Enhanced viability of populations of high-priority species in restored or enhanced habitats. Acres of wildlife habitat maintained primarily through prescribed burns. Number of landowners employing growing season burns.
116	The Georgia Forestry Commission will be assessing and revising the Forest Action Plan in the near future. DNR will contribute to the wildlife conservation component in the Plan and identify opportunities for future collaboration on conservation	H	The Forest Action Plan provides the framework for forest-related programs and activities by GFC and its conservation partners. DNR will provide input on wildlife conservation needs and opportunities, attend planning meetings, and participate in outreach and other activities to facilitate the plan revision.	Information on Forest Action Plan data requests, data provided, meetings attended, and wildlife conservation objectives incorporated.	Level of participation in the revision and implementation of the plan; timely completion of the plan revision and incorporation of SWAP conservation objectives
117	Propagate rare plants identified as being most at risk of extinction and likely to benefit most from a coordinated propagation and reintroduction effort. Make use of and modify (for Georgia) existing protocols employed by other states and countries. Safeguarding sites (incl. reintroduction, enhancement, and newly created sites) would be identified from the available mix of public, and private lands within the state. Habitat maintenance plans and long-term monitoring program would also be developed for each Safeguardingf site.	VH	Because opportunities for rare plant site acquisition are limited, greater emphasis must be placed on augmenting populations of critically threatened plants on existing protected areas. One area that offers promise is the propagation and planting of rare, endangered and special concern plants for the reintroduction of historical populations, enhancement of existing populations, and the establishment of new safeguarding populations in suitable habitat.	Prioritized list of rare plants that can be successfully propagated and reintroduced over a 10 year period. Protocols and guidelines used by other state and federal programs and agencies will be reviewed. Number and location of plants, ecotypes represented, population size, reproductive effort, areal extent, threats, etc.	List of plants prioritized based on the potenital for propagation and reintroduction; guidelines for collection, notation, and horticulture; plants produced from ex situ propagation. Identification of numerous suitable sites for reintroduction, enhancement, or safeguarding Stable/growing populations with reproductive effort and recruitment level necessary to provide for long-term viability.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
118	Improve Public Land Management	Create DNR online database of monitoring projects. Conduct periodic meetings to share data, coordinate efforts, and address problems. Hire a DNR monitoring program coordinator.	Monitoring, Database, Administration	Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants, other USFWS funds	DNR (WRD, PRHSD, EPD)	USFWS, U.S. Geologic Survey, USGS Cooperative Fish and Wildlife Unit, U.S. Forest Service, The Nature Conservancy, National Park Service
119	Improve Public Land Management	Develop an adaptive management approach for high priority plants and natural communities on public lands	Monitoring, Research, Habitat Protection	Ongoing, Proposed	*Ceratiola ericoides, Echinacea laevigata, Elliottia racemosa, Lindera melissifolia, Oxypolis canbyi, Rhus michauxii, Xerophyllum asphodeloides,* Oaky Woods Prairies, herbaceous seepage bogs, longleaf pine sandhill, others as need arises	All	All	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6, other USFWS funds	DNR	GPCA and its member institutions, USGS Cooperative Fish and Wildlife Research Unit, various colleges and universities

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
118	The database will be a tool to share monitoring reports, provide a standardized system to store protocols, data, qualitative information regarding land management results, and metadata about projects. Implementation would likely occur as a two-phase process, with the first phase to develop the system for posting project reports and qualitative management results, and the second to develop the system for storing and accessing protocols, data, and metadata. Monitoring meetings are a venue for staff to share ideas on monitoring in a peer-review environment for improving monitoring and conservation projects. A monitoring coordinator would review and compile monitoring plans, facilitate communication between partners to facilitate collaboration, set standards for protocol development, protocol documentation, data management, and reporting, communicate with academic institutions to develop opportunities for collaborative adaptive management projects, and provide venues for sharing of results, technologies, and ideas.	VH	Within DNR, there is lack of awareness of monitoring projects and associated challenges, even among biologists studying the same groups of species and ecological systems. Improving coordination of monitoring within DNR will serve as a model for coordination of monitoring among partners state-wide. Improving coordination and standardization is critical to improving rare species and habitat monitoring, which provides knowledge needed to determine optimal conservation and management actions. Monitoring occurs over many specializations and roles in Georgia. A person dedicated to coordinating monitoring within DNR and its partners is necessary to bridge the complex monitoring nextwork in the state, and to facilitate communication about monitoring results to decision makers and natural resource managers.	Monitoring project protocols, metadata, results. Inventory of rare species and habitat monitoring by DNR and partners. Incoroporation of monitoring protocols, results, and metadata on DNR monitoring projects into a unified database.	Implementation of a system to easily store and access information about rare species and habitat monitoring. Improved coordination of monitoring programs within DNR.
119	Design and carry out adaptive management projects for focal rare species and habitats where they are being managed on public conservation lands and the effects of management are uncertain or there is risk to the rare element. Monitoring results feedback directly to land managers so management actions can be improved in future iterations.	VH	Landscape scale management may conflict with micro-site management needs for certain rare plant species, or effects of management for certain rare plants and habitats may be uncertain. In these cases there is risk of management negatively impacting the rare plants and habitats and monitoring is a high priority. Monitoring projects will be prioritized according to the species affected and the uncertainty or risk of management to be enacted. Monitoring will be designed so only critical variables are measured and results feedback directly into determining subsequent management actions.	Critical population and habitat data to indicate status of the focal elements, related environmental variables, management events	Number of projects where monitoring results directly inform land management decisions, Documentation of improved communication among rare species biologists and public land management staff.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
120	Improve Public Land Management	Implement integrated resource management of federal lands and waters (including oceanic habitats), emphasizing restoration and maintenance of natural communities and rare species populations. Work with DNR and other conservation organizations to enhance ecosystem functions and address regional conservation needs.	Management	Ongoing, Proposed	Numerous	All	All	Federal agency operating funds; DoD Legacy Management Program; DoD Encroachment and Buffering funds; State Wildlife Grants, Nongame Wildlife Fund	DoD, USFS, USFWS, NPS, NOAA, CRD	DNR, TNC, NatureServe, USGS
121	Improve Public Land Management	Implement integrated resource management of state lands and waters (fresh, brackish, and salt), emphasizing restoration and maintenance of natural communities and rare species populations (i.e., ecosystem management). Work with other conservation organizations to address regional conservation needs.	Management	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, other WRD operating funds, NFWF,	DNR	GFC, TNC, Joseph W. Jones Ecological Research Center, UGA-WSFR, UGA-NARSAL, NESPAL, private landowners

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
120	Conduct surveys of federal lands to determine distribution and status of rare species and natural communities. Map location and extent of high priority habitats and landscape features using systems that are compatible across agency boundaries. Incorporate management recommendations for these features in long term management plans. Exchange information on rare species and natural communities with Georgia DNR and other organizations that maintain biodiversity databases. Contribute to ecoregional strategies for control of exotic species and restoration of natural communities. Share information and expertise relating to inventory, mapping, management, and monitoring of species and communities.	VH	Federal lands (national parks, wildlife refuges, and forests; military bases) contain some of the most significant habitats and populations of rare species in the state. Continued collaboration between DNR, federal land managing agencies, and private conservation organizations is critical for improvements in capacity to maintain Georgia's natural diversity. Increased collaboration and coordination of conservation efforts can result in protection of wildlife corridors and landscape features necessary for long term ecosystem maintenance. This collaboration should include oceanic habitats under federal jurisdiction	Location and condition of high priority species and habitats. Information on minimum viable population sizes, historic vegetation and land use patterns, restoration potential, management alternatives, and threats to species/habitats. Opportunities for protection of edgeholdings and inholdings through fee-simple acquisition or easements. Opportunities for collaborative research and management projects	Improved condition of wildlife populations and habitats on federal lands. Increased connectivity and protection of wildlife corridors and landscape features. Greater interagency exchange of information and expertise regarding rare species and natural community inventory, management, and monitoring.
121	Revise and update management plans for WMAs and other state lands as needed to address specific restoration objectives. Emphasize restoration of former pine plantations to stands that closely resemble natural forest and savanna communities and reintroduction of fire as a management tool wherever appropriate and feasible. Utilize information from historic aerial photos and land lot survey data from the 1800s to identify historic vegetation. Continue collaboration with partners to determine and implement appropriate methods for restoration of natural habitats, including restoration of groundcover in longleaf pine ecosystem. Monitor results of restoration efforts. Coordinate with CRD to protect coastal marshes, waterways and rare upland habitats	VH	Many state-owned WMAs (especially in the Coastal Plain) are former industrial forest lands. Restoration of these stands to uneven aged pine forests and savannas would benefit many high priority species. Integrated resource management of state properties for a wide range of nongame species will complement ongoing management for game species. Greater use of prescribed fire as a management tool for restoration and management of natural communities will provide numerous benefits for high priority species. Historic aerial photos and models of historic vegetation derived from land lot survey witness tree data can help identify restoration objectives.	Various measures of stand density, vegetation structure, and community composition. Population sizes of high priority species associated with these habitats. Information from historic aerial photos, historic vegetation models, soil surveys, and other sources. Information on condition of potential donor sites used for harvesting native groundcover species, as well as potential recipient sites.	Improved structural and compositional characteristics of former industrial timber stands within each WMA. Total number of stands/acres restored. Increased population sizes and overall viability of high priority species. Acres planted with native groundcover species harvested from donor sites; native groundcover species diversity and abundance in recipient sites

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
122	Improve Public Land Management	Strengthen and expand the fire photo monitoring program	Monitoring	Ongoing and Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants	DNR	Georgia State Parks Division, Interagency Burn Team
123	Improve Public Land Management	Survey state-owned lands for federal and state protected species and other species of concern and incorporate conservation objectives into management plans	Survey, Management	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	State Botanical Garden, Georgia Botanical Society, Audubon Society, local volunteers.
124	Improve Public Land Management	Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands	Management	Ongoing, Proposed	*Rana capito, Notophthalmus perstriatus, Gopherus polyphemus, Ambystoma cingulatum,* others	SP, SCP	All	State Wildlife Grants, Nongame Wildlife Fund, Section 6	DNR	USFWS, UGA, Zoo Atlanta, Atlanta Botanical Garden
125	Improve SWAP Communications	Increase awareness of the SWAP among partner organizations.	Communications, Outreach	Proposed	Numerous	All	All	Nongame Wildlife Fund	DNR	Communications Team members
126	Improve SWAP Communications	Promote the conservation actions, themes and goals of the SWAP to five priority stakeholder groups to increase stakeholders' support for wildlife conservation; awareness of the SWAP, its importance, themes and successes; and, awareness of the partnership effort involved.	Communications, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund	DNR	SWAP Communications Team members (WRD, TGC, GDOT, GFA, GFC, Georgia Power, TNC, DoD,USFWS, USFS and NRCS). Other potential partners include CRD, UGA, Botanical Garden of Georgia and others.

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
122	Photo monitoring of prescribed fire effects has been installed at 25 sites state-wide. Tasks for improvement include: develop efficient software mechanisms to submit, catalogue, view, and quantitatively analyze photos; expand sites to monitor different management types, WMA's, and reference habitats; and incorporate quantitative data into the protocol at high priority sites.	VH	A statewide fire monitoring program was initiated in 2009 to improve documentation of the prescribed fire program, indicate whether long-term burning objectives are being met, and involve local site managers in monitoring their management activities. The photographs are the only readily available documentation of fire effects at many managed conservation lands and, with these improvement to the program, they will be better organized, more accessible, and an excellent resource for demonstrating long term change.	Systematized photographs and associated land management events; fire effects and vegetation community data	Number of sites with fire monitoring conducted at least biennually, ability to submit and easily catalouge photos, ability to query photos and generate cleanly formatted layouts.
123	Determine location and distribution of protected species and species of concern on Wildlife Management Areas, Natural Areas, Public Fishing Areas and State Parks.	H	The status of many species is unknown on state-owned lands. Protection and management of these species can not be accomplished without accurate and up to date occurrence information.	High priority species found on a WMA, NA, PFA, or State Park, specific locations of populations, colonies, or individuals, estimate of numbers of individual when feasible.	Number of WMAs, NAs, PFAs, and State Parks thoroughly surveyed for all high priority species.
124	Establish or augment populations of high priority animal species on protected lands in the Coastal Plain. Candidate species include gopher frog, striped newt, flatwoods salamander, gopher tortoise, and red-cockaded woodpeckers	H	The gopher frog and gopher tortoise have been proposed for federal listing. The need for listing these species may be minimized if proactive conservation measures can be implemented on protected lands. Other listed or candidate species should be evaluated. for establishment or augmentation on public lands	Potentially suitable habitats for establishment or augmentation of populations will be evaluated. Population levels will be monitored.	Establishment of viable populations of high priority animal species on public land.
125	This "in-reach" will mimic communications with the five stakeholder groups but with the focus on SWAP partner organizations. Work with individual partners will identify best ways to reach their staffs on specific messaging.	VH	In-reach is important, considering that partners are the face of the SWAP. Raising awareness and understanding of the plan among our staffs will better prepare them to address the topic with constituents and fellow workers, and can widen the base of support for the SWAP.	Data collected will vary according to the particular "in-reach" initiatives, but may include number of messages and surveys of recipients.	Online surveys of willing partner organizations can set benchmarks to monitor changes in knowledge of the SWAP. Partners' use of products can also be reported.
126	Create messaging, including calls to action, from the SWAP revision themes and technical team needs. Match communication options and products (social media posts, news releases, video, events, etc.) to the audience and situation or issue targeted. Share messaging through the partners network. Continue development of audience contact lists.	H	As noted, this effort will feed from overall SWAP focal points set by the Advisory Committee, as well as specific priority communication needs identified by the individual technical teams.	None, except for any data resulting from use of surveys and possibly web analytics to gauge impacts.	Use of online surveys to set baseline support and awareness will be explored, along with follow-up surveys to measure effects. Where appropriate, analytics can be used to gauge traffic at related websites.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
127	Improve SWAP Communications	Work with the SWAP Education Team as needed to achieve its recommendations. Specifically: 1) Help create an online survey supporting an assessment of Georgians' wildlife conservation literacy; 2) help with the content of core educational concepts, related messaging and educational materials; 3) help identify SWAP stories per ecoregion for use in regional education networks and community groups.	Communications, Education	Proposed	Numerous	All	All	See individual environmental education conservation action items.	DNR	See individual environmental education conservation action items.
128	Increase Capacity for Wildlife Conservation	Establish a consistent source of state funding for land protection to support wildlife conservation	Funding	Ongoing, Proposed	Numerous	All	All	TBD	TNC, TGC, TCF, TPL, GWF, State Legislature, Governor's Office	DNR, UGA, Georgia Land Conservation Center, NWF, others
129	Increase Capacity for Wildlife Conservation	Expand DNR Nongame Conservation Section Aquatic Program	Administration	Proposed	Numerous	All	Numerous	State Wildlife Grants, Nongame Fund, NOAA grants	DNR	USFWS, TNC,
130	Increase Capacity for Wildlife Conservation	Facilitate DNR Law Enforcement Division officer training to address nongame wildlife law enforcement needs.	Education, Regulation	Ongoing, Proposed	Numerous	All	All	Nongame Wildlife Fund, state appropriations	DNR	UGA-GMNH, NatureServe

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
127	Work with members of the SWAP Education Team and partner organizations to identify areas in which coordinated communication efforts are needed. Specifically: 1) Help create an online survey supporting an assessment of Georgians' wildlife conservation literacy; 2) help with the content of core educational concepts, related messaging and educational materials; 3) help identify SWAP stories per ecoregion for use in regional education networks and community groups. Utilizing key messages drafted by Education	H	See individual environmental education conservation action items.	Data collected will vary according to the particular communication initiatives, but will include metrics associated with development and distribution of key messages and surveys conducted as components of these communication campaigns.	Various metrics related to communications objectives, including messages developed and distributed, number of recipients, survey results, etc.
128	Provide guidance and support for establishment of a consistent and stable source of state funding for land protection, including fee-simple acquisition, acquisition of conservation easements, and other forms of permanent habitat protection	VH	This conservation action is a critical component for the achievement of species and habitat conservation objectives outlined in this document. Georgia must have a consistent, long-term source of funding for land protection to conserve critical habitats and populations of high priority species. No such funding source exists at the state level. Georgia has relied on a combination of federal grants, private donations, and short-lived state funded efforts to protect wildlife habitat. This approach has been only partly effective in addressing conservation needs for the wide array of imperiled species and habitats in the state.	Information on funding mechanisms used in Georgia and other states, laws and regulations needed to establish funding programs, and level of public support for wildlife habitat acquisition. Assessment of public awareness of wildlife conservation needs and current lack of consistent state funding to address these needs.	Identification, public approval, and establishment of a fundiing mechanism to provide long-term support for land protection for wildlife conservation. Development of specific criteria to ensure that the fund is used to address critical wildlife conservation needs identified through an iterative assessment process based on best available scientific data.
129	Expand DNR Nongame Conservation Section aquatic program so that each major basin in the state has an aquatic species conservation coordinator. Each coordinator would work with key partners to conserve and monitor high priority aquatic species and watersheds in each basin. Four basins are Atlantic, Gulf Slope, Coosa, and Tennessee	VH	The state only has 2 dedicated biologist positions to inventory, protect and recover 165 high priority species . Our work load is increasing due to our involvement with monitoring and conservation of candidate and petitioned species as well as coordination of DNR efforts on the Robust Redhorse Conservation Committee.	N/A	Full time biologist dedicated to Coosa, Tennessee, Mobile, and Gulf Slope drainages.
130	Provide additional training on laws and regulations established to protect nongame wildlife. Provide technical support and staff resources to address enforcement of nongame and protected species regulations.	VH	Increasing familiarity with laws and regulations pertaining to nongame and endangered wildlife and providing regionally relevant data on distribution of these species will help staff assess and address enforcement needs in each region. Providing additional staff resources will be necessary to fully address enforcement needs in many areas.	Number of programs/refresher courses given and training material provided. Number of cases involving nongame or endangered species investigated.	Number of cases investigated involving illegal nongame activities; overall awarness of nongame conservation issues and regulations.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
131	Increase Capacity for Wildlife Conservation	Improve biodiversity databases and increase data-sharing with conservation partners	Database	Ongoing	All	All	All	State Wildlife Grants, other federal grants, matching funds from landowners, Nongame Wildlife Fund	DNR	University System of Georgia; USFWS, TNC, NatureServe, biological consulting firms, conservation planners, private landowners
132	Increase Capacity for Wildlife Conservation	Improve capacity to work with corporate landowners to protect wildlife habitat; provide technical support through additional staff or contractors	Administration	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, other federal grants, matching funds from landowners	DNR, NatureServe, corporate landowners	The Conservation Fund, TNC, NWF, biological consultants
133	Increase Capacity for Wildlife Conservation	Increase availability and use of federal funds for land acquisition (fee-simple and conservation easements) and land management	Funding	Ongoing, Proposed	Numerous	All	All	LWCF, WSFR, Forest Legacy, DoD, Recovery Land Acquisition, Coastal Wetland Grants, NAWCA Grants	USFWS, DNR, DoD, GFC, NRCS, NPA	NFWF, TNC, TCF,NWF

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
131	Develop protocol for electronic submission of rare species datasets to WRD. Establish formal data-sharing agreements with UGA and other conservation partners; develop a system for providing on-line access to biodiversity data; assess and update database records for all high priority species. Develop a database to document sites where surveys were conducted but target species were not detected (This information helps identify future survey needs and also better informs status assessments). Rank occurrences of all high priority species and habitats for conservation purposes.	VH	Continued development and improvement of WRD biodiversity databases is necessary in order to more accurately assess the distribution and condition of rare species and natural communities and prioritize conservation actions acccordingly. Established data sharing agreements provide for responsible and appropriate use to achieve conservation objectives while protecting sensitive habitats, rare species populations, and private property rights. Ranking of occurrences helps ensure that the most important populations are addressed first and that resources are not wasted on populations with limited potential viability.	Records on location & condition of rare species populations and significant natural communities; biodiversity data users; information requests handled.	Number of new/updated database records; number of data use agreements; number of information requests handled; number of occurrences of high priority species in WRD databases.
132	Develop strong cooperative relationships with major corporate landowners; exchange data on rare species and significant natural communities; rank properties based on biodiversity value and provide technical assistance in land management; develop options for long-term protection, including fee-simple acquisition, conservation easements, and incentive programs.	H	Need to be be able to provide timely technical assistance to avoid loss or degradation of critically important wildlife habitats and respond to imminent large-scale divestiture of properties. This will require additional staff or contractors to provide technical assistance to implement biological inventories and conservation programs and explore options for long-term protection.	Presence/absence data for rare species on corporate lands; indices of biodiversity value based on rare species and significant natural communities.	Number of surveys conducted on lands of corporate partners. Acres of natural habitat and number of populations of high-priority species conserved through long term management plans or permanent land protection.
133	Improve coordination between conservation organizations to obtain and use federal funds for long-term protection of high-priority habitats and species. Assess funding programs and potential land protection projects and obtain necessary matching funds through innovative partnerships.	VH	Several federal programs provide significant opportunities for land protection, but the ability to obtain and use these funds depends on many factors, including providing nonfederal matching funds. Better coordination of conservation organizations and nonfederal funding sources in Georgia can result in more effective use of federal funds to protect high priority habitats and species.	Types of federal funding programs and amount of federal funds available. Criteria for application of funds. Availability of nonfederal matching funds or other forms of match. Location and availability of high priority properties.	Number of high priority species and habitats protected or enhanced through use of federal funds. Acreage of high priority sites protected through federal funding programs.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
134	Increase Capacity for Wildlife Conservation	Increase state funding to support WRD's nongame wildlife conservation programs	Funding	Proposed	All High Priority Species and Habitats	All	All	State appropriations	State Legislature	GWF, TNC, other conservation organizatons
135	Increase Capacity for Wildlife Conservation	Strengthen network of support for wildlife conservation programs and initiatives	Administration	Proposed	All High Priority Species and Habitats	All	All	In-kind or part of current organization budgets.	TNC, GWF, TGC, Georgia River Network, Georgia Conservation Voters, 100 Miles	Georgia Land Conservation Center, Georgia Water Coalition, National Wildlife Federation
136	Reduce Impacts from Development and Other Activities	Conduct studies and distribute findings on impacts to wildlife and effectiveness of mitigation efforts for solar and wind energy projects.	Research, Outreach	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, other federal funds, private foundations	DNR, Georgia Power, Georgia Southern University, UGA, USFWS	Georgia Power, EMCs, MEAG, GA Solar Energy Association, AFWA
137	Reduce Impacts From Development and Other Activities	Conserve populations of rare plants in transmission line corridors; maintain or enhance native vegetation for pollinators and migratory birds	Management	Ongoing	Numerous	All	All	Nongame Wildife Fund, federal grants, private foundations, private landowners	DNR, Georgia Power, local EMCs,	State Botanical Garden, Georgia Botanical Society, UGA,

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
134	Increase state appropriated funds for support of WRD's nongame wildlife conservation efforts, including staff, equipment, and operating expenses. This funding would provide support primarily for the Nongame Wildife & Natural Heritage Section, but could also support nongame conservation efforts by other WRD Sections as well as DNR's conservation partners.	VH	In 2015 the Georgia legislature approved a $300,000 appropriation for nongame conservation projects by WRD, the first in more than a decade. The largest source of private funding for the Section is the sale of nongame license plates. Revenue from the sale of these license plates is variable and uncertain. The ability to obtain federal funding for many conservation programs depends on availability of nonfederal matching funds. In addition, few state funds are available to support environmental education programs by WRD; many of these efforts are supported by private donations to the Nongame Wildlife Fund, TERN, and other entities. Expanding state funding for the Nongame Conservation Section of WRD would free up additional funds for education-related efforts and provide more matching funds for federally funded projects.	Information on current levels and sources of funding for nongame wildlife conservation efforts, including staff, equipment, and project-related expenses. Information on funding needed to support future efforts to conserve high priority species and habitats, provide education and outreach programs to the public, and meeting matching fund requirements for grants.	Amount of state funding for nongame wildlife conservation programs in WRD; number of conservation and education programs funded.
135	Strengthen coalition of environmental organizations to communicate SWAP objectives and work for improvements in policies, fundng, and capacity for wildlife conservation.	VH	A stronger and more coordinated coalition of conservation partners is needed to call attention to wildlife and habitat conservation needs statewide.	Number of wildlife conservation initiatives proposed and discussed with decision makers.	State policy and funding to support wildlife conservation and habitat protection.
136	Use standard protocols to improve comparability to other studies, enhance coordination among states, and provide a consistent message to managers, decision makers, and the public.	M	Two projects are currently underway that will provide useful information on small-scale solar and wind generation projects. DNR will collaborate with Georgia Power, USFWS, and Georgia Southern University on a wind energy demonstration project on Skidaway Island, and with Georgia Power, USFWS, and UGA on a solar power demonstration project on the UGA campus in Athens.	Wind power: Impacts on birds, bats, and other target taxa. Solar power: impacts on native groundcover, birds, pollinators.	Studies conducted; results distributed to solar power companies, states, managers, decision makers, and the public to inform best management practices
137	Identify, delineate, and develop management plans for populations of high priority plants occurring in transmission line corridors. Communicate with management crews to ensure that vegetation management techniques are compatible with maintenance of rare plant populations. Offer technical assistance and financial incentives to landowners to restore habitat adjacent to transmission corridors. Monitor use of sites by pollinators and migratory birds	H	Several populations of rare plants occur under powerlines maintained by Georgia Power or local EMCs. The most important of these populations need to be delineated with special management signs and management guidelines developed to avoid unintended impacts from vegetation management. Opportunities to restore or enhance adjacent habitat will be explored. These habitats are also important for many migratory birds and pollinators.	Location, condition and extent of rare plant populations. GPS coordinates, management requirements, potential site viability, land ownership. Use of native vegetation by pollinators and migratory birds.	Number of rare plant populations delineated and protected through special management guidelines. Number of natural communities protected and/or enhanced. Use by pollinators and migratory birds documented.

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
138	Reduce Impacts From Development and Other Activities	Continue to expand the knowledge base and use of native plants	Education, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund, NRCS and USFWS funds	DNR, GPCA and its member institutions	GAEPPC, GPCA and its member institutions
139	Reduce Impacts from Development and Other Activities	Develop procedures for engaging with developers in solar, wind, and biomass energy, and collaborate on the development of best practices. Provide technical assistance to avoid or minimize impacts to high priority species and habitats. Conduct outreach to the public and decision makers about potential impacts to wildlife and potential solutions.	Conservation planning, Outreach	Ongoing, Proposed	Numerous	All	All	Nongame Wildlife Fund, USFWS, private foundations	DNR, Georgia Power, USFWS, GA Solar Energy Association	EMCs, MEAG, U.S. Industrial Pellet Association, AFWA
140	Reduce Impacts From Development and Other Activities	Expand use of WRD biodiversity data for environmental review, public outreach, permitting, and development of site management plans to minimize impacts on rare species and sensitive habitats	Database	Ongoing	Numerous	All	All	State Wildlife Grants, Nongame Fund	DNR (WRD)	TNC, UGA, USFWS, Forestry for Wildlife Partners, NatureServe, DOD, USFS, NPS, GDOT, biological consulting firms, conservation planners

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
138	Work with DNR partners to educate the public and the green industry with regard to the dangers of using non-native plants and the benefits of using native alternatives. Work to encourage the use and sale of natives by the public and green industry. Help DNR's partners, especially the GPCA and GAEPPC, research and document the benefits of native plants	M	Use of non-native plants by the public and the green industry continues to be a primary cause of environmental degradation, as well as an on-going threat for even more disastrous future problems. Any reduction in the use of non-natives and any increase in the use of natives (which provide a myriad of positive benefits for wildlife) is very important.	Lists of non-native plant species sold by green industry in GA and lists of native plant alternatives available. Industry data on sales on native and non-native species.	Sales of native vs. non-native plants by green industry members. Responses to public surveys addressing invasive species issues and use of native plants.
139	Develop procedures for engaging developers in the siting, permitting, mitigation, and implementation stages of solar and wind energy development. Help develop and promote a voluntary best practices one-pager. Promote early consultation with the Nongame Conservation Section of Georgia Department of Natural Resources as the first step during the site selection process to avoid impacts to known species/habitats of conservation concern. Participate in meetings and workshops with energy industry and wildlife agency representatives to identify ways to engage in all stages of the solar development process. Develop a “Risk Map” to be used as an early planning tool for solar, wind, and biomass energy project siting.	VH	Solar and wind energy project developments provide benefits for energy diversification but can result in negative impacts to native wildlife species. Careful planning and technical assistance are needed to ensure that impacts to at-risk species and sensitive habitats are avoided or minimized. DNR will work with partners to develop voluntary best practices, participate in consultation on species and habitats of concern, and develop tools to help with planning.	Information on siting, mitigation, and implementation practices that are compatible with wildlife conservation. Information from other state and regional programs that interact with solar and/or wind energy developers.	Procedures developed; risk map and other resources developed; number of entities receiving technical assistance; number of meetings and workshops attended
140	Make data available by multiple mapping units on WRD website; post high priority streams on GIS clearinghouse; incorporate high priority watershed into information request procedures; post pictures and accounts for all protected species on WRD website; support development of taxonomic guides for rare species; develop EO ranks for elements on lands of Forestry for Wildlife Partners and other land managers	VH	These efforts will help ensure greater awareness of rare species concerns among planners, consultants, land managers, and the general public, and will help ensure that these concerns will be addressed in environmental review of projects and development of site management plans.	Life history data, location data; information on types of data users and needs;	Number of contacts to WRD website for rare species information; number of EO ranks for high priority species on Forestry for Wildlife Partner lands; number of taxonomic guides produced; number of pictures and species accounts for protected species on WRD website

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
141	Reduce Impacts From Development and Other Activities	Facilitate training for and compliance with Best Management Practices for erosion & sedimentation control, stormwater runoff, and stream buffer protection	Management, Education, Regulation	Ongoing	Numerous	All	All	Land disturbing activity fees, state, federal, and local government funds	DNR (EPD), GSWCC, Local governments, ARC, Metropolitan North Georgia Water Planning District, industries, county governments, River Basin Center	USFWS, TNC, Georgia River Network, developers, site managers, property owners, neighborhoods, property associations, county governments
142	Reduce Impacts From Development and Other Activities	Help minimize the impacts to high priority species and habitats from petroleum pipeline development and other state or regional projects.	Conservation Planning, Regulation	Ongoing	Numerous	All	All	State funds, Nongame Wildlife Funds, USFWS	DNR	GDOT, FERC, USFWS, pipeline companies, local governments
143	Reduce Impacts From Development and Other Activities	Implement targeted dam and culvert removal/replacement projects and mitigation projects to restore and conserve stream banks and channels	Management	Ongoing	Numerous	All	Numerous	GDOT, USFWS, SARP, USACE, FEMA, FWHA	USFWS, DNR	SARP, TNC, American Rivers, UGA, USACE, County road departments, consulting firms
144	Reduce Impacts From Development and Other Activities	Minimize impacts to high priority species and habitats from the exploration and potential development of energy resources off the coast of Georgia.	Conservation Planning, Regulation	Ongoing	Marine and coastal species	SCP	Marine waters	State funds, Nongame Wildlife Fund, USFWS, NOAA	DNR (CRD, WRD), USFWS, NOAA	Bureau of Ocean Energy Management, energy developers and contractors

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
141	Includes a wide variety of training, monitoring, and enforcement activities pertaining to erosion and sediment control, stormwater management, wastewater management, and stream buffer protection for activities relating to construction and development. Provide technical information on BMPs through websites, workshops, and publications.	H	A variety of BMPs and training programs have been developed to provide protection for water quality. These BMPs can provide protection for high priority aquatic and terrestrial species as well, depending on the local setting. Continued emphasis on training industrial site managers, utility workers, county officials, and the general public is needed to ensure that all persons involved in land development or other land-disturbing activities are aware of regulations and methods to reduce resulting impacts to aquatic habitats. Monitoring and enforcement activities are also critical to ensure compliance with state and local standards.	Number of training programs provided; level of compliance with BMPs and stream buffer ordinances; number of stormwater pollution prevention plans for industrial sites; number of municipalities with stormwater management programs, including local ordinances and public education activities. Annual progress reports submitted to EPD.	Full compliance with erosion and sedimentation control standards; control of stormwater flows to minimize impacts on aquatic habitats; maintenance of intact stream buffers; control or treatment of wastewater and stormwater within state water quality standards. Increased awareness of and compliance with regulations and BMPs for protection of water quality.
142	DNR will work with GDOT, FERC, USFWS, and pipeline companies to avoid or minimize impacts of pipeline projects on rare species, natural communities, and conservation lands. DNR will also work with local governments and regulators to avoid or minimize impacts from landfills and similar projects.	H	Major petroleum pipeline projects cross multiple habitats and have the potential to impact numerous high priority species and habitats. Involvement by DNR staff in reviews of proposed projects and interaction with pipeline developers and state and federal regulators is critical for protection of wildlife habitats and public and private conservation lands. Involvement in enviromental review is also needed for more local projects such as landfills.	Proposed pipeline routes; locations of rare species, natural communities, and public and private conservation lands.	Level of engagement with agencies and companies to minimize impact to wildlife of proposed petroleum pipelines and other projects.
143	Use barrier inventories and models to strategically target barriers for removal. Monitor aquatic communities before and after removal. Continue working with the Corps of Engineers to select mitigation properties that restore and conserve stream reaches in high priority Georgia watersheds.	VH	Barriers fragment aquatic species populations and prevent movements to spawning, feeding, refuge, and nursery habitats. Barriers also block colonization after local extinction. In order to achieve watershed level benefits, mitigation projects must be strategically located and adequately designed. Mitigation is expensive, so it is important that resources are invested to achieve maximum benefits for rare species and habitats.	Species distributions above and below barriers before and after project completion, assessment of unintended consequences associated with invasive species, sediment and contaminants.	Miles of stream re-connected; proportion of stream habitat restored or protected.
144	Provide timely reviews of proposed projects related to energy exploration and potential energy resource development in marine waters. Collaborate with federal and state agencies and local governments to address potential impacts to high priority species and other important natural resources	H	Off-shore energy exploration and development has the potential to impact species of conservation concern. DNR involvement in reviews of proposed projects and collaboration with federal regulators are critical for protection of wildlife resources in marine and coastal environments.	Information on proposed projects, areas of potential impact, high priority species and habitats, and other resources of concern.	Level of engagement with agencies and companies to minimize impact from offshore energy exploration

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
145	Reduce Impacts from Development and Other Activities	Participate in regional efforts to understand impacts to wildlife and develop strategies to minimize the impacts of biomass energy development. Identify and apply relevant lessons from other states and regions. Promote biomass energy guidelines consistent with wildlife conservation.	Conservation Planning, Education, Outreach	Ongoing	Numerous	All	All	State Wildlife Grants, other federal grants, private foundations	DNR	DOE, USDA, GFC, AFWA, SFI, US Industrial Pellet Association, landowners, public
146	Reduce Impacts From Development and Other Activities	Provide technical assistance to farmers to protect streams in high priority watersheds	Management	Ongoing	Numerous	All	Numerous	Farm Bill Programs, 319 grants, Partners for Fish and Wildlife Program	NRCS	USFWS, DNR, TNC, GSWCC
147	Reduce Impacts From Development and Other Activities	Reduce impacts of ATV use on streams and other sensitive habitats.	Management and Education	Proposed	Primary emphasis is on aquatic species and habitats, but includes other sensitive habitats	All	All, but especially Ohoopee River and Altamaha River	Unknown	DNR, GON	Georgia Water Coalition, ATV manufacturers
148	Reduce Impacts From Development and Other Activities	Reduce impacts of unpaved roads, parking lots, boat ramps, and camping areas on aquatic habitats	Management, Education	Proposed	Aquatic species	All	All	Federal highway ROW funds, state matching construction funds	DNR, USFS	GDOT, county road departments
149	Reduce Impacts From Development and Other Activities	Update GDOT mussel sampling protocol	Survey and Monitoring	Proposed	Numerous	All	Numerous	Unknown	USFWS, DNR	GDOT

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
145	Promote adherence to AFWA's Guidelines for the Integration of Fish and Wildlife Conservation with Biomass Production; the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) standards during the development of field trials of engineered high energy crops; and, any guidelines from NCS that are applicable to local conditions. Guidelines may include avoiding conversion of native habitat to establish bioenergy crops, avoiding introductions of invasive species, minimizing the use of water for bioenergy production, and following harvest guidelines that minimize impact to fish and wildlife.	M	Biomass energy production is a growing field and provides great opportunities for economic development in Georgia. Guidelines should be developed for use of materials and sites that do not contribute to loss or decline in at-risk species or natural communities. AFWA and other organizations have developed guidelines that could be adopted and modified as needed to ensure that biomass energy production is aligned with wildlife conservation goals.	Data on biomass energy production practices that are compatible with wildlife conservation, as well as those methods and materials that contribute to loss or decline in species diversity and habitat quality.	Number of available regional efforts in which GADNR participates; Relevant lessons identified and applied to outreach efforts and development of best practices;messages developed and delivered on alignment of biomass energy and wildlife conservation goals.
146	Work with partners to help target programs to high priority watersheds. Examples are riparian restoration, plugging ditches, streambank stabilization, alternative water sources for cattle, etc.	VH	Agricultural activities can contribute signficant amounts of sediment, nutrients, and pesticides to streams, with negative impacts to species and habitats.	Sediment, nutrient, and pesticide levels in streams before and after restoration practices are implemented	Miles of riparian buffers restored, miles of ditches plugged or improved, number of practices implemented
147	Educate citizens about the impact of ATV's on streambank stability and shoreline habitats through commercials, fliers, etc. Provide information about other sensitive habitats that should be recognized and avoided by ATV users.	M	ATV misuse was frequently cited by technical team and stakeholders as a threat to aquatic habitat quality. Direct impacts from physically crushing freshwater mussels is also likely in some areas. ATVs also impact other sensitive habitats such as wet prairies and granite outcrops.	Information on specific impacts in various watersheds or ecoregions; number of ATV riders and manufacturers	Number of messages produced and distributed through fliers, commercials, etc. Number of ATV companies that supply info on responsible riding to customers.
148	Acquire funds to pave frequently used dirt roads that contribute significantly to sediment loads in adjacent streams. Close infrequently used and eroding dirt or gravel roads, or re-engineer turnouts to decrease sediment losses. Improve deteriorating boat ramps as needed to reduce local sediment losses. Renovate or relocate camping areas or trails that contribute to sedimentation or streambank destabilization	M	Unpaved roads can add large volumes of sediment to streams. These impacts must be assessed in relation to the impacts of impervious surfaces from paved roads. In some cases, little-used roads can be closed by the landowner (e.g., USFS). In other cases, changes in placement of turnouts or maintenance methods may adequately address problems of sedimentation.	Information on high priority roads for paving or closure, high-traffic areas near campgrounds, deteriorating boat ramps, and other problem areas adjacent to high-priority streams.	Reduced local erosion/sedimentation rates and improved streambank stability.
149	Update Georgia Department of Transportation mussel sampling protocol. This protocol was developed in the mid-2000's and needs to better address the probability of detecting mussels during surveys. Protocols for gastropod surveys should be also be addressed.	H	A major issue with rare species surveys is the problem of incomplete species detection. If the species is not found during a survey, it may still be present. Models can be developed that estimate the probability of detecting a mussel or snail species for different sampling methods	Detection history for target species for different sampling methods	Updated protocol shared with partners

High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
150	Reduce Impacts From Development and Other Activities	Work with Georgia Department of Transportation and federal agencies to minimize impacts from highway construction and facilitate protection and mitigation of high priority habitats	Database, Management, Habitat Protection	Ongoing, Proposed	All	All	All	Federal Highway funds; State Wildlife Grants, Nongame Wildlife Fund, Georgia Wetland Trust Fund	DNR, GDOT, FWHA	USFWS, COE, EPA, TNC, Georgia Land Conservation Center, EPD, UGA, land trusts

High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
150	Develop an MOU between DNR and GDOT to facilitate collaborative efforts to minimize impacts from road construction projects to high priority species and habitats. Share information on locations of rare species and significant natural communities and sites that are suitable for mitigation activities. Emphasize protection of sites that will conserve high priority species and habitats and expand public recreational opportunities.	VH	Ongoing and future road construction projects have potential to impact high priority species and habitats in many areas of the state. Efforts to continue and expand collaboration between DNR and GDOT will be critical for protection of high priority species and habitats and expansion of state properties that provide diverse opportunities for public recreation.	Locations of high priority highway construction projects and associated wetland and stream mitigation needs. Locations of rare species and natural communities in need of protection, and properties that could provide appropriate and meaningful mitigation opportunities.	Number of mitigation sites protected through fee-simple acquisition or other means and managed to preserve, restore, or enhance wetland and/or stream habitats. Minimized impacts to high priority species and habitats through coordination of planning and assessment efforts.

2015 - 2016 GEORGIA HUNTING SEASON DATES AND LIMITS

Species		Season	Limit
Deer	Archery, Either sex	September 12 - October 9, Statewide	Twelve (12) per season, Statewide No more than ten (10) may be antlerless and no more than two (2) may be antlered. One of the antlered deer must have at least 4 points, one inch or longer, on one side of the antlers. Firearms deer hunting is not allowed in Clayton, Cobb, DeKalb, Fulton (north of GA Hwy. 92), and that portion of Glynn county lying within Jekyll Island. In the portion of Forsyth county south of GA Hwy. 20, only shotguns and muzzleloaders may be used (no other firearms allowed). In Hancock, Harris, Meriwether, Montgomery, Randolph, Talbot and Troup counties, only antlered bucks with at least 4 points on either side are legal. In Dooly and Macon counties, antlered bucks must have a minimum 15-inch outside spread. **Either sex deer dates are listed in the Hunting Seasons & Regulations publication and at www.gohuntgeorgia.com.**
	Extended Archery, Either Sex only for Clayton, Cobb, DeKalb, Forsyth, Fulton, Gwinnett & Rockdale	January 2 - 31	
	Primitive Weapons, Either sex	October 10 - 16, Statewide	
	Firearms:	October 17- January 10, Statewide	
Bear	Northern Zone:	Archery: Sept. 12 - Oct. 9 Primitive Weapons: Oct. 10 -16 Firearms: Oct. 17 - Jan. 10	Two (2) per season; provided, however, that no more than one (1) of which may be taken from the Southern/Central Bear Zones.
	Central Zone	Firearms: Dec. 12	
	Southern Zone:	Firearms: Sept. 24 - 26; Oct. 1 - 3; Oct. 8 - 10	
Turkey	Statewide	March 26 - May 15 (2016)	3 gobblers per season

SMALL GAME & MIGRATORY BIRDS (except waterfowl)

Squirrel	Statewide	August 15 - February 29	12 per day
Alligator	Zone & Quota Limited	August 14 - October 5	1 per quota permit holder
Fox & Bobcat	Statewide	December 1 - February 29	No Limit
Opossum	Statewide	October 15 - February 29	No Limit
Raccoon	Statewide	October 15 – February 29	3 per day
Rabbit	Statewide	November 14 - February 29	12 per day
Quail	Statewide	November 14 - February 29	12 per day
Grouse	Statewide	October 15 - February 29	3 per day
Crows	Statewide	November 1 - February 29	No Limit
Dove*	Statewide	September 5 - 20 October 10 – November 1 November 26 - January 15	15 per day, 30 in possession
Woodcock	Statewide	December 5- January 18	3 per day
Snipe	Statewide	November 15 – February 28	8 per day
Marsh Hens	Statewide	September 25 – November 15 November 21 – December 8	15 per day
Falconry	Statewide	October 1 – March 15	12 quail/rabbit/squirrel & 3 grouse per day

*subject to approval by Board of Natural Resources

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