Significant Habitats
in the Town of DOVER, Dutchess County, New York

Report to the Town of Dover and the Dutchess Land Conservancy

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EXECUTIVE SUMMARY

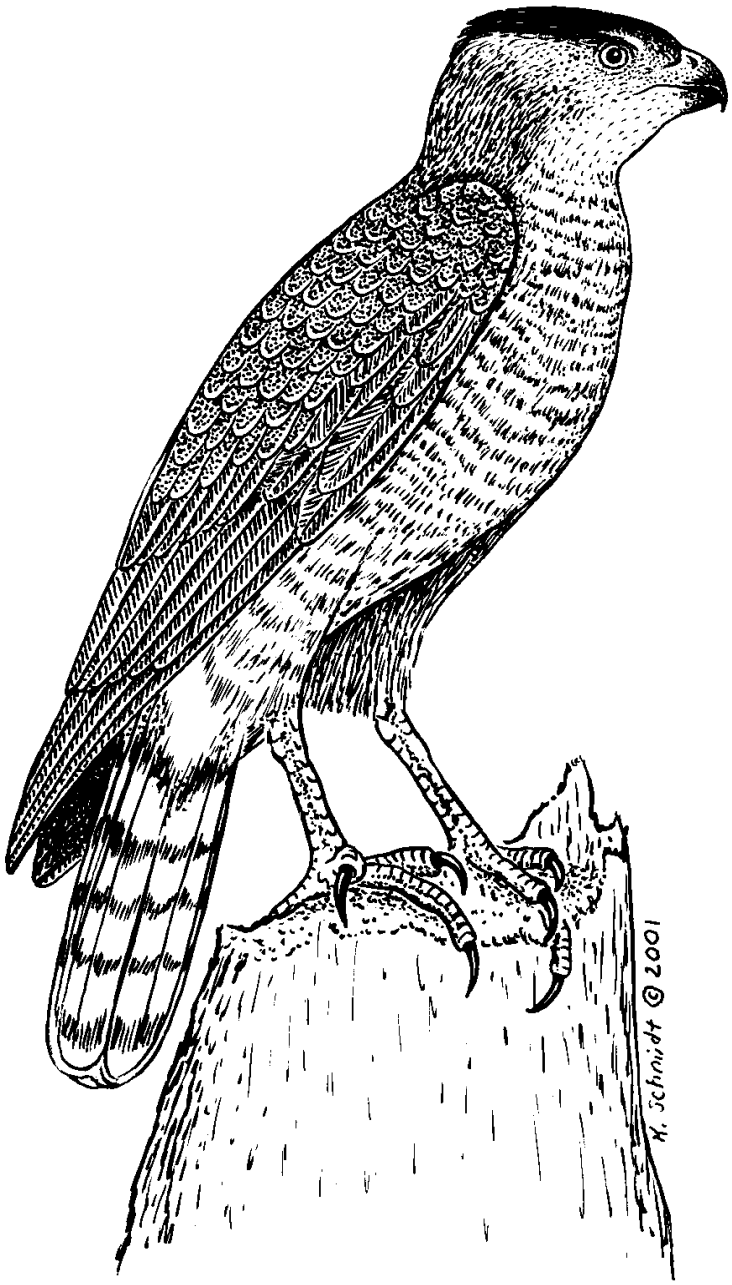
Hudsonia biologists identified and mapped ecologically significant habitats in the Town of Dover during two periods: September 2008 through December 2010 and May 2016 through December 2017. Through map analysis, aerial photograph interpretation, and field observations we created a large-format map showing the locations and configurations of habitats throughout the town. Some of the habitats are rare or declining in the region or support rare species of plants or animals, while others are high-quality examples of common habitats or habitat complexes. Among our more interesting finds were:

- three cool ravines
- 78 fens
- 38 red cedar barrens and 36 marble knolls
- nearly 250 ac (100 ha) of oak-heath barrens and associated crest habitats
- five acidic bogs
- 132 intermittent woodland pools, 40 pool-like swamps, and six kettle shrub pools
- extensive wetland complexes, including a large portion of the Great Swamp
- five areas of contiguous meadow of greater than 100 ac (40 ha) each
- extensive tracts of contiguous forest, including five blocks of greater than 1,000 ac (400 ha) each

In this report we describe each of the mapped habitat types, including their ecological attributes, some of the species of conservation concern they may support, and their sensitivities to human disturbance. We address conservation issues associated with these habitats, provide specific conservation recommendations, and delineate six areas in Dover that may serve as suitable units for conservation planning. We also provide instructions on how to use this report and the habitat map for conservation planning, policy-making, and site-specific environmental reviews.

The habitat map and report, which contain ecological information unavailable from other sources, can help the Town of Dover identify the areas of greatest ecological significance, develop conservation goals, and establish conservation policies and practices that will help to

protect biodiversity resources while serving the social, cultural, and economic needs of the human community.



Cooper's Hawk

Cooper’s hawk

INTRODUCTION

Background

Most land development in rural landscapes occurs without knowledge of the biological resources that may be lost or harmed. The consequences include widespread degradation of habitats and water resources, habitat fragmentation, loss of native biodiversity, and loss of ecosystem services to the human community.

Although many land-use decisions are necessarily made on a site-by-site basis, the long-term viability of biological communities, habitats, and ecosystems requires consideration of whole landscapes. Very little biodiversity information is available, however, for large areas such as entire towns, counties, or watersheds, making it difficult for landowners, developers, municipal planners, and others to incorporate biodiversity protection into day-to-day decision-making.

To address this need, Hudsonia Ltd., a nonprofit institute for scientific research and education, initiated a habitat mapping program in 2001. Using the approach set forth in the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001) we identify important biological resources over large geographic areas and inform local communities about effective measures for biodiversity conservation.

Hudsonia has now completed town-wide habitat maps of eleven Dutchess County towns—Dover, Amenia, Beekman, Clinton, East Fishkill, North East, Pine Plains, Poughkeepsie, Rhinebeck, Stanford, and Washington—and the City of Poughkeepsie; sections of Hyde Park, Fishkill, and LaGrange; the Town of Woodstock and part of the Town of Marbletown in Ulster County; and other large areas in several other counties. These projects have been funded by a variety of private and public sources. Funding for the Dover project was provided by the Millbrook Tribute Garden (through the Dutchess Land Conservancy [DLC]), the Educational Foundation of America, the Town of Dover, an anonymous donor (through the DLC), and many other individual donors (see *Acknowledgments*). We received endorsement and assistance rom the Dover Conservation Advisory Council (CAC), the Town Board, and many landowners.

The project was complete in two major phases, based on the availability of funding. Preliminary digital mapping for the entire town was completed by Nava Tabak in 2009, and field work performed by Tabak on the southern quarter of the town (south of Pleasant Ridge Road and the west-to-east flowing section of the Ten Mile River), plus an area along the Appalachian Trail off of S. East Mountain Rd., in 2008-2010. Chris Graham updated the preliminary mapping in 2016 and conducted field work in the remainder of the town in 2016-2017. Gretchen Stevens, director of Hudsonia's Biodiversity Resources Center, supervised the project and edited the report.

We have drawn on prior Hudsonia biodiversity research in the Town of Dover to inform this project. Kiviat conducted a study of significant habitats in Dover (1988), drawing on field work he conducted from 1975 to 1988. Hudsonia mapped and field-checked habitats on the former Hudson Valley Psychiatric Center property (now Olivet University)) in 2004 and the Stone Church Preserve in 2005 and 2016.

Through map analysis, aerial photograph interpretation, and field observations, we created a map of ecologically significant habitats in the Town of Dover. Some of these habitats are rare or declining in the region, and some may support rare or declining species of plants or animals, while others are common habitats or habitat complexes. The emphasis of this project was on identifying and mapping general habitat types; we did not conduct species-level surveys or map the locations of rare species.

To facilitate inter-municipal and regional planning, we strive for consistency in the ways that we define and identify habitats and present the information for town use, but we also strive to improve our methods and products as the program evolves. Many passages in this report on general habitat descriptions, general conservation and planning concepts, and information applicable to the region as a whole are taken directly from previous Hudsonia reports accompanying habitat maps in Dutchess County (e.g., Tollefson and Stevens 2004, Bell et al. 2005, Tabak et al. 2006, Knab-Vispo et al. 2008, Deppen et al. 2009,) without specific attribution. This report, however, addresses our findings and specific recommendations for the Town of Dover. We intend for each of these projects to build on the previous ones, and believe

that the expanding body of biodiversity information will be a valuable resource for site-specific, town-wide, and region-wide planning and conservation efforts.

We hope that this map and report will help landowners understand how their properties contribute to the larger ecological landscape, and will inspire them to implement habitat protection and enhancement measures voluntarily. We also hope that the citizens and municipal agencies of the Town of Dover will engage in proactive land-use and conservation planning to ensure that future land development is planned with a view to long-term protection of the town's considerable biological resources.

What is Biodiversity?

The concept of biodiversity, or biological diversity, encompasses all of life and its processes, including ecosystems, biological communities, populations, species, and genes, as well as their interactions with each other and with the non-biological components of their environment, such as soil, water, air, and sunlight. Protecting native biodiversity is an important component of any effort to maintain healthy, functioning ecosystems that sustain the human community and the living world around us. Intact ecosystems make the earth habitable by moderating the climate, cycling essential gases and nutrients, purifying water and air, producing and decomposing organic matter, sequestering carbon, and providing many other essential services. They also serve as the foundation of our natural resource-based economy.

The decline or disappearance of native species can be a symptom of environmental deterioration or collapse. While we do not fully understand the roles of all organisms in an ecosystem and cannot fully predict the consequences of the decline or extinction of any particular species, we do know that each organism, including inconspicuous ones such as fungi and insects, plays a unique role in the maintenance of biological communities. Maintaining the full complement of native species in a region allows an ecosystem to withstand stresses and adapt to changing environmental conditions.

What are Ecologically Significant Habitats?

A "habitat" is simply the place where an organism or population lives or where a biological community occurs, and is defined according to both its biological and non-biological components. Individual species will be protected for the long term only if their habitats remain intact. The local or regional disappearance of a habitat can lead to the local or regional extirpation of species that depend on that habitat. Habitats that we consider to be "ecologically significant" include:

1. Habitats that are rare or declining in the region.
2. Habitats that support rare species and other species of conservation concern.
3. High-quality examples of common habitats (e.g., those that are especially large, isolated from human activities, old, or lacking harmful invasive species).
4. Complexes of connected habitats that, by virtue of their size, composition, or configuration, have significant biodiversity value.
5. Habitat units that provide buffers from human activities or landscape connections between other important habitat patches.

Because most wildlife species need to travel among different habitats to satisfy their basic survival needs, landscape patterns can have a profound influence on wildlife populations. The size, connectivity, and juxtaposition of habitats in the landscape all have important implications for biodiversity. In addition to their importance from a biological standpoint, habitats are also manageable units for planning and conservation over large areas such as whole towns. By illustrating the locations and configurations of ecologically significant habitats throughout the Town of Dover, the habitat map that accompanies this report provides valuable ecological information that can be incorporated into local land-use planning and decision-making.

Study Area

The Town of Dover is located in eastern Dutchess County in southeastern New York. At 36,024 ac (14,585 ha), it has a population of roughly 8,700 residents (2010 US Census). Centers of population are the hamlets of Dover Plains and Wingdale; other hamlets include Chestnut Ridge, Dogtail Corners, Dover Furnace, South Dover, and Webatuck. Most properties are small (median size = 1.1 ac [0.45 ha]), but there is an unusual number of large land-holdings for the region, with 56 properties of at least 100 ac (40 ha); 13 of at least 500 ac (200 ha); five of over 1,000 ac (400 ha); and two holdings currently exceeding 2,000 ac (800 ha). Publicly-owned land, most of it with formal conservation status, totals about 2690 ac (1090 ha), and privately-held conservation land (fee-owned or under conservation easement) another 1,500 ac (710 ha).

The town's landscape is a striking contrast between mountains and valley. Broad, imposing ridges bound the town on two sides: West Mountain on the west and East Mountain (including Schaghticoke and Preston Mountains) on the east, both with numerous smaller hills, ridges, valleys, streams, and wetlands. Between those ridges lies the Harlem Valley, a north-south-oriented valley that extends from mid-Columbia County, through Dutchess and into Putnam County. The Ten Mile River and its major tributary, the Swamp River, drain the Harlem Valley in Dover, the former flowing south down the center of town before veering eastward and egressing near Dogtail Corners into Connecticut, where it shortly joins the Housatonic River (Figure 1). The stream valley along this eastward flow divides Schaghticoke Mountain, to the north, from a collection of hills to the south including Leather Hill and part of Hammersly Ridge. Along the Swamp River, which flows northward on its way to meet the Ten Mile River in Dover Plains, lies a sizeable portion of the Great Swamp, one of the largest freshwater wetlands in the state.

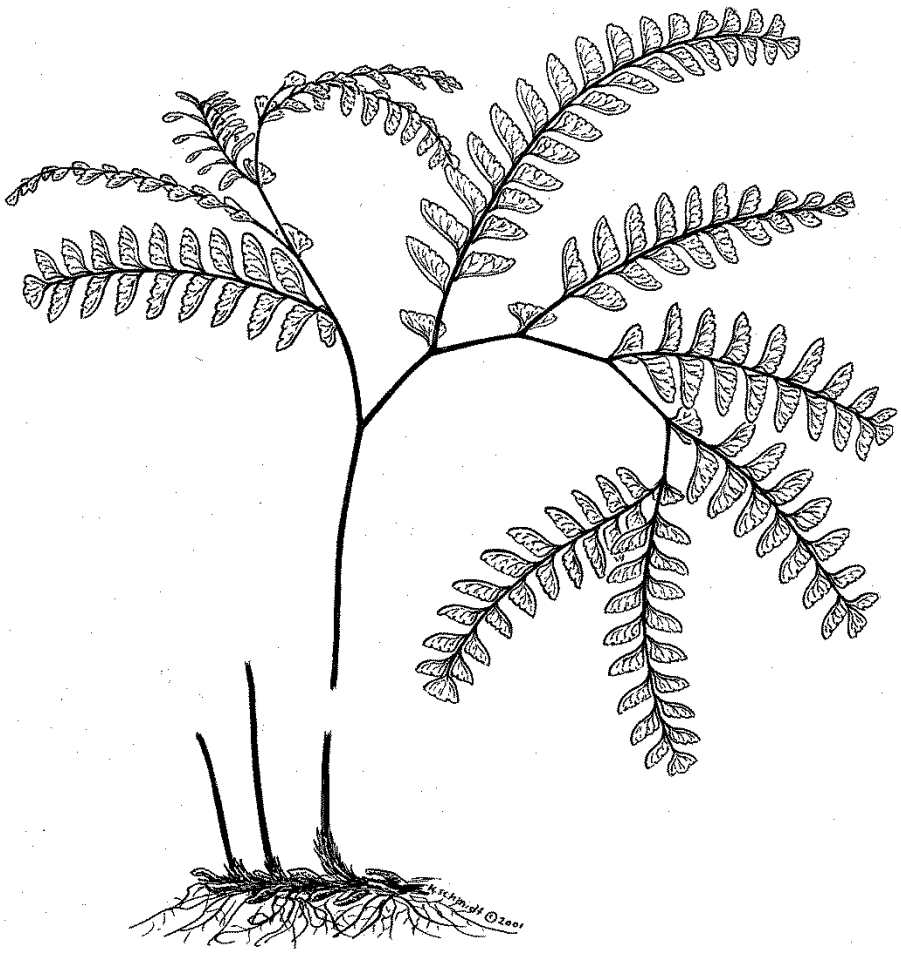
Elevations in Dover range from 290 ft (90 m) above sea level (asl), where the Ten Mile flows out of town, to ~1440 ft (440 m) asl atop Preston Hill, on East Mountain. East Mountain around Preston Mountain is the highest part of Dover, with a few other unnamed hills reaching 1400 ft (430 m) asl. Outside of this area, the highest point is Dennis Hill (1360 ft (415 m) asl), just north of Pleasant Ridge Road on the western edge of town.

Dover's bedrock is quite varied (Figure 2). The Harlem Valley is mostly underlain by Stockbridge marble, a calcareous bedrock, with smaller areas of slate and phyllite on the western side. West Mountain comprises large areas of both the Walloomsac Formation (slate, phyllite) and Everett Schist (schist, graywacke), while East Mountain is largely interlayered metasedimentary rock and granitic gneiss, with a smaller extent of Poughquaq quartzite (quartzite, conglomerate) on the lower, western slopes. The hills in the southeastern corner of town, south of the Ten Mile River, consist of the Manhattan Formation (pelitic schist, gneiss).

Surficial material in Dover is primarily glacial till, with smaller areas of alluvium, outwash sand and gravel, kames, and peat and muck (Cadwell et al. 1989). Exposed bedrock is common on the eastern and western ridges. Cadwell et al. show alluvium only along the Swamp River and Ten Mile River, but smaller areas of alluvial deposits likely occur along other streams. Sand and gravel occur in kames and glacial outwash—deposited by receding glaciers—at low to mid-elevations (up to ~800 ft), usually adjacent to alluvium or peat and muck. The largest areas of peat and muck are in the Great Swamp.

Primary land uses in Dover are residential, agricultural, and recreational. Residential development is concentrated in the Harlem Valley. Dover Plains and Wingdale are the main population centers, but exurban and rural residential development are widespread in the Harlem Valley and in the hills of the southern third of town (Figure 3). Hay production is the most common agricultural use; other significant uses include livestock grazing, vegetable crops, and maple sugaring. Active and recently abandoned agricultural fields occur mostly at lower elevations throughout the town, but are especially concentrated in the northern Harlem Valley (north of Duncan Hill Road) and on Chestnut Ridge. Recreational uses include hiking, nature-watching, and fishing in many parks and preserves (totaling nearly 2700 ac [1090 ha]); horseback riding, mostly on private land; and hunting on severalprivate hunting reserves, which combine managed fields (often planted with wildlife crops) and large expanses of forest. At least four of these reserves exceed 1,000 ac (400 ha), and several others exceed 200 ac (80 ha). Other prominent land uses include several gravel mines, forestry, energy infrastructure (an under-construction natural gas-fired power plant), religious camps, and a Christian university

with >2,000 ac (800 ha) of land holdings. (The latter two uses comprise a mix of developed and undeveloped land.)



Maidenhair fern

1.Watersheds

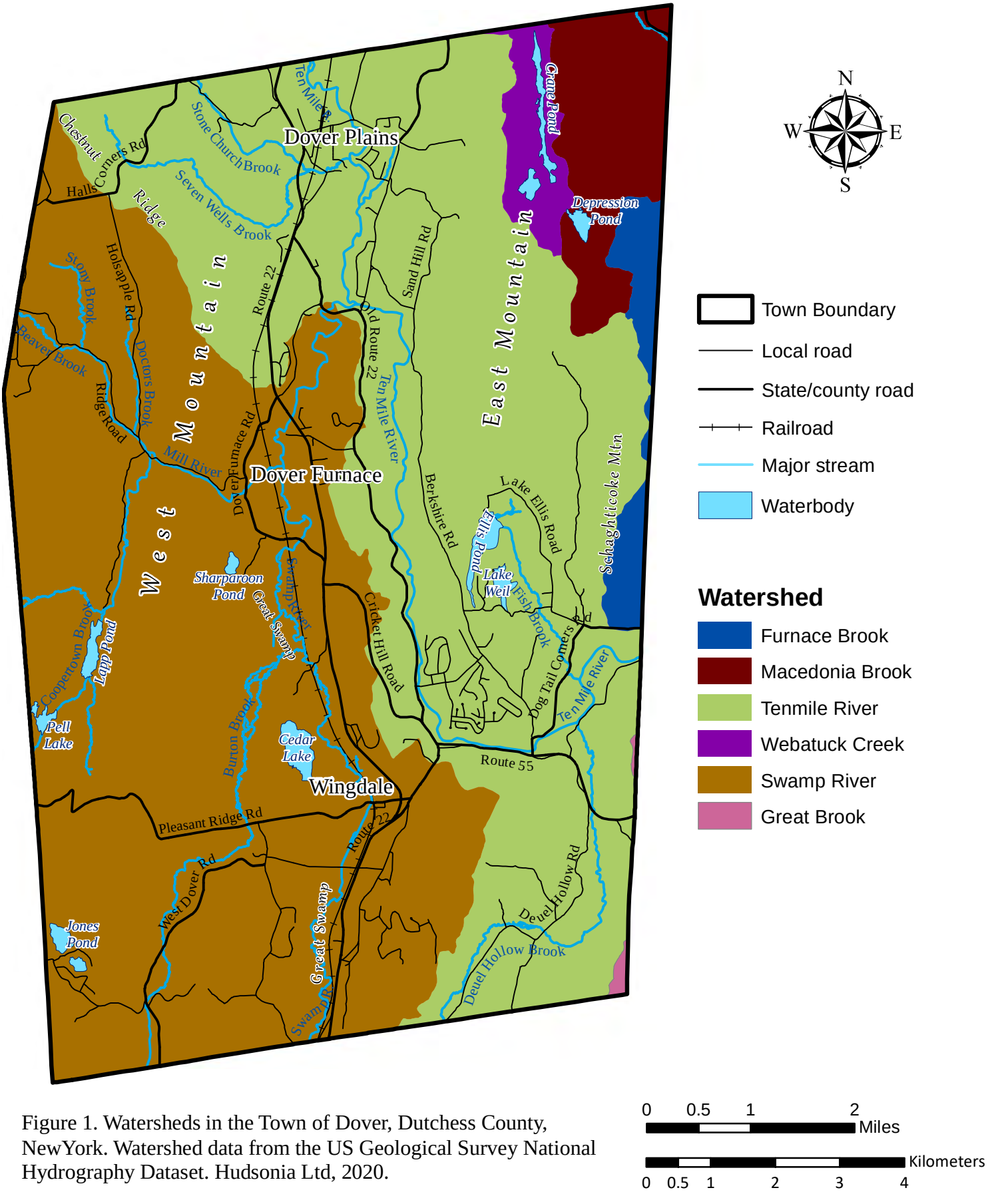


Figure 1. Watersheds in the Town of Dover, Dutchess County, NewYork. Watershed data from the US Geological Survey National Hydrography Dataset. Hudsonia Ltd, 2020.

2. Bedrock geology

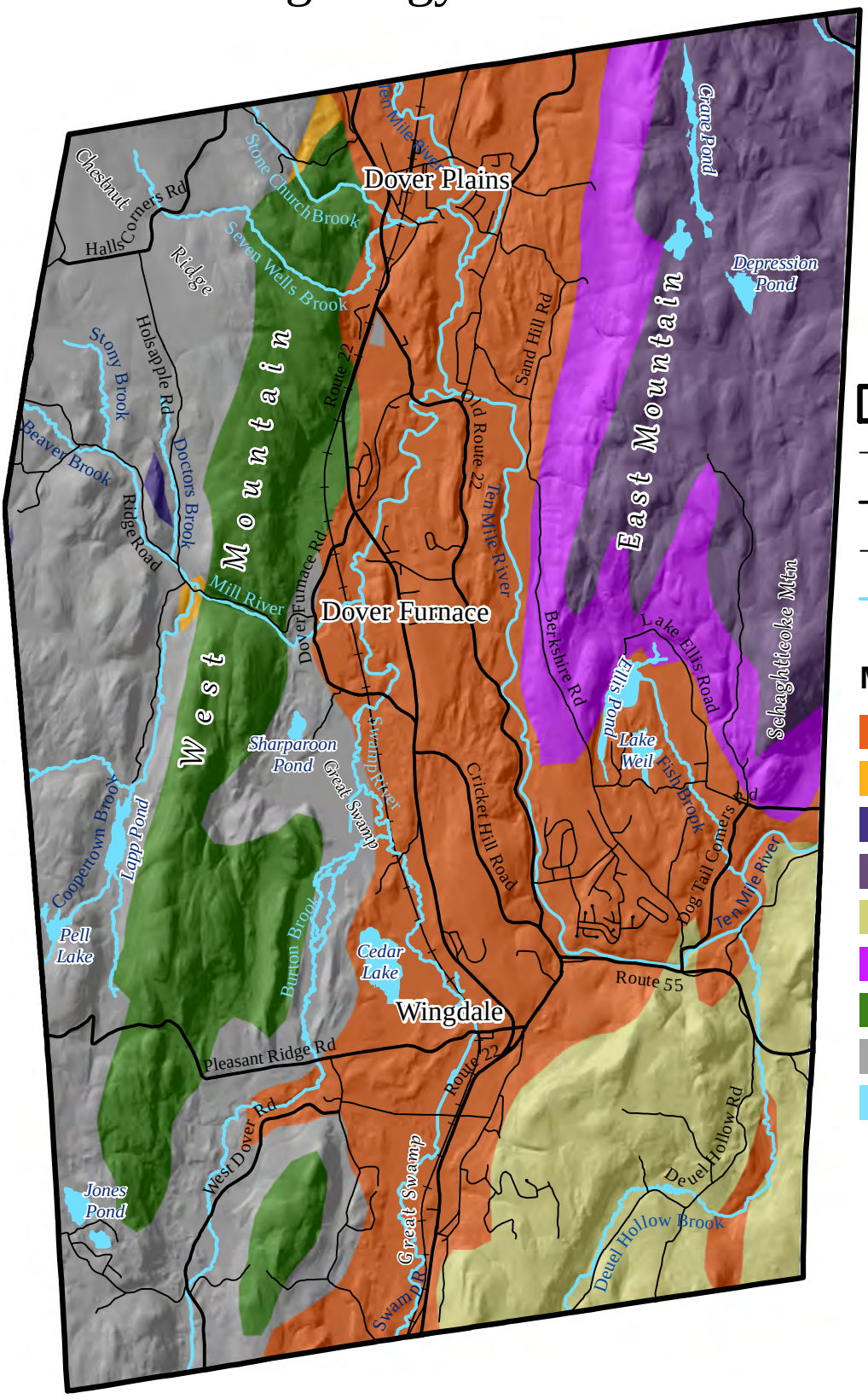


Figure 2. Generalized bedrock geology in the Town of Dover, Dutchess County, NewYork. Geology data from Fisher et al. (1970) and downloaded from the NYS Museum. Hudsonia Ltd, 2020.

METHODS

Hudsonia employs a combination of laboratory and field methods in the habitat identification and mapping process, as described below.

Gathering Information and Predicting Habitats

We use a combination of map features (e.g., slopes, bedrock chemistry, and soil texture, depth, and drainage) and features visible on stereoscopic aerial photographs (e.g., exposed bedrock, vegetation cover types) to predict the location and extent of ecologically significant habitats. In addition to previous studies conducted by Hudsonia biologists in Dover (e.g., Kiviat 1988), and biological data provided by the New York Natural Heritage Program, we used the following resources for this project:

- *1:40,000 scale color infrared stereoscopic aerial photograph prints* from the National Aerial Photography Program series taken in spring 1994, obtained from the US Geological Survey. Viewed in pairs with a stereoscope, these prints provide a three-dimensional view of the landscape and are extremely useful for identifying vegetation cover types, wetlands, streams, and cultural landscape features.

- *High-resolution 4-band and color infrared digital orthophotos* taken in springs 2004, 2009, 2013, and 2016 (with 6-, 12-, or 24-inch resolution), obtained from the New York State GIS Clearinghouse. We used these digital aerial photos for on-screen digitizing of habitat boundaries.

- *US Geological Survey topographic maps* (Dover Plains, Amenia, Verbank, Pawling, Poughquag 7.5 minute quadrangles). Topographic maps illustrate elevation contours, surface water features, and significant cultural features (e.g., roads, railroads, buildings). We used contour lines to predict the occurrence of such habitats as cliffs, wetlands, intermittent streams, and seeps. Digital (drg) USGS data were obtained from the NYS GIS Clearinghouse.

- *Bedrock and surficial geology maps* (Lower Hudson Sheets) produced by the New York Geological Survey (Fisher et al. 1970, Cadwell et al. 1989). The bedrock and surficial

geologies strongly influence the development of particular soil properties and aspects of groundwater and surface water chemistry, and have important implications for the biotic communities that become established on any site.

- *Soil Survey of Dutchess County, New York* (Faber 2002). Specific attributes of soils, such as depth, drainage, texture, and pH, convey a great deal of information about the types of habitats that are likely to occur in an area. Shallow soils, for example, may indicate the locations of crest, ledge, and talus habitats. Poorly and very poorly drained soils usually indicate the location of wetland habitats such as swamps, marshes, and wet meadows. The location of alkaline soils can be used to predict the occurrence of fens and calcareous wet meadows.

- *Geographic Information Systems (GIS) data*. We obtained several of our GIS data layers from the New York State GIS Clearinghouse, including municipal boundaries, roads, and hydrographical features. National Wetlands Inventory data, prepared by the US Fish and Wildlife Service, were obtained from their website. We obtained soils data from the Natural Resources Conservation Service website; bedrock geology and surficial geology data from the New York State Museum website; and NYS-regulated wetlands data (created by NYSDEC) from the Cornell University Geospatial Information Repository. We also obtained 5-ft (1.5-m) contour data from the Dutchess County Planning Department and tax parcel data from the Dutchess County Office of Real Property Tax. We used ArcMap 9.2, 10.4, 10.5, and 10.7 software (Environmental Systems Research Institute 2006, 2014, 2015, and 2019) to examine these data layers and the orthophoto images and to digitize habitat boundaries.

Preliminary Habitat Mapping and Field Verification

We prepared a preliminary map of predicted habitats based on map analysis and stereo interpretation of aerial photographs. We digitized the predicted habitats onscreen over orthophoto images using ArcMap 9.2 and 10.4 mapping software. With these draft maps in hand we conducted field visits to as many of the mapped habitat units as possible to verify or correct their presence and extent, to assess their quality, and to identify habitats that could not be identified remotely.

We identified landowners using tax parcel data, and before going to field sites we contacted landowners for permission to visit their land. We prioritized sites for field visits based both on opportunity (i.e., willing landowners and public property) and our need to answer questions regarding habitat identification or extent that could not be answered remotely. For example, distinctions between wet meadow and calcareous (calcium-rich) wet meadow, and calcareous crest and acidic crest, can only be made in the field. In addition to conducting field work on private land, we viewed habitats from adjacent properties, public roads, and other public-access areas. We were unable to visit every parcel in the town, so this prioritization contributed to our efficiency and accuracy in carrying out the work.

We field-checked approximately 42% of undeveloped land in the Town of Dover. We used remote sensing alone to map habitats in areas that we did not see in the field, but we also extrapolated the findings from our field observations to adjacent parcels and similar settings throughout the town. We assume that the areas of the habitat map that were field-checked are generally more accurate than areas we did not visit.

Defining Habitat Types

Habitats are useful for categorizing places according to apparent ecological function, and are manageable units for scientific inquiry and for land-use planning. For these town-wide habitat mapping projects we classify broad habitat types that are identifiable largely by their vegetation and other visible physical properties. Habitats exist as part of a continuum of intergrading characteristics, however, and drawing a line to separate two "habitats" often seems quite arbitrary. Furthermore, some habitat types are intermediates between two other defined habitat types, and some habitat categories can be considered complexes of several habitat types. In order to maintain consistency within and among habitat mapping projects, we have developed certain mapping conventions that we use to classify habitats and delineate their boundaries. Some of these conventions are described in Appendix A. All of our mapped habitat boundaries should be considered approximations. Much of the Town of Dover was only mapped remotely, and even the field-checked habitat boundaries were sketched without use of GPS or other land survey equipment.

Each habitat profile in the *Results* section, below, describes the general ecological attributes of that habitat type. Developed areas and other areas that we consider non-significant habitats (e.g., structures, paved and gravel roads and driveways, other impervious surfaces, and small lawns, meadows, and woodlots) are shown as white (no symbol or color) on the habitat map. Areas that have been developed or otherwise altered significantly since 2016 (the most recent orthophoto date) were identified as such only if we observed them in the field or consulted newer aerial photo images, so it is likely that we have underestimated the extent of developed land in the town.

Final Mapping and Presentation of Data

We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map. We printed the final large-format habitat map at a scale of 1:10,000 on three sheets using a Hewlett Packard DesignJet 800PS plotter. We also printed the entire town map on a single sheet (41 x 41 in; 104 x 104 cm) at a scale of 1:19,000. The GIS database that accompanies the map includes additional information about many of the mapped habitat units, including some of the plant and animal species observed in the field. The habitat map, GIS database, and this report have been conveyed to the Town of Dover for use in conservation and land-use planning and decision-making. We request that any maps printed from this database for public viewing be printed at scales no larger than 1:10,000, and that the habitat map data be attributed to Hudsonia Ltd. Although the habitat map was carefully prepared and extensively field-checked, there are inevitable inaccuracies in the final map. Because of this, we request that the following caveat be printed prominently on all maps:

> *"This map is suitable for general land-use planning, but is unsuitable for detailed planning and site design or for jurisdictional determinations. Boundaries of wetlands and other habitats depicted here are approximate."*

RESULTS

Overview

The large-format Town of Dover habitat map illustrates the diversity of habitats throughout the town and the complexity of their configuration in the landscape. A reduction of the completed habitat map is shown in Figure 3. Of the total 36,024 ac (14,585 ha) in the town, **we mapped** approximately 89% as ecologically significant habitats (i.e., without structures, paved roads, manicured lawns, etc.). Existing development was dispersed along roads and at the ends of sometimes long driveways throughout the town, so that undeveloped land has been fragmented into discontinuous and irregularly shaped patches. Figure 4 shows blocks of contiguous habitat areas classified by size. Several types of common habitats covered extensive areas within these blocks. For example, approximately 66% of the town was forested (including both upland forest and swamp habitats), 12% was upland meadow (active agricultural areas and other managed and unmanaged grassland and forb-dominated habitats), and 12% was wetland. Some of the less common habitats we documented were marble knolls, fens, acidic bogs, cool ravines, red cedar barrens, crest oak woodlands, and oak-heath barrens. In total, we identified 36 different habitat types in the town that we consider to be of ecological importance (Table 1).

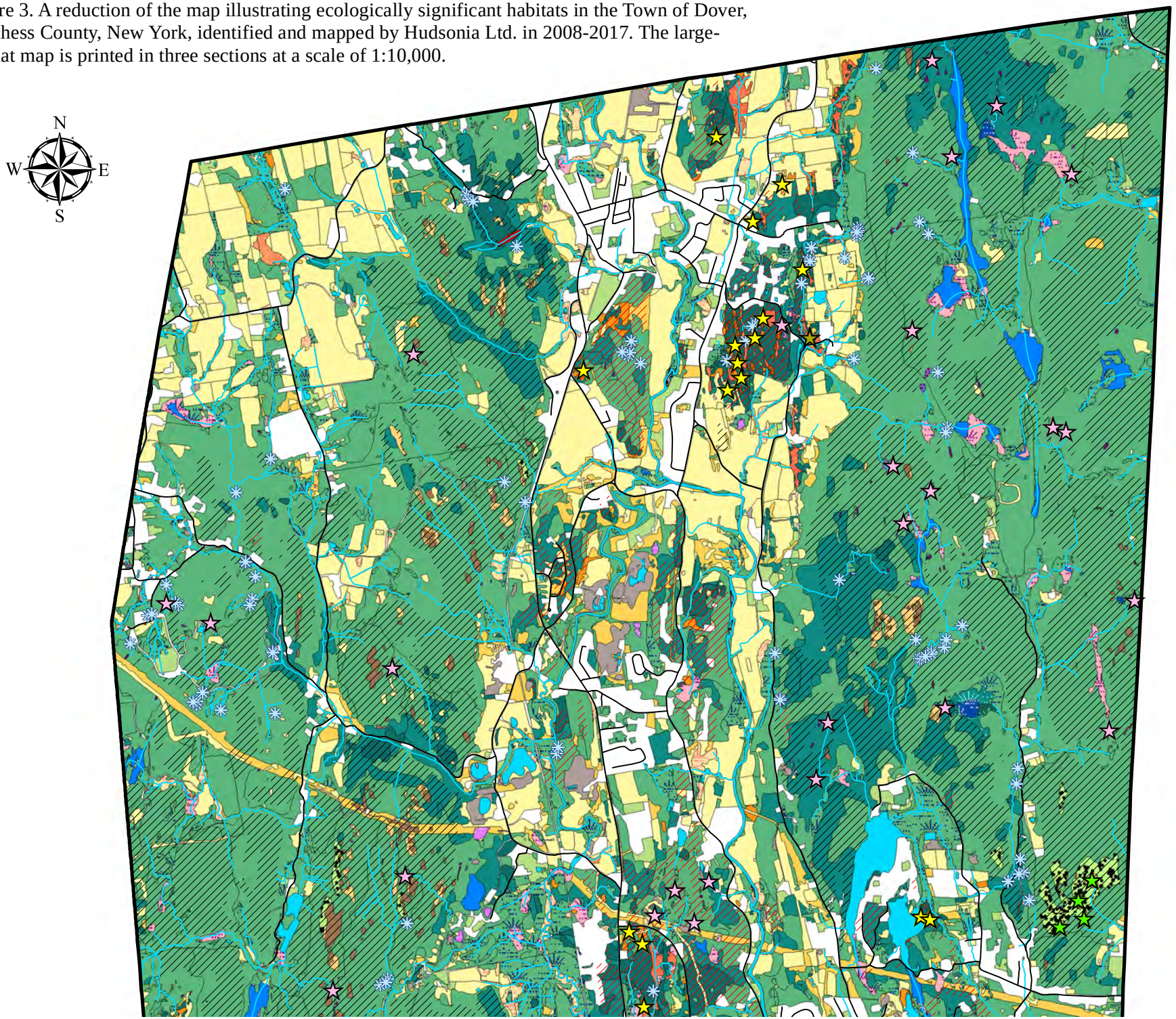
The mapped areas represent ecologically significant habitats that have been altered to various degrees by past and present human activities. Most areas of upland forest, for example, have been logged repeatedly in the past 300 years, so they lack the structural complexity of old-growth forests. The hydrology of many wetlands in the town has been extensively altered by filling, draining, and construction of dams and roads. Non-native plants such as purple loosestrife and common reed (introduced invasive species) are common and sometimes dominant plants in marshes and wet meadows and on moist disturbed soils throughout the town. Although we have documented the location and extent of important habitats throughout the town, only in some cases have we provided information on the quality and condition of particular habitat units.

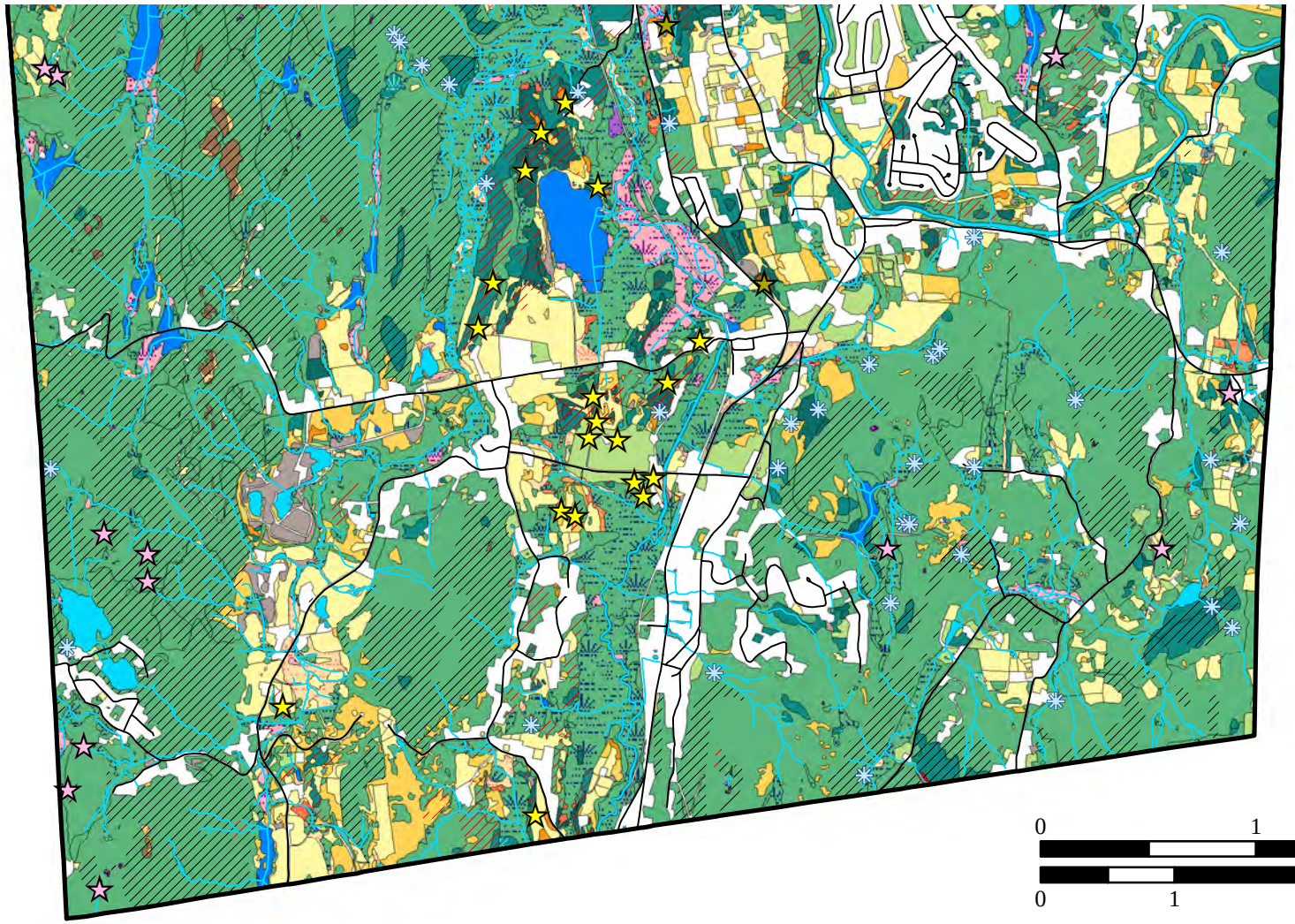
Table 1. Ecologically significant habitats identified by Hudsonia in the Town of Dover, Dutchess County, New York.

Upland habitats	Wetland habitats
Calcareous crest/ledge/talus	Acidic bog
Cinquefoil shrubland[1]	Buttonbush pool
Cool ravine	Calcareous wet meadow
Crest hickory woodland[2]	Conifer swamp
Crest oak woodland	Constructed pond
Crest/ledge/talus	Fen
Cultural	Hardwood & shrub swamp
Floodplain hardwood forest	Intermittent woodland pool
Gravel/cobble shore	Marsh
Marble knoll	Mixed forest swamp
Oak-heath barren	Open water
Orchard/plantation	Spring/seep
Red cedar barren	Stream
Red cedar woodland	Wet meadow
Rocky barren[3]	
Talus slope woodland	
Upland conifer forest	
Upland hardwood forest	
Upland meadow	
Upland mixed forest	
Upland shrubland	
Waste ground	

[1] described as a subcategory of upland shrubland
[2] described as a subcategory of crest oak woodland
[3] described as a subcategory of oak-heath barren

Figure 3. A reduction of the map illustrating ecologically significant habitats in the Town of Dover, Dutchess County, New York, identified and mapped by Hudsonia Ltd. in 2008-2017. The large-format map is printed in three sections at a scale of 1:10,000.





0 1 2 Miles

0 1 2 Kilometers

Town boundary
Road
Developed area

Habitats

Spring
Stream
Pool-like swamp
Wet meadow
Calcareous wet meadow
Fen
Marsh
Hardwood & shrub swamp
Mixed forest swamp
Conifer swamp
Intermittent woodland pool
Acidic bog
Buttonbush pool
Kettle shrub pool
Open water
Stream/constructed pond
Cinquefoil shrubland
Marble knoll
Crest, ledge, talus
Calcareous crest, ledge, talus
Unvegetated ledge
Gravel/cobble shore
Cultural
Waste ground
Orchard/plantation
Upland meadow
Upland shrubland
Oak-heath barren
Crest oak woodland
Red cedar barren
Red cedar woodland
Talus slope woodland
Upland hardwood forest
Upland mixed forest
Upland conifer forest
Floodplain hardwood forest
Cool ravine

4. Contiguous habitat patches

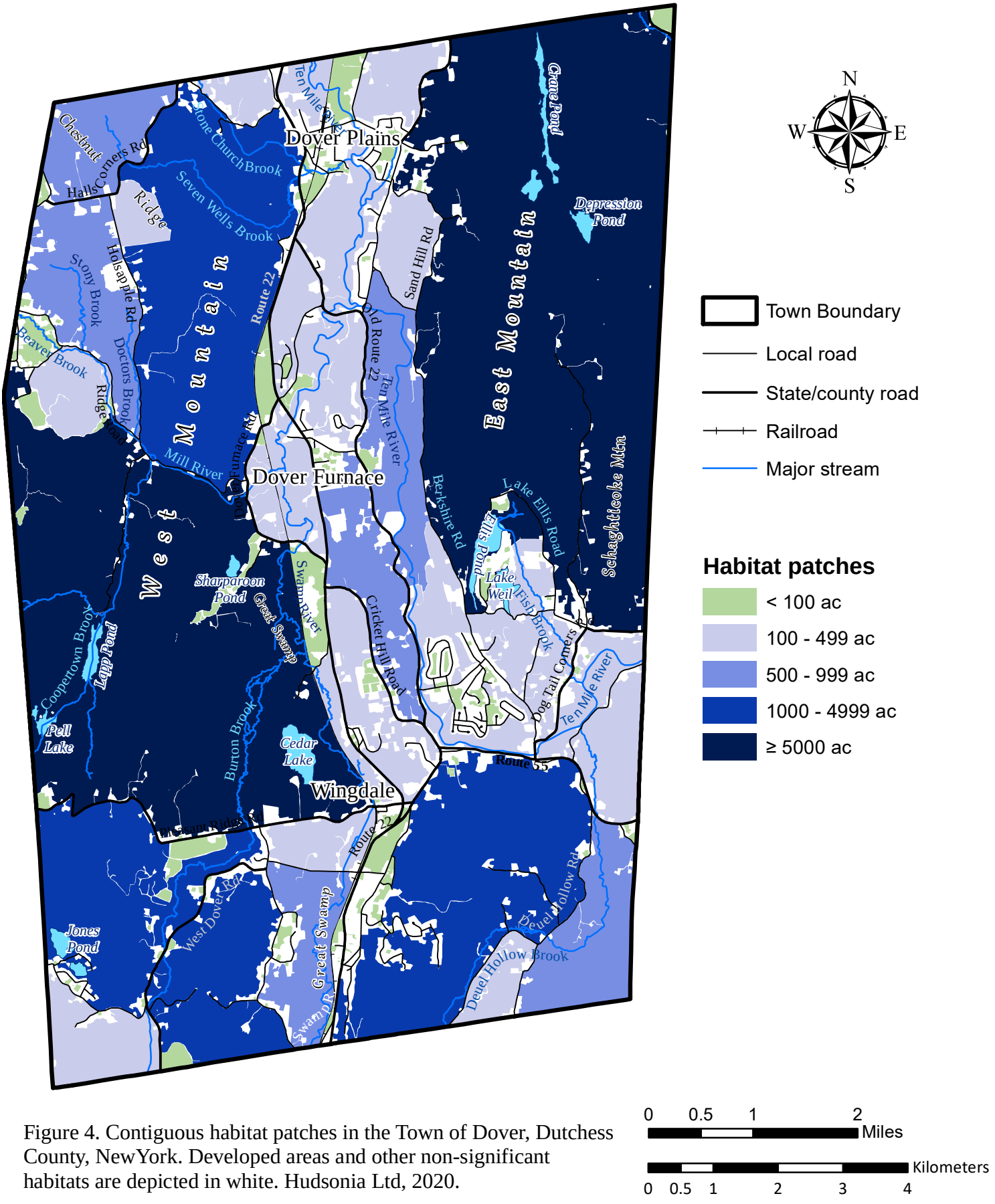


Figure 4. Contiguous habitat patches in the Town of Dover, Dutchess County, NewYork. Developed areas and other non-significant habitats are depicted in white. Hudsonia Ltd, 2020.

HABITAT DESCRIPTIONS

In the following pages we describe some of the ecological attributes of the habitats identified in the town, and discuss some conservation measures that can help to protect these habitats and the species of conservation concern they may support. A series of large-format maps (scales of 1:10,000 and 1:19,000) accompanying this report depict the locations of habitats. Figure 3 is a reduced version of the whole-town map. In the narrative below we indicate plant and animal species of conservation concern (those that are listed as such by state agencies or by non-governmental organizations) by placing an asterisk (*) after the species name. Appendix C provides a longer list of rare species associated with each habitat, including their statewide or regional conservation status. Species in that appendix could occur in their assigned habitat types (or in other types) but are not necessarily present in any particular habitat unit. The letter codes used in Appendix C to describe the conservation status of rare species are explained in Appendix B. Appendix D gives the common and scientific names of all plants mentioned in this report.

UPLAND HABITATS

UPLAND FOREST

Ecological Attributes

We classified upland (i.e., non-wetland) forests into four general types for this project: upland hardwood forest, upland conifer forest, upland mixed forest, and floodplain hardwood forest. (Conifer and mixed forests in floodplains were few, and were mapped as upland conifer forest and upland mixed forest, respectively.) All four types ranged in age from young stands in which most trees were just 3-6 inches (in) (7-15 centimeters (cm)) in diameter at breast height (dbh), to the most mature stands, in which the dominant canopy trees were 18-24 in (30-46 cm) dbh or larger. We recognize that upland forests are very variable, with each of these four types encompassing many distinct biological communities, but our broad forest types are useful for general planning purposes, and are also the most practical for our remote mapping methods.

Above: Dry hickory-oak forest.

Below: Young hardwood forest with heavy Japanese barberry invasion.

Upland Hardwood Forest

Upland hardwood forest is the most common habitat type in Dover and the region, and is extremely variable in species composition, size and age of trees, vegetation structure, soil drainage and texture, and other habitat factors. The habitat includes many different types of deciduous forest communities, and is used by a large array of common and rare species of plants and animals. Many smaller habitats, such as intermittent woodland pools and crest, ledge, and talus, are frequently embedded within areas of upland hardwood forest.

Common trees of upland hardwood forests in the region include maples (sugar, red), oaks (black, red, scarlet, white, chestnut), hickories (shagbark, pignut), white ash, black birch, black locust, and black cherry. Common understory and ground-layer species include maple-leaved viburnum, witch-hazel, downy serviceberry, Japanese barberry, common buckthorn, Bell's honeysuckle, black huckleberry, lowbush blueberries, and a wide variety of wildflowers, sedges, ferns, and mosses. Forests on calcium-rich soils may support rare plants such as fairywand,* lily-leaved twayblade,* or green rock- cress.*

Upland hardwood forest accounted for 50% of the total land area of the town. Older upland hardwood forests (dominant trees with dbh ≥ 18 in (46 cm)) in town were often dominated by

some combination of oaks (red, black, chestnut), sugar maple, and black birch. Older forests on the higher, rockier terrain of West and East Mountains were especially dominated by red oak and chestnut oak; scarlet oak was often a co-dominant species of drier ridge-top forests of West Mountain. Other occasional to common trees of older forests included white oak, black birch, pignut hickory, white ash, red maple, American beech, black tupelo, tulip poplar, eastern white pine, and eastern hemlock. Sugar maple, red oak, black oak, and black birch were common dominants of other mature forests (dbh's of 12-18 in [30-46 cm]) on lower slopes and gentler terrain, with a variety of other trees (e.g., red maple, yellow birch, pignut hickory, American beech) mixed in. Younger forests were often dominated by some combination of sugar maple, red maple, black birch, black cherry, black locust, and white ash, and other occasional to common species included American elm, shagbark hickory, red oak, yellow birch, big-toothed aspen, eastern white pine, and eastern red cedar. In a few areas, evidently on calcareous soils (on marble bedrock), occurred calcicolous (calcium-associated) trees such as American basswood, bur oak,* and chinquapin oak.* The last was even a dominant canopy tree in a few places.

Common woody understory plants included striped maple, witch-hazel, downy serviceberry, and mountain laurel, in addition to saplings of birches, maples, American beech, hickories, white ash, and other trees. (Oak regeneration was generally uncommon.) Mountain laurel formed dense, sometimes extensive thickets in cooler areas with shallow, acidic soils, especially on West and East Mountains. Non-native, invasive shrubs were widespread, and were especially common in younger forests and near forest edges. These included multiflora rose, Japanese barberry, Bell's honeysuckle, privet, and autumn-olive. Japanese barberry seemed to particularly thrive in hardwood forests underlain by marble bedrock, often forming dense, nearly impenetrable thickets over large expanses. In mature forest interiors (i.e., farther from forest edges) over more acidic substrates, invasive shrubs were often uncommon or even absent.

Hardwood forests with calcium-rich soils, either over marble or other calcareous bedrock, often supported diverse herbaceous communities with numerous calcicoles (calcium-associated plants). These included maidenhair spleenwort, maidenhair fern, bristle-leaved

sedge,* wild columbine, white baneberry, early meadow-rue, and American alumroot.* American prickly-ash,* a calcicolous shrub, occurred in some rich forests in marble areas.

Upland forests of all kinds provide habitat for a large array of wildlife, including many species of conservation concern. Eastern box turtle* spends most of its time in upland forests and meadows, finding shelter under logs and organic litter. Spotted turtle* uses upland forests for aestivation (summer dormancy) and travel. Many snake species, such as eastern ratsnake,* northern black racer,* and red-bellied snake, forage widely in upland forests and other habitats, and many amphibians, such as Jefferson/blue-spotted salamander,* slimy salamander,* red-backed salamander, and wood frog, spend much of their lives in upland forests. Upland hardwood forests provide important nesting habitat for raptors, including red-shouldered hawk,* Cooper's hawk,* sharp-shinned hawk,* broad-winged hawk, and barred owl,* and many species of songbirds, including numerous warblers, vireos, thrushes, and flycatchers. American woodcock* forages and nests in young hardwood forests and shrublands. Acadian flycatcher,* wood thrush,* cerulean warbler,* Kentucky warbler,* and scarlet tanager* are some of the birds that may require large forest-interior areas to nest successfully and maintain populations in the long term. Large mammals such as black bear,* bobcat,* and fisher* also require large expanses of forest, although they use many other kinds of habitats as well. Many small mammals are associated with upland hardwood forests, including eastern chipmunk, southern flying squirrel, and white-footed mouse. Higher densities of small mammals occur in forest areas with abundant logs and other woody debris, and these are favored by snakes such as northern copperhead, eastern ratsnake, and northern black racer. Hardwood trees larger than 5 in (12.5 cm) dbh—especially those with loose, platy bark such as shagbark hickory, those with deeply furrowed bark such as black locust, or snags with peeling bark—can be used by Indiana bat* (which is known from Dover), northern myotis,*and other bats for summer roosting and nursery colonies.

Numerous bird species of conservation concern are present in Dover's large upland forests. Barred owl,* red-shouldered hawk,* scarlet tanager,* and wood thrush* were commonly observed during the study. We occasionally heard black-throated green warbler* and Blackburnian warbler* in mixed conifer-hardwood stands. Hooded warbler,* a bird at the

northern limit of its range, is known to breed in at least two forested areas in Dover, and cerulean warbler,* a species that requires large forests to thrive, has been observed as a breeding bird during the last several years off South East Mountain Road. Magnolia warblers* may be nesting at Nellie Hill Preserve (Barbara Butler, pers.comm.).

Upland Conifer Forest

This habitat type comprises both naturally occurring upland forests in which conifers represent more than 75% of canopy cover, and conifer plantations with pole-sized (5-10 in (12-25 cm) dbh) and larger trees. Eastern hemlock, eastern white pine, and eastern red cedar are typical species of naturally occurring conifer stands in the area. Eastern red cedar is relatively short-lived and is typically replaced by hardwoods over time, while eastern hemlock forests are long-lived and capable of perpetuating themselves in the absence of significant disturbance, insect infestation, or disease.

Red cedar-dominated forests, which often had canopies of dense red cedar and few other trees, were a prominent feature of the Harlem Valley. These forests share some of the ecological attributes of red cedar woodlands but have a mostly closed canopy that prevents direct sunlight from reaching the forest floor. They may support some of the same rare plants with which red cedar woodlands are associated (see below), especially in brighter, sunnier spots under small canopy openings. Autumn-olive and Japanese barberry were

Red cedar forest with rich herbaceous layer

often common to abundant in the understory, and American prickly-ash and privet locally common.

In parts of red cedar forests with scant shrub cover, a diverse herbaceous flora with abundant calcicoles was sometimes present, including ebony spleenwort, purple cliffbrake,* bristle-leaved sedge* (often in dense carpets), sweet vernal grass, Robin's plantain, American alumroot,* late purple aster, common spiked lobelia, harebell, wild columbine, golden Alexanders, round-leaved ragwort, black-eyed Susan, field pussytoes, white wood aster, and goldenrods. (Not all of these are calcicoles.) Certain areas, evidently with groundwater seepage below the soil surface, harbored mixtures of upland and wetland plants, the latter including wrinkle-leaved goldenrod, grass-of-parnassus, eastern lousewort,* dwarf raspberry, sensitive fern, marsh fern, cinnamon fern, and royal fern. Lily-leaved twayblade (NYS-Endangered)* and fairywand (NYS-Endangered)* may occur in red cedar forest. Glaucous sedge (non-native) was widespread and invasive in the Harlem Valley's rich conifer, mixed, and hardwood forests, sometimes forming large, dense patches that seemed to exclude other species.

Conifer stands are used by many species of owls (e.g., barred owl,* great horned owl, long-eared owl*) and other raptors (e.g., Cooper’s hawk,* sharp-shinned hawk*) for roosting and sometimes nesting. Red-breasted nuthatch,* purple finch,* black-throated green warbler,* and Blackburnian warbler* nest in conifer stands. American woodcock* sometimes uses conifer stands for nesting and foraging. Conifer stands also provide important habitat for a variety of mammals, including eastern cottontail, red squirrel, and eastern chipmunk (Bailey and Alexander 1960). Conifer stands provide winter shelter for white-tailed deer and can be especially important for them during periods of deep snow cover.

Upland Mixed Forest

We use the term "upland mixed forest" for non-wetland forested areas with both hardwood and conifer species in the overstory, where conifer cover is 25-75% of the canopy. In most cases, we distinguished between conifer and mixed forest by aerial photograph interpretation. Mixed forests are less densely shaded at ground level and tend to support a higher diversity and greater abundance of understory and ground-layer species than pure conifer stands.

Hemlock-hardwood forest

Floodplain forest

Floodplain forests occur along (usually perennial) streams and deeply flooding wetlands and experience occasional and irregular flooding, with mean intervals between floods ranging from frequent (yearly or more often) to occasional (every few years or decades). The plant communities share some species of both forested swamps and non-floodplain upland forests, and also include some that seem to specialize in floodplains, such as eastern sycamore, eastern cottonwood, green dragon,* ostrich fern, and hairy-fruited sedge). See the Stream and Riparian Corridor subsection below and in the Conservation Priorities and Planning section for information on occurrence and conservation recommendations.

Occurrence in the Town of Dover

Taken together, the four types of upland forests account for 59% of the land area of the town, and occur in patches ranging from less than 1 ac (< 0.4 ha) to over 6,000 ac (2,400 ha). Dover's forests are some of the largest and most intact in our region. At the time of this study, twenty-two patches exceeded 100 ac (40 ha); seven were greater than 500 ac (200 ha); five exceeded 1,000 ac (400 ha); and two occupied more than 3,000 ac (1,200 ha) in Dover. Furthermore, many of these forest blocks extend into adjacent towns, so they are actually larger than the

extents mapped within Dover. For example, the largest forest block in Dover, a 5,800-ac (2,320 ha) expanse on East Mountain, is contiguous with roughly 3,000 ac (1,200 ha) of forest in Connecticut, resulting in a contiguous forest of nearly 9,000 ac (3,600 ha). We presume that virtually all forests in the town have been cleared or logged in the past and that no "virgin" stands remain. Forested areas on very steep slopes and a few other areas may have been logged selectively but not completely cleared.

Upland mixed forest and upland conifer forest were widespread in the town, and together accounted for about 9% of the area of Dover. Eastern hemlock, eastern red cedar, white pine, and pitch pine were the most common conifer species. Eastern red cedar dominated many mixed and conifer forests (and occurred in swamps and fens) in the Harlem Valley. Hemlock and hemlock-hardwood stands occurred in ravines, on northern and eastern slopes, at higher elevations, and in other cool areas. They were especially extensive in a few locations: at the northern end of East Mountain; in a large area on the western side of East Mountain, north of Ellis Pond; and in cool stream valleys along Cooperstown Brook, Seven Wells Brook, and Stone Church Brook (all on West Mountain). Pitch pine occurred on shallow, rocky, acidic soils of crests and hills, often as part of crest oak woodlands or oak-heath barrens (see below); small white pine stands were widespread in town in a variety of situations.

Sensitivities/Impacts

Forests of all kinds are important habitats for wildlife. Extensive forested areas that are unfragmented by roads, driveways, trails, utility corridors, residential lots, or meadows are especially important for certain organisms, but are increasingly rare in the region. Fragmenting features pose many threats to wildlife and the forest itself. Paved and unpaved roads act as barriers which many species will not cross or cannot safely cross (Forman and Deblinger 2000). For example, mortality from vehicles can significantly reduce the population densities of amphibians (Fahrig et al. 1995), and many animals will not breed near traffic noise (Trombulak and Frissell 2000). Long driveways intruding deep into forests cause significant fragmentation of core forest areas. Development along existing roads is far less disruptive, though it may still block important wildlife travel corridors between forested patches. Roadways, including

driveways, can provide access to interior forest areas for nest predators (such as raccoon and opossum) and the brown-headed cowbird (a brood parasite), which reduce the reproductive success of many forest interior birds. Where dirt roads or trails cut through forest, vehicle, horse, bicycle, and pedestrian traffic can harm tree roots and cause soil erosion. Runoff from roads and driveways can pollute nearby areas with road salt, petroleum hydrocarbons, heavy metals, and sediments. Forests are also susceptible to invasion by shade-tolerant non-native herbs and shrubs, which may easily be dispersed along roads and trails and by logging machinery, ATVs, other vehicles, and hiking boots.

In addition to fragmentation, forest habitats can be degraded in many other ways. Clearing the forest understory destroys habitat for birds such as wood thrush,* which nests in dense understory vegetation, and black-and-white warbler* and ovenbird,* which nest on the forest floor. Removal of mature and especially over-mature (large) trees eliminates habitat for lichens, fungi, and bryophytes, as well as the many kinds of animals that use cavities and that forage in and around large and decaying trees. Selective logging can also damage the understory and cause soil erosion, compaction, and rutting, and sedimentation of streams. Soil compaction and removal of dead and downed wood and debris eliminates habitat for mosses, lichens, fungi, birds, amphibians, reptiles, small mammals, and invertebrates. Human habitation in fire-prone forests has led to the suppression of naturally occurring wildfires which can be important for some forest species and the forest ecosystem as a whole.

Introduced forest pests are also threatening forest health in southeastern New York. Of particular note are the hemlock woolly adelgid (HWA) and the emerald ash borer (EAB). HWA is a non-native aphid-like insect that has infested many eastern hemlock stands from Georgia to New England and has caused widespread loss of hemlocks in the region. The adelgid typically kills trees within 10 years and has the potential to cause the near extirpation of hemlock forests in the region (McClure 1991). We noted HWA on hemlocks in Dover, but do not know to what extent the pest is affecting hemlock stands as a whole.

The emerald ash borer (EAB) is a non-native tree borer (a jewel beetle) that infests ash species from New Hampshire to Georgia and west to Colorado, and is now found in over 40 of New

York's 62 counties (https://www.dec.ny.gov/animals/7253.html). While the adults do little damage, the larvae feed on the inner bark of the tree; a heavy infestation effectively girdles a tree, killing it within two to four years. EAB is expected to kill most of the three native ash species of the region—white ash, green ash, and black ash. The EAB is now common in western Dutchess County and has been found in Dover.

The Conservation Priorities and Planning section of this report gives recommendations for protecting and fostering the habitat values of large forests, and figures 3 and 5 illustrate locations of contiguous forest blocks in Dover.

COOL RAVINE

Ecological Attributes

The habitat that we identify as a "cool ravine" is a narrow ravine with steep, high, rocky walls flanking a rocky perennial or intermittent stream. The ravine walls are commonly forested with a mixture of hardwoods and eastern hemlock. The physical and biological structure of this habitat creates an unusually shady, cool, moist microclimate that supports plants of more northern affinities, such as mountain maple,* fly honeysuckle,* Canada yew,* yellow birch, red-berried elder, and hobblebush.* Bryophyte cover (mosses and liverworts) is often extensive. Other characteristic plants include mountain laurel and lowbush blueberry. Ferns such as ebony spleenwort, walking fern,* and purple cliffbrake* may be present if the rocks are calcareous.

The fauna of cool ravine habitats is not well known. Stream salamanders such as northern dusky* and northern two-lined salamander are likely to use cool ravine habitats. Northern slimy salamander* may use the rocky ravine walls, and other terrestrial-breeding salamanders may be abundant there and in the surrounding forest. Rare and uncommon birds such as winter wren,* Acadian flycatcher,* Blackburnian warbler,* Louisiana waterthrush,* and black-throated green warbler* sometimes nest in and near these habitats. Mammals may include woodland jumping mouse* and southern redback vole.

Occurrence in the Town of Dover

We mapped three cool ravines in Dover. One was the well-known Stone Church Gorge in the Stone Church Preserve. A very small cool ravine was found along Seven Wells Brook, a tributary to Stone Church Brook that flows off West Mountain south of the latter stream. We also found a cool ravine straddling the Dover-Pawling border on a tributary to Deuel Hollow Brook in southern Dover. All three ravines supported hemlock-northern hardwood forests with such cooler-climate shrubs as hobblebush,* mountain maple,* red-berried elder, and Canada yew.* Herbaceous species included broad beech fern, New York fern, rock polypody, starflower, purple trillium, two-leaved mitrewort, two-leaved toothwort, garlic-mustard, jack-in-the-pulpit, and dwarf enchanter's-nightshade.* Mosses and liverworts were abundant. We observed brook trout,* northern slimy salamander,* least flycatcher, Acadian flycatcher,* winter wren, eastern phoebe, and Louisiana waterthrush* in or near the cool ravines.

Cool ravine rock formation

Sensitivities/Impacts

These scenic areas often attract recreational use which can result in trampling, littering, soil erosion, and noise disturbance to nesting birds and other wildlife. Roads, substantial trails, or other clearings may also allow incursions by the brown-headed cowbird, a brood parasite that could pose a significant threat to the nesting success of cool ravine songbirds. Any clearing of trees and shrubs could alter the shade-tolerant plant community, cause soil erosion, and lead to elevated temperature in the stream and ravine bank habitats. Pollution of upstream waters can harm the stream habitats, and creation of reservoirs alters the habitat for aquatic and riparian

biota. See the Conservation Priorities section for recommendations on preserving the habitat values of cool ravines, and figures 3 and 9 for locations of cool ravines in Dover.

CREST/LEDGE/TALUS

Ecological Attributes

Rocky crest, ledge, and talus habitats often occur together, so they are described and mapped together for this project. Crest and ledge habitats occur where soils are very shallow and bedrock is partially exposed at the ground surface, either at the summit or on the shoulder of a hill or knoll (crest) or elsewhere (ledge). These habitats are usually embedded within other habitat types, most commonly upland forest. They can occur at any elevation, but may be most familiar on hillsides and hilltops in the region. Talus is the term for the fields of large rock fragments that often accumulate below steep ledges and cliffs. Some crest, ledge, and talus habitats support well-developed forests, while others have only sparse, patchy, and stunted vegetation. Because we could not field-verify many parts of the town, we use a combination of mapped shallow soils and steep slopes to predict the presence of crest, ledge, and talus in areas that we did not visit. We also extrapolated from ledgy areas that we did see to nearby areas with similar topography and soils.

Crest, ledge, and talus habitats often appear to be harsh and inhospitable, but they can support an extraordinary diversity of uncommon and rare plants and animals. Some species, such as wall-rue,* smooth cliffbrake,* purple cliffbrake,* and northern slimy salamander* are found only in and near rocky places in the region. The communities and species that occur at any particular location are determined by many factors, including bedrock type, outcrop size, aspect, exposure, slope, elevation, biotic influences, and kinds and intensity of human disturbance.

Because distinct communities develop in calcareous and non-calcareous environments, we distinguished calcareous bedrock exposures wherever possible. We mapped as “calcareous crest, ledge, and talus” those areas that we identified as such in the field and nearby areas with similar physiography. In addition, because marble was virtually the only bedrock we saw in the Harlem Valley, and because its presence is reliably indicated by an abundance of eastern red

cedars, we mapped many occurrences of calcareous crest, ledge, and talus in the Harlem Valley that we did not field-verify, based on the presence of red cedar forest (as observed in aerial orthophotos). On the habitat map, the "crest, ledge, and talus" designation serves as a catch-all for non-calcareous outcrops and talus plus other such rocky habitats of unknown chemistry, and we expect some areas mapped as "crest, ledge, and talus" are in fact calcareous.

Calcareous crests often have trees such as eastern red cedar, northern hackberry,* basswood, and butternut; shrubs such as bladdernut, American prickly-ash, and Japanese barberry; and herbs such as wild columbine, ebony spleenwort, maidenhair spleenwort, maidenhair fern, and fragile fern. They can support numerous rare plant species, such as walking fern,* yellow corydalis,* and Carolina whitlow-grass.* Non-calcareous crests often have trees such as red oak, chestnut oak, eastern hemlock, and occasionally pitch pine; shrubs such as lowbush blueberries, chokeberries, and scrub oak; and herbs such as Pennsylvania sedge, little bluestem, common hairgrass, bristly sarsaparilla, and rock polypody. Rare plants of non-calcareous crests include mountain spleenwort,* clustered sedge,* and slender knotweed.*

Common calcicoles of marble bedrock in Dover included ebony spleenwort, bristle-leaved sedge,* glaucous sedge, wild columbine, round-leaved ragwort, Robin's plantain, and late purple aster. Purple cliffbrake,* common spike lobelia,* American prickly-ash,* chinquapin oak,* and bur oak* were occasional to locally common in marble areas. Calcicoles of non-marble calcareous bedrock included maidenhair fern, silvery spleenwort, showy orchid,* early meadow-rue, two-leaved mitrewort, bloodroot, Dutchman's breeches, yellow corydalis,* Allegheny-vine,* blue cohosh, and spikenard.*

Northern hairstreak* (butterfly) occurs with oak species, which are host plants for its larvae, and olive hairstreak* occurs on crests with its host eastern red cedar. Rocky habitats with larger fissures, cavities, and exposed ledges may provide shelter, den, and basking habitat for timber rattlesnake,* northern copperhead,* and other snakes of conservation concern. Five-lined skink,* a regionally rare lizard, is known to occur in ledgy habitats in Dover. Northern slimy salamander* occurs in non-calcareous wooded ledge and talus areas. Breeding birds of crest habitats include Blackburnian warbler,* worm-eating warbler,* and cerulean warbler.* Bobcat*

and fisher* use crests and ledges for travel, hunting, and cover. Porcupine and bobcat use ledge and talus habitats for denning. Southern red-backed vole* and long-tailed shrew* are found in some rocky areas, and eastern small-footed bat* roosts in talus habitat.

Occurrence in the Town of Dover

Crest, ledge, and talus was abundant on hills, ridges, and slopes throughout the town. In fact, we mapped rocky habitats on nearly 50% of the town's area, though much of this coverage was predicted remotely from overlapping mapped locations of shallow soils and steep slopes. West Mountain and East Mountain were both extremely rocky, each with vast areas of exposed crests, cliffs, boulders, and talus fields. (A few extensive talus fields with more open forest canopies were mapped as talus slope woodlands, and some areas of exposed crests with sparse canopies were mapped as crest oak woodland; see below.) Most of the extensive calcareous crest, ledge, and talus in town consisted of marble bedrock exposed on hills, ridges, and road-cuts in the Harlem Valley. We also mapped a few field-surveyed areas of non-marble bedrock as calcareous crest, ledge, talus based on the presence of calcicoles.

Above: Allegheny-vine on calcareous talus

Below: maidenhair spleenwort on marble bedrock

Sensitivities/Impacts

Crest, ledge, and talus habitats often occur in locations that are valued by humans for recreational uses, scenic vistas, house sites, and communication towers. Construction of trails, roads, and houses destroys crest, ledge, and talus habitats directly, and causes fragmentation of these habitats and the forested areas of which they are often a part. Rare plants of crests are vulnerable to trampling and collecting; rare snakes are susceptible to road mortality, harassment, intentional killing, and collecting; and rare breeding birds of crests are easily disturbed by human activities nearby. The shallow soils of these habitats are susceptible to erosion from construction and logging activities and from foot and ATV traffic. The Conservation Priorities and Planning section of this report gives recommendations for preserving the habitat values of these rocky habitats, and figures 3 and 6 illustrate generalized locations of crest, ledge, and talus habitat in Dover.

OAK-HEATH BARREN and rocky barren

Ecological Attributes

A special subset of rocky crest habitat (see above), oak-heath barren occurs on ridgetops and shoulders with exposed non-calcareous bedrock, shallow, acidic soils, and vegetation dominated by some combination of pitch pine, scrub oak, other oaks, and heath (Ericaceae)

Oak-heath barrens

shrubs. Schist, gneiss, and quartzite are among the common types of exposed bedrock. The soils are extremely shallow, excessively well drained, and nutrient-poor. Some of these ecosystems may be maintained by episodic fires, which limits colonization by species that are not fire-adapted, helps certain plant species such as pitch pine regenerate, returns nutrients to the soil, and prevents the overgrowth of trees that can shade out typical barrens species (which require full sunlight). Because these barrens are usually located in exposed areas with shallow soils, woody plants are susceptible to breakage from wind and winter storms (Thompson and Sarro 2008); this exposure contributes to the sparse tree growth and shrubby, stunted character of barrens vegetation. Due to the open canopy, oak-heath barrens tend to have a much warmer daytime microclimate than the surrounding forested habitat, especially in the spring and fall.

We use the term ”rocky barrens” for similarly exposed, dry areas of sparsely vegetated bedrock, but with flora not dominated by a combination of scrub oak, heath shrubs, and pitch pine. They may be on acidic or calcareous bedrock.

The droughty, infertile, and exposed conditions have a strong influence on the composition and structure of the plant community; trees are often sparse and stunted. Our definition corresponds to the “pitch pine-oak-heath rocky summit of Edinger et al. (2014). Exposed, unvegetated ledge is occasional to common. The shrub layer (predominantly scrub oak and heath shrubs) is dominant. There may be occasional pitch pine as well as saplings and stunted individuals of chestnut oak, red oak, and scarlet oak. In addition to often abundant scrub oak, shrubs may include blueberries, black huckleberry, deerberry, and sweetfern. Common herbs include Pennsylvania sedge, poverty-grass, common hairgrass, little bluestem, and bracken fern. Lichens and mosses are sometimes abundant.

Scrub oak was usually abundant on Dover's oak-heath barrens, sometimes forming dense thickets. Pitch pine and other oaks were often occasional in the overstory. Other common to abundant species included black huckleberry, lowbush blueberries, sedges, poverty-grass, and various mosses and lichens. Occasional to uncommon plants included little bluestem, downy goldenrod, orange-grass, northern dewberry, pink corydalis, and sweetfern. We found several regionally rare species, with Greene's rush,* Appalachian cherry,* dwarf shadbush

(*Amelanchier spicata*),* and winged sumac among them.* Unvegetated bedrock exposures were also common. Most rocky barrens were dominated by herbaceous plants, such as sweet vernal grass, little bluestem, and various sedges and forbs, with lichens and mosses common as well. One small barren within a hickory stand had a calcicolous flora and contained such regionally rare plants as Virginia dwarf dandelion,* common Venus' looking glass,* and hoary mountain-mint.*

Oak-heath barrens (and rocky barrens) can have significant habitat value for timber rattlesnake* and northern copperhead.* Deep rock fissures can provide crucial shelter and overwintering habitat for these species and the exposed ledges provide basking and breeding habitat in the spring and early summer. Birds of this habitat include common yellowthroat, worm-eating warbler,* prairie warbler,* field sparrow,* eastern towhee,* and whip-poor-will.* A number of rare butterflies that use scrub oak, little bluestem, lowbush blueberry, or pitch pine as their primary larval food plant tend to concentrate in oak-heath barrens, including Edwards' hairstreak,* cobweb skipper,* Leonard's skipper,* and brown elfin. Oak-heath barrens also appear to be refuges for several rare oak-dependent moths.

Occurrence in the Town of Dover

We mapped 143 oak-heath barrens in Dover. Most were small (median size = 0.4 ac [0.2 ha]), but 14 were larger than 2 ac (0.8 ha), five were larger than 4 ac (1.6 ha), and two exceeded 10 ac (4 ha). Furthermore, many formed more extensive complexes with other nearby barrens. The majority were found on West Mountain, though several occurred on East Mountain, including one extensive complex. We mapped only about a dozen, mostly small rocky barrens. Because these communities are difficult to find remotely, we expect there are additional, small oak-heath and rocky barrens in areas of exposed bedrock that we did not field-check.

Sensitivities/Impacts

The most immediate threat to these fragile habitats is human foot traffic; barrens near trails are often visited for scenic views and for picnicking and camping. Trampling, soil compaction, and soil erosion can damage or eliminate rare plants, discourage use by rare animals, and encourage invasions of non-native plants. Barrens on hilltops can also be disturbed or destroyed by the

construction and maintenance of communication towers. Construction of roads and buildings in the areas between rocky barrens and other exposed crests can fragment important migration corridors for snakes and butterflies, thereby isolating neighboring populations and reducing their long-term viability. Because rare snakes tend to congregate on rocky barrens and other exposed crests at certain times of the year, the snakes are highly vulnerable to being killed, harassed, or collected by poachers. Barrens communities tend to be maintained, in part, by fire, wind, and ice, and human suppression of wildfires eliminates one of these important natural disturbances. The scarcity of fires enables other, less specialized forest species to colonize these areas. The Conservation Priorities and Planning section gives recommendations for protecting and fostering the habitat values of barrens habitats, and figures 3 and 6 illustrate locations of these habitats in Dover.

WOODLANDS: CREST OAK, CREST HICKORY, AND TALUS SLOPE

As defined here, "woodlands" have lower tree densities and a more open canopy, than a closed-canopy forest, and thus allow more light into the forest understory. Crest oak and crest hickory woodlands occur on rocky crests along ridgetops and hills, and are often adjacent to oak-heath barrens (see below). Talus slope woodlands occur on talus fields in which boulders are numerous and large enough to produced an open-canopied woodland. (Talus slopes with closed-canopy forests are mapped simply at upland hardwood forest with a crest/ledge/talus overlay.) Such woodlands are uncommon in the region but are well-represented in Dover.

Crest oak woodlands are dominated by sparse, often scraggly and stunted, tree oaks (chestnut, red, scarlet) and often abundant scrub oak in the understory. We also include here a variant in which pitch pine, whose sparse crown tend to allow high levels of light transmission, is dominant or co-dominant. Other common species are black huckleberry, lowbush blueberries, cow-wheat, sedges, poverty-grass, and various mosses and lichens.

Crest hickory woodlands have similar vegetation structure and ecological value to those of crest oak woodlands, but their canopies are dominated by hickories (shagbark, pignut,

mockernut), with perhaps occasional oaks. Talus slope woodlands share the flora of other dry, sunny, and rocky upland hardwood forests in our region: oaks and black birch are often dominant canopy species. Common understory species include witch-hazel, downy serviceberry, mountain laurel, common elderberry, striped maple, and tree saplings. Herbs of talus woodlands may include rock polypody, marginal wood fern, Appalachian sedge, Swan's sedge, ribbed sedge, hairy Solomon's-seal, false Solomon's-seal, and wild sarsaparilla.

Talus slope woodland

Rocky woodlands have many of the same ecological values as other crest, ledge, and talus habitats. Northern hairstreak* (butterfly) occurs with oak species, which are host plants for its larvae. Rocky habitats with larger fissures, cavities, and exposed ledges may provide shelter, den, and basking habitat for timber rattlesnake,* northern copperhead,* and other snakes of conservation concern. Five-lined skink* uses crest, ledge, and talus habitats for basking, foraging, shelter, and overwintering. Breeding birds of woodland habitats include turkey vulture,* whip-poor-will,* common raven,* prairie warbler,* and worm-eating warbler.* Bobcat* and fisher* use crests and ledges for travel, hunting, and cover, and porcupine and bobcat use talus habitats for denning. Eastern small-footed bat* roosts in talus habitat.

Occurrence in the Town of Dover

We mapped 72 crest oak woodlands in Dover. Most were small (median size = 0.9 ac [0.4 ha]) and occurred on West Mountain, but the two largest (13 and 11 ac [5 and 4 ha]) were situated side-by-side on East Mountain (and among several oak-heath barrens). Also, many smaller

crest oak woodlands occurred in clusters or were contiguous with large oak-heath barrens, forming complexes of open, dry, rocky habitats. Crest hickory woodlands were limited to a few small examples on Schaghticoke Mountain among talus slope woodland, unvegetated crest, ledge, and talus, and hickory forest. Only one of these was seen in the field; the others were mapped remotely. Most of the talus-slope woodland, including the largest, at 69 ac (28 ha), was also on Schaghticoke Mountain, though we mapped several instances on West Mountain. Because these communities are difficult to find remotely, we expect there are additional woodlands in rocky areas that we did not field-check.

Sensitivities/Impacts

Threats are similar to those that affect oak-heath barrens. Crest woodlands near trails are often visited for scenic views or picnicking. Trampling, soil compaction, and soil erosion can damage or eliminate rare plants, discourage use by rare animals, and encourage invasions of non-native plants. Rare snakes of crest woodlands are vulnerable to collection or killing by poachers. Fragmentation of migration corridors for snakes and other crest woodland animals can occur when roads or buildings are constructed between crest woodlands and other rocky habitats. Human suppression of wildfires eliminates one of the major disturbances that help to maintain the flora and vegetation structure of crest woodlands. An absence of fire may enable other, less specialized forest species to colonize these areas, perhaps leading to succession to closed-canopy forest. The Conservation Priorities and Planning section of this report gives recommendations for protecting and fostering the habitat values of these habitats, and figures 3 and 6 illustrate their locations in Dover.

RED CEDAR WOODLAND

Ecological Attributes

Red cedar woodlands feature an overstory of widely-spaced eastern red cedar trees and grassy meadow remnants between them. Red cedar is one of the first woody plants to colonize abandoned pastures on mildly acidic to alkaline soils in this region, and red cedar woodlands are often transitional between upland meadow and young forest habitats. The seeds of red cedar are bird-dispersed, and the seedlings are successful at becoming established in the hot, dry conditions of old pastures (Holthuijzen and Sharik 1984). The cedars tend to develop

particularly dense stands in areas with calcareous (calcium-rich) soils. Other, less common trees of this habitat include gray birch, red maple, quaking aspen, and red oak. The understory vegetation is similar to that of upland meadows. Kentucky bluegrass and other hayfield and pasture grasses are often dominant in the understory, particularly in more open stands; little bluestem is often dominant on poorer soils. Red cedars can persist in these stands for many years even after a hardwood forest grows up around them. Beyond a certain density of red cedars, when few open grassy spaces remain, we classified stands as upland conifer or upland mixed forest.

Red cedar woodland

We found several plant species of conservation concern in red cedar woodlands, including Bicknell's sedge,* rough pennyroyal,* Carolina whitlow-grass,* yellow wild flax,* green milkweed,* whorled milkweed,* and slender ladies' tresses.* We also observed an olive hairstreak* nectaring on fen plants near a red cedar woodland. The olive hairstreak* (butterfly) uses red cedar as a larval host. Open red cedar woodlands with exposed gravelly or sandy soils may be important nesting habitat for several reptile species of conservation concern, including wood turtle,* spotted turtle,* eastern box turtle,* and eastern hognose snake.* These animals may travel considerable distances overland from their primary wetland, stream, or forest habitats to reach the nesting grounds. Eastern hognose snake may also use these habitats for basking, foraging, and over-wintering. Red cedar woodlands may provide habitat for roosting raptors, such as northern harrier* and northern saw-whet owl.* The berry-like cones of red cedar are a food source for eastern bluebird,* cedar waxwing, and other birds. Saw-whet owl and many songbirds, including field sparrow,* eastern towhee,* and brown thrasher* also use red cedar for nesting

and roosting. Insectivorous birds such as black-capped chickadee and golden-crowned kinglet forage in red cedar.

Occurrence in the Town of Dover

The distribution of red cedar woodlands is closely related to the agricultural history of the town and the timing of agricul-tural abandonment. Most red cedar woodlands were in the Harlem Valley and were scattered and small. Only a handful were larger than 2 ac (0.8 ha); the largest was about 9 ac (4 ha). From aerial orthophoto inspection, it is evident that red cedar woodlands were much more common as recently as 2004, but many of these woodlands have since grown up into closed-canopy upland mixed forest or conifer forest or have been lost to residential development.

Sensitivities/Impacts

Extensive occurrences of red cedar woodlands are uncommon in Dutchess County, and in Dover they are often associated with uncommon habitat types such as marble knolls. Red cedar woodlands on abandoned agricultural lands are often considered prime development sites, and thus are particularly vulnerable to direct habitat loss or degradation. Woodlands on steep slopes with fine sandy soils may be especially susceptible to erosion from ATV traffic, driveway construction, and other human uses. Use of heavy equipment may harm or destroy the nests of turtles, snakes, and ground-nesting birds. Human disturbances may also facilitate the invasion of non-native forbs and shrubs that tend to diminish habitat quality by forming dense stands that discourage or displace native plant species. Minimizing disturbance and maintaining unfragmented connections with nearby wetlands, meadows, and forests will help to protect the unusual communities of these habitats. Red cedar woodlands are typically a transitional habitat, however, and will ordinarily develop into young forest with the cedars gradually overtopped by deciduous trees.

MARBLE KNOLL AND RED CEDAR BARREN

Ecological Attributes

Marble knolls are an uncommon habitat type that is restricted in Dutchess County to the Harlem Valley region. They occur primarily along the broad valley floor where Stockbridge

Marble bedrock forms numerous low hills, usually with extensive marble outcrops. In addition to marble outcrops, these hills usually have sandy or gravelly soils, which help to create a warm and dry microclimate (Kiviat 1988). Marble knolls may have an open canopy or only scattered trees, allowing ample sunlight to reach ground vegetation. We did not map densely forested knolls as marble knolls, because they do not generally support the rare species listed below. Many marble knolls have been used for pasture within the last few decades, and they tend now to support red cedar woodlands with small meadow-like openings, with grasses such as little bluestem and Indian grass.* These open areas provide some of the best habitat for rare plants characteristic of marble knolls. Marble knolls can support a variety of habitats, including upland meadows, red cedar woodlands, and red cedar barrens, so the map shows those habitats with a star symbol indicating the marble knoll.

Red cedar barrens are sparsely-vegetated habitats with a large proportion of exposed marble bedrock or marble sand. Red cedars are present but may be few and small. The barrens may be on knolls, cliffs, ridges, or even flat, eroded areas.

Red cedar barrens and marble knolls that have at least a partly open canopy can be important sites for rare plant species such as side-oats grama,* Bicknell's sedge,* Carolina whitlow-grass,* Torrey's mountain-mint,* yellow wild flax,* large twayblade,* green milkweed,* and northern blazing-star* (Kiviat 1988). These meadow-like openings also support many of the rare plants of other calcareous crests (see above). At least 19 plant species listed as Endangered, Threatened, or Rare in New York are known to occur in marble knoll and red cedar barren habitats.

Dover's marble knolls and red cedar barrens both commonly supported red cedars, as well as other trees, including quaking aspen, gray birch, and oaks. Autumn-olive was a common shrub of marble knolls, sometimes in abundance. Other common plants of both habitats included poverty-grass, sweet vernal grass, little bluestem, bristle-leaved sedge,* glaucous sedge, shrubby cinquefoil, white sweet clover, late purple aster, bladder campion, spotted knapweed, lyre-leaved rock-cress, wild columbine, and harebell. We also found rare plants such as purple

cliffbrake,* Indian grass,* side-oats grama,* Bicknell's sedge,* rock sandwort,* yellow wild flax,* whorled milkweed,* green milkweed,* and northern blazing-star.*

Knolls and barrens provide habitat similar to crest, ledge, and talus for reptiles such as eastern hognose snake* and may also be used by Fowler's toad.* Red cedar canopies on marble knolls may provide roosting habitat for northern saw-whet owl* (Kiviat 1988) among other raptor species (see the section on red cedar woodland above).

A marble knoll. (Not all have such large openings.)

Occurrence in Dover

We mapped 36 marble knolls in Dover, though we expect there are more, as these are difficult to map remotely. All were in the Harlem Valley, and most were concentrated in a few specific areas therein. A number of knolls occurred in northern Dover, around the hamlet of Dover Plains (including those in the Nellie Hill and Roger Perry preserves). Another concentration was found in southern Dover, north and south of Pleasant Ridge Rd. These included several highly degraded knolls on the Olivet University Golf Course, which have the topography and marble outcrops of marble knolls but do not currently support the native plant communities typical of knolls due to management for turf grass. In a few upland areas lacking exposed bedrock, we found plants characteristic of marble knolls, especially abundant shrubby cinquefoil. We mapped these areas as cinquefoil shrublands, and they are described below in the upland shrubland section.

We found 38 red cedar barrens; the largest was 1 ac (0.4 ha). Most were in the Roger Perry Preserve, where striking white sands, formed from the erosion of marble bedrock, covered significant areas.

Sensitivities/Impacts

Marble knolls and red cedar barrens may be desirable areas for mining, house construction, and other intensive uses. The calcareous sands of these areas are very susceptible to erosion. Removal of vegetation, use of pesticides, alteration of water runoff patterns, or soil disturbance by motor vehicles, bicycles, foot traffic, or construction equipment could do great harm to rare plant communities. On the other hand, the rare plants of marble knolls benefit from maintaining the meadow openings that might otherwise be overgrown by red cedars or other trees and shrubs. The Conservation Priorities and Planning section of this report gives recommendations for protecting and fostering the habitat values of marble knolls and red cedar barrens, and figures 3 and 7 illustrate locations of these habitats in Dover.

Carolina whitlow-grass

Northern blazing-star

UPLAND SHRUBLAND

Ecological Attributes

We use the term "upland shrubland" for shrub-dominated upland (non-wetland) habitats. In most cases these are lands in transition between meadow and young forest, but they also occur along utility corridors maintained by cutting or herbicides and in areas of recent forest clearing. Land use (both historical and current) and soil characteristics are important factors influencing the species composition of shrub communities. Shrublands may be dominated by non-native, invasive species such as Japanese barberry, Bell's honeysuckle, autumn-olive, Oriental bittersweet, and multiflora rose, or they may be more diverse, including some non-native invasive species as well as native grasses and forbs; native shrubs such as meadowsweet, gray dogwood, northern blackberry, and raspberries; and scattered seedlings and saplings of eastern red cedar, hawthorns, eastern white pine, gray birch, red maple, quaking aspen, and oaks. Occasional large, open-grown trees (e.g., sugar maple, red oak, white oak, eastern sycamore) left as shade for livestock or for ornament may be present. Many non-native, invasive plants tend to thrive in places with fine soil texture (Lundgren et al. 2004, Johnson et al. 2006) and a history of agricultural use (up to 40-80 years or more before present) and in areas that were heavily grazed in the past. Recently-logged areas tend to develop a shrub layer including abundant tree saplings and sprouts and northern blackberry.

A few species of rare plants are known from calcareous shrublands in the region, such as stiff-leaved goldenrod,* butterflyweed,* and shrubby St. Johnswort.* In highly calcareous areas, shrubby cinquefoil may dominate the shrub community of an upland habitat. We mapped several such areas in Dover as cinquefoil shrubland. We believe these areas may support rare plants and invertebrates similar to those found on marble knolls or in fens.

Rare butterflies such as Aphrodite fritillary,* dusted skipper,* Leonard's skipper,* and cobweb skipper* may occur in shrublands where their larval host plants are present (the fritillary uses violets and the skippers use native grasses such as little bluestem). Upland shrublands and other non-forested upland habitats may be used by turtles for nesting or aestivation (e.g., painted turtle, wood turtle,* spotted turtle,* and eastern box turtle*) or for foraging (eastern box turtle). Many bird species of conservation concern nest in upland shrublands and adjacent upland

meadow habitats, including brown thrasher,* blue-winged warbler,* golden-winged warbler,* prairie warbler,* field sparrow,* and eastern towhee.* Many shrubland birds (including blue-winged warbler) do not seem to be area-sensitive in shrubland patches larger than about 1 ha, and they will nest in small to medium-sized shrublands within forest openings, particularly those with low vegetation, few trees, and dense shrub cover (Askins et al. 2007). Nevertheless, most of these birds avoid forest edges (Schlossberg and King 2008) and, consequently, extensive upland shrublands (>12.5 ac [5 ha]) and those that form large complexes with meadow habitats may be particularly important for these breeding birds (Shake et al. 2012). Several species of hawks and falcons use upland shrublands and adjacent meadows for hunting small mammals such as meadow vole, white-footed mouse, eastern cottontail, and New England cottontail.*

New England cottontail, our only native northeastern cottontail, was once common in the region but is now listed as a rare species or species of Special Concern in New England and New York. This species is very similar to the eastern cottontail, the non-native rabbit that is much more common in the region. The eastern cottontail is able to take advantage of a variety of habitats, whereas the New England cottontail seems to do best in large shrublands with dense shrub thickets. Southeastern New York east of the Hudson River (including Dover) and northwestern Connecticut are believed to be very important parts of the remaining range of this species. In fact, much of Dover is within an area determined by the US Fish and Wildlife Service to be one of the few remaining core breeding areas of the New England cottontail, and is the location of the first part of the Great Thicket National Wildlife Refuge, established by the USFWS to stem the losses of the New England cottontail and other shrubland-dependent species. .

Occurrence in the Town of Dover

Upland shrublands were abundant in the lowlands of Dover but were mostly small (median area = 0.7 ac [0.3 ha]). However, 15 shrublands were larger than 10 ac (4 ha), three exceeded 20 ac (8 ha), and one was 48 ac (19 ha). Common species included Bell's honeysuckle, multiflora rose, gray dogwood, Japanese barberry, eastern red cedar, goldenrods, and grasses. Common birds of Dover's upland shrublands included gray catbird, blue-winged warbler,* yellow

warbler, and eastern towhee.* Golden-winged warblers have been observed at Nellie Hill during a few years within the last five or so years (Barbara Butler, pers. comm.).

We mapped only three cinquefoil shrublands, though we suspect there are more in areas we were not able to see in the field. In addition to shrubby cinquefoil, which was common if not dominant, these shrublands variously contained red cedar and tamarack saplings, autumn-olive, common reed, little bluestem, yellow sedge, Virginia mountain-mint, and red cedar seedlings. Regionally rare species included variegated scouring rush,* Indian grass,* hair beak-sedge,* Kalm's lobelia,* and whorled milkwort.*

Sensitivities/Impacts

Shrublands and meadows are closely related habitats. Having diverse ages and structures in these habitats may promote overall biological diversity, and can be achieved by rotational mowing and/or brush-hogging. To reduce the impacts of these management activities on birds, mowing should be timed to coincide with the post-fledging season for most birds (e.g., October and later), and only take place every few years, if possible. Prescribed or spontaneous fires can also maintain shrublands and grasslands. As in upland meadows, soil compaction and erosion caused by ATVs, other vehicles, and equipment can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. If shrublands are left undisturbed, most will eventually become forests, which are also valuable habitats.

UPLAND MEADOW

Ecological Attributes

This broad category includes active cropland, hayfields, pastures, fallow fields, and other upland areas dominated by herbaceous (non-woody) vegetation. Upland meadows are typically dominated by grasses and forbs and have less than 20% shrub cover. The ecological values of these habitats can differ widely according to the types of vegetation present and the disturbance histories (e.g., tilling, mowing, grazing, pesticide applications). Extensive hayfields or pastures dominated by grasses, for example, may support grassland-breeding birds (depending on the mowing schedule or intensity of grazing), while intensively cultivated crop fields have less habitat value for wildlife of conservation concern. We mapped these distinct types of meadow

as a single habitat for practical reasons, but also because after abandonment these open areas tend to develop similar general habitat characteristics and values. Undisturbed meadows develop diverse plant communities of grasses, forbs, and shrubs and support an array of wildlife, including invertebrates, some frog species, reptiles, mammals, and birds. Meadows with shallow, nutrient-poor soils (especially common in mid-slope locations) often support a higher abundance and diversity of native, warm-season grasses and other native plants (Vispo and Knab-Vispo 2012). It is for both present and potential ecological values that we consider all types of meadow habitat to be ecologically significant.

Several species of rare butterflies, such as Aphrodite fritillary,* dusted skipper,* Leonard's skipper,* swarthy skipper,* meadow fritillary,* and striped hairstreak use upland meadows that support their particular host plants. Upland meadows can be used for nesting by wood turtle,* spotted turtle,* box turtle,* painted turtle, and snapping turtle. Grassland-breeding birds such as upland sandpiper,* grasshopper sparrow,* vesper sparrow,* savannah sparrow,* eastern meadowlark,* and bobolink* use extensive meadow habitats for nesting and/or foraging, and certain raptors such as short-eared owl,* northern harrier,* and golden eagle* use large, open meadows as winter hunting or roosting grounds. Wild turkeys forage on invertebrates and seeds in upland and wet meadows. Upland meadows often have large populations of small mammals (e.g., meadow vole) and can be important hunting grounds for raptors, foxes, and eastern coyote.

Occurrence in the Town of Dover

Upland meadow was the second most common habitat type in the Town of Dover, accounting for 12% of the total town area, or 4,200 ac (1,680 ha). Most meadows were associated with current or recent agricultural use. Figure 8 illustrates the location and distribution of meadow habitat in the town (including upland meadow, wet meadow, calcareous wet meadow, and fen), coded by size. The figure does not show areas of upland shrubland that in some cases had large patches of herbaceous cover. Upland meadows were common throughout the town, but the highest concentrations, and most of the largest meadows, were in northwestern and north-central Dover.

Fences and hedgerows dividing fields can significantly alter the habitat value for many grassland-nesting birds; if these are treated as fragmenting features, then the largest meadows were 84 and 80 ac (34 and 32 ha; Figure 8), with four others larger than 50 ac (20 ha). Hayfields were the most common kind of upland meadow in the town; other uses included row crops, pastures, and equestrian fields. Less-intensively managed upland meadows (including oldfields) were common but generally much smaller.

Sensitivities/Impacts

Principal causes of the loss of high-quality meadow habitat in the Northeast are the intensification of agriculture, regrowth of shrubland and forest after abandonment of agriculture, and residential development. The dramatic decline of grassland-breeding birds in the Northeast has been attributed to the loss of large patches of suitable meadow habitat; many of these birds need large meadows that are not divided by fences or hedgerows, which can harbor predators (Wiens 1969). Mowing of upland meadows during the bird-nesting season can cause extensive mortality of eggs, nestlings, and fledglings. Another threat to upland meadow habitats is the soil compaction and erosion caused by ATVs, other vehicles, and equipment, which can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. Destruction of vegetation can affect rare plants and reduce viable habitat for butterflies. Farmlands where pesticides and artificial fertilizers are used may have a reduced capacity to support native biodiversity. Horse pastures potentially have open-space, scenic, and biodiversity values, but those that are grazed intensively have little current value for native biodiversity. Meadows with a more diverse set of native plants are often less productive for agriculture, and could be good candidates for conservation management. The Conservation Priorities and Planning section of this report provides recommendations for maintaining high-quality, large meadow habitats, and figures 3 and 8 illustrate the locations and distribution of meadow habitat in Dover.

We discuss management of large meadows for birds later in this report, but good management of small meadows can be critical for other groups, such as butterflies, moths, bees, and dragonflies. Different species of butterflies depend on different kinds of meadow habitats (oldfields/ hayfields; stream margins; wet meadows/ pond margins; dry, shallow-soiled fields),

and different species have variously timed life cycles synchronized with the availability of foliage and nectar from the plants that are food sources for their larval and adult stages. Perhaps the best management strategy for butterfly conservation is to mow fields only in halves or portions which cut across topography. For example, if the field has wet and dry parts, cut half the wet and half the dry in any one year, rather than all the wet this year, and all the dry next year (Conrad Vispo, pers. comm.).

Dover hayfields

GRAVEL/COBBLE SHORE

Gravel/cobble shore consists of unvegetated or sparsely vegetated gravel (small rock fragments) and cobble (fist-sized and larger rock fragments) substrate. This habitat lies along the channels of larger perennial streams and is therefore subject to frequent flooding. Although we consider it here as an upland habitat, a mix of upland and wetland species may occur, much as in a floodplain forest. Vegetation is mostly forbs, sedges, and grasses, although scattered trees and shrubs also occur.

The loose substrates of gravel/cobble shores may make them attractive to nesting or foraging turtles, including wood turtle,* spotted turtle,* and eastern box turtle.* Gravelly areas also provide nesting grounds for spotted sandpiper, killdeer, and possibly common nighthawk.* Rare plants, rare odonates (dragonflies and damselflies), and rare tiger beetles could occur, but these have not been studied in our region.

Gravel/cobble shore was very limited in extent in Dover and was identified only along the Ten Mile River. Out of ten mapped occurrences, the largest patch was just under 1 ac (0.4 ha). However, because this habitat is difficult to detect remotely, we expect there may be other small stretches of gravel/cobble shore along the Ten Mile River.

ORCHARD/PLANTATION

This habitat type includes actively maintained or recently abandoned fruit orchards, tree farms, and plant nurseries. Conifer plantations with larger, older trees were mapped as "upland conifer forest," and those that had been partially harvested and colonized by shrubs were mapped as "upland shrubland." Christmas tree farms are potential northern harrier* nesting habitat. Fruit orchards with old trees may provide breeding habitat for eastern bluebird* and can be valuable to other cavity-using birds, bats, and other animals. The habitat value of active orchards or plantations is often compromised by frequent mowing, application of pesticides, and other human activities; we considered this an ecologically significant habitat type both for its current and potential future (i.e., post-abandonment) ecological values. These habitats have some of the vegetation structure and ecological values of upland meadows and upland shrublands, and will ordinarily develop into young forests if they remain undisturbed after abandonment. In the Town of Dover, orchards and plantations were few and small.

WASTE GROUND

Waste ground is an ecologists' term for land that has been severely altered by previous or current human activity, but lacks pavement or structures. Most waste ground areas have been stripped of vegetation and topsoil, or filled with soil or debris, and remain unvegetated or sparsely vegetated. This category encompasses a variety of highly altered areas such as active and abandoned sand and gravel mines, rock quarries, mine tailings, dumps, organic waste piles,

unvegetated wetland fill, landfill cover, sites where buildings have been razed, and construction sites.

Although waste ground often has low habitat value, there are notable exceptions. Several rare plant species are known to inhabit waste ground environments, including rattlebox,* slender pinweed,* field dodder,* and slender knotweed.* Rare lichens or mosses may potentially occur in some waste ground habitats. Several snake and turtle species of conservation concern, including eastern hognose snake,* spotted turtle,* and wood turtle,* may use the open, gravelly areas of waste grounds for burrowing, foraging, or nesting habitat. Bank swallow* and belted kingfisher often nest in the stable walls of active or inactive portions of soil mines and occasionally in piles of soil or sawdust. Bare, gravelly, or otherwise open areas provide nesting grounds for spotted sandpiper, killdeer, and possibly whip-poor-will* or common nighthawk.* Little is known of the invertebrate fauna of waste grounds in the region but these habitats might support rare species.

Waste ground was common in Dover. We mapped numerous currently or recently active gravel mines and quarries, including four larger than 15 ac (6 ha). These were located on kames and outwash deposits in or near the Harlem Valley. Other, smaller waste ground patches included construction-related piles of soil, gravel, and waste scattered throughout town.

CULTURAL

We define “cultural” habitats as areas that are significantly altered and intensively managed (e.g., mowed) but are not otherwise developed with pavement or structures. We consider them to be ecologically significant when they are adjacent to other ecologically significant habitats (i.e., when they are not entirely surrounded by developed areas) and when fairly large. We identified this as a significant habitat type more for its potential ecological values than its current values, which are reduced by frequent mowing, application of fertilizers and pesticides, or other types of management and intensive human uses.

Nonetheless, eastern screech-owl* and barn owl* are known to nest, forage, and roost in cultural areas. American kestrel,* spring migrating songbirds, and bats may forage in these

habitats, and wood duck and American kestrel* may nest here, as may several species of turtle. Large individual ornamental or fruit trees can provide habitat for cavity-nesting birds such as eastern bluebird,* roosting bats (including Indiana bat* and its nursery colonies), and many other animals, and for mosses, liverworts, and lichens, potentially including rare species. Of the different types of places mapped as "cultural" habitats, cemeteries are particularly well suited to provide habitat for a variety of species, since mature trees are often present, noise levels often minimal, and vehicular traffic is infrequent and slow.

Many cultural areas have "open space" values for the human community (e.g., recreational or scenic), and some provide important services such as buffering less-disturbed habitats from human activities and linking patches of undeveloped habitat. Because cultural areas are already significantly altered, however, their habitat values are greatly diminished compared to those of relatively undisturbed habitats. Cultural areas in Dover totaled about 600 ac (240 ha), or roughly 2% of the town. They included playing fields, riding rings, a golf course, cemeteries, large lawns, and manicured borders of ponds. The Olivet University Golf Course, at 60 ac (24 ha), was the largest cultural area in Dover.

WETLAND HABITATS

SWAMP

Ecological Attributes

A "swamp" is a wetland dominated by woody vegetation (trees or shrubs). We mapped three general types of swamp habitat in the town: hardwood and shrub swamp, mixed forest swamp, and conifer swamp.

Hardwood and Shrub Swamp

We combined deciduous forested and shrub swamps into a single habitat type because the two are often mixed and can be difficult to separate using remote sensing techniques. Common species included red maple, slippery and American elms, green and black ashes, yellow birch, and swamp white oak (trees); winterberry holly, highbush blueberry, swamp

azalea, spicebush, alders, Japanese barberry, and multiflora rose (shrubs); and skunk-cabbage, marsh-marigold, beggar-ticks, false-nettle, common jewelweed, yellow iris, tussock sedge, wood reedgrass, cinnamon fern, sensitive fern, and royal fern (herbaceous plants).

Conifer Swamp

A conifer swamp is a forested swamp in which conifers represent 75% or more of the tree canopy. In this region the usual conifer species of swamps are eastern hemlock and eastern red cedar, and occasionally white pine. A dense evergreen canopy has a strong influence on the understory plant community and structure of these swamps. The shrub and herbaceous layers are typically sparse and low in species diversity, and shading creates a cool microclimate, allowing snow and ice to persist longer into the early spring growing season. *Sphagnum* mosses may be abundant. Conifers growing in wetlands frequently have very shallow root systems and are therefore prone to windthrow. The resulting tip-up mounds, root pits, and coarse woody debris all contribute to the habitat's complex structure and microtopography.

Mixed Forest Swamp

Mixed forest swamps have a canopy composed of 25-75% conifers. This habitat has characteristics intermediate between those of hardwood and conifer swamps, and shares many of the ecological values of those habitats.

Swamps are important to a wide variety of birds, mammals, amphibians, reptiles, and invertebrates, especially when they are contiguous with other wetland types or embedded within large areas of upland forest. Hardwood and shrub swamps along the floodplains of clear, low-gradient streams can be an important component of wood turtle* habitat. Other turtles such as spotted turtle* and box turtle* frequently use swamps for summer foraging, drought refuge, and travel corridors, and spotted turtle may overwinter in swamps. Pools within swamps are used by several pool-breeding amphibian species, and are the primary

Hardwood - white pine swamp, a type of mixed forest swamp

breeding habitat of blue-spotted salamander.* Four-toed salamander,* believed to be regionally rare or scarce, uses swamps with rocks or abundant, moss-covered, downed wood or woody hummocks. Eastern ribbon snake* forages for frogs in swamps. Red-shouldered hawk,* barred owl,* great blue heron,* wood duck, American black duck,* red-headed woodpecker,* Canada warbler,* and white-eyed vireo* nest in hardwood swamps.

Among the hardwood and shrub swamps that we mapped, we noted a particular type worth distinguishing (denoted with purple stars on the large-scale habitat map), which we call a "pool-like swamp." Pool-like swamps have woody vegetation characteristic of swamps, but are pool-forming, isolated from other wetlands or streams, and are seasonally dry, thus maintaining a fish-free environment that may have ecological roles similar to those of intermittent woodland pools. See the section on intermittent woodland pools (below) for additional ecological attributes and occurrence information.

Occurrence in the Town of Dover

Hardwood and shrub swamp (or hardwood swamp, for short) was the most extensive wetland habitat type in the town, totaling about 2,400 ac (970 ha), or about 7% of the town area. Swamps ranged from smaller than 0.1 to over 170 ac (< 0.04 - > 69 ha), and were often contiguous with other wetland habitats such as marsh, wet meadow, and open water (including beaver ponds). Thirty-seven hardwood swamps exceeded 10 ac (4 ha), six were greater than 50 ac (20 ha), and three occupied more than 100 ac (40 ha). Most of the largest swamps were within the Great Swamp, west of Rt. 22 in southern Dover, and these were part of much larger contiguous wetlands. Smaller swamps were abundant and widespread throughout the town. Water depth and duration varied greatly in Dover's swamps, with some drying out completely in the summer months and others retaining relatively deep pools.

Mixed forest swamps and conifer swamps were uncommon and mostly small in Dover. Only two exceeded 5 ac (2 ha), the largest being 16 ac (6 ha). In the Harlem Valley, we mapped numerous small mixed and conifer swamps with eastern red cedar. Elsewhere, eastern hemlock was the more common conifer, though white pine was co-dominant in several swamps.

Sensitivities/Impacts

While some swamps, like other wetlands, may be protected by federal or state laws, that protection is usually incomplete or inadequate, and most swamps are still threatened by a variety of land uses. Small swamps embedded in upland forest may be overlooked in environmental reviews, but can have extremely high biodiversity values, and play similar ecological roles to those of intermittent woodland pools (see below). Many of the larger swamps are located in low-elevation areas where human land uses are also concentrated. They can easily be damaged by alterations to the quality or quantity of surface water runoff, or by disruptions of groundwater sources that feed them. Swamps that are surrounded by agricultural land are subject to runoff contaminated with agricultural chemicals, and those near roads and other developed areas often receive runoff high in sediment and toxins. Polluted runoff and groundwater can degrade a swamp's water quality, affecting the ecological condition (and thus habitat value) of the swamp and its associated streams. Maintaining flow patterns and water volumes in swamps is important to the plants and animals of these habitats. Direct disturbance,

such as logging, can damage soil structure, plant communities, and microhabitats, and provide access for invasive plants. Ponds for ornamental or other purposes are sometimes excavated or impounded in swamps, but the lost habitat values of the pre-existing swamp usually far outweigh any habitat values gained in the new, artificial pond environment. Connectivity between swamp habitats and nearby intact upland and wetland habitats is essential for amphibians that breed in swamps and for other resident and transient wildlife of swamps.

The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of swamps within larger wetland complexes, and figures 3 and 11 show the locations of wetlands throughout the town. Recommendations for preserving the habitat values of pool-like swamps are given in the Conservation Priorities and Planning section on intermittent woodland pools.

ACIDIC BOG

Ecological Attributes

An acidic bog is a rare wetland habitat that is perennially wet, principally fed by rainwater (instead of groundwater), very nutrient-poor, and dominated by shrubs of the heath family and extensive carpets or floating mats of peat mosses (*Sphagnum*) and other vegetation. Bog substrates consist of deep, partially decomposed peat mosses and other organic matter that isolate the bog from groundwater influence. Acidic bogs, therefore, are fed primarily by precipitation and by surface runoff from the immediate watershed. The insulation provided by the moss mats sometimes helps to preserve underlying ice into late spring or early summer, thereby maintaining a cool microclimate that supports a relict boreal plant community. Leatherleaf, sheep-laurel, swamp azalea, highbush blueberry, black chokeberry, and peat mosses are typical bog plants in this region.

Rare and uncommon plants of acidic bogs in this region include pod-grass,* pitcher-plant,* round-leaved and spatulate-leaved sundews,* rose pogonia,* grass pink,* dragon's mouth,* white-fringed orchid,* cranberries,* tussock cottongrass,* and Virginia chain fern.* Several rare insect species depend on rare bog plants. For example, the bog copper*(butterfly) deposits its eggs exclusively on cranberries,* and pitcher plant* is the larval host of two moths, the

pitcher plant borer* and the pitcher plant moth.* Acidic bogs also seem to be the exclusive habitat of three rare dragonflies—subarctic darner,* ebony bog haunter,* and ringed bog haunter.* Four-toed salamander* may occur in bogs and other wetlands with deep mats of *Sphagnum* and other mosses on rocks, logs, and woody hummocks. Breeding birds of acidic bogs in the region include golden-winged warbler,* northern waterthrush,* and eastern bluebird. Southern bog lemming* could occur in bogs and adjacent forests.

Pitcher plants growing in peat moss of an acidic bog.

Occurrence in the Town of Dover

We documented five acidic bogs in Dover, a large number for our region. Two were sizeable, at 5 ac (2 ha) and 7 ac (3 ha). The largest bog we mapped was in Tamarack Swamp, on East Mountain. It was a black spruce*-tamarack bog, a rare type of bog for southeastern New York. (Most are dominated by heath shrubs.) In the 1980s, Kiviat found an extensive, thick mat of Sphagnum mosses; abundant shrubs including highbush blueberry, swamp azalea, and mountain holly;* and herbaceous plants including pitcher plant,* goldthread, and creeping snowberry* (Kiviat 1988 and E. Kiviat, pers. comm.)

Sensitivities/Impacts

Acidic bogs are very rare in Dutchess County. The biological communities of acidic bog habitats are closely tied to the water chemistry, water temperature, and hydroperiods of these environments. Bog soils and vegetation are easily damaged by foot traffic and similar disturbances. Grazing, trampling, and alterations to the watershed (e.g., tree removal, soil

disturbance, fertilizers, pesticides, alterations to groundwater or surface water drainage) could adversely affect this habitat. Because bog ecology seems to depend on a cool microclimate and low nutrient availability, bogs are sensitive to removal of forest in surrounding areas and to nutrient pollution. Protection of large forested buffer zones around bogs would help to maintain the water quality essential to bog ecology, and to insulate the bog community from other aspects of human disturbance. The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of acidic bogs, and figures 3 and 9 illustrate the locations of bogs in Dover.

INTERMITTENT WOODLAND POOL

Ecological Attributes

An intermittent woodland pool is a small wetland partially or entirely surrounded by forest, usually with sparse or no vegetation within the pool itself. Typically these pools have no surface water inlet or outlet (or an ephemeral one) and contain standing water during fall,

Eastern ribbon snake, a user of intermittent woodland pools.

winter, and spring that dries up by mid- to late summer during a normal year. This habitat is a subset of the widely recognized "vernal pool" habitat (which may occur in forested or open settings). Despite the small size of intermittent woodland pools, those that hold water through early summer can support amphibian diversity equal to or higher than that of much larger wetlands (Semlitsch and Bodie 1998, Semlitsch 2000). Seasonal drying and lack of a stream connection ensure that these pools do not support fish, which are major predators on amphibian

eggs and larvae. The surrounding forest supplies the pool with organic detritus, which is the base of the pool's food web. The forest is also essential habitat for adult pool-breeding amphibians during the non-breeding season.

"Pool-like swamps" have hydrological properties similar to intermittent woodland pools, in addition to abundant woody vegetation and hummocks characteristic of swamps. Because of their isolation from streams and other wetlands, these swamps may have ecological roles similar to those of intermittent woodland pools—e.g., they may provide a seasonal source of water with fewer aquatic predators, breeding habitat for pool-breeding amphibians, and refuge for turtles.

Common plant species of pools in Dover included black tupelo, red maple, highbush blueberry, winterberry holly, royal fern, tussock sedge, hop sedge, and woolgrass, mostly around pool edges. We found false hop sedge,* a NYS-Threatened species, in two intermittent woodland pools.

Intermittent woodland pools (and many pool-like swamps) provide critical breeding and nursery habitat for wood frog,* Jefferson salamander,* marbled salamander,* and spotted salamander* and are also used by other amphibians such as spring peeper, blue-spotted salamander* and four-toed salamander.* Reptiles such as spotted turtle* and eastern ribbon snake* use intermittent woodland pools for foraging, rehydrating, and resting. Wood duck, mallard, and American black duck* use intermittent woodland pools for foraging, nesting, and brood-rearing, and a variety of other waterfowl and wading birds use these pools for foraging. During the breeding season, birds may be more abundant and diverse around intermittent woodland pools than elsewhere in upland forest (McKinney and Paton 2009). The invertebrate communities of these pools can be rich, providing abundant food for songbirds such as yellow warbler, common yellowthroat, and northern waterthrush.* Pool-like swamps can provide breeding habitat for Louisiana waterthrush.* Fairy shrimp are nearly restricted to intermittent woodland pools, and springtime physa* is a regionally rare snail associated with such pools. Large and small mammals use these pools for foraging and as water sources.

Very small (e.g., 2-10 m diameter), isolated, intermittent or ephemeral pools in open areas or forest edges may support clam shrimps. At least one clam shrimp that occurs in the region is globally rare (Mattox's clam shrimp, *Cyzicus gynecia*), and others may be rare in New York or the region (see Schmidt and Kiviat 2007, Schmidt et al. 2018).

Occurrence in the Town of Dover

We mapped 132 intermittent woodland pools and 40 pool-like swamps in Dover. They were most common on West Mountain and, especially, East Mountain, with only a few in the Harlem Valley. All the mapped intermittent woodland pools were smaller than 1 ac (0.4 ha). Because pools were small and often difficult to identify on aerial photographs, we expect there are additional such habitats that we did not map.

Pool-like swamps tended to be larger, though not all parts of these swamps necessarily had standing water. The largest was nearly 3 ac (1.2 ha), and nine others exceeded 1 ac (0.4 ha).

Sensitivities/Impacts

We consider intermittent woodland pools to be one of the most imperiled habitats in the region. Although they are widely distributed, the pools are small (often less than 0.1 ac [0.04 ha]) and their ecological importance is often undervalued. They are frequently drained or filled by landowners and developers, used for dumping, treated for mosquito control, and sometimes converted into ornamental ponds. They are often overlooked in environmental reviews of proposed developments, and even when the pools themselves are spared in a development plan, the surrounding forest so essential to the ecological functions of the pools is frequently destroyed. Intermittent woodland pools are often excluded from federal and state wetland protection due to their small size, their intermittent surface water, and their isolation from streams or larger waterbodies. It is these very characteristics of size, isolation, and intermittency, however, which make woodland pools uniquely suited to species that do not reproduce or compete as successfully in larger wetland systems. The Conservation Priorities section of this report provides recommendations for protecting the habitat values of intermittent woodland pools (as well as heath swamps and pool-like swamps), and figures 3 and 10 illustrate locations of these pools in Dover.

KETTLE SHRUB POOL AND BUTTONBUSH POOL

Ecological Attributes

A "kettle shrub pool" is a seasonally or permanently flooded shrubby pool in glacial outwash landscapes. (A glacial kettle is a depression formed by the melting of a stranded block of glacial ice near the end of the last Ice Age.) The pool is normally dominated by buttonbush, though buttonbush may appear and disappear over the years in a given location. Other shrubs such as highbush blueberry, swamp azalea, winterberry holly, and willows may also be abundant. In some cases, an open water moat entirely or partly surrounds a shrub thicket in the middle of the pool, which may include small trees such as red maple or green ash. Conversely, the shrub stands may occupy the outer portions of the area with open water in the middle. These pools are typically isolated from streams, though some may have a small intermittent inlet and/or outlet. Standing water is normally present in winter and spring but often disappears by late summer or remains only in isolated puddles. A buttonbush pool has a similar flora and structure, but occurs in non-outwash terrain. We assume that the two kinds of habitats share many ecological attributes.

Hudsonia has found one state-listed rare plant (buttonbush dodder*), at least three regionally rare plants (the moss *Helodium paludosum*,* short-awned foxtail,* and pale alkali-grass*), and the regionally rare eastern ribbon snake* in kettle shrub pools in the region. The pools are used by spotted turtle,* painted turtle, wood duck, mallard, American black duck,* and green heron, and farther west in Dutchess County are the core habitat of the Blanding's turtle* (NYS-Threatened). (Blanding's turtles are not known to occur in Dover or other towns of eastern Dutchess County.) Buttonbush pools also have many of the habitat attributes of intermittent woodland pools and are used by many intermittent woodland pool-species (see above).

Occurrence in the Town of Dover

We documented six kettle shrub pools and five buttonbush pools in Dover, with a mean size of 1.6 ac (0.6 ha). The largest were 4 ac (1.6 ha) and 3.5 ac (1.4 ha). Many were within a narrow strip of outwash sand and gravel and kames in the Harlem Valley—also one of the areas of concentrated gravel mines in town.

Sensitivities/Impacts

Buttonbush pools and kettle shrub pools may be particularly sensitive to changes in hydrology. Groundwater extraction or changes in infiltration in the vicinity could alter the pool's hydroperiod and water depth, and alteration of surface water entering or leaving the pool could drastically change its character. These pools are also sensitive to changes in water chemistry; runoff from roads, agricultural fields, lawns, and construction sites all negatively affect water quality. Development and habitat fragmentation in the surrounding landscape threaten the habitat connections between these pools and other wetland and upland habitats that are essential to pool-breeding amphibians, turtles, and other wildlife. Like intermittent woodland pools, buttonbush pools are occasionally excavated for ornamental ponds and are often partly drained by means of ditches. The presence of glacial outwash soils around kettle shrub pools makes such areas attractive places for gravel mining, which may alter the water chemistry or hydroperiod. More information about this habitat is in Kiviat (1993, 1997), Kiviat and Stevens (2001), and Kiviat and Stevens (2003). The Conservation Priorities section of this report provides recommendations for protecting the habitat values of kettle shrub pools and buttonbush pools, and figures 3 and 10 illustrate locations of these pools in Dover.

MARSH

Ecological Attributes

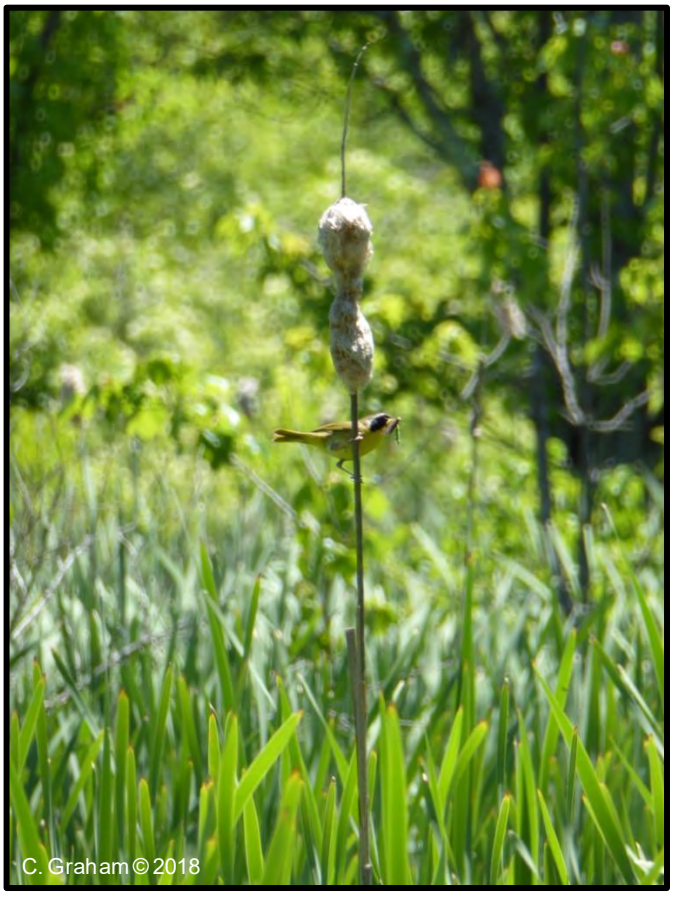
A marsh is a wetland that has standing water for most or all of the growing season and is dominated by herbaceous (non-woody) vegetation. Marshes often occur at the fringes of deeper water bodies (e.g., lakes and ponds), or in close association with other wetland habitats such as wet meadows or swamps. The edges of marshes, where standing water is less permanent, often grade into wet meadows. Many of the marshes we observed in the field were dominated by some combination of common reed, cattails, rice cut-grass, and lakeside sedge. Other common herbaceous plants included tussock sedge, woolgrass, bur-reeds, purple loosestrife, smartweeds, and climbing hempweed. Some marshes are dominated by floating-leaved plants such as pond-lilies, watershield, and duckweeds.

Several rare plant species are known from marshes in the region, and the diverse plant communities of some marshes provide habitat for butterflies such as the Baltimore

checkerspot,* monarch,* and northern pearly eye. Marshes are also important habitats for reptiles and amphibians, including northern water snake, painted turtle, snapping turtle, spotted turtle,* green frog, pickerel frog, and spring peeper. Numerous bird species, including marsh wren,* common gallinule,* American bittern,* least bittern,* great blue heron,* Virginia rail,* sora,* American black duck,* and wood duck use marshes for nesting or nursery habitat. Pied-billed grebe* also uses this habitat where it occurs adjacent to open water areas. Many raptors, wading birds, and mammals use marshes for foraging.

Occurrence in the Town of Dover

We mapped about 380 ac (150 ha) of marsh in the town. The two largest marshes (23 and 24 ac [10 ha]) were part of a 90-ac (36-ha) marsh complex within the Great Swamp. Most of those marshes had formerly been hardwood swamp and still contained abundant dead standing trees, which contained an inactive great blue heron* rookery. Another large marsh (15 ac [6 ha]) was found east of Crane Pond on East Mountain. Marshes were frequently contiguous with or embedded in hardwood swamps or wet meadows.



Common yellowthroat in cattail marsh

Several were influenced by beaver activity. In some cases we mapped areas of open water within marshes as a distinct habitat (see below). In areas where beavers are active, the location and extent of open water is likely to change from year to year.

Sensitivities/Impacts

In addition to direct disturbances such as filling or draining, marshes are subject to stresses from offsite (upgradient) sources. Alteration of surface water runoff patterns or groundwater flows can lead to dramatic changes in the plant and animal communities of marshes. Polluted stormwater runoff from roads, parking lots, lawns, and other surfaces in developed landscapes carries sediments, nutrients, de-icing compounds, and other contaminants into the wetland. Nutrient and sediment inputs and human or beaver alteration of water levels can also alter the plant community and facilitate invasion by non-native plants such as purple loosestrife and common reed. Purple loosestrife and common reed have displaced many native wetland graminoids in the marsh habitats of our region in recent decades and are dominant in numerous marshes in the town. Noise and direct disturbance from human activities can discourage breeding activities of marsh birds. Because many animal species of marshes depend equally on surrounding upland habitats for their life history needs, protection of the ecological functions of marshes must go hand-in-hand with protection of the surrounding habitats. Some of the larger marshes in Dover are very lake-like and could have similar sensitivities as open water habitats (see habitat profile below). The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of marshes within larger wetland complexes, and figures 3 and 11 illustrate the locations of marshes and other wetlands in Dover.

WET MEADOW

Ecological Attributes

A wet meadow is a wetland dominated by herbaceous (non-woody) vegetation, and which retains little or no standing water during most of the growing season. The period of inundation or soil saturation is longer than that of an upland meadow, but shorter than that of a marsh. Some wet meadows are dominated by purple loosestrife, common reed, reed canary-grass, or tussock sedge, while others have a diverse mixture of wetland grasses, sedges, forbs, and scattered shrubs. Mannagrasses, woolgrass, reed canary-grass, soft rush, spotted Joe-Pye-weed, common jewelweed, sensitive fern, and marsh fern are some typical native plants of wet meadows. Common plant species in Dover included common reed, reed canary-grass, purple loosestrife, sensitive fern, soft rush, goldenrods, and sedges.

Wet meadows with diverse plant communities may have rich invertebrate faunas. Blue flag and certain sedges and grasses of wet meadows are larval food plants for regionally-rare butterflies. Wet meadows with tall vegetation provide nesting and foraging habitat for songbirds such as marsh wren,* and wading birds such as American bittern.* Wet meadows that are part of extensive meadow areas (both upland and wetland) may be especially important to species of grassland-breeding birds. Large and small mammals use wet meadows and a variety of other meadow habitats for foraging.

Occurrence in the Town of Dover

Wet meadows were widely distributed in Dover and commonly occurred within and along the margins of swamps and marshes and in low-lying areas within upland meadows. We mapped 315 ac (128 ha) of wet meadow. Most occurrences were smaller than 1 ac (0.4 ha). One wet meadow off of West Dover Road was 32 ac (13 ha), most of which was being hayed.

Sensitivities/Impacts

Some wet meadows are able to withstand light grazing by livestock, but heavy grazing or frequent mowing can destroy the soil structure, eliminate sensitive plant species, and invite non-native weeds. Mowing and grazing when soils are dry, e.g., in late summer, are less damaging to the soils and the plant community, and postponing mowing until late August, September, or October will help to protect late-nesting birds. Wet meadows that are part of larger complexes of meadow and shrubland habitats are prime sites for development or agricultural uses, and are often drained, filled, or excavated. Because many wet meadows are omitted from state, federal, and site-specific wetland maps, they are frequently overlooked in environmental reviews of development proposals. See the Conservation Priorities and Planning section of this report for recommendations on mowing practices (in the large meadows section) and on preserving the habitat values of wet meadows within larger wetland complexes. Figures 3 and 11 shows the locations of wet meadows and other wetlands in Dover.

CALCAREOUS WET MEADOW

Ecological Attributes

A calcareous wet meadow is a specific type of wet meadow habitat (see above) that is strongly influenced by calcareous (calcium-rich) groundwater or soils. These conditions favor the establishment of a calcium-adapted plant community, including such species as sweetflag, lakeside sedge, New York ironweed, rough-leaved goldenrod, and blue vervain. Calcareous indicator species in Dover included interior sedge, yellow sedge, porcupine sedge, pendulous bulrush,* blue vervain, New York ironweed, sweetflag, and climbing hempweed. The vegetation is often lush and tall. Calcareous wet meadows often occur adjacent to fens (see below) and may include some fen plant species, but can be supported by water sources other than groundwater seepage. Fens and calcareous wet meadows can be distinguished by factors such as hydrology (including beaver flooding and abandonment in calcareous wet meadows), vegetation structure, and the plant community.

High-quality calcareous wet meadows with diverse native plant communities may support species-rich invertebrate communities, including phantom cranefly* and rare butterflies such as Dion skipper,* two-spotted skipper,* and Baltimore checkerspot.* Plants of conservation concern include fringed gentian* and swamp birch.* Eastern ribbon snake* and spotted turtle* use calcareous wet meadows for basking and foraging. Bog turtles* use calcareous wet meadows that are adjacent to fens for summer foraging and nesting habitat. Many common wetland animals such as green frog, pickerel frog, red-winged blackbird, and swamp sparrow use calcareous wet meadows.

Occurrence in the Town of Dover

We documented 41 calcareous wet meadows scattered throughout the town. Most were in the Harlem Valley, although the two largest—off Halls Corners Road (11 ac [4 ha]) and off Route 55 (5 ac [2 ha])—were not. Calcareous wet meadows can be distinguished from other wet meadows only by field observation, so it is probable that some of the mapped “wet meadows” we did not visit were calcareous wet meadows.

Sensitivities/Impacts

Calcareous wet meadows have sensitivities to disturbance similar to those of non-calcareous wet meadows (see above) and fens (see below). They are particularly vulnerable to nutrient enrichment and siltation, which often facilitate the spread of invasive species. Like other small wetland habitats, they are often omitted from wetland maps and consequently overlooked in the environmental reviews of development proposals. The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of fens and calcareous wet meadows.

FEN

Ecological Attributes

A fen is a shrub- and herb-dominated wetland that is fed by calcareous groundwater seepage. Fens almost always occur in areas influenced by carbonate bedrock (e.g., limestone or marble), and are identified by their low, often sparse vegetation and their distinctive plant community. Tussocky vegetation and small seepage rivulets are often present, and some fens have substantial areas of bare mineral soil or organic muck. Typical plants of fens include shrubby cinquefoil, alder-leaved buckthorn,* red-osier dogwood, autumn willow, sage-leaved willow, Kalm's lobelia, grass-of-Parnassus, bog goldenrod, spike-muhly, sterile sedge, porcupine sedge, yellow sedge, and woolly-fruited sedge.

Dover fens were typically dominated by a combination of shrubby cinquefoil and various sedges and rushes, although shrubs such as willows (several species), alders, and red-osier dogwood were commonly scattered throughout. Trees such as eastern red cedar, tamarack, and red maple could be rare to occasional. Common herbaceous species included marsh fern, yellow sedge, porcupine sedge, interior sedge, fringed brome, purple loosestrife, swamp milkweed, rough-leaved goldenrod, purple-stemmed aster, Virginia mountain-mint, grass-of-Parnassus,* and Kalm's lobelia.* We also found numerous species of conservation concern, including hidden spikemoss,* prairie wedge-grass,* woolly-fruited sedge,* winged loosestrife,* buckbean,* rose pogonia,* fringed gentian,* round-leaved sundew,* alder-leaved buckthorn,* and sage-leaved willow.* We found many areas where fens had been overgrown with shrubs or tall herbaceous plants such as cattails, and many of the mapped fens were being

Fen dominated by graminoids, including the sweeping leaves of woolly-fruited sedge.

encroached upon by such plants, often an indication of excess nutrients. Such growth may have been checked by historic livestock grazing (Kiviat et al. 2010). Fens in and near Dutchess County were analyzed by Kiviat et al. (2010).

Fens are a rare habitat type in the region because of the limited distribution of carbonate bedrock, calcareous soils, and calcareous groundwater seepage, and the historic alteration of wetlands. Fens support many species of conservation concern, including rare plants, invertebrates, reptiles, and breeding birds. More than 12 state-listed rare plants are found almost exclusively in fen habitats, including handsome sedge,* Schweinitz's sedge,* bog valerian,* scarlet Indian paintbrush,* spreading globeflower,* and swamp birch.* Rare butterflies such as Dion skipper* and black dash,* as well as rare dragonflies, such as forcipate emerald* and Kennedy's emerald,* are largely restricted to fen habitats. Other uncommon

invertebrates, including phantom cranefly,* can also be found in fens. Fens comprise the core habitat for the NYS-Endangered bog turtle* in southeastern New York, and are also used by other reptiles of conservation concern such as the spotted turtle* and eastern ribbon snake.*

Occurrence in the Town of Dover

We mapped 78 fens in Dover; some were quite small and many were situated very close to other fen patches as part of a larger fen complex. Most were in the Harlem Valley over marble bedrock. Concentrations of fens occurred off Cricket Hill Road; in and around the Roger Perry Preserve; and on both sides of Poplar Hill Road, at the north end of town. The largest fen, off of Cricket Hill Road, was nine ac (4 ha), and another, east of Sand Hill Rd, was six ac (2 ha). Because fens are difficult to identify by remote sensing, there may be other unmapped fens in areas we did not visit. Unmapped fens could occur in low-elevation areas with calcareous bedrock or soils, including edges or interiors of wet meadows, swamps, marshes, or calcareous wet meadows, upper edges of stream floodplains, or at the bases of ridges.

Sensitivities/Impacts

Fens are highly vulnerable to degradation from direct disturbance and from activities in nearby upland areas. Nutrient and salt pollution from septic systems, fertilizers, or road runoff, disruption of groundwater flow by new wells or excavation nearby, sedimentation from agricultural or construction activity, or direct physical disturbance can lead to changes in the character of the habitat, including a decline in overall plant diversity and invasion by non-native species and tall shrubs (Aerts and Berendse 1988, Panno et al. 1999, Richburg et al. 2001, Drexler and Bedford 2002). Such changes can render the habitat unsuitable for bog turtle* and other fen animals and plants that require the particular structural, chemical, or hydrological environment of an intact fen. The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of fens.

SPRINGS and SEEPS

Ecological Attributes

Springs and seeps are places where groundwater discharges to the ground surface, either at a single point (a spring) or diffusely (a seep). Although springs often discharge into ponds, streams, or wetlands such as fens and swamps, we generally mapped only springs and seeps that discharged conspicuously into upland locations. Springs and seeps originating from deep groundwater sources flow more or less continuously, and emerge at a fairly constant temperature, creating an environment that is cooler in summer and warmer in winter than the surroundings. For this reason, seeps and springs sometimes support aquatic species that are ordinarily found at more northern or southern latitudes. The habitats created at springs and seeps are determined in part by the hydroperiod and the chemistry of the soils and bedrock through which the groundwater flows before discharging. (Fens [see above] are a special kind of seepage habitat fed by calcareous groundwater, but are mapped here as fens instead of seeps because of their unusual habitat characteristics.) Springs and seeps are water sources for many streams, and they help maintain the cool water temperature of streams, which is an important habitat characteristic for certain rare and declining fishes, amphibians, and other aquatic organisms. Springs and seeps also serve as water sources for animals during droughts and in winters when other water sources are frozen.

Above: seep. Below: spring.

Very little is known about the ecology of seeps in the Northeast. Golden saxifrage is a plant more-or-less restricted to springs and groundwater-fed wetlands and streams. A few rare invertebrates are restricted to springs in the region.The Piedmont groundwater amphipod* could occur in the area (Smith 1988). Gray petaltail* and tiger spiketail* are two rare dragonflies found in seeps. Springs emanating from calcareous bedrock or calcium-rich surficial deposits sometimes support an abundant and diverse snail fauna. Northern dusky salamander* uses springs and cool streams.

Occurrence in the Town of Dover

We mapped 118 springs and 165 seeps scattered across the town. Because the occurrence of springs and seeps is difficult to predict by remote sensing, we mapped only those we saw in the field and those that had a distinct signature on one of our map sources. We expect there are many more springs and seeps in the town that we did not map. More detailed surveys of these habitats should be conducted as needed on a site-by-site basis.

While there were particular concentrations in the southeastern and northwestern parts of town, springs and seeps can be found in any part of Dover. While most seeps were smaller than one ac (0.4 ha), four were larger than five ac (2 ha), and one seep was 16 ac (6 ha). In some cases, several mapped springs and seeps occurred in clusters associated with the same physiographic feature, e.g., a particular hill or stream drainage. Many seeps and springs occurred along streams or at the bases of slopes. Seeps contained typical wetland vegetation or a mixture of wetland and upland plants.

Sensitivities/Impacts

Springs are easily disrupted by disturbance to up-gradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltrating waters. Some springs have been modified for water supply, with constructed or excavated basins and sometimes spring houses. Pumping of groundwater for human or livestock water supply can deplete water available to nearby springs and seeps.

OPEN WATER

Ecological Attributes

"Open water" habitats include naturally formed ponds and lakes, large pools lacking floating or emergent vegetation within marshes and swamps, and unvegetated ponds that may have originally been constructed by humans but have since reverted to a more natural state (e.g., surrounded by unmanaged vegetation). Open water areas can be important habitat for many common species, including invertebrates, fishes, frogs, turtles, waterfowl, muskrat, beaver, and bats. Open water areas sometimes support submerged aquatic vegetation that can provide important habitat for aquatic invertebrates, fish, and turtles, and food for waterfowl. Spotted turtle* uses ponds and lakes during both drought and non-drought periods, and wood turtle* may overwinter and mate in open water areas. Wood duck, American black duck,* pied-billed grebe,* osprey,* bald eagle,* American bittern,* and great blue heron* may use open water areas as foraging habitat. Bats, mink, and river otter* also forage at open water habitats.

Occurrence in the Town of Dover

We mapped 66 open water habitat units. Many of the larger ones were on East Mountain, though a few occurred on West Mountain, including 36-ac (14 ha) Lapp Pond. Crane Pond, at 51 ac (20 ha), was the largest open water unit, and Depression Pond (24 ac [10 ha]) the third largest. (Some other large water bodies were mapped as constructed ponds; see below.) Many of the open water areas in town were evidently created by beaver activity. Areas of open water within beaver wetlands are dynamic habitats that expand or contract according to beaver activity, and are often transitional to marshes or wet meadows.

Sensitivities/Impacts

The habitat values of natural open water areas are often greater than those of constructed ponds, since the areas are less intensively managed, less disturbed by human activities, and surrounded by undeveloped land. Open water habitats are vulnerable to human impacts such as shoreline development, aquatic weed control, use of motorized watercraft, and runoff from roads, lawns, and agricultural areas. Aquatic weed control, which may include harvesting, herbicide application, or introduction of grass carp, is an especially important concern in open water habitats, and the potential negative impacts should be assessed carefully before any such

activities are undertaken (Heady and Kiviat 2000, Kiviat 2009). Because open water areas are often within larger wetland and stream complexes, any disturbance to the habitat may have far-reaching effects on the surrounding landscape. To protect water quality and habitat values, broad zones of undisturbed vegetation and soils should be maintained around ponds and lakes. If part of a pond or lake must be kept open (unvegetated) for ornamental, recreational, or other reasons, it is best to avoid dredging and to allow other parts of the pond to develop abundant vegetation. This can be accomplished by harvesting aquatic vegetation only where necessary to create open lanes or pools for boating, fishing, or swimming.

CONSTRUCTED POND

Ecological Attributes

Constructed ponds are water bodies that have been excavated or dammed by humans, either in existing wetlands or stream beds, or in upland terrain. Many of these ponds are created for fishing, watering livestock, irrigation, swimming, boating, or aesthetics. Some are constructed near houses or other structures to serve as a source of water in the event of a fire, while others were excavated during mining. If constructed ponds are not intensively managed by humans, they can be important habitats for many of the common and rare species that are associated with naturally formed open water habitats (see below). We have classified naturally formed water bodies that are now intensively managed by humans as constructed ponds to better represent their habitat values. Conversely, we have mapped constructed ponds that have long been unmanaged and are now surrounded by intact habitats as “open water” or “marsh,” depending on the vegetation.

Occurrence in the Town of Dover

Most of the water bodies in the town were constructed ponds, and most of these were agricultural or ornamental ponds. Ornamental ponds were usually located within landscaped areas in close proximity to residences. We mapped nearly 280 constructed ponds, most of them small (median size = 0.2 ac [0.08 ha]). Cedar Lake (74 ac [30 ha]), Ellis Pond (67 ac [27 ha]), Lake Weil (31 ac [12 ha]), and the large pond north of Jones Pond (27 ac [11 ha]) were the largest constructed ponds in Dover. Because of the potential value of constructed ponds as drought refuges and foraging areas for turtles, waterfowl, wading birds, and other wildlife, we

mapped constructed ponds within developed areas as well as those surrounded by intact habitats. Constructed ponds with substantial cover of emergent vegetation (e.g., cattail, purple loosestrife, common reed) were mapped as marshes.

Sensitivities/Impacts

The habitat values of constructed ponds vary depending on the landscape context and the extent of human disturbance. In general, the habitat value is higher when the ponds have undeveloped, unmanaged shorelines, are relatively undisturbed by human activities, have more vascular plant vegetation, and are embedded within an area of intact habitat. Because many constructed ponds are not buffered by sufficient natural vegetation and undisturbed soils, they are vulnerable to the adverse impacts of agricultural or road runoff, septic leachate, and pesticide or fertilizer runoff from lawns and gardens. We expect that many of the ponds maintained for ornamental purposes are treated with herbicides and perhaps other pesticides, or contain introduced fish such as grass carp and various game and forage fishes. Since constructed ponds can serve as habitat for a variety of common and rare species, these impacts should be minimized whenever possible.

The habitat values of constructed ponds (and especially intensively managed ornamental ponds) do not ordinarily justify altering streams or destroying natural wetland or upland habitats to create them. In most cases, the loss of ecological functions of the pre-existing natural habitats far outweighs any habitat value gained in the artificially created environments.

STREAM, FLOODPLAIN FOREST, and RIPARIAN CORRIDOR

Ecological Attributes

"Perennial streams" flow continuously throughout years with normal precipitation, but some may dry up during droughts. They provide essential water sources for wildlife throughout the year, and are critical habitat for many plant, vertebrate, and invertebrate species. We loosely define "riparian corridor" as the zone along a perennial stream that includes the stream banks, the floodplain, and adjacent steep slopes. These corridors can support a variety of wetland and non-wetland forests, meadows, and shrublands.

We did not map actual riparian corridors but instead mapped zones of a set width on either side of streams (Figure 12). These zones represent a minimum area along the stream that is needed for effective protection of stream water quality, habitat quality, and wildlife (see Streams and Riparian Corridors in the Priority Habitats section). Our mapped zones do not necessarily cover the whole riparian corridor for any stream, however, which varies in width depending on factors such as local topography, soil characteristics, and land uses in the watershed, and in some cases the size of the stream.

A rocky perennial stream

We mapped floodplain forest along the Swamp River and Ten Mile River. We used a combination of topography, soils, orthophoto imagery, and spatial data from the Hawthorne Valley Farmscape Ecology Program (Knab-Vispo and Vispo 2010) to delineate floodplain forest, and, where possible, conducted field work to verify its presence. Floodplains forest encompasses both upland and swamp forests.

Floodplain forests experience flooding at frequent (yearly or several times per year) or occasional (every few years or decades) intervals. Typical floodplain forests include a mixture of upland and wetland plant species and floodplain specialists such as eastern sycamore, eastern cottonwood, and pin oak. Floodplain forests tend to have high species diversity and high biological productivity. Many species of fish and wildlife depend on riparian habitats in some way for their survival (Hubbard 1977, McCormick 1978). The soils of floodplains are often sandy or silty.

Rare plants of riparian areas in the region include cattail sedge,* Davis’ sedge,* green dragon,* winged monkeyflower,* and goldenseal.* We found Davis' sedge* at one location in Dover.

The fish and aquatic invertebrate communities of perennial streams may be diverse, especially in clean-water streams with unsilted bottoms. Brook trout* and slimy sculpin* are two native fish species that require clear, cool streams for successful spawning. Wild brook trout, however, are now confined largely to small headwater streams in the region, due to degraded water quality and competition from brown trout, a non-native species that has been stocked in many streams. Wood turtle* uses perennial streams with deep pools and recumbent logs, undercut banks, or muskrat or beaver burrows. Perennial streams and their riparian zones, including sand and gravel bars, provide nesting or foraging habitat for many species of birds, such as spotted sandpiper, belted kingfisher, tree swallow, bank swallow, winter wren,* Louisiana waterthrush,* great blue heron,* and green heron. Red-shouldered hawk* and cerulean warbler* nest in areas with extensive riparian forests, especially those with mature trees. Bats, including Indiana bat,* use perennial stream corridors for foraging. Muskrat, beaver, mink, and river otter* are some of the mammals that regularly use riparian corridors.

"Intermittent streams" may flow for a few days or for many months during the year, but ordinarily dry up at some time during years of normal precipitation. They are the headwaters of most perennial streams, and are significant water sources for lakes, ponds, and wetlands of all kinds. The condition of these streams therefore influences the water quantity and quality of those larger water bodies and wetlands. Intermittent streams provide microhabitats not present in perennial streams, supply aquatic organisms and organic drift to downstream reaches, and can be important local water sources for wildlife (Meyer et al. 2007). Their loss or degradation in a portion of the landscape can affect the presence and behavior of wildlife populations over a large area (Lowe and Likens 2005). Plants such as winged monkeyflower* and may-apple* are sometimes associated with intermittent streams. Although intermittent streams have been little studied by biologists, they have been found to support rich aquatic invertebrate communities, including regionally rare mollusks (Gremaud 1977) and dragonflies. Both perennial and intermittent streams provide breeding, larval, and adult habitat for northern dusky salamander* and northern two-lined salamander. The forests and, sometimes, meadows adjacent to streams provide foraging habitats for adults and juveniles of these species.

Occurrence in the Town of Dover

Perennial streams occupied the major valleys in the town. The largest streams were the Ten Mile River and its major tributary, the Swamp River, each of which flows through Dover for about 11 miles (18 km). Other named perennial streams included Coopertown Brook, Burton Brook, Mill River, Deuel Hollow Brook, Doctors Brook, Fish Brook, and Stone Church Brook (Figure 12). Numerous perennial tributaries flowed into these large streams. The combined length of perennial streams mapped in the town was 59 mi (95 km). Intermittent streams were myriad, with a combined length of at least 208 mi (335 km).

Sensitivities/Impacts

Removal of trees or other shade-producing vegetation along a stream can lead to elevated water temperatures that adversely affect aquatic invertebrate and fish communities. Clearing of vegetation in and near floodplains can reduce the important exchange of nutrients and organic materials between the stream and the floodplain, and reduce the amount and quality of organic detritus available to support the aquatic food web. It can also diminish the floodplain's capacity for floodwater attenuation, leading to increased flooding downstream, scouring and bank erosion, and sedimentation of downstream reaches. Any alteration of flooding regimes, stream water volumes, timing of runoff, and water quality can profoundly affect these habitats and the species that use them. Hardening of the stream banks with concrete, riprap, gabions, or other materials reduces the biological and physical interactions between the stream and floodplain, and tends to be harmful both to stream and floodplain habitats. Removal of snags (fallen trees or logs) from the streambed degrades habitat for fishes, turtles, snakes, birds, muskrats, and their food organisms. Stream corridors are prone to invasion by Japanese knotweed, an introduced plant that is spreading in the region (Talmage and Kiviat 2004).

The habitat quality of a stream is affected not only by direct disturbance to the stream or its floodplain, but also by land uses throughout the watershed. (A watershed, or catchment, is the entire land area that drains into a given water body). Watershed urbanization (including roads and residential, industrial, and commercial development) has been linked to deterioration in stream water quality (Parsons and Lovett 1993). Activities in the watershed that cause soil erosion, changes in surface water runoff, reduced groundwater infiltration, or contamination of

surface water or groundwater are likely to affect stream habitats adversely. For example, an increase in impervious surfaces (roads, parking lots, roofs) may elevate runoff volumes, leading to erosion of stream banks and siltation of stream bottoms or incision (deep erosion of streambeds), degrading the habitat for invertebrates, fish, and other animals. Road runoff often carries contaminants such as petroleum hydrocarbons, heavy metals, road salt, sand, and silt into streams. Applications of fertilizers and pesticides to agricultural fields, golf courses, lawns, and gardens in or near the riparian zone can degrade the water quality and alter the biological communities of streams. Construction, logging, soil mining, clearing for vistas, creating lawns, and other disruptive activities in and near riparian zones can hamper riparian functions and adversely affect the species that depend on streams, riparian zones, and nearby upland habitats.

The Conservation Priorities and Planning section of this report provides recommendations for protecting the habitat values of streams and riparian corridors, and figures 3 and 12 illustrate the locations of streams in Dover.

Calico pennant (female)

CONSERVATION PRIORITIES AND PLANNING

Most local land-use decisions in southeastern New York are made on a site-by-site basis, without the benefit of good ecological information about the site or the surrounding lands. The loss of biological resources from any single development site may seem trivial, but the cumulative losses from thousands of site-by-site decisions are substantial. Regional impacts include the disappearance of certain habitats from whole segments of the landscape, the fragmentation and degradation of many other habitats, the local extinction of species, the depletion of overall biodiversity, and the impairment of ecosystem function and services.

Because biological communities, habitats, and ecosystems cross property and municipal boundaries, the best approach to biodiversity conservation is from the perspective of whole landscapes. The Dover habitat map and the information provided in this report can be applied directly to land-use and conservation planning and decision making at multiple scales. In the following pages, we outline recommendations for: 1) identifying priorities for town-wide conservation, land-use planning, and habitat enhancement; 2) developing general strategies for conservation of biodiversity and water resources; and 3) reviewing site-specific land-use proposals.

PRIORITY HABITATS IN DOVER

The Town of Dover is extraordinarily endowed with native biological diversity, including many habitats, plant species, and wildlife that are uncommon or rare in other parts of the region and the state.

Much of Dover is in the Harlem Valley Calcareous Wetlands Significant Biodiversity Area designated by NYSDEC for its unusual ecological communities and rare species of plants and animals (Penhollow et al. 2006). Unusual habitats—fens, marble knolls, cool ravines, red cedar barrens, acidic bogs, and others— support rarities such as juniper hairstreak,* blue-spotted salamander,* four-toed salamander,* eastern spadefoot toad,* spotted turtle,* wood turtle,* eastern ribbon snake,* whip-poor-will,* and hooded warbler.* Fens constitute the core habitat

for bog turtle (NYS-Endangered). Table 2 lists species of plants and animals of statewide conservation concern that are known from Dover.

By employing a proactive approach to land-use and conservation planning, the Town of Dover has the opportunity to protect the integrity of remaining biological resources for the long term. With limited funds, time, and attention to devote to conservation purposes, municipal agencies can use the best available scientific information to decide how to direct those resources for the best conservation results. Important considerations in prioritizing such efforts include protecting sensitive habitat types, high-quality habitat units, and a variety of habitats that are well-connected and well-distributed over the landscape. Below we highlight some habitat types that we consider to have the highest priority for conservation in the town—the "priority habitats." It must be understood, however, that we believe all the habitat areas depicted on the large-format habitat map are ecologically significant and worthy of conservation attention.

We used the requirements of a selected group of species to help identify some of the areas where conservation efforts might yield the greatest return for biological diversity (see Table 3). Many are rare or declining in the region or statewide. Each of these species or groups requires a particular habitat type for a crucial stage in its life cycle (e.g., hibernation, breeding), and those "core habitats" typically form the hub of the animal's habitat complex. In many cases, the focal species also requires additional habitat types within a certain distance for other life history needs. This distance defines the extent of the species' habitat complex and, therefore, the minimum area that needs to be protected or managed to maintain the local population. We call this the "conservation zone" and discuss the size of this zone in the "Conservation Issues" and "Recommendations" subsections for each priority habitat description, below. (The conservation zone distances are measured from the outer periphery of the core habitat, not from its center.) We used findings in scientific literature to delineate the priority conservation zone for the species of concern (Table 3). If the habitats of the species of concern are protected, many other rare and common species that occur in the same habitats will also be protected.

Table 2. Species of statewide conservation concern observed in Dover. Included are only species ranked as endangered, threatened, rare, or special concern in the NYS Environmental Conservation Law, or ranked as S1, S2, or S3 by the New York Natural Heritage Program.

Common name	Scientific name	Status[1]	Observer[2]	Habitat
PLANTS				
Yellow giant-hyssop	*Agastache nepetoides*	T S2S3	NYNHP	upland hardwood forest
Whorled milkweed	*Asclepias verticillata*	R S2	Hudsonia	red cedar barren, red cedar woodland
Green milkweed	*Asclepias viridiflora*	T S2	Hudsonia	red cedar barren, red cedar woodland, red cedar forest
Mountain spleenwort	*Asplenium montanum*	T S2S3	Hudsonia	crest, ledge, talus
Side-oats grama	*Bouteloua curtipendula* var. *curtipendula*	E S2	Hudsonia	upland meadow, red cedar woodland, upland mixed forest
Grass moss	*Brachythecium digastrum*	S1	NYNHP	red cedar forest
Bicknell's sedge	*Carex bicknellii*	R S3	Hudsonia	red cedar woodland
Bush's sedge	*Carex bushii*	R S3	Hudsonia	wet meadow, upland meadow
Clustered sedge	*Carex cumulata*	T S2S3	Hudsonia	rocky barren
Davis's sedge	*Carex davisii*	T S2	Hudsonia	upland hardwood forest
Emmons' sedge	*Carex emmonsii*	R S3	Hudsonia	marble knoll
False hop sedge	*Carex lupuliformis*	T S2	Hudsonia	intermittent woodland pool
Scarlet Indian-paintbrush	*Castilleja coccinea*	E S1	NYNHP	fen, upland hardwood forest
Devil’s-bit	*Chamaelirium luteum*	E S1S2	NYNHP	upland hardwood forest, upland mixed forest
Yellow corydalis	*Corydalis flavula*	R S3	Hudsonia	upland hardwood forest
Smartweed dodder	*Cuscuta polygonorum*	E S1	Hudsonia	stream
Flexible hair moss	*Ditrichum flexicaule*	S1	NYNHP	red cedar forest
Rough pennyroyal	*Hedeoma hispida*	T S2S3	Hudsonia	red cedar woodland, upland meadow
American alumnroot	*Heuchera americana* var. *americana*	R S3	Hudsonia	upland hardwood forest
Northern blazing-star	*Liatris scariosa* var. *novae-angliae*	T S2	Hudsonia	red cedar barren
Southern yellow flax	*Linum medium* var. *texanum*	T S2	NYNHP	fen
Yellow wild flax	*Linum sulcatum*	T S2	Hudsonia	red cedar barren, red cedar woodland, upland hardwood forest
Lily-leaved twayblade	*Liparis liliifolia*	E S1	Hudsonia	upland hardwood forest, red cedar forest
Virginia false gromwell	*Lithospermum virginianum*	E S1	NYNHP	red cedar woodland, upland mixed forest
Prairie loosestrife	*Lysimachia quadriflora*	E S1	Hudsonia	fen, calcareous wet meadow
Basil mountain-mint	*Pycnanthemum clinopodioides*	E S1	NYNHP	red cedar woodland
Torrey's mountain-mint	*Pycnanthemum torrei*	E S1	NYNHP	red cedar woodland

(continued)

Table 2 (cont.)

Common name	Scientific name	Status[1]	Observer[2]	Habitat
PLANTS (cont.)				
Hidden spikemoss	*Selaginella eclipes*	E S1	Hudsonia	fen
Hanging long beak moss	*Sematophyllum demissum*	S1	NYNHP	cool ravine
Prairie wedge-grass	*Sphenopholis obtusata*	E S1	Hudsonia	fen, calcareous ledge
Carolina whitlow-grass	*Tomostima reptans*	T S2	Hudsonia	red cedar woodland, red cedar forest, upland hardwood forest
ANIMALS				
Cooper's hawk	*Accipiter cooperii*	SC S4	Hudsonia	upland hardwood forest
Golden eagle	*Aquila chrysaetos*	E SHB S1N	RTWBC	meadow
Short-eared owl	*Asio flammeus*	E S2	RTWBC	meadow
Red-shouldered hawk	*Buteo lineatus*	SC S4B	Hudsonia	upland hardwood forest
Whip-poor-will	*Caprimulgus vociferus*	SC S3B	Hudsonia	rocky barren, upland hardwood forest
Northern harrier	*Circus cyaneus*	T S3B S3N	RTWBC	meadow
Golden-winged warbler	*Vermivora chrysoptera*	SC	RTWBC	shrubland, open woodland
Cerulean warbler	*Dendroica cerulea*	SC	RTWBC	mature deciduous forest
Timber rattlesnake	*Crotalus horridus*	T S3	Hudsonia	oak-heath barren, crest oak woodland, upland hardwood forest
Bog turtle	*Glyptemys muhlenbergii*	E S2	NYNHP	calcareous wetlands
Eastern spadefoot	*Scaphiopus holbrookii*	SC S2S3	NYNHP	red cedar barren
New England cottontail	*Sylvilagus transitionalis*	SC S1S2	NYNHP	upland shrubland

[1] Status: E = NYS Endangered. T = NYS Threatened. R = NYS Rare (plants). SC = NYS Special Concern (animals). See Appendix B for explanations of NYNHP rarity ranks (S1, S2, S3, etc.).

[2] Observer: NYNHP = New York Natural Heritage Program. RTWBC = Ralph T. Waterman Bird Club (pers. comm. Barbara Butler). Hudsonia is listed as the Observer for observations made during this habitat mapping project.

Table 3. Priority habitats, species of concern, and associated priority conservation zones identified by Hudsonia in the Town of Dover, Dutchess County, New York, 2009-2017.

Priority Habitat	Associated species or group of concern	Priority conservation zone	Rationale	References
Large forest	Forest interior-breeding birds	Unfragmented patches of at least 130-200 ac (50-80 ha)	Required for high probability of supporting breeding hermit and wood thrush in a 60% forested landscape.	Rosenberg et al. 2003
Cool ravine	Acadian flycatcher*	Unfragmented forest patches of 100+ ac (40+ ha)	A conservative estimate of minimum forested area required for successful breeding populations.	Robbins 1979, Robbins et al. 1989, Whitehead and Taylor 2002
Oak-heath barren, crest-oak woodland, & extensive clt	Timber rattlesnake*	1.5 mi (2.4 km) from winter den	A minimum radius of intact habitat from the den needed to protect all but the farthest ranging males.	Brown 1993
Large meadow	Grassland-breeding birds	Unfragmented patches greater than 25 ac (10 ha)	Required for maintaining viable breeding populations.	Vickery et al. 1994, Walk and Warner 1999, Balent and Norment 2003
Marble knoll and red cedar barren	Rare plants	Entire knoll and barren, connections between knolls and barrens	Needed to preserve rare plant communities and to allow for propagule dispersal among knolls and barrens.	Not available
Acidic bog	Rare plants	Watershed of bog	Needed to protect hydrology and water chemistry on which bog plants and associated species depend.	Crum 1988
Intermittent woodland pool	Pool-breeding amphibians	750 ft (230 m) from pool	Area of non-breeding season habitat considered critical for sustaining populations.	Madison 1997, Semlitsch 1998, Calhoun and Klemens 2002, Veysey et al. 2011
Fen	Bog turtle*	2500 ft (750 m) from fen	Represents the reported overland distance traveled between wetlands within a habitat complex; encompasses the recommended "Bog turtle Conservation Zone" aimed at protecting habitat integrity.	Eckler and Breisch 1990, Klemens 2001
Wetland complex	Spotted turtle	Minimum upland zone of 400 ft (120 m) beyond outermost wetlands in a complex	Corresponds to maximum reported distance of nests from the nearest wetland.	Joyal et al. 2001
Perennial stream	Wood turtle	820 ft (250 m) from stream	Encompasses most of the critical habitat, including hibernacula, nesting areas, spring basking sites, foraging habitat, and overland travel corridors.	Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997, Tingley et al. 2011

* Species of statewide conservation concern. See Appendix B.

Large Forest

Target Areas

A stand of American beech.

In general, forested areas (including upland forest, woodlands, and forested swamp) with the highest conservation value include large forest tracts, mature and relatively undisturbed forests, forests with unusual tree species composition, and those with a lower proportion of edge to interior habitat. Smaller forests that provide connections between other forests, such as corridors or patches that could be used as "stepping stones," are also valuable in a landscape context. The largest forest areas are illustrated in Figure 5. Five forests in Dover exceeded 1,000 ac (400 ha). The largest of these, at over 6,000 ac (2,400 ha), occupied much of East Mountain and was contiguous with roughly another 3,000 ac (1,200 ha) in Connecticut. Most of West Mountain was also covered with large blocks of forest, including patches of 4,000+ (1,600+ ha), 2,000+ (800+ ha), and 1,000+ ac (400+ ha). Another 2,000-ac (800-ha) patch spread across the southeastern hills and extended south into Pawling. Seven other contiguous forest blocks exceeded 250 ac (100 ha), a critical threshold for several forest-breeding birds of our region (Rosenberg et al. 2003; see below).

Conservation Issues for Selected Focal Species

Loss and fragmentation of forests are the two most serious threats facing forest-adapted organisms. The decline of extensive forests has been implicated in the declines of numerous "area-sensitive" species, which require many hundreds or thousands of acres of contiguous forest to sustain local populations. These include large mammals such as black bear* and bobcat* (Godin 1977, Merritt 1987), some raptors (Bednarz and Dinsmore 1982, Billings 1990,

Crocoll 1994), and many migratory songbirds (Robbins 1979, 1980; Ambuel and Temple 1983, Wilcove 1985, Hill and Hagan 1991, Lampila et al. 2005). In addition to reduced total area, fragmented forest has a larger proportion of edge habitat. Temperature, humidity, and light are altered near forest edges, and the edge environments favor a set of disturbance-adapted species, including many nest predators and a brood parasite (brown-headed cowbird) of forest-breeding birds (Murcia 1995). Large forests, particularly those that are more round and less linear, support forest species that are highly sensitive to disturbance and predation along forest edges. A study of forest breeding birds in mid-Atlantic states found that black-and-white warbler,* black-throated blue warbler,* cerulean warbler,* worm-eating warbler,* and Louisiana waterthrush* were rarely found in forests smaller than 250 ac (100 ha). The study suggested that the minimum forest area these birds require for sustainable breeding ranges from 370 ac (150 ha) for worm-eating warbler* to 2,500 ac (1,000 ha) for black-throated blue warbler (Robbins et al. 1989). For wood thrush,* only forest patches larger than 200 ac (80 ha) are considered highly suitable for breeding populations in our region (Rosenberg et al. 2003). Although bird area requirements vary regionally and locally (Rosenberg et al. 1999, 2000), these area values demonstrate the need to preserve large forests for these birds, all of which occur in Dover. Large forests with rocky crests also provide hunting habitat for reptiles of conservation concern such as northern copperhead,* timber rattlesnake,* and northern black racer* (see section on crest/ledge/talus and rocky barren, below).

Forest fragmentation can also inhibit or prevent animals from moving across the landscape, and can result in losses of genetic diversity and local extinctions in populations from isolated forest patches. For example, some species of frogs and salamanders are unable to disperse effectively through non-forested habitat due to desiccation and predation (Rothermel and Semlitsch 2002). Road mortality of migrating amphibians and reptiles can result in reduced population densities (Fahrig et al. 1995) or changes in sex ratios in local populations (Marchand and Litvaitis 2004).

Another threat to large forests in our region is the spread of invasive insect species, such as the hemlock woolly adelgid and the emerald ash borer; both are present in Dover forests. The Asian long-horned beetle could arrive here soon from New York City, Long Island or western

Barred owlets (fledglings)

Massachusetts; it threatens native maple, birch, and willow trees and has the potential to greatly affect the forestry, maple syrup, and nursery industries (APHIS 2008). Transporting of untreated firewood is now limited by law to less than 50 mi from its origin to limit the spread of these pests in New York (NYSDEC 2009).

In addition to their tremendous values for wildlife, forests are perhaps the most effective type of land cover for sustaining clean and abundant surface water (in streams, lakes, ponds, and wetlands) and groundwater. Forests with intact canopy, understory, ground vegetation, and floors (i.e., organic duff and soils) are extremely effective at promoting infiltration of precipitation (Bormann et al. 1969, Likens et al. 1970, Bormann et al. 1974, Wilder and Kiviat 2008), and may be the best insurance for maintaining groundwater quality and quantity, and for maintaining flow volumes, temperatures, water quality, and habitat quality in streams. Forests also moderate local air temperatures, and store large amounts of carbon in their soils and in their above- and below-ground biomass, offsetting significant volumes of our carbon emissions to the atmosphere.

Recommendations

We recommend that the remaining blocks of large forest in the Town of Dover be considered priority areas for conservation and that efforts be taken to keep these habitats intact wherever possible. If new development in these large forested areas cannot be avoided, it should be concentrated near forest edges and near existing roads and other development so that as much forest area as possible is preserved without fragmentation. New roads or driveways should not extend into the interior of the forest, where they divide the habitat into smaller, isolated patches. Some general guidelines for forest conservation include the following:

1. **Protect large, contiguous forested areas** wherever possible, and avoid development and other disturbance of forest interiors.
2. **Protect patches of forest types that are less common in the town regardless of their size**. These include mature forests (and old-growth, if any is present), natural conifer stands, and forests with an unusual tree species composition.
3. **Maintain or restore broad corridors of intact habitat between large forested areas.** For example, a forested riparian corridor or a series of smaller forest patches may provide connections between larger forest areas. Forest patches on opposite sides of a road may provide a "bridge" across the road for forest-dwelling animals.
4. **Maintain the forest canopy and understory vegetation intact**.
5. **Maintain standing dead wood, downed wood, and organic debris, and prevent disturbance or compaction of the forest floor**.

5. Contiguous forest patches

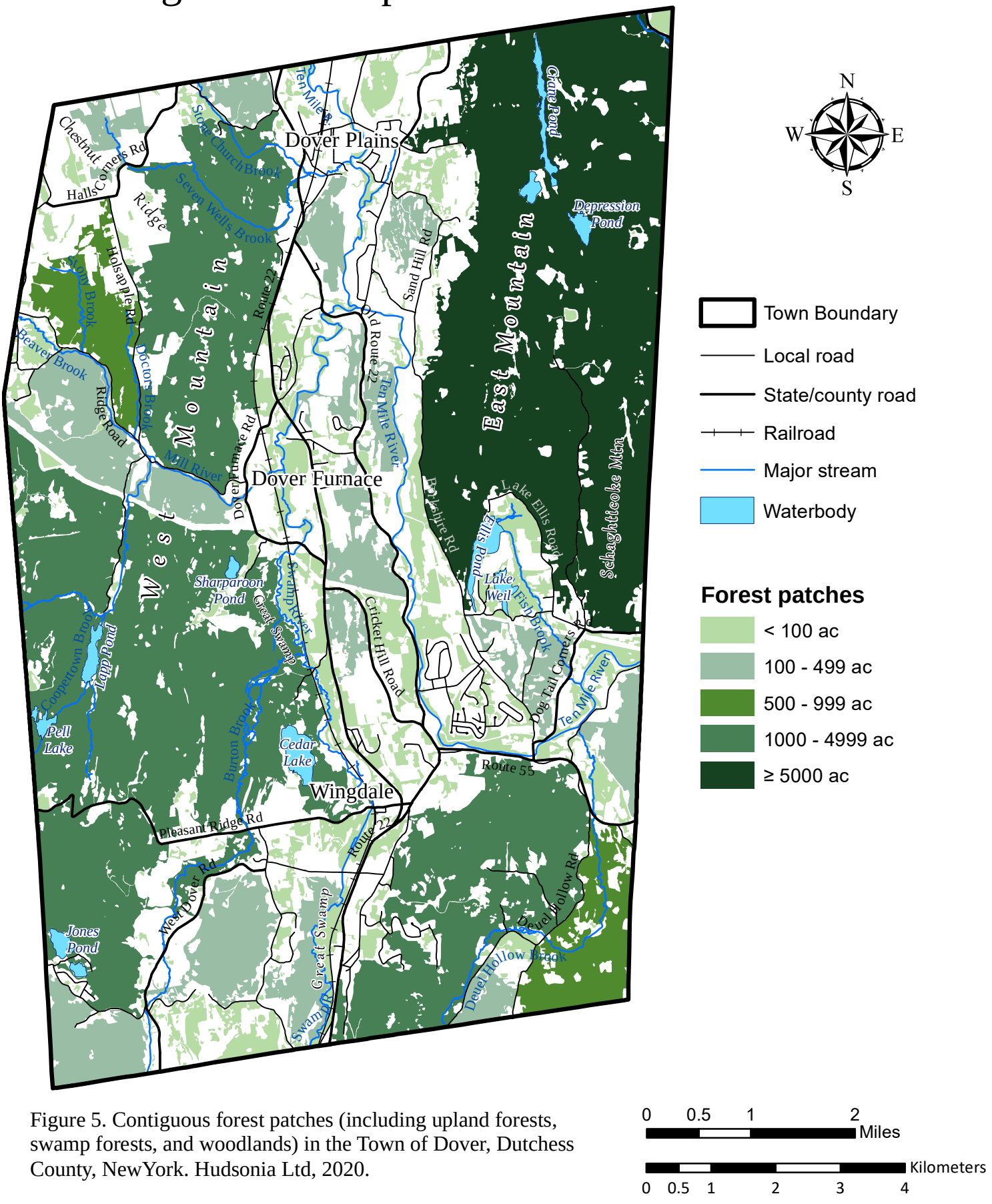


Figure 5. Contiguous forest patches (including upland forests, swamp forests, and woodlands) in the Town of Dover, Dutchess County, NewYork. Hudsonia Ltd, 2020.

Cool Ravine

Target Areas

Dover has several ravines with dense hemlock forest, but we identified just three of these as "cool ravines," special habitats with unusual physical structure and vegetation and a cool microclimate (Figure 9). There could be other cool ravines that we missed, and all steep hemlock-forested areas are worthy of protection.

Conservation Issues

The rocky substrates and the cool, moist, deeply shaded conditions are essential to the unusual biological communities of cool ravine habitats. The plants and animals of cool ravines could be harmed by any activities in or near the ravines that would alter the stream water quality or flow, affect the light, air temperature, or soil conditions, disturb the vegetation, or disrupt the surrounding forest. At least some of the breeding birds of these habitats are likely to need large forested areas around the ravines (Robbins et al. 1989).

The ecological importance of cool ravines may be magnified as global warming progresses. The cool, moist conditions of these habitats may provide a temporary haven for plants and animals stressed by general warming trends.

Acadian flycatcher* can be used as a focal species for delineating conservation zones for cool ravines. This regionally rare songbird is listed by the US Fish and Wildlife Service as a Bird of Conservation Concern. It nests in cool ravines and other cool, moist, mature forest habitats (DeOrsey and Butler 2006). Each nesting pair may require at least 74 ac (30 ha) of forest around their nest site, but much larger forested areas are needed to sustain an Acadian flycatcher population in the long term (Robbins 1979, Freemark and Collins 1992, Robbins et al. 1989). Fragmentation of the forest increases the Acadian flycatcher's (and other forest birds') vulnerability to brood parasitism by the brown-headed cowbird and to nest predation by a variety of birds and mammals (Robinson et al. 1995).

Recommendations

1. **Prevent any disturbance of soils or vegetation on the ravine walls or lip**.

2. **Maintain an undisturbed, forested zone out to 650 ft (200 m) from the ravine edge**. Within this zone, avoid any new construction of roads or buildings, and any new disturbance of soils or vegetation. This will help maintain stream water temperatures and other aspects of water quality, protect the ravine walls from erosion, and protect songbird-nesting habitat in the ravine.

3. **Maintain quality and quantity of streamwater**. This includes maintaining seasonal fluctuations in stream flows, maintaining cool streamwater temperatures, and preventing siltation and other forms of pollution from upstream or upgradient sources.

4. **Minimize recreational uses during spring through mid-summer** to avoid disturbing nesting birds. Design any trails such that access to interior ravine areas is limited. (This would not apply to the Stone Church gorge which has long been developed as a public attraction.)

5. **Maintain a large forested area around the ravine** to help maintain stream water temperatures, protect the ravine walls from erosion, and protect the ravine nesting habitats for songbirds.

Acadian flycatcher

Oak-Heath Barrens, Woodlands, and Other Crest, Ledge, and Talus

Target Areas

We mapped 143 oak-heath barrens, 14 other rocky barrens, and 72 crest oak woodlands on East Mountain and, especially, West Mountain. A few crest-hickory woodlands were found on Schaghticoke Mountain, as was extensive talus slope woodland, which also occurred in several places on West Mountain. Other crest, ledge, and talus habitats were abundant on hills, ridges, and slopes throughout the town (Figure 6). West Mountain and East Mountain were both extremely rocky, each with vast areas of exposed crests, cliffs, boulders, and talus fields. Most of the extensive calcareous crest, ledge, and talus in town consisted of marble bedrock exposed on hills, ridges, and road-cuts in the Harlem Valley.

Conservation Issues for Selected Focal Species

Oak-heath barrens and crest oak woodlands are uncommon in southeastern New York, and Dover has one of the largest concentrations of these habitats that we know of. These barrens and woodlands may provide core habitat for several rare reptiles that require rock outcrops and exposed conditions at crucial stages in their life cycle. Timber rattlesnake,* a NYS-Threatened species, is known to occur in Dover, but its populations have been declining in the northeastern US due to loss or disturbance of habitat, collection of the snakes for live trade, and malicious killing (Brown 1993, Klemens 1993). Timber rattlesnakes den in ledgy areas such as oak-heath barrens and crest oak woodlands, and migrate long distances from the den during the summer. Males have been reported to travel over four mi (6.4 km) from the den, but the average travel distance is closer to 2 mi (3.2 km). To protect most of the snakes in a given population, protection of undisturbed habitat within a minimum radius of 1.5 mi (2.4 km) from the den is recommended (Brown 1993). Other snakes such as northern copperhead,* eastern ratsnake,* and northern black racer* den in crest, ledge, and talus habitats and also range far into the surrounding landscape to forage in forests and meadows. Copperheads, for instance, will travel on average 0.4 mi (0.7 km) from their dens and have been known to travel up to 0.7 mi (1.2 km) (Fitch 1960). All are vulnerable to loss or disturbance of habitat, and proximity to human activities exposes the snakes to collection for live trade, harassment, and killing (Klemens 1993).

In the past, oak-heath barrens and other rocky crests were not often threatened by development because the steep rocky terrain made the construction of houses, roads, and other structures too expensive. Recently, however, increasing numbers of houses are being constructed on or near crests. Barrens occurring on hill summits and ridge tops are also viewed as prime sites for communication (cell) towers. Intensive foot traffic (especially along established trails) can severely degrade the fragile vegetation of oak-heath barrens and expose rare reptiles to fatal human encounters. Perhaps one of the greatest threats to the long-term viability of the rare animals associated with oak-heath barrens is the fragmentation of habitat complexes. The construction of houses, roads, and other structures in these areas can isolate habitat complexes and the animal populations they support by preventing migration, dispersal, and genetic exchange. This, in turn, can limit the ability of these populations to adapt to changing climatic or other environmental conditions and make them more prone to local extinction.

Crest oak woodlands and oak-heath barrens are disturbance-maintained ecosystems (ice, fire, wind). The plant communities of these habitats are especially adapted to fire, and some plant species even require episodic wildfires to persist. Residential land development in the vicinity of barrens habitats leads to human suppression of wildfires, thus eliminating an essential disturbance factor for these habitats. Without fire events, other forest species can colonize these areas, and eventually out-compete the barrens specialists.

Because of their landscape position (at lower elevations) and bedrock composition, calcareous crest, ledge, and talus areas have generally been subjected to more regular disturbances and development pressures than the high ridges. Both forested and open calcareous rocky areas provide habitat for rare plants and animals, but in disturbed places they often support dense populations of non-native plants. The marble bedrock weathers to form sandy soils, which make these areas highly susceptible to erosion. For further information see the marble knoll section (below).

Recommendations

To help protect oak-heath barren habitats and their associated rare species, we recommend the following measures:

1. **Protect oak-heath barrens** and their closely associated crest, ledge, and talus habitats from disturbances of any kind including, but not limited to, the construction of communication towers, mining, housing and road construction, and high intensity human recreation. In public-use areas, posting cautionary signs that warn of the fragile nature of the habitat may be an important first step.

2. **Protect oak-heath barrens from disturbances associated with high-intensity human recreation.** Keep any new trails distant from oak-heath barrens.

3. **Protect critical adjoining habitats within 1.5 mi (2.4 km) of the barrens.** To protect timber rattlesnakes, protect undisturbed habitat within a minimum radius of 1.5 miles (2.4 km) from a known or suspected den (Brown 1993). Habitats within this zone should be considered critical components of the barren habitat "complex." As much as possible, avoid new development of any kind, including roads and driveways within this 1.5-mi zone. If development cannot be avoided, design it to maximize the amount and contiguity of undisturbed habitat. Special measures may also need to be taken (in consultation with the NYSDEC) to restrict the potential movement of rare snakes into the newly developed areas, thereby minimizing the likelihood of human-snake encounters (which are often fatal for the snake) and road mortality. Protecting large areas of contiguous habitat surrounding oak-heath barrens will not only protect potential foraging habitats and travel corridors, but will also help support the ecological and natural disturbance processes (e.g., fire) that help sustain the barrens habitats.

4. **Maintain corridors between oak-heath barren habitat complexes.** Keep the intervening areas between habitat complexes intact to preserve long-distance migration corridors for timber rattlesnake and other species for population dispersal and to accommodate snakes displaced from degraded habitats.

5. **Avoid direct disturbance to timber rattlesnake dens**, and restrict nearby logging to the winter months when the snakes are hibernating (Brown 1993).

6. **Consult with the Endangered Species Unit of the NYSDEC** about any activity proposed in the vicinity of a known or suspected timber rattlesnake habitat.

6. Crest/ledge/talus and oak-heath barrens

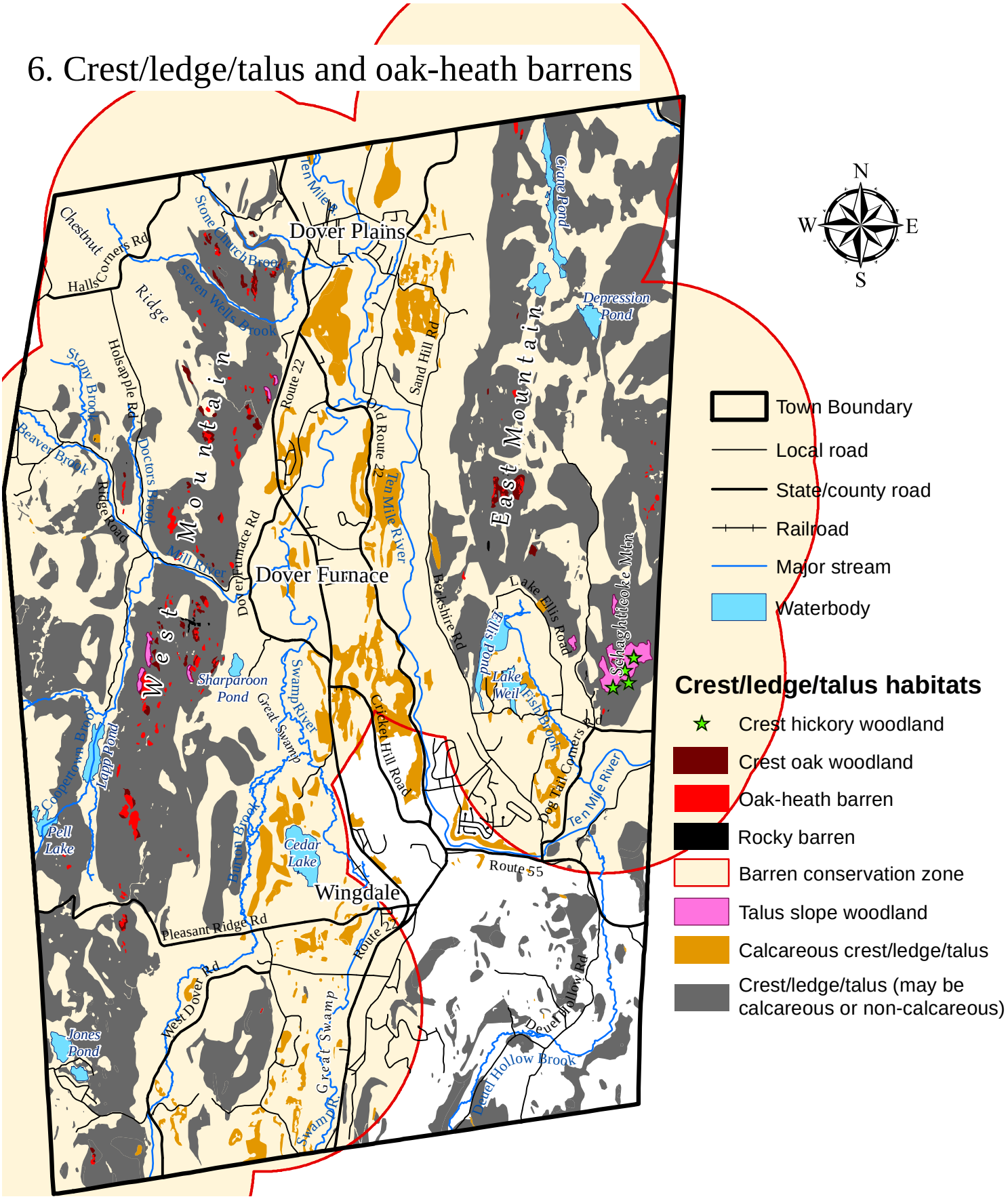


Figure 6. Generalized distribution of crest, ledge, and talus habitats, with locations of oak-heath barrens and other rocky habitats, in the Town of Dover, Dutchess County, NewYork. Barren conservation zones extend 1.5 mi (2.4 km) from boundaries of rocky and oak-heath barrens. Hudsonia Ltd, 2020.

Marble Knolls and Red Cedar Barrens

Target Areas

We mapped 36 marble knolls and 38 red cedar barrens in the Harlem Valley in Dover (Figure 7), and we expect there are more in places we were not able to field check. Some of these possible locations have been flagged with question marks on the map.

Two red cedar barrens. Below: the unusual "white sands of Dover"

Conservation Issues for Selected Focal Species

Marble knolls and red cedar barrens are unusual habitats known to support many rare species of plants and animals (Kiviat 1988). Many of Dover's marble knolls are in transition from agricultural uses (mostly grazing) to forested habitats, but still retain some meadow areas and openings within the developing shrub thickets and young forest. The meadow openings and the exposed bedrock areas are the primary habitats for the rare plants of marble knolls. Coarse sandy soils in these openings and in red cedar barrens can also provide good nesting habitat for box turtle,* spotted turtle,* wood turtle,* eastern hognose snake,* and other reptiles. Some of these animals may need to travel long distances from their primary wetland or forest habitats to reach the marble knoll nesting grounds. Maintaining intact habitats and corridors around the knolls

and barrens will allow these animals safe movement between habitats, and will also facilitate dispersal of plant propagules (seeds, spores, etc.) and repopulation of plant communities.

Recommendations

1. **Protect marble knolls and red cedar barrens from disturbances** such as the construction of communication towers, construction of buildings or roads, mining, and high intensity human recreation.

2. **Protect intact habitats around knolls and barrens** to allow safe movement of mobile wildlife using habitat complexes.

3. **Maintain corridors between knolls and barrens**. Protecting intact habitats in the intervening areas between marble knolls will allow for plant and animal movement and dispersal between knolls. This may be especially important for plants such as yellow wild-flax* and Carolina whitlow-grass,* two annuals that must continually reestablish themselves by seed dispersal.

4. **Maintain open areas**. Use light grazing, occasional mowing, or occasional manual removal of tall woody plants (e.g., eastern red cedar) and invasive shrubs (e.g., autumn-olive) where necessary to maintain meadow habitats for the rare plants of marble knolls and red cedar barrens, and to maintain unshaded reptile nesting areas.

5. **Consult with the New York Natural Heritage Program** about any activity proposed in the vicinity of a marble knoll or red cedar barren habitat to ascertain whether rare species are at risk.

Juniper hairstreak (butterfly)

7. Calcareous habitats

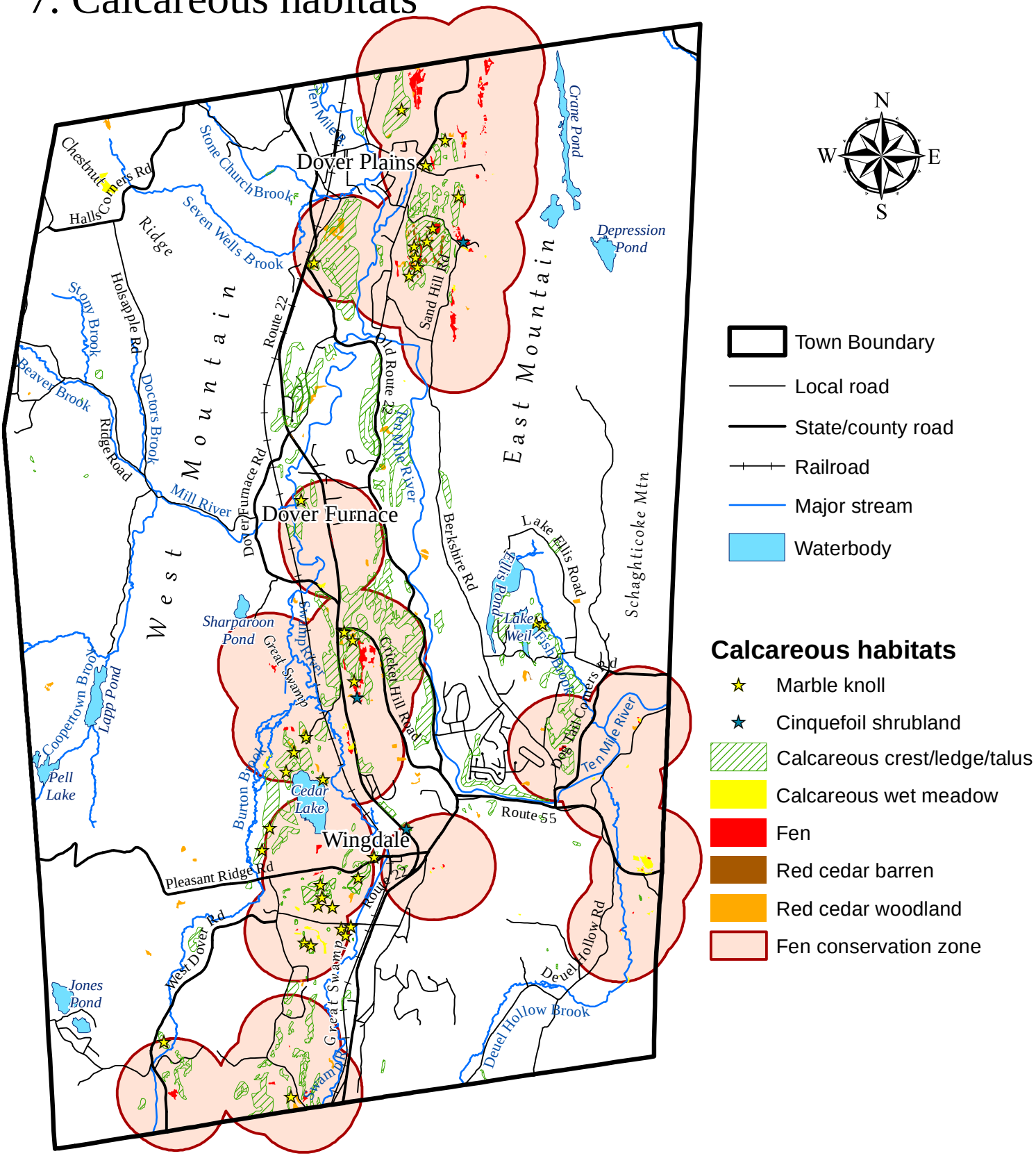


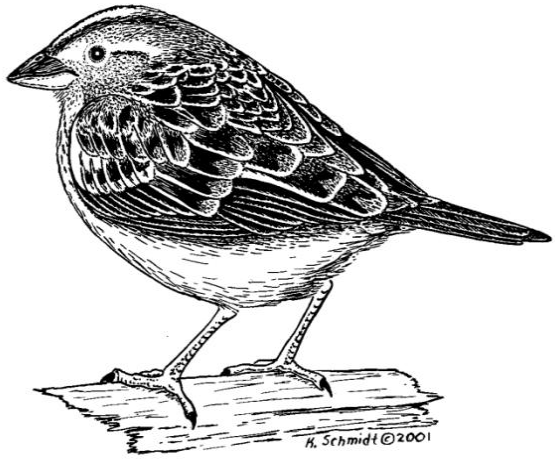
Figure 7. Calcareous habitats in the Town of Dover, Dutchess County, NewYork. Fen conservation zones extend 2,460 ft (750 m) from fen boundaries. Hudsonia Ltd, 2020.

Large Meadows

Target Areas

Large, contiguous meadow complexes (including upland, wet, and calcareous wet meadows and fens), particularly lightly grazed pasture, carefully managed hayfields, or large meadows dominated by grasses, can be valuable for a host of wildlife species and the critical nesting habitats for rare and uncommon grassland-breeding birds. Cultivated fields have little current value as nesting habitat for these species, but may regain habitat value when used as pasture or hayfields and managed for grassland bird habitat, or if they are allowed to go fallow. Figure 8 illustrates the location and distribution of meadow habitats in the town (including upland meadow, wet meadow, and calcareous wet meadow), classified by size.

For grassland breeding birds, fences and hedgerows provide hunting perches and other access for nest predators, and thus can reduce the habitat quality for successful nesting. Figure 8 illustrates how meadow patch sizes differ when hedgerows and fences are taken into account as fragmenting features. When fences and hedgerows are not treated as fragmenting features, the largest contiguous meadow complex, at 220 ac (88 ha), occurred in the northwestern corner of Dover in the town; two other meadows exceeding 100 ac (40 ha) occurred in close proximity to this one, and another two 100-ac (40-ha) meadows were in the Harlem Valley of north-central Dover. When fences and hedgerows are treated as fragmenting features, the largest single meadows were six meadows exceeding 50 ac (20 ha) in northwestern and north-central Dover. Several of the largest meadows (both as single meadows and meadow complexes) had high area-to-edge ratios, an important characteristic for grassland-breeding birds, because it allows for more space where birds can nest far from trees, utility wires, and other tall features that offer perches for predatory raptors.



Grasshopper sparrow

Conservation Issues for Selected Focal Species

While there can be significant habitat value in small patches of upland meadow (e.g., for

plants, invertebrates, and small mammals), large grassy meadows are especially important for grassland-breeding birds. Such area-sensitive birds include upland sandpiper,* bobolink,* eastern meadowlark,* grasshopper sparrow,* savannah sparrow,* and vesper sparrow.* Northern harrier* does not nest here, but hunts over large meadows in late summer, winter, and spring, and short-eared owl* is an occasional winter visitor to large Dutchess County fields (DeOrsey and Butler 2006). Several golden eagles* have been observed using the large meadows of the Ten Mile River Preserve (a private game reserve) in recent winters (Barbara Butler, pers. comm.).

Grassland-breeding birds have declined dramatically in the Northeast in recent decades due, apparently, to habitat loss, as suitable meadows have been fragmented and overtaken by regrowth of forest, converted to row crops, or lost to residential and commercial development (Askins 1993, Brennan and Kuvlesky 2005). Although area requirements for grassland birds in the Northeast vary by species, all the birds listed above (except short-eared owl) have demonstrated area-sensitivity (Ribic et al. 2009), and the consistent finding is that these species require relatively large unfragmented grasslands. A study in grassland barrens in Maine found that grassland-breeding birds were more likely to nest in grasslands of 25 to 500+ ac (10-200+ ha) (Vickery et al. 1994). Balent and Norment (2003) found that grasshopper sparrow in New York had higher nest success in fields > 20 ac (8 ha). Bobolinks were found to breed successfully on 10 ac (4 ha) of undisturbed meadow in New Hampshire (part of a 20-ac (10-ha) open area) (Weidman and Litvaitis 2011). The landscape context of individual fields is critical as well, and meadows with more open (agricultural) land in the surrounding 1,200-5,000 ac (500-2,000 ha) have greater conservation value for these birds (Shustack et al. 2010). Although grassland species may be observed in smaller grasslands, it is believed that to sustain long-term breeding populations in New York, many of these birds require grasslands of hundreds or thousands of acres. Fences and hedgerows can reduce nesting success for grassland-breeding birds by providing cover and perching sites for raptors and other species that prey on the birds or their eggs (Wiens 1969). Because many grassland birds have such specific habitat requirements for nesting, their survival in the northeastern US may ultimately depend on active farmland and management of non-agricultural meadows (Askins 1993).

Meadows are among the habitats most vulnerable to future development. In agricultural areas, for example, development is often an attractive alternative to the economic challenges faced by farmers. Even when development does not destroy the entire meadow habitat, the remaining fragments are often too small to support the rare and uncommon birds of grasslands. Development around meadows can promote increased predation on grassland-breeding bird nests by human-subsidized predators such as raccoon, striped skunk, and domestic cat. Grasslands and the rare species they support are also highly vulnerable to other human activities such as mowing, conversion to row crops, application of pesticides, and ATV traffic.

Recommendations

In cases where grassland owners have flexibility in their mowing and grazing practices, Massachusetts Audubon (2018) has the following management suggestions for minimizing harm to grassland birds in meadows of the Northeast:

1. **Do not mow fields between May 15 and August 15.** This will avoid much of the nesting, nursery, and fledging seasons; if mowing must occur before then, leave some unmowed strips or patches. If a site must be mowed during June or early July, make the site unattractive to ground-nesting birds by mowing every two to three weeks beginning in late May. This will minimize the occurrence of nesting birds' being lured into the ecological trap of a field that will be mowed. Mowing in fall is least disruptive (some birds continue breeding into August or September), and leaves vegetation short for those birds that select for low grasses in the spring.

2. **Collect cut hay at least every 3 years**. Birds prefer fields with less thatch, as it allows easier travel close to the nest. Thatch also favors forbs, which delays "green-up" in spring and makes fields less attractive to birds. (Thatch is a positive habitat feature for many other meadow organisms, however, and helps to replenish soil nutrients and structure. Meadow management, therefore, should be designed differently for different conservation objectives.)

3. **Remove fences, hedgerows, or tree lines between smaller fields** to enlarge the habitat area for grassland breeding birds. Also, reclaim field edges by removing encroaching woody vegetation. Visual openness is an important characteristic for birds assessing habitat suitability.

4. **Discourage the growth of forbs and woody vegetation**. Most of the grassland breeders prefer meadows dominated by grasses. Timing of mowing can be key: mowing before September 15 each year can help reduce the abundance of broad-leaved forbs, which set seed later in the fall.

5. **Raise mower blades six inches or more, use flushing bars, and avoid night mowing** when birds are roosting to help reduce bird mortality.

6. **Minimize disturbance during the growing season.** Minimizing foot traffic, dog walking, farm equipment, and other disturbances reduces stress on grassland-breeding birds.

7. **Coordinate management practices among neighbors.** Encourage neighbors to adopt bird-friendly meadow management practices. The higher the concentration of large, open fields in an area, the better for grassland-breeding birds.

For farmland in active production:

General

If possible, leave some fields out of production each year. This provides wildlife habitat as well as replenishing soils.

Row crops

Land currently in annual row crop production has little habitat value for birds or other wildlife. However, farming practices on those fields can influence habitat quality elsewhere on the farm. For example, herbicide use (Kirk et al. 2011) and insecticide use (Mineau et al. 2005) result in lowered abundance and diversity of birds. In between cash crops, a graminoid cover crop rotation can provide bird habitat while adding carbon to soils. Depending on management, perennial crops are more bird-friendly in many cases.

Hayfields (adapted from USDA 2010)

1. **Delay harvest.** The later in the season mowing occurs, the greater percentage of young will have fledged. For example, about 70% of bobolink nests will have fledged by July 13. The longer cutting is delayed, however, the lower the protein content of the hay. Lower-quality hay can be used for livestock with lower protein needs, for bedding, or for mulch.

2. **Leave late-cut refuges.** If a farm consistently produces more hay than it needs, it can make sense to delay harvesting on some fields or portions of fields. Good refuge areas could be wet meadows or meadows with poor soils, or the middle few acres of a larger field. Select areas where there is bird activity (bobolinks are a good, visible, indicator species), away from forest edges. It is best to maintain the same refuges consistently, since many birds return to the same nesting location year after year.

3. **Early harvest followed by a delayed second harvest.** This strategy is perhaps the best compromise between good quality hay and successful nesting for birds. Maximum protein content (and thus hay value) is generally obtained by a late-May harvest. This destroys birds' nests fairly early in their cycle, and most will then re-nest. Delaying the second cutting gives those birds time to successfully fledge young. In Vermont, nest success was greatly increased by an early cutting (**prior to June 1**) followed by a delayed cutting (**at least 65 days later)** (Perlut et al. 2011). Later cutting means a larger quantity of lower-quality hay. This mowing schedule has been incentivized in Vermont so that enrolled farmers receive a payment of $135/ac.

4. **Raise mower blades six inches or more, use flushing bars, and avoid night mowing** when birds are roosting to help reduce bird mortality. Leaving higher stubble has the added benefit of increasing moisture retention in the field, reducing erosion, and providing increased yield in the subsequent harvest (Saumure et al. 2007).

Pastures (adapted from Perlut and Strong 2011)

1. In general, **reduce stocking rate and/or decrease the time animals spend in a given field:** lower intensity grazing is better for birds.

2. **For rotational grazing, each paddock should be at least 1.2 ac (0.5 ha).**

3. **Rotate animals out of a paddock when they have grazed grass down to 5 inches (13 cm)** to prevent overgrazing and leave some cover for nesting birds.

4. **Provide rest time of 42-50 days between rotations**, to allow birds time to fledge young.

5. **Delay any mowing or clipping of grazed paddocks until mid-July.**

6. **If possible, leave fallow paddocks** (away from forest edges and development); these can be mowed after mid-July to provide low-protein forage.

While the ecological values of upland meadows are diverse and significant, it is important to remember that most upland meadows in this area were once upland forest, another very valuable habitat type in our region. Therefore, while focusing on the conservation of existing upland meadows with high biodiversity, there is little harm in allowing some meadows (particularly smaller ones, or those that are contiguous with areas of upland forest) to revert to shrubland or forest.

Beyond the ecological values of meadows, there are many other compelling reasons to conserve active and potential farmland. From a cultural and economic standpoint, maintaining the ability to produce food locally has obvious advantages for local quality of life (i.e., availability of fresh produce, meat, poultry, and dairy products), local food security, and the worldwide imperative to reduce carbon emissions. Active farms also contribute to the local economy and to the character and beauty of the town's landscape.

Acidic Bogs

Target Areas

We mapped five acidic bogs in Dover: four on East Mountain and one on West Mountain. The largest (7 ac [3 ha]) was in Tamarack Swamp on East Mountain, and another, farther north on East Mountain, was 5 ac (2 ha).

Conservation Issues for Selected Focal Species

Acidic bogs are very rare in Dutchess County, and are known to support rare species of plants and animals. Certain plant species, such as cranberries* and pitcher plant,* are seldom found outside of bog habitats in this region. In turn, the rare bog copper*(butterfly) depends on cranberries to reproduce, and the pitcher-plant borer* and pitcher-plant moth* are only found in the presence of their host, the pitcher-plant. Bog communities are very sensitive to direct disturbance, such as trampling, and to indirect disturbances in the watershed—such as tree removal, soil disturbance, applications of fertilizers or pesticides, or alterations to groundwater or surface water drainage—that could alter the water chemistry, water temperature, or

8. Meadows

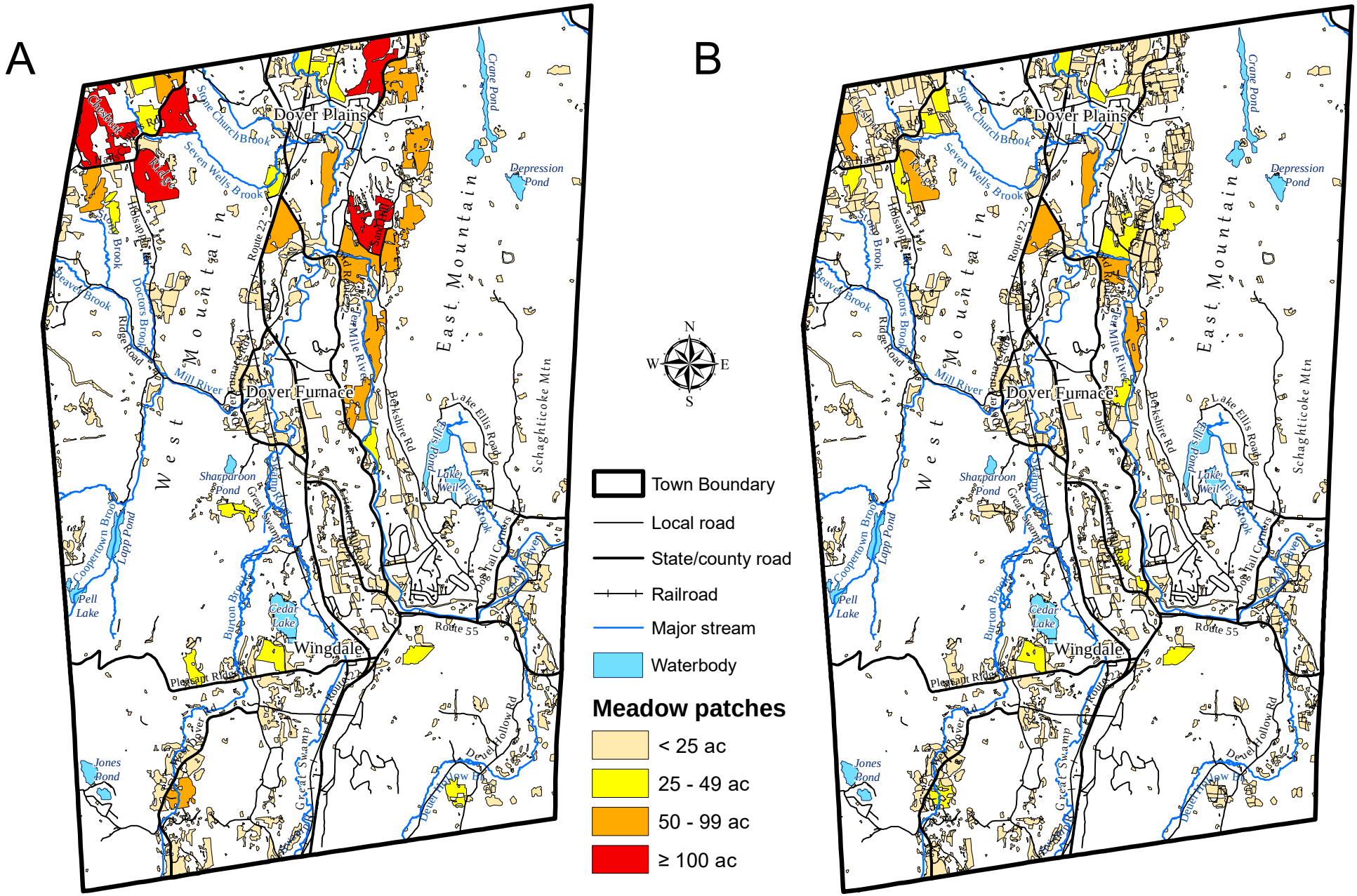


Figure 8. Contiguous meadow patches (including upland meadows, wet meadows, and fens) in the Town of Dover, Dutchess County, New York. A) Meadow patches without consideration of fences or hedgerows; B) meadow patches with fences and hedgerows shown as fragmenting features. Hudsonia Ltd, 2020.

hydroperiod of the bog. Enrichment by nitrogen or phosphorus compounds (typical nutrients in runoff from lawns, gardens, and agricultural fields) can kill or reduce the vigor of *Sphagnum* mosses or allow the bog to be overtaken by other plants (Roy et al. 1997). Significantly raised water levels of long duration can drown the anchored *Sphagnum*, and lowered water levels can allow oxygenation and rapid decomposition of the peat (Crum 1988, Kulzer et al. 2001). A decaying bog could become a significant source of carbon emissions to the atmosphere (Moore 2002). The best ways to preserve bog habitat intact are to prevent direct human disturbance and maintain a large buffer zone of undisturbed forest.

Recommendations

To help protect acidic bogs, we recommend the following measures:

1. **Protect the bog footprint itself.**
   Avoid trampling and other direct disturbance of acidic bogs. If hiking trail access to one of these special areas is necessary, locate the trail so that the bog can be observed from the surrounding uplands. If applicable, consider signage to alert visitors to the sensitivity of bog environments.

2. **Establish a conservation zone that includes the bog's entire watershed.** Within this zone,
   - Maintain water quality. Avoid construction of buildings or roads, as well as alterations to groundwater or surface water drainage.
   - Maintain hydrology. Avoid changing water levels or patterns of inflow and outflow. This requires attention to activities in the bog's watershed such as road and building construction, stormwater management infrastructure, and applications of fertilizers or pesticides.
   - Maintain microclimate. Protect forest as much as possible in the bog vicinity.

9. Acidic bogs and cool ravines

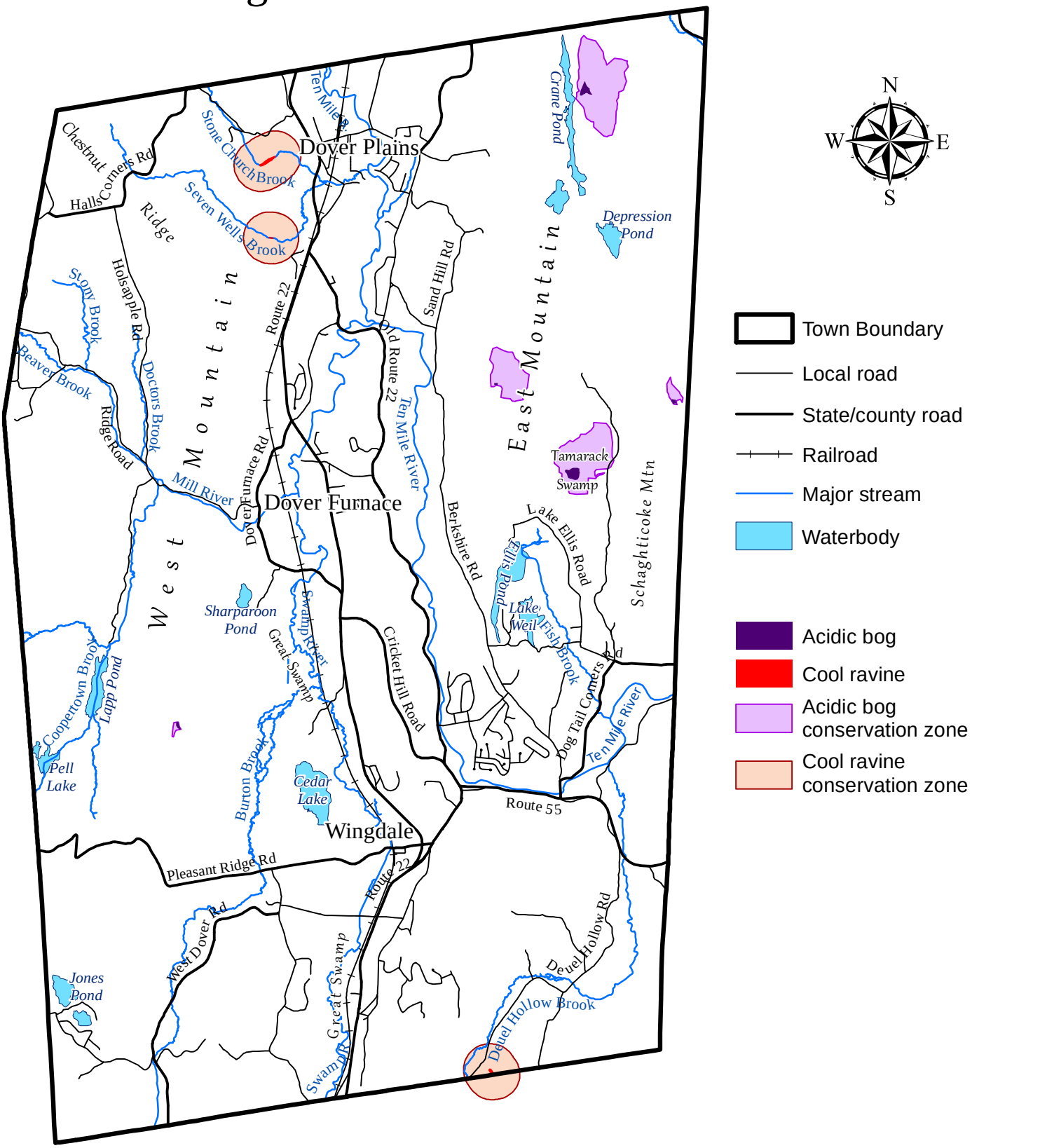


Figure 9. Acidic bogs and cool ravines with associated conservation zones in the Town of Dover, Dutchess County, NewYork. Acidic bog conservation zones consist of the entire bog watershed. Cool ravine conservation zones measure 1,200 ft (366 m) from the ravine edge. Hudsonia Ltd, 2020.

Intermittent Woodland Pools, Pool-Like Swamps, Buttonbush Pools, and Kettle Shrub Pools

Target Areas

We identified and mapped 132 intermittent woodland pools in the town (Figure 10), and there are likely to be others that we missed. In addition, we mapped 40 pool-like swamps with ecological functions probably similar to those of intermittent woodland pools. Kettle shrub pools and buttonbush pools also share some characteristics of intermittent woodland pools, namely temporary surface water and hydrological isolation, and are included here. While each intermittent pool may be important to preserve, groups or networks of pools (which are found throughout the town) and their surrounding forests are particularly valuable from a habitat perspective (see also the "Wetland Complexes" section, below). Groups of pools can support amphibian and reptile metapopulations—groups of small populations that are able to exchange individuals and recolonize sites where populations have recently disappeared.

Intermittent woodland pool, dry in summer.

Conservation Issues for Selected Focal Species

Because they lack fish and certain other predators, intermittent woodland pools provide crucial breeding and nursery habitat for several amphibian species that cannot successfully reproduce in other wetlands, including several of the mole salamanders (Jefferson salamander,* marbled salamander,* spotted salamander*) and wood frog.* These amphibians can be used as the focus for conservation planning for intermittent woodland pools. Except for their relatively brief breeding season and egg and larval stages, these species are exclusively terrestrial and require the deep shade, thick leaf litter, uncompacted soil, and coarse woody debris of the surrounding upland forest for foraging, shelter, and overwintering. The upland forested area within a 750 ft

(230 m) radius of the intermittent woodland pool is considered necessary to support populations of amphibians that breed in intermittent woodland pools (Calhoun and Klemens 2002), although many of the pool-breeding amphibians travel much farther to their terrestrial habitat areas. Disturbance of vegetation or soils within this area—including the direct loss of pool and forest habitats, alteration of the pool hydroperiod, and degradation of pool water quality or forest floor habitat quality—can have significant adverse effects on amphibians.

Pool-breeding amphibians are especially vulnerable to upland habitat fragmentation because of their seasonal movement patterns. Each year adults migrate to the intermittent woodland pools to breed, and then adults and (later) juveniles disperse from the pool to terrestrial habitats. Jefferson salamanders are known to migrate seasonally up to 2,050 ft (625 m) from their breeding pools into surrounding forests (Semlitsch 1998). A wood frog adult may travel as far as 3,835 ft (1,169 m) from a breeding pool (Calhoun and Klemens 2002). Both salamanders and frogs are vulnerable to vehicle mortality where roads or driveways cross their travel routes. Roads, especially dense networks of roads or heavily-traveled roads, have been associated with reduced amphibian populations (Fahrig et al. 1995, Lehtinen et al. 1999, Findlay and Bourdages 2000). A New Hampshire study found that road density within 1,000 m was the best predictor of egg mass abundance (a proxy for population size) for wood frog and spotted salamander (Veysey et al. 2011). Open fields and clearcuts are another barrier to forest-dwelling amphibians. Juveniles have trouble crossing open fields due to a high risk of desiccation and predation in those exposed environments (Rothermel and Semlitsch 2002).

Populations of these amphibian species depend not only on a single woodland pool, but on a forested landscape dotted with such wetlands among which individuals can disperse (Semlitsch 2000). A network of pools is essential to amphibians for several reasons. Each pool is different from the next in vegetation structure, plant community, and hydroperiod, so each may provide habitat for a different subset of pool-associated species at different times. Also, different pools provide better or worse habitat each year, due to their internal characteristics and those of their watersheds, and year-to-year variations in precipitation and air temperatures. To preserve the full assemblage of species in the landscape, a variety of pools and upland forest connections

10. Woodland pools

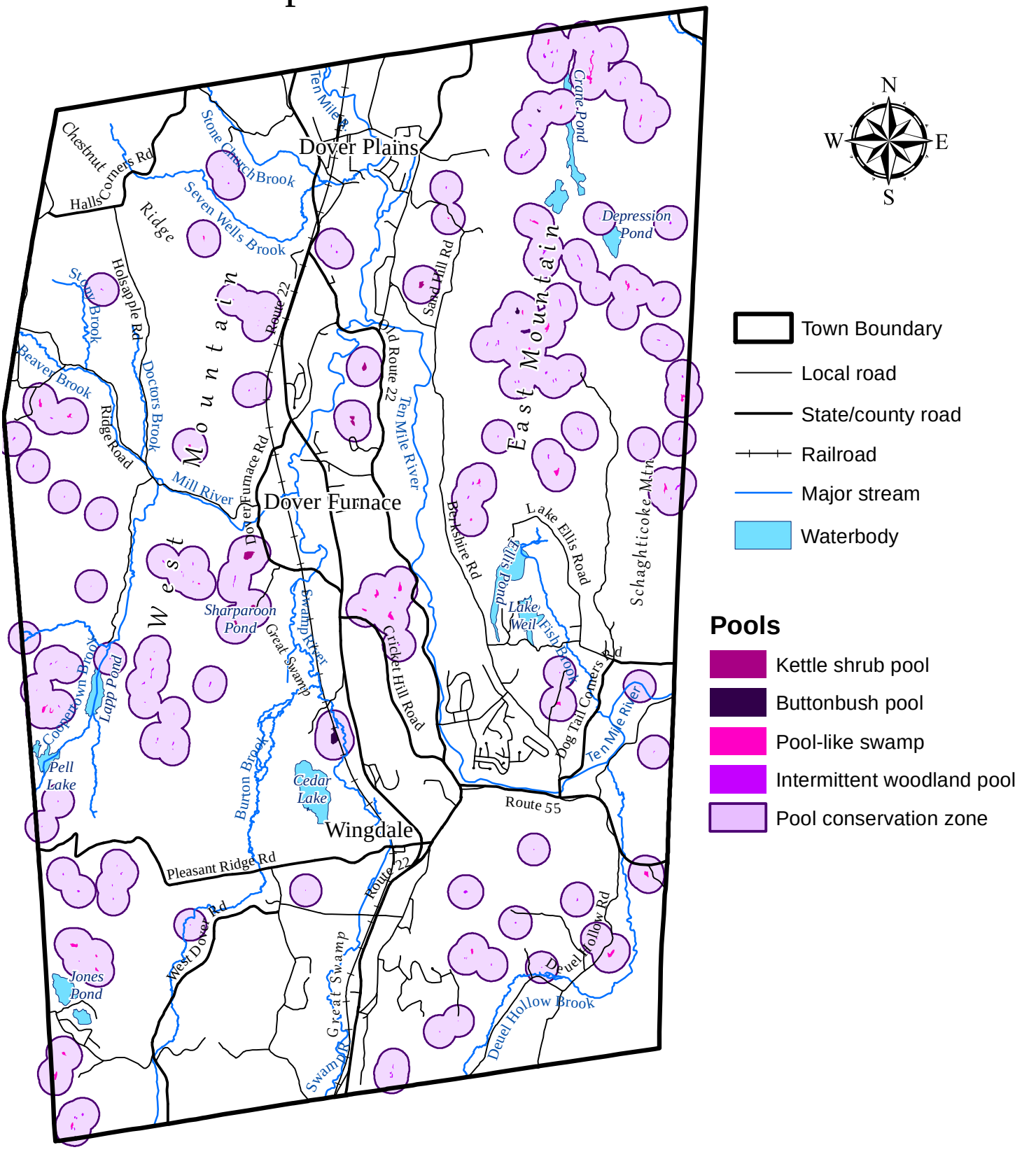


Figure 10. Woodland pools, including intermittent woodland pools, pool-like-swamps, kettle shrub pools, and buttonbush pools, in the Town of Dover, Dutchess County, NewYork. Pool conservation zones extend 750 ft (229 m) from pool boundaries. Hudsonia Ltd, 2020.

between pools must be present to connect local populations (Semlitsch and Bodie 1998). Nearby pools can also serve to "rescue" a population: if the population at one pool is extirpated, individuals from another pool can recolonize the site. This rescue effect is needed to maintain the metapopulation over the long term (Semlitsch and Bodie 1998). Thus, protecting the salamander and frog species associated with intermittent woodland pools requires protecting not only their core breeding habitat (i.e., an intermittent woodland pool), but also their key foraging and wintering habitats in the surrounding upland forests, and the forested migration corridors between individual pools and pool complexes (Gibbons 2003).

Recommendations

To help protect pool-breeding amphibians and the habitat complexes they require, we recommend the following measures be applied to all intermittent woodland pools, heath swamps, and pool-like swamps (adapted from Calhoun and Klemens 2002):

1. **Protect the intermittent woodland pool depression**. Intermittent woodland pools are often overlooked during environmental reviews of proposed development projects and are frequently drained, filled, or dumped in. We recommend that intermittent woodland pools be permanently protected from development and disturbance of any kind including the construction of houses, roads, lawns, and permanent ponds within the pool depression. This zone of protection should include the pool basin up to the spring high water mark and all associated vegetation. The soil in and surrounding the pool should not be compacted in any manner and the vegetation, woody debris, leaf litter, and stumps or root crowns within the pool should not be removed.

2. **Avoid channeling runoff from roads and developed areas** (including overflow from stormwater ponds) into intermittent woodland pools. Such runoff carries substances harmful to amphibians (such as road salt and nitrate) to the pools, and alters pool water volumes.

3. **Protect all upland forest within 100 ft (30 m) of the intermittent woodland pool**. During the spring and early summer this zone provides important shelter for high densities of adult and recently metamorphosed salamanders and frogs. The forest in this zone also helps shade the pool, maintains pool water quality, and provides important leaf litter and woody debris to the pool ecosystem. This organic debris constitutes the base of the pool food web and provides attachment sites for amphibian egg masses.

4. **Maintain critical terrestrial habitat within 750 ft (230 m) of the pool**. The upland forests within 750 ft (230 m) or more of a woodland pool are critical foraging and shelter habitats for pool-breeding amphibians during the non-breeding season. Roads, development, logging, ATV use, and other activities within this terrestrial habitat can crush many amphibians and destroy the forest floor microhabitats that provide them with shelter and invertebrate food. Development within this zone can also prevent dispersal and genetic exchange between neighboring pools, thereby making local extinction more likely. A minimum of 75% of this zone should remain in contiguous (unfragmented) forest with an undisturbed forest floor. Wherever possible, forested connections between individual pools should be identified and maintained to provide overland dispersal corridors.

We also recommend the following for all development activity proposed within the critical terrestrial habitat zone (750 ft (230 m)) of an intermittent woodland pool:

1. **Avoid or minimize the potential adverse affects of roads to the greatest extent possible**. Pool-breeding salamanders and frogs are especially susceptible to road mortality from vehicular traffic, predation, and desiccation. Curbs and other structures associated with roads frequently intercept and funnel migrating amphibians into stormwater drains where they may be killed. To minimize these potential adverse impacts:
    - Locate no new roads and driveways with projected traffic volumes in excess of 5-10 vehicles per hour within 750 ft (230 m) of the pool.
    - Regardless of traffic volumes, limit the total length of roads and driveways within 750 ft of a woodland pool to the greatest extent possible and tightly cluster any new development to minimize forest fragmentation. .
    - Use gently sloping curbs or no-curb alternatives to reduce barriers to amphibian movement.
    - Use oversized square box culverts (2 ft wide by 3 ft high (0.6 m x 0.9 m)), spaced at 20-ft (6-m) intervals, near wetlands and known amphibian migration routes to facilitate amphibian movements under roads. Use special outward-facing “curbing” along the adjacent roadway to deflect amphibians into the box culverts.

2. **Maintain woodland pool water quality and quantity at pre-disturbance levels**. Development within a woodland pool’s watershed can degrade pool water quality by increasing sediments, nutrients, and other pollutants. Even slight increases in sediments or pollution can stress and kill amphibian eggs and larvae, and may have

adverse long-term effects on the adults. Activities such as groundwater extraction (e.g., from wells) or the redirection of natural surface water flows can reduce the pool hydroperiod below the threshold required for successful egg and larval development. Increasing impervious surfaces or channeling stormwater runoff toward pools can increase pool hydroperiod, which can also adversely affect the ability of amphibians to reproduce successfully. Protective measures include the following:

- Do not use intermittent woodland pools for stormwater detention, either temporarily or permanently.
- Aggressively treat stormwater throughout the development site, using methods that allow for the maximum infiltration and filtration of runoff, including grassy swales, filter strips, "rain gardens," and oil-water separators in paved parking lots. Direct all stormwater away from nearby woodland pools.
- Avoid or minimize the use of pesticides and fertilizers within the woodland pool's watershed. If mosquito control is necessary, limit it to the application of bacterial larvicides, which may have lesser negative impacts on non-target pool biota than other methods. Avoid using de-icing salts such as sodium chloride where they will pollute surface runoff into amphibian breeding pools. These salts cannot be removed from water or soils by means of treatment methods currently in use.
- Maintain both surface water runoff and groundwater inputs to intermittent woodland pools at pre-construction levels. Carefully design stormwater management systems in the pool's watershed to avoid changes (either increases or decreases) in seasonal pool depths, volumes, and hydroperiods.
- Minimize impervious surfaces including roads, parking lots, and buildings to reduce runoff problems and resulting stormwater management needs.

3. **Avoid creating stormwater detention basins and other artificial depressions** that intermittently hold water (e.g., vehicle ruts) within 750 ft (230 m) of an intermittent woodland pool or in areas that might serve as overland migration routes between pools. These "decoy wetlands" can attract large numbers of pool-breeding amphibians, but the eggs laid in them rarely survive due to the high sediment and pollutant loads or short hydroperiods. Ruts, for example, may also serve as larval habitats for undesirable species of mosquitoes.

4. **Modify potential pitfall hazards** such as swimming pools, soil test pits, other excavations, window wells, or storm drain catch basins to prevent the entrapment and death of migrating amphibians. Soil test pits should be backfilled immediately after tests are completed.

5. **Schedule construction activities to occur outside the peak amphibian movement periods of spring and early summer (late summer and fall for marbled salamander)**. If construction activity during this time period cannot be avoided, install temporary exclusion fencing before the breeding migration around the entire site to keep amphibians out of the active construction areas.

For recommendations on protecting intermittent woodland pools in working forests, both for forest management planning and for harvest operations, see Calhoun and DeMaynadier (2004). Other resources for conservation of small wetlands in New York are listed on the NYSDEC website (http://www.dec.ny.gov/docs/remediation_hudson_pdf/hrebswres.pdf).

Fens and Calcareous Wet Meadows

Target Areas

We mapped 78 fens and 41 calcareous wet meadows in the Town of Dover (Figure 7). This number is probably an underestimate, since these habitats are best identified in the field; we have flagged some possible additional fens with question marks on the map. Clusters of fens occurred off Cricket Hill Road; in and around the Roger Perry Preserve; and on both sides of Poplar Hill Rd, at the north end of town. Because extensive calcareous bedrock (i.e., marble) underlies the Harlem Valley, Dover contains an exceptionally high number of fens, a regionally uncommon habitat.

Conservation Issues

Fens and calcareous wet meadows are uncommon in the northeastern US and many provide important habitat for plant and animal species of conservation concern (see Appendix A). One of the most imperiled species associated with fens in Dutchess County is the bog turtle,* listed as Endangered in New York and Threatened on the federal list. Fens (and associated calcareous wet meadows) are the core habitat of the bog turtle in Dutchess County, and the entire wetland matrix in which some fens occur is considered an important part of its habitat. Few of the remaining fens in this region currently support bog turtle populations, which may be due to habitat loss and degradation. Bog turtles have been rediscovered recently in Orange County, but may be extirpated (or nearly so) in Westchester and Rockland counties. Any of the high-

quality fens in the Town of Dover could be potential bog turtle habitat, but even those without bog turtles may support other plants and animals of conservation concern. We recommend, therefore, that all fens and calcareous wet meadows be considered potential bog turtle habitat and that the special protective measures discussed below be implemented to safeguard the integrity of these sensitive areas.

Fens are maintained by calcareous groundwater seepage. Alterations to the quality or quantity of groundwater or surface water feeding the fen can alter the soil characteristics, vegetation structure, or plant community composition, and can render the habitats unsuitable for bog turtle and other species of conservation concern. Thus, even if the fen itself is not disturbed, activities in areas surrounding a fen can affect the fen habitat. Furthermore, although bog turtles spend most of their lives in fens and associated wetlands, they also require safe travel corridors between fens for dispersal and other long-term movements. In New York, bog turtles may travel overland 2,500 ft (750 m), or nearly one-half mile, between individual wetlands within a habitat complex (Eckler and Breisch 1990). Maintaining connections to other wetland habitats within a one-half mile (0.8 km) radius of a known or potential bog turtle habitat may be crucial to sustaining the long-term genetic viability of bog turtle populations and the ability of individuals to relocate as habitat quality changes.

Fen dominated by shrubby cinquefoil

Recommendations

The Town of Dover has an unusual number of fens, and is thus in a position to implement a conservation plan with far-reaching consequences

for biodiversity in the region. Conservation of fens requires attention not only to the fen itself, but also to surrounding land uses. Because some of the high quality fen complexes (and their associated conservation zones) in Dover cross multiple privately owned parcels, fen conservation also requires coordinating across property boundaries. Fens that are known to harbor bog turtles, or may serve as potential future habitat for the turtle, require special protective measures. The US Fish and Wildlife Service (Klemens 2001) recommends not only protecting the actual wetland complex but also prohibiting disturbance and development within a 300 ft (90 m) distance from the wetland boundaries. This buffer may be crucial to safeguarding wetland habitat quality, hydrology, and turtle travel corridors. The US Fish and Wildlife Service recommends the following (excerpted from Klemens [2001]):

1. **Protect the wetland footprint**. The entire wetland, not just those portions that have been identified as, or appear to be, optimal for nesting, basking, or hibernating, should be protected from direct destruction and degradation. The following activities (not an inclusive list) should be avoided within the wetland:
    - development of any kind;
    - wetland draining, ditching, tiling, filling, excavation, stream diversion, or construction of impoundments;
    - herbicide, pesticide, or fertilizer application (except as part of approved bog turtle management plan);
    - mowing or cutting of vegetation (except as part of approved bog turtle management plan); and
    - delineation of lot lines for development, even if the proposed building or structure will not be in the wetland.
2. **Establish a 300 ft buffer zone**. A protective "buffer" 300 ft (90 m) wide around known or potential bog turtle wetlands will help prevent or minimize the effects of human activities. Activities in this zone could indirectly destroy or degrade the fen habitat over the short or long term and should be thoroughly evaluated in consultation with the US Fish and Wildlife Service and NYSDEC. Activities in this zone that may adversely impact bog turtles and their habitats include, but are not limited to, the following:
    - development of roads, residences, driveways, parking lots, sewer lines, utility lines, stormwater or sedimentation basins, or other structures;
    - mining;
    - herbicide, insecticide, other pesticide, or fertilizer application;
    - farming (with the exception of light to moderate grazing); and
    - stream bank stabilization (e.g., rip-rap or other hardening).

3. **Assess potential impacts within at least 2600 ft (800 m) of the fen**. Despite the distance, development activities occurring within the drainage basin of the fen or at least one-half mile (800 m) from the boundary of the buffer zone may adversely affect bog turtles and their habitat. Development within this area may also sever important travel corridors between wetlands occupied or likely to be occupied by bog turtles, thereby isolating populations and increasing the likelihood of road mortality as turtles attempt to disperse.
    - Activities such as the construction of roads and other impervious surfaces, groundwater extraction (e.g., wells), septic/sewer facilities, and mining have a high potential to alter the hydrology and chemistry of the fen habitat.
    - Construction of new roads and bridges should be avoided within this area.
    - Existing roads with medium to high volume traffic may be ideal candidates for "turtle underpasses" that may provide safer travel passageways for this species.
    - All activity proposed within this zone should be thoroughly reviewed in consultation with the Endangered Species Unit of the NYSDEC using the most up-to-date scientific information on this species and its sensitive habitats.

Grass-of-Parnassus, a plant of fens

Wetland Complexes

Target Areas

A wetland complex is any group of adjacent and nearby swamps, marshes, wet meadows, fens, ponds, streams, or other wetlands or waterbodies. Characteristics that lend especially high biodiversity value to wetland complexes are large size, inclusion of a wide variety of wetland types, and intact upland habitat between wetlands. Important and varied wetland complexes occurred throughout the town, but the largest was the Great Swamp of southwestern Dover. There, hardwood swamp, marsh, wet meadow, fen, constructed pond, other wetland types, and the river itself combine to form a contiguous wetland complex of over 1,400 ac (560 ha) (Figure 11).

Elsewhere, linear wetland complexes were common along perennial and intermittent streams. In northeastern Dover, fens were prominent components of several wetland complexes. The largest, at over 50 ac (20 ha), was a long, linear complex east of Poplar Hill Rd that included 13 fens totaling 12 ac (5 ha). Intermittent woodland pools and pool-like swamps also formed myriad small and large complexes, i.e., groupings in which each pool is within the conservation zone (750 ft [230 m]) of one or more other pools. In fact, 11 complexes consisted of five or more pools embedded in unfragmented habitat (mostly forest); one complex had 18 pools, and another 15 pools, both on East Mountain. The only such complex in the Harlem Valley lay north of Cricket Hill Road, where six pools were nested in a matrix of unfragmented forest (upland and swamp).

Conservation Issues for Selected Focal Species

Many animals move among several types of wetland and upland habitats throughout the year. For instance, spotted turtle* (NYS Species of Special Concern) is a highly mobile species that depends on a variety of habitats to survive and reproduce. It is known to use marsh, fen, wet meadow, hardwood and shrub swamp, kettle shrub pool, buttonbush pool, intermittent woodland pool, and open water habitats within a single year (Fowle 2001). Furthermore, although it depends on many kinds of wetlands, spotted turtle may spend up to three-quarters of its time during the active season in uplands. This species follows an annual pattern of activity (which likely varies by individual, population, and region): it usually overwinters in bottomland

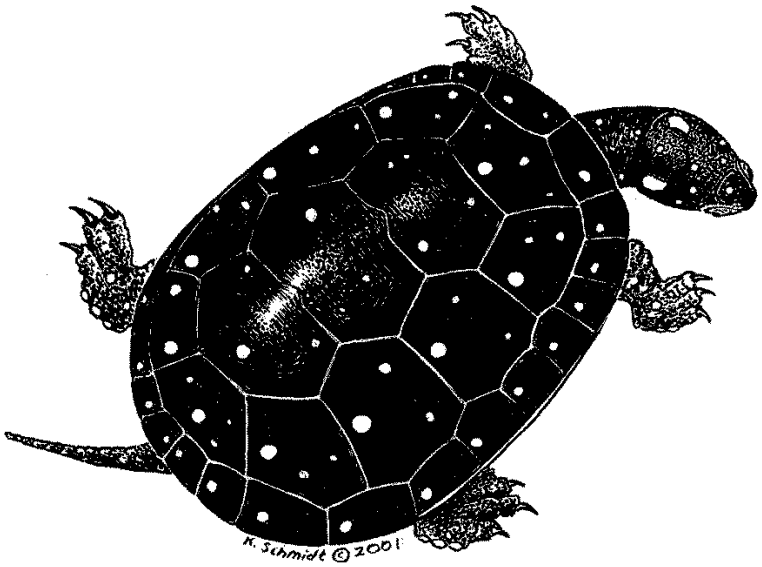
hardwood swamps or wet meadows, spends spring and early summer in one to several seasonal and permanent pools, travels up to 1,870 ft (570 m) to nest in open upland habitat, and spends late summer aestivating (quiescent) in upland forest. It can travel 3,300 ft (1,000 m) or more between wetlands. Because of this intricate annual pattern of habitat use, whole complexes of wetland and upland habitats are required to support spotted turtle populations, including seasonal wetlands such as intermittent woodland pools (Joyal et al. 2001, Milam and Melvin 2001). The spotted turtle exemplifies mobile wildlife species that depend on a mosaic of wetland and upland habitats and require safe travel routes between those habitats.

Recommendations

1. **Protect intermittent woodland pools, pool-like swamps, fens, acidic bogs, and their conservation zones** as described in previous sections of this report. These habitats are used by spotted turtle and many other species of conservation concern.

2. **When these habitats are located within 3,300 ft (1,000 m) of a swamp, marsh, or wet meadow (wintering habitat), protect the intervening upland habitats**. These upland areas encompass spotted turtle travel corridors, and nesting, aestivation (summer dormancy), and basking sites.

3. **Protect from disturbance the potential spotted turtle nesting habitat areas within 390 ft (120 m) of all the wetlands**. Spotted turtle usually nests in open sites such as fields or lawns, but sometimes also in sedge tussocks in wetlands.



Spotted turtle

11. Wetlands

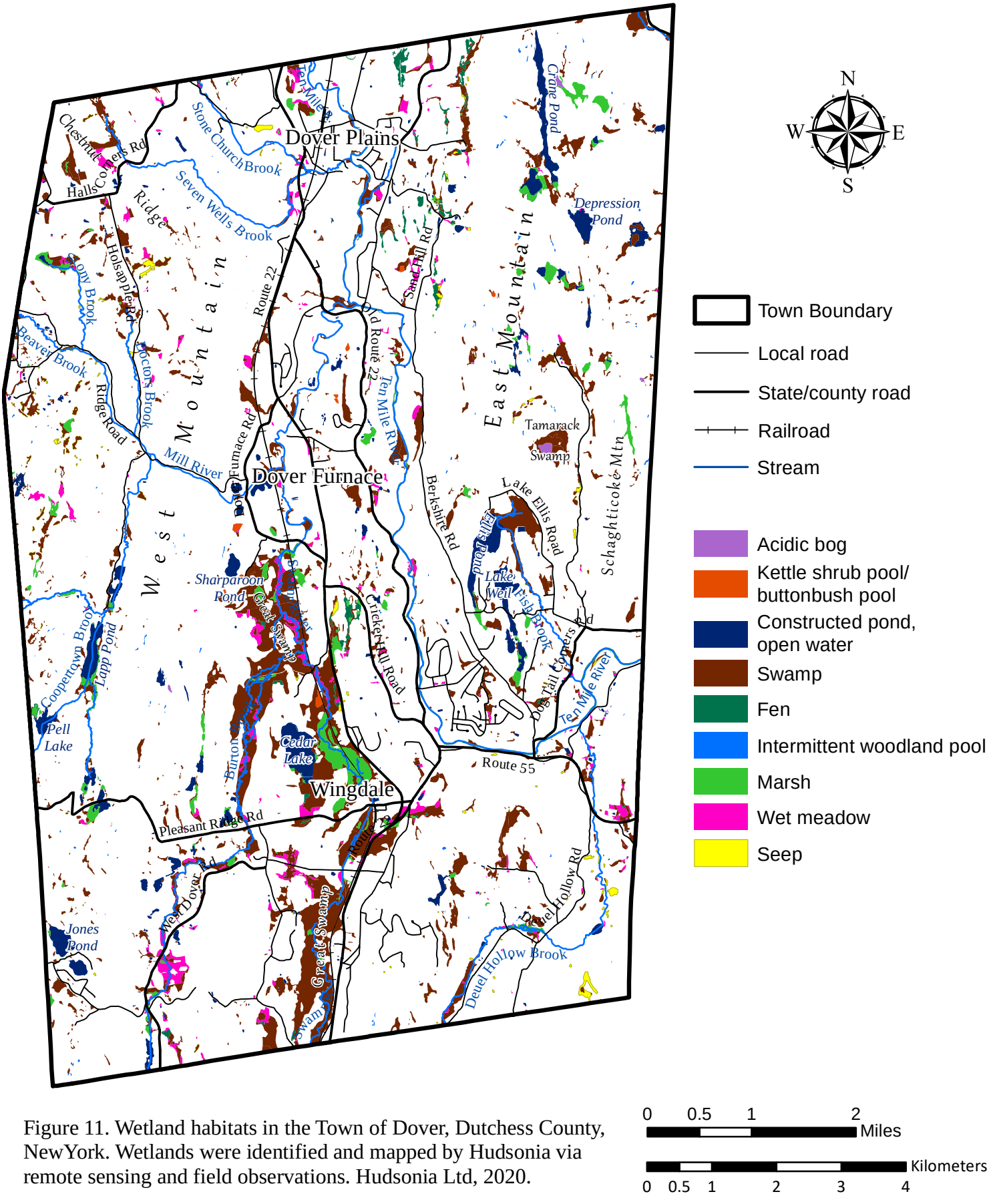


Figure 11. Wetland habitats in the Town of Dover, Dutchess County, NewYork. Wetlands were identified and mapped by Hudsonia via remote sensing and field observations. Hudsonia Ltd, 2020.

Streams, Floodplain Forests, and Riparian Corridors

Target Areas

The Ten Mile River and its tributary the Swamp River are the largest perennial waterways in Dover. There are also numerous smaller perennial streams and myriad intermittent streams throughout the town. Floodplain forest is common along the above-named streams. The streams themselves, the associated floodplain forests, and other floodplain habitats provide habitat for many plants and animals (both resident and transient) and are important to the ecology of the entire stream watersheds (figures 1 and 12).

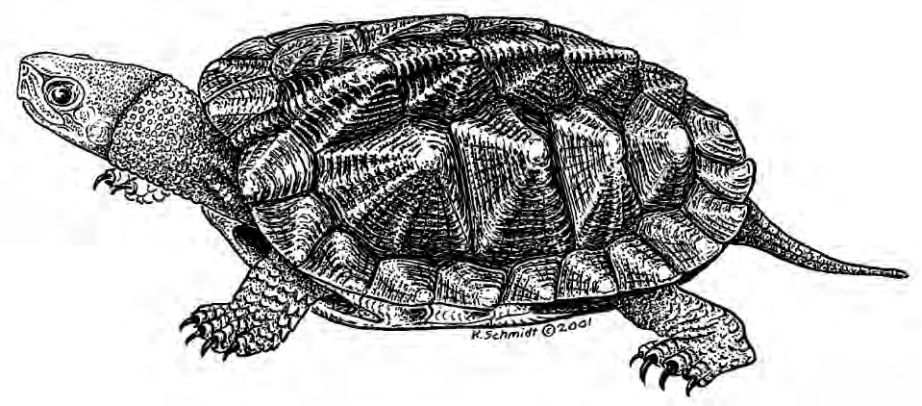
Conservation Issues for Selected Focal Species

Low gradient, perennial streams can be essential core habitat for the wood turtle* (NYS Special Concern). Wood turtles use streams with overhanging banks, muskrat burrows, submerged logs, or other underwater shelter for overwintering. In early spring, they use logs and stream banks for basking. In late spring and summer, wood turtles (especially females) move into and beyond the adjacent riparian zone to bask and forage in a variety of wetland and upland habitats, and females may travel long distances from their core stream habitat to find open, sparsely vegetated upland nesting sites.

Riparian hemlock forest

Conserving wood turtle populations requires protecting not only their core habitat (the perennial stream), but also their riparian wetland and upland foraging habitats, upland nesting areas, and the migration corridors between these habitats. The wood turtle habitat complex can encompass the wetland and upland habitats within 820 ft (250 m) or more of a core stream habitat (Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997, Tingley et al. 2009). Human land uses within this habitat complex can have significant adverse effects on wood turtles and their habitats. These effects include habitat degradation from stream alteration; habitat fragmentation from culverts, bridges, roads, and other structures; the direct loss of wetland habitat; degraded water quality from siltation, pesticides, fertilizers, sewage, and toxic compounds; increased nest predation by human-subsidized predators; disturbance from human recreational activities; and road mortality of nesting females and other individuals migrating between habitats.

Water quality in large streams depends on the water quality and quantity of the smaller perennial and intermittent streams and sheet runoff that feed them (Lowe and Likens 2005), and on the condition of land and water throughout the watershed. To help protect water quality and habitat in small streams, protect the adjoining lands (soil and vegetation) to at least 160 ft (50 m) on each side of the stream. This conservation zone provides a buffer for the stream and can filter sediment, nutrients, and contaminants from runoff, stabilize stream banks, prevent channel erosion, contribute organic material, regulate microclimate, and preserve other ecosystem processes (Saunders et al. 2002).



Wood turtle

Recommendations

To help protect wood turtles and the habitat complexes they require, we recommend the following measures:

1. **Protect the integrity of stream habitats**.
    - Prohibit engineering practices that alter the physical structure of the stream channel such as stream channelization, artificial stream bank stabilization (e.g., rock rip-rap, concrete), construction of dams or artificial weirs, vehicle crossing (e.g., construction or logging equipment, ATVs), and the clearing of natural stream bank vegetation. These activities can destroy key hibernation and basking habitats for the wood turtle and interfere with other interactions between aquatic and terrestrial systems.
    - Avoid direct discharge of stormwater runoff, chlorine-treated wastewater, agricultural chemicals, and other potential pollutants.
    - Establish a stream conservation zone extending at least 160 ft (50 m) on either side of all streams in the watershed, including perennial and intermittent streams, regardless of whether or not they are used by wood turtles. Keep these conservation zones naturally vegetated and undisturbed by construction, conversion to impervious surfaces, cultivation and livestock use, pesticide and fertilizer application, and installation of septic leachfields or other waste disposal facilities.

2. **Protect riparian wetland and upland habitats**. Protect all riparian wetlands adjacent to known or potential wood turtle streams from filling, dumping, drainage, impoundment, incursion by construction equipment, siltation, polluted runoff, water withdrawals, and hydrological alterations. In addition, preserve large, contiguous blocks of upland habitats (e.g., forests, meadows, and shrublands) within 820 ft (250 m) of a core wood turtle stream to the greatest extent possible to provide basking, foraging, and nesting habitat, and safe travelways for this species. Special efforts may be needed to protect particular components of the habitat complex such as wet meadows and alder stands—wood turtle has been found to favor stands of alder, and wet meadows are often sought by wood turtles, especially females, for spring basking and foraging (Kaufmann 1992). These wetlands, however, are often omitted from state, federal, and site-specific wetland maps and are frequently overlooked in the environmental reviews of development proposals. Wood turtles also spend time in agricultural fields where they are often killed by tractors. Mowing of hayfields can result in high mortality of wood turtles, but the effects can be reduced somewhat by any of the following measures: mowing after mid-September, using a sickle-bar rather

than a rotary or flail mower, raising the blade higher than 6 inches (15 cm) (this increases hay yield in the subsequent harvest as well), leaving an unmowed strip of at least 33 ft (10 m) at the edge of the field until after mid-September, and mowing from the center of a field outward or starting from the side farthest from the stream to allow turtles to flee (Saumure et al. 2007, Erb and Jones 2011). Hatchlings may remain in fields from their emergence in August through mid-November, and are also put at risk by mowing (reviewed in Tingley et al. 2009).

3. **Minimize impacts from new and existing stream crossings**. Undersized bridges and narrow culverts may be significant barriers to wood turtle movement along their core stream habitats. Wood turtles may shy away from passing beneath or entering such structures, and instead choose an overland route to reach their destination. Typically, the overland route involves crossing a road or other developed area, often resulting in death. If a stream crossing completely blocks the passage of turtles, individuals can be cut off from important foraging or basking habitats, or be unable to interbreed with turtles of neighboring populations. Such barriers could significantly diminish the long-term viability of wood turtle populations. If new stream crossings must be constructed, we recommend that they be specifically designed to accommodate the passage of turtles and other wildlife. The following prescriptions may offer important first steps to improving the connectivity of stream corridors (adapted from Singler and Graber 2005):
    - Use bridges and open-bottomed arches instead of culverts.
    - Use structures that span at least 1.2 times the full width of the stream so that one or both banks remain in a semi-natural state beneath the structure. This may encourage the safe passage of turtles and other wildlife.
    - Design the structure to be at least 4 ft (1.2 m) high and have an openness ratio of at least 0.5 (openness ratio = the cross-sectional area of the structure divided by its length). Higher openness ratio values mean that more light is able to penetrate into the interior of the crossing. Brighter conditions beneath a crossing may be more favorable for the passage of wood turtles and other animals.
    - Construct the substrate within the structure of natural materials and match the texture and composition of upstream and downstream substrates. If possible, install the crossing in a manner that does not disturb the natural substrate of the stream bed.
    - If the stream bed must be disturbed during construction, design the final elevation and gradient of the structure bottom so as to maintain water depth and velocities at low flow that are comparable to those found in natural stream

segments just upstream and downstream of the structure. Sharp drops in elevation at the inlet or outlet of the structure can be a physical barrier to passage by wood turtles and other stream organisms.

4. **Minimize impacts from new and existing roads**. Road mortality of nesting females and individuals dispersing to new habitats is one of the greatest threats to wood turtle populations. To help minimize the adverse effects of roads on this species, we recommend the following actions be undertaken within the 820 ft (250 m) wide stream conservation zone:
    - Prohibit the building of new road crossing or adjoining wood turtle habitat complexes. This applies to public and private roads of all kinds, including driveways.
    - Keep vehicle speeds low on existing roads by installing speed bumps, low speed limit signs, and wildlife crossing signs.

5. **Maintain broad corridors between habitats and habitat complexes**. Maintain broad, naturally vegetated travel corridors between individual habitats within a complex (e.g., between core stream habitats, foraging wetlands, and potential nesting areas) and between neighboring habitat complexes.

6. **Protect nesting areas**. Wood turtles often nest in upland meadow or open shrublands, habitats that also tend to be prime areas for development. Construction of roads, houses, and other structures on potential nesting habitats could severely limit the reproductive success of the turtles over the long term. We recommend that large areas of potential nesting habitat within the 820 ft (250 m) stream conservation zone (e.g., upland meadows, upland shrublands, waste ground with exposed gravelly or sandy soils) be protected from development and other disturbance. Management of known or potential nesting habitat may be necessary to keep it open; see recommendations in “Large Meadows” section, and in Measure 2, above.

12. Streams

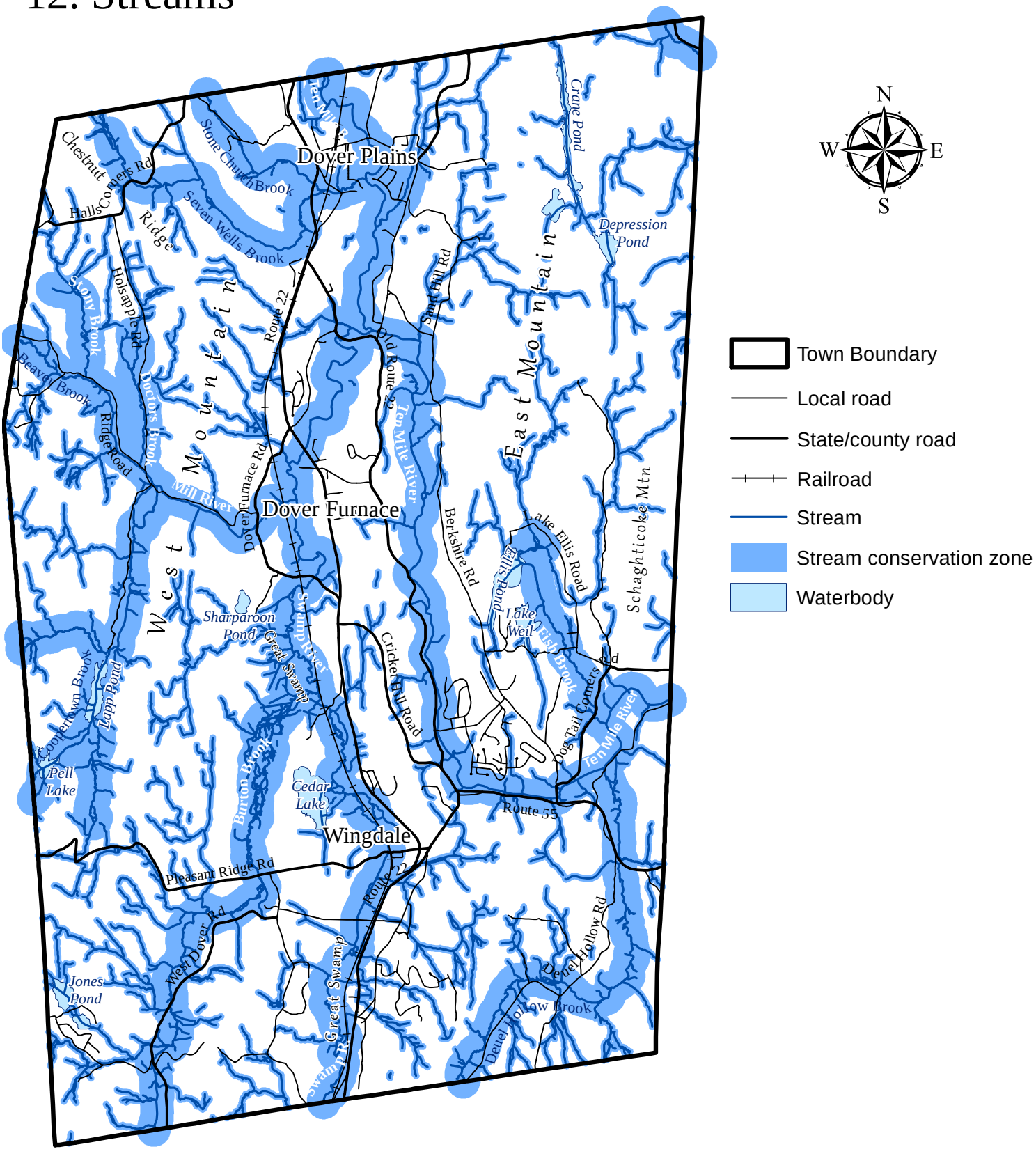


Figure 12. Streams and associated conservation zones in the Town of Dover, Dutchess County, NewYork. Conservation zones extend 820 ft (250 m) from perennial stream edges and 164 ft (50 m) from other stream edges. Hudsonia Ltd, 2020.

GENERAL GUIDELINES FOR BIODIVERSITY CONSERVATION

We hope that the Town of Dover habitat map and this report will help landowners understand how their land fits into the larger ecological landscape, and will inspire them to voluntarily adopt habitat protection measures. We also hope that the town will ensure that future development is planned with a view to long-term protection of Dover's extraordinary biological resources.

A variety of regulatory and non-regulatory means can be employed by a municipality to achieve its conservation goals, including volunteer conservation efforts by individual landowners, master planning, zoning ordinances, tax incentives, land stewardship incentives, permit conditions, land acquisition, conservation easements, and public education. The *Biodiversity Assessment Manual* (Kiviat and Stevens 2001) and *Conserving Natural Areas and Wildlife in Your Community* (Strong 2008) describe the array of tools and resources available to municipalities to help protect their natural assets. *Conservation Thresholds for Land-Use Planners* (Environmental Law Institute 2003) synthesizes information from the scientific literature to provide guidance to land-use planners interested in establishing regulatory setbacks from sensitive habitats. A publication from the Metropolitan Conservation Alliance (2002) offers a model local ordinance to delineate a conservation overlay district that can be integrated into a comprehensive plan and local zoning ordinance. The *Local Open Space Planning Guide* (NYSDEC and NYSDOS 2004) describes how to take advantage of laws, programs, technical assistance, and funding resources available to pursue open space conservation, and provides contact information for relevant organizations.

In addition to regulations and incentives designed to protect specific types of habitat, the town can also apply some general practices on a town-wide basis to foster biodiversity conservation. The examples listed below are adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001). We encourage the Town of Dover to apply these measures to town-wide planning and to every new land-use proposal that comes before the town, and to distribute this list to applicants who are considering new land-use projects.

- **Encourage and provide incentives for developers to consider environmental concerns early in the planning process**, and to incorporate biodiversity conservation and water conservation principles into their choice of development sites, their site design, and their construction practices.**Protect large, contiguous, undeveloped tracts** wherever possible.
- **Concentrate new development near existing population centers and along existing roads**; discourage construction of new roads in undeveloped areas. **Promote clustered and pedestrian-centered development** wherever possible to maximize extent of unaltered land and minimize expanded vehicle use.
-
- **Plan landscapes with interconnected networks of undeveloped habitats** (preserve and restore links between natural habitats on adjacent properties). When considering protection for a particular species or group of species, design the networks according to the particular needs of the species of concern.
- **Preserve natural disturbance processes** such as fires, floods, seasonal water level changes, landslides, and wind exposures wherever possible.
- **Restore and maintain broad buffer zones** of natural vegetation along streams, shores of water bodies and wetlands, and around the perimeters of other sensitive habitats.
- **Direct human uses toward the least sensitive areas**, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.
- **Encourage development of altered land instead of unaltered land.** Promote redevelopment of brownfields and previously altered sites, "infill" development, and re-use of existing structures wherever possible (with exceptions for such areas that support rare species that would be harmed by development).
- **Preserve farmland soils and farmland potential** wherever possible by minimizing development on Prime Farmland Soils or Farmland Soils of Statewide Importance, and avoiding fragmentation of active or potential farmland.
-

- **Minimize areas of lawn and impervious surfaces** (roads, parking lots, sidewalks, driveways, roof surfaces) and design stormwater management to maintain pre-construction volumes and seasonal patterns of onsite runoff retention and infiltration. These measures will foster groundwater recharge, protect offsite surface water quality, and moderate downstream flood flows. Retrofit existing infrastructure to achieve these goals wherever possible.
- **Restore degraded habitats wherever possible**, but do not use restoration projects as a license to destroy existing habitats. Base any habitat restoration on sound scientific principles and research in order to maximize the likelihood of having the intended positive impacts on biodiversity and ecosystems. Any restoration plan should include monitoring of the restored habitat to assess the outcomes and regular maintenance to protect restored features from degradation.
- **Modify urban areas (such as hamlets) to provide more habitat elements** (for example, rain gardens and tree-lined streets). Use public education and incentives to encourage private landowners to improve the habitat quality of their yards.
- **Promote the establishment of conservation agreements** on parcels of greatest apparent ecological value.

USING THE HABITAT MAP FOR TOWNWIDE CONSERVATION PLANNING

The Dover habitat map illustrates the sizes of habitat units, the degree of connectivity between habitats, and the juxtaposition of habitats in the landscape, all of which have important implications for regional biodiversity. Habitat fragmentation is among the primary threats to biodiversity worldwide (Davies et al. 2001) and regionally. While some species and habitats may be adequately protected in small patches, many wide-ranging species, such as black bear,* barred owl,* and red-shouldered hawk,* require large, unbroken blocks of habitat. Many species, such as wood turtle* and Jefferson salamander,* need to travel among different habitats to satisfy their basic needs for food, water, cover, nesting areas, and population dispersal. Landscapes that are fragmented by roads, utility corridors, and development limit animal movements and interactions, disrupting patterns of dispersal, reproduction, competition,

and predation. Habitat patches surrounded by human development function as islands, and species unable to move between habitats are vulnerable to genetic isolation and possible local extinction over the long term. Landscapes with interconnected networks of unfragmented habitat, on the other hand, are more likely to support a broad diversity of native species and the ecological processes and disturbance regimes that maintain the habitats for those species. Intact corridors and habitat connectivity allow for the movement of organisms as they adapt to changing conditions, so are even more important in the face of global climate change. Careful siting and design of new development can help to protect the remaining large habitat patches (Figure 4) and maintain broad corridors between them.

The habitat map can also be used to identify priority areas for conservation, including those that support rare species or seem particularly important to regional biodiversity. For instance, fens and nearby wetland and upland habitats may support some of the few remaining populations of bog turtle* in the region. Figures 5-12 illustrate the areas we have identified as "priority habitats" and their "conservation zones." These places are especially valuable if they are located within larger areas of intact and connected habitats (Figure 4).

Finally, we have delineated six "conservation areas" (Figure 13) that may serve as suitable units for town-wide or local conservation planning. The habitat map and this report are practical tools that will help the town select areas for protection and identify sites for new development where the ecological impacts will be minimized. The map can also be used with the habitat maps of adjacent towns—Amenia, Beekman, and Washington—for conservation planning across town boundaries. (Those habitat maps are available at https://hudsonia.org/programs/biodiversity-resources-center/habitat-mapping/habitat-maps-and-reports/.)

REVIEWING SITE-SPECIFIC LAND USE PROPOSALS

In addition to town-wide land-use and conservation planning, the habitat map and report can be used for reviewing site-specific development proposals, providing ecological information about both the proposed development site and the surrounding areas that might be affected. We recommend that landowners and reviewers considering a new land-use project take the

following steps to evaluate the impact of the proposed change on the habitats present on and near the site:

1. Consult the large-format habitat map to see which ecologically significant habitats, if any, are located on and near the site in question.
2. Read the descriptions of those habitats in this report; note the discussion of habitat sensitivities.
3. Consult Figures 5-12 to see if any of the "Priority Habitats" or their conservation zones occur on or near the site. Note the conservation issues and recommendations for each.
4. Consider whether the proposed development project can be designed or modified to ensure that the habitats of greatest ecological concern and their conservation zones, as well as the ecological connections between them, are maintained intact. Examples of design modifications include but are not limited to:

    - Locating human activity areas as far as possible from the most sensitive habitats.
    - Minimizing intrusions into large forested or meadow habitats.
    - Minimizing intrusions into forested areas that are within 750 ft (230 m) of an intermittent woodland pool.
    - Avoiding disturbances that would disrupt the quantity or quality of groundwater available to onsite or offsite streams or wetlands fed by groundwater.
    - Channeling stormwater runoff from paved areas or fertilized turf through oil-water separators and into detention basins or "rain gardens" instead of directly into ditches, streams, ponds, or wetlands.
    - Locating developed features such that broad corridors of undeveloped land are maintained between important habitat areas onsite and nearby.

Because the habitat map has not been 100% field-verified we emphasize that, at the site-specific scale, it should be used only as a general guide for land-use planning and decision making. Site visits by qualified professionals should be an integral part of the review process for any proposed land-use change.

ENHANCEMENT OF DEVELOPED AREAS

A well-rounded biodiversity conservation approach in settled landscapes must also consider areas that are already developed. Although developed areas are much used by common wildlife species that are well-adapted to human activities and infrastructure (e.g., rock pigeon, European starling, gray squirrel, raccoon, striped skunk, and various rodents), uncommon species can also inhabit or travel through developed areas if nearby habitats are suitable. Bats (including Indiana bat*) and certain species of birds (including eastern screech owl,* barn owl,* and Cooper's hawk*) will take advantage of individual trees, small groves, and structures in developed areas. Various turtles sometimes nest in lawns and gardens.

There are many landscape modifications and land-use practices that can be applied to the developed parts of Dover that would assist in the protection of species of conservation concern. In areas of concentrated development, some small areas may serve as buffers to intact habitats by moderating the effects of development, some may provide travel corridors for wildlife, and some may themselves provide habitat for certain species. Hudsonia did not map these small areas or isolated habitat features (such as individual trees) as habitats in their own right due to our mapping protocols at a town-wide scale (see Appendix A). However, the habitat map can help to focus habitat enhancement efforts on developed locations where they will achieve the greatest returns for biodiversity conservation.

Following are some examples of conservation measures for developed areas (adapted in part from Adams and Dove 1989, and Adams 1994). There are many additional ways in which settled areas can be modified to reduce their negative environmental impacts and even contribute positively to the natural environment; many examples of their implementation can be found in European cities (Beatley 2000). The costs of implementing these measures and their effectiveness at particular locations will vary, and while some must be implemented by town agencies or other government entities, others can be practiced by private landowners on their own small or large properties. The town can take a leading role in educating the general public about such actions and encouraging landowner participation.

Enhancing Habitat Characteristics

1. ***Preserve trees of a variety of species and age classes.*** Trees are an important component of the habitat of many wildlife species, and some species of plants and animals can use hedgerows as habitat corridors. Trees also provide services such as moderating climate extremes, reducing wind velocities, controlling erosion, and abating noise.
    - Preserve large trees wherever possible, and especially those with exfoliating bark that might serve as summer roost sites for bats.
    - Plant a variety of native tree species along streets, and reduce the use of salt on roads to minimize damage to the trees.
    - Allow natural regeneration of trees where possible, to provide replacements for older trees and those that must be removed for safety reasons.
    - Allow dead trees (snags) to remain standing and fallen trees to decay in place where safety concerns allow. Snags provide good habitat for animals such as insects, bats, cavity-nesting birds, and certain amphibians; decomposing trees provide both habitat and a source of nutrients for plants, fungi, and invertebrates.

2. ***Replace lawn areas with multi-layered landscapes.*** Manicured lawns have little biodiversity value and their maintenance requires higher inputs of water and chemicals than other types of horticultural landscaping, such as native wildflower meadows, perennial gardens, or ornamental woodlands. Lawns are usually maintained with motorized lawn mowers, which contribute to air and noise pollution. Wildflower meadows will not only help to support native animals, but their maintenance requires less mowing, and thus produces fewer carbon emissions to the atmosphere. Use of native species in ornamental plantings is important, as native ornamental shrubs tend to support many times the number of native invertebrates and birds that non-native ornamentals do (Tallamy 2007), and some non-native ornamentals are invasive species. While the choice to maintain lawns in residential areas is often one of personal taste or safety, public education and landowner incentives can promote native plant landscaping that provides higher quality resources for wildlife while reducing water, air, and noise pollution in developed areas.

3. ***Manage constructed ponds (such as stormwater control ponds and ornamental ponds) for wildlife.***
    - Avoid or minimize the use of pesticides and fertilizers in and near ponds.
    - Plant or maintain shoreline vegetation.
    - Add small, gently sloping, vegetated islands to large ponds (> 5 ac [2 ha]).
    - Encourage a combination of emergent vegetation and open water (i.e., interspersed shallow and deep areas).
    - Include irregular shorelines, gently sloped shores, and the capability for controlling water levels in the design of new ponds.

4. ***Restore natural stream buffers wherever possible.*** Vegetated streambanks and floodplains help to prevent erosion, moderate flooding, and protect water quality. They enhance the habitat quality of the stream and in some cases its recreational value. They also allow for natural movements of the stream channel over time, which improves the stream's capacity to dissipate the energy of water flow. (See the Streams and Riparian Corridors priority habitat section above).

5. ***Maximize onsite infiltration of rainwater and snowmelt.*** Impervious surfaces such as pavement and roofs alter hydrological patterns by preventing precipitation from infiltrating the soil, and promote rapid overland flow to ditches, streams, and ponds instead. This effect prevents the recharge of groundwater and the filtration of pollutants by soil and vegetation, while increasing the likelihood of flooding, stream bank erosion, and surface water pollution (including sedimentation).
    - Encourage the use of pervious driveway materials in residential and commercial construction and renovation.
    - Construct stormwater retention ponds, wetlands, and rain gardens that allow infiltration of surface water to groundwater.
    - Follow stormwater Best Management Practices (BMPs) in areas of new construction. Examples of BMPs include preserving natural vegetation and installing and maintaining soil retention structures, check dams, soil traps, and silt fences. A national menu of stormwater BMPs can be found on the US Environmental Protection Agency website (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm).
    - Encourage the collection of rainwater for use in gardens and lawn areas.

Minimizing Disturbance To Resident And Migratory Biota

1. ***Minimize the impacts of roads on wildlife.*** One of the greatest immediate threats to wildlife in settled areas is road mortality. A study to identify roadways with the highest incidence of wildlife mortality could be used to direct the following measures to the places where they will be most effective. The maps of conservation zones in this report could also inform such efforts (e.g., roads within conservation zones for intermittent woodland pools could be priorities for facilitating amphibian crossings).
    - Reduce speed limits and post wildlife crossing signs along road segments where wildlife crossings are concentrated.
    - Install structures for safe wildlife crossing, such as culverts, overpasses, underpasses, and modified roadside curbs. Design such passageways to accommodate the largest possible number of species. Information about wildlife crossings is provided online by agencies such as the US Department of Agriculture and US Department of Transportation.
    - Modify the immediate roadside areas to promote safer wildlife crossings. Factors to be considered include the location of barriers such as guardrails, type of roadside vegetation, and distance of vegetation to the road's edge (Barnum 2003, Clevenger et al 2003).

2. ***Minimize noise and light pollution.*** High levels of noise and light in residential areas can alter the behavior of many wildlife species during critical parts of their life histories. While some noise and light are inevitable in settled environments, certain sources can be minimized. Below are examples of measures that could be incorporated into municipal codes to help reduce harm to wildlife from noise and light pollution.
    - Require that outdoor lights be directed downward (rather than outward or upward) to minimize light pollution in offsite and overhead areas.
    - Require that outdoor lights be controlled by motion sensors so that they are on only when needed.
    - Encourage the use of light technologies (such as low-pressure sodium lights) that minimize the attraction of flying insects, and prohibit the use of "bug-zappers."
    - Prohibit the use of fireworks in order to minimize wildlife disturbance.

3. ***Discourage human-subsidized predators, including domestic cats and dogs.*** Human-subsidized predators are species such as raccoon, opossum, and striped skunk, whose populations often burgeon in response to conditions created by humans. These species

are serious predators on bird eggs and nestlings, turtle eggs, and other wildlife. Domestic cats and dogs can be similarly disruptive to native wildlife. In addition, human interference with the habits and diets of wild animals affects population dynamics and can lead to nuisance behavior.

- Properly secure trash receptacles and compost piles.
- Feed pets indoors, and do not intentionally feed wildlife.
- Supervise cats and dogs when they are outdoors, and keep cats indoors if possible.

4. ***Include biodiversity considerations in development planning.***

- Plan for lower-disturbance human activities/developments adjacent to intact habitats, and establish undisturbed buffer zones outside of sensitive habitat areas.
- Consider wildlife travel routes (including bird flight paths) in the placement of developments and buildings.
- Fence, fill in, or cover pitfall hazards such as window wells, soil test pits, and in-ground pools that can trap small mammals, amphibians, and reptiles.
- In critical habitat areas, identify potential barriers to wildlife movement, such as stone walls or chain-link fences (excluding those designed to prevent access to pitfalls), and design or modify them to have spaces or openings to allow safe passage.
- Encourage building designs that minimize harm to wildlife. For example, consult New York City Audubon's publication "Bird-Safe Building Guidelines" (Brown and Caputo 2007) when planning building construction and renovation.

Chinquapin oak, a regionally rare tree

CONSERVATION AREAS IN DOVER

To synthesize the information presented above and facilitate discussion of conservation priorities, we have divided the town into six "conservation areas" (CA's), each with a unique character and combination of priority habitats (Figure 13). We hope that this approach will illustrate the larger ecological context of particular locations and help to focus local conservation efforts on those measures most appropriate to each conservation area. For discussion of conservation issues and recommendations for each habitat type, refer to the preceding sections.

Northwestern Meadows Conservation Area (NMCA)

This small area in the northwestern corner of Dover (Chestnut Ridge) includes the gently sloped foothills of West Mountain. The area is noteworthy for its high concentration of meadows—roughly 800 ac (320 ha)—including many large meadows. Priority habitats in the NMCA are:

- Large meadows and meadow complexes. The largest meadow complex (213 ac [85 ha]) and three of the six largest in town, all >100 ac (40 ha), occurred here, as well as five others of greater than 25 ac. Most of the meadows were in hay; perhaps somecould be managed to promote grassland-breeding birds (see above).
- Wetland complexes. There were a few sizeable wetland complexes in the NMCA, whose waters feed Doctors Brook, Mill River, and Seven Wells Brook.
- Large forest. Parts of 2200-ac (880 ha) and 560-ac (220 ha) forest blocks extended into the southern end of the NMCA.

West Mountain Conservation Area (WMCA)

West Mountain spans the length of Dover from north to south, topping out at 1360 ft (415 m) asl at the summit of Dennis Hill. Extensive areas of exposed schist forms the highest concentration of oak-heath barrens, crest-oak woodlands, and dry chestnut oak forest in the town. The broad mountain ridge is mostly forested and contains numerous small wetlands in ravines and depressions. Priority habitats in the area include:

- Three forest blocks of over 1,000 ac (400 ha), including most of the second-largest tract in Dover, at over 4,000 ac (1,600 ha). Most of the forest of West Mountain is little

fragmented by development, with only a few east-to-west roads and a shrubby utility corridor breaking up the forest. We observed slimy salamander,* Cooper's hawk,* broad-winged hawk, yellow-billed cuckoo, wood thrush*, black-throated green warbler,* black-throated blue warbler,* Blackburnian warbler,* worm-eating warbler,* Louisiana waterthrush,* scarlet tanager,* and bobcat,* among other species of conservation concern, in the extensive forest here.

- Two cool ravines, including the impressive and much-loved Stone Church Gorge. We recorded least flycatcher, Acadian flycatcher,* eastern phoebe, winter wren,* Blackburnian warbler,* and Louisiana waterthrush* in or near the ravines.
- The highest concentration of oak-heath barrens and crest-oak woodlands in Dover, on exposed schist in a band east of Holsapple and Cooperstown Roads. Large complexes of these open, dry habitats may support numerous plants and animals of conservation concern. We heard whip-poor-wills* on one such complex.
- A small acidic bog east of Bald Mountain.
- Sixty-three isolated pools, including 49 intermittent woodland pools and 14 pool-like swamps. There were also five pool complexes, or groupings of pools whose conservation zones (750 ft from pool edge) overlap, that contained five or more pools. Wood frog* and spotted salamander* were observed in some of these pools.

Harlem Valley Conservation Area (HVCA)

The Harlem Valley is a long, narrow valley underlain mostly by Stockbridge marble. It runs down the center of Dover and contains the entire Dover section of the Ten Mile River and part of the Swamp River. Most of the residential development in the town is concentrated in this area, whose terrain is gentler and easier to build on than that of other parts of town. Nevertheless, because of the prevalence of marble bedrock, the Harlem Valley supports numerous occurrences of regionally rare habitats and a large array of species of regional and state-wide conservation concern. We identified the following priority habitats in the HVCA:

- Numerous large meadows and meadow complexes. The majority of these were concentrated in Dover Plains and along the eastern edge of the Harlem Valley, along Old State Rt. 22, Berkshire Rd, Lime Kiln Rd, and Sand Hill Rd, but there were scattered large meadows elsewhere. In the northern Harlem Valley, in fact, were two

meadow complexes that exceeded 120 ac (48 ha), four that exceeded 80 ac (32 ha), and another six of greater than 50 ac (20 ha). Most of these were in agricultural usage and, together, represent a significant opportunity to manage large areas for grassland-breeding birds (see *Large Meadows*, above). Another nine meadows throughout the HVCA were over 25 ac (10 ha). Golden eagles have been observed in recent winters hunting the large meadows of the Ten Mile River Preserve, a private game reserve (Barbara Butler, pers. comm.)

- All of the red cedar barrens (38) and marble knolls (36) in Dover, due to the predominance of marble bedrock and abundant marble outcrops. We found rare plants such as purple cliffbrake,* Indian grass,* side-oats grama,* Bicknell's sedge,* rock sandwort,* yellow wild flax,* whorled milkweed,* green milkweed,* and northern blazing-star* in these habitats.
- The majority of fens in Dover (53), including two of the three largest (16 ac [6 ha]) and 6 ac [2 ha]), as well as 21 calcareous wet meadows. Many of the fens and calcareous wet meadows were clustered in complexes with other ecologically significant habitats. We found regionally rare plants such as large purple fringed orchid,* round-leaved sundew,* sage-leaved willow,* and alder-leaved buckthorn,* as well as multiple populations of hidden spikemoss* (NYS-Endangered).

Fox Hill in the Harlem Valley

- Twenty-two pools, including five kettle shrub pools and 11 intermittent woodland pools. Of particular note was a complex of six pools north of Cricket Hill Rd, embedded in a block of intact, ecologically significant habitat. Two of the kettle shrub pools are large (4 ac (1.6 ha) and 3 ac (1.2 ha)) and may provide valuable habitat for pool-breeding amphibians, spotted turtle,* and other species of conservation concern.

- The entire Dover section of the Ten Mile River and a significant reach of the Swamp River. The riparian zone mostly constituted forest and meadow, with some residential development. Most of the floodplain forest in Dover occurred in small patches along the Ten Mile River. Swamps and floodplain forests along clear, low-gradient, perennial streams are part of the core habitat of wood turtles.*

Great Swamp Conservation Area (GSCA)

This small conservation area encompasses over 1,500 ac of the Great Swamp in Dover. Though the Great Swamp lies within the Harlem Valley and is influenced by the same marble bedrock, we consider it separately here in order to underscore its importance and its unique character. Priority habitats within the GSCA included:

The Great Swamp

- Twenty fens. One of the largest fens (9 ac [4 ha]) and one of the most extensive fen complexes in Dover lay off Cricket Hill Road. Fens contained rare plants such as hidden spikemoss (NYS-Endangered),* prairie wedge-grass (NYS-Endangered),* rigid sedge,* rose pogonia,* buckbean,* and alder-leaved buckthorn.* We found northern green bog orchid* in a calcareous wet meadow.
- Large wetland complex: the entire conservation area is a large wetland complex (>1500 ac [600 ha]) containing hardwood swamp, marsh, wet meadow, fen, and other wetlands. There was an inactive great blue heron* rookery—now being used for great-horned owl nesting —among abundant standing snags in a marshy area next to the Swamp River, and an active heron rookery in the swamp south of Pleasant Ridge Road and west of Route 22 . Ruffed-grouse* was heard drumming most springs around Sharperoon Pond during the 1990's and 2000's (Barbara Butler, pers. comm.).

- Most of the Dover portion of the Swamp River flows through this conservation area. We found smartweed dodder* (NYS-Endangered) in the river, and observed mink and river otter.
- Large forest. Hardwood swamp and floodplain forest in the northern part of the GSCA contributed a sizeable component of a 4,000-ac (1,600-ha) forest block.

East Mountain Conservation Area (EMCA)

East Mountain has the highest summit in Dover. It is a large, mostly forested, little-developed ridge that is generally less dry than West Mountain, though it includes the dry hickory forests and talus woodlands of Schaghticoke Mountain. It harbors many small, isolated pools and large wetland complexes in its dips and hollows. Among the priority habitats were:

- Large forest. Virtually all the forest in this conservation area comprised a single forest block ~6,400 ac (2,560 ha) in Dover, plus roughly 3,000 ac (1,200 ha) more in Kent, Connecticut. We observed eastern ratsnake,* bald eagle,* yellow-billed cuckoo, brown creeper,* worm-eating warbler,* black-throated green warbler,* black-throated blue warbler,* and scarlet tanager* in the forest. Hooded warbler* and cerulean warbler* are also known to breed in the forest of East Mountain (Barbara Butler, pers. comm.). Snakes of conservation concern may use the extensive talus and occasional oak-heath barren. Bobcat and black bear are reported to be common (Wayne Morill, pers. comm.)
- Barrens and woodlands. We mapped 38 oak-heath barrens, seven crest oak woodlands, four crest hickory woodlands, seven rocky barrens, and four talus slope woodlands. Most of these dry habitats were at the southern end of East Mountain, including extensive talus slope woodland on the southern and western slopes of Schaghticoke Mountain. The two largest crest-oak woodlands in Dover formed the core of a nearly 30-ac (12-ha) complex of crest habitats.
- Extensive crest, ledge, and talus. Much of East Mountain was covered with ledges, outcrops, and talus. Talus fields were often jumbles of large boulders and blocks with abundant crevices and cavities that could provide habitat for rare snakes and for small-footed bat.* In one narrow valley with calcareous bedrock and talus, we found four-toed salamander,* Allegheny vine,* and spikenard.*

- Four acidic bogs. One of these, in Tamarack Swamp, is seven ac (three ha) and is a regionally rare black spruce*-tamarack swamp with pitcher plant* and creeping snowberry,* among other plants (Kiviat 1988). Another small bog contained little club spur orchid.*
- Seventy-two pools, including four buttonbush pools and 55 intermittent woodlands pools. East Mountain had the highest concentration of isolated pools in Dover. It had five pool complexes of at least five pools, including complexes with 10, 15, and 18 pools, respectively. One pool contained a large population of false hop sedge (NYS-Threatened).*
- Numerous wetland complexes, including five of $\geq$ 25 ac (10 ha). The largest complex exceeded 100 ac (40 ha) and contained Crane Pond.

Southeastern Hills Conservation Area (SHCA)

This area in the southeastern corner of Dover encompasses Leather Hill, Gardner Hill, part of the Hammersly Ridge, and other hills. Underlain by pelitic schist and gneiss, the terrain is less rugged and rocky than that of either West Mountain or East Mountain. There is a moderate amount of residential development, yet there are still large contiguous areas of ecologically significant habitats. The Appalachian Trail bisects the area, zigzagging across the hills. The conservation area is characterized by:

- Large forests. Three large forest blocks—at 2,000 ac (800 ha), 600 ac (240 ha), and 200 ac (80 ha)—covered most of the conservation area. The largest block is very fragmented by residential development.
- A cool ravine on a tributary to Deuel Hollow Brook, which contained mountain maple* and hobblebush.*
- Twenty isolated pools, including 17 intermittent woodland pools and three pool-like swamps. One pool had false hop sedge (NYS-Threatened).*
- Five fens.
- Three wetland complexes of 30-35 ac (12-14 ha)

13. Conservation areas

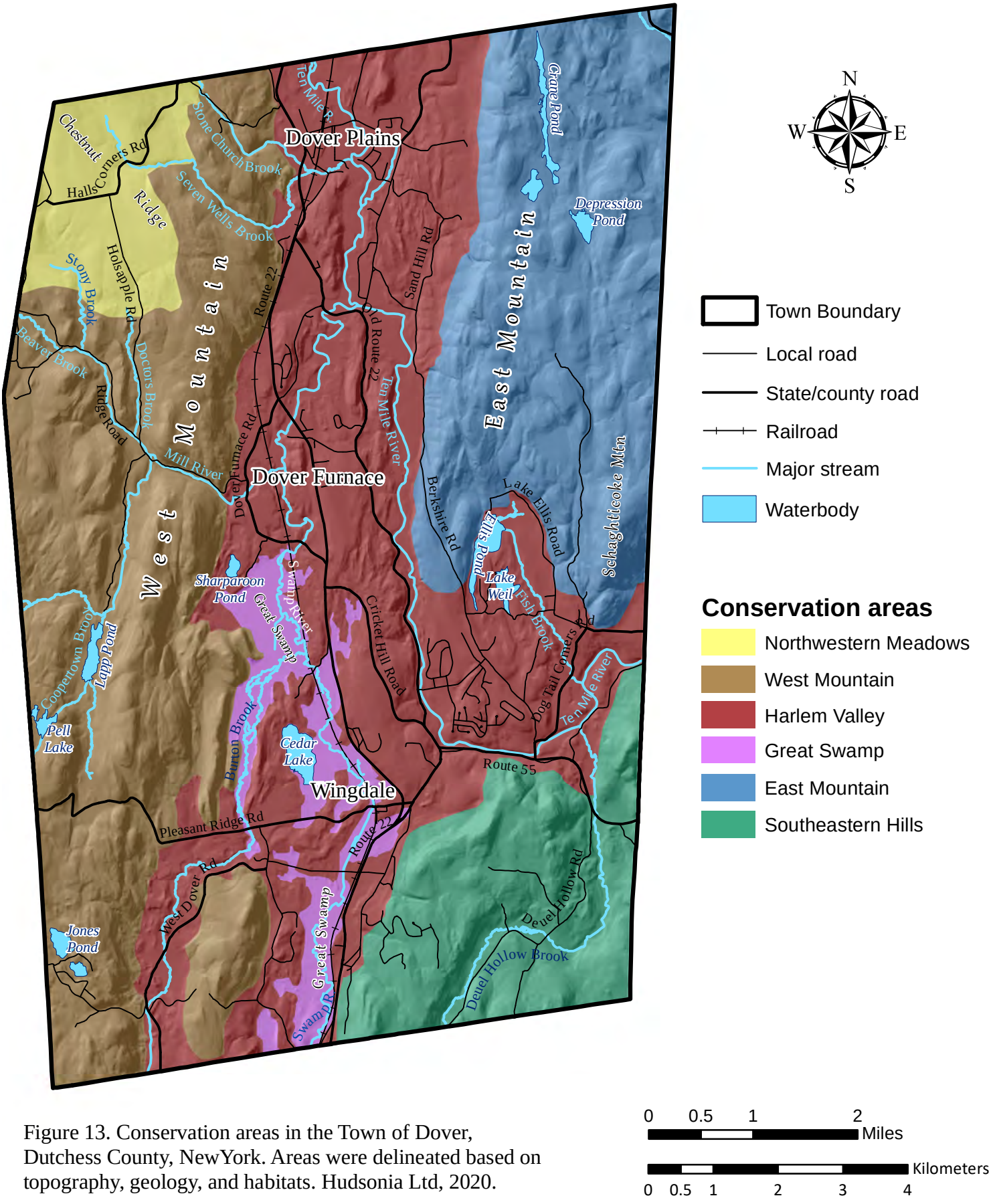


Figure 13. Conservation areas in the Town of Dover, Dutchess County, NewYork. Areas were delineated based on topography, geology, and habitats. Hudsonia Ltd, 2020.

CONCLUSION

Dover has an extraordinary concentration of unusual habitats, unfragmented large habitats, and rare species. West Mountain and East Mountain both support unbroken tracts of forest of thousands of acres. The valleys and other low-lying areas of the town contain numerous large meadows, which are important for grassland-breeding and grassland-wintering birds as well as other organisms. Embedded in these large "matrix" habitats are smaller examples of the rare, unusual, and threatened. For example, acidic bogs and calcareous fens, regionally uncommon habitats both, are found here. The latter are especially well-represented, with over 70 known examples in the marble-strewn Harlem Valley. Hundreds of intermittent woodland pools and other pool-forming habitats dot the upland forests of the town, providing refuge for pool-breeding amphibians and spotted turtles. And the crests and ridges of West Mountain and East Mountain are covered with extensive open, rocky habitats such as oak-heath barrens, which may support numerous species of conservation concern. In total, the town is home to dozens of rare species of plants and animals, and has the potential to support numerous others. Some of these organisms find one of their last strongholds in New York, or in the world, in the Town of Dover.

Worm-eating warbler

There are significant opportunities for biodiversity conservation in the rural landscapes of the Town of Dover. In anticipation of future development pressure, however, strategic land-use and conservation planning are needed to ensure that species, communities, water resources, and ecosystems are protected for the long term. The habitat map and this report will equip information about local habitats of ecological significance, so that steps can be taken to protect the resources of greatest importance.

The “habitat approach” to conservation is quite different from the traditional parcel-by-parcel approach to land-use decision making. It requires examining the landscape beyond the

Prairie warbler, a bird of crest-oak woodlands and oak-heath barrens.

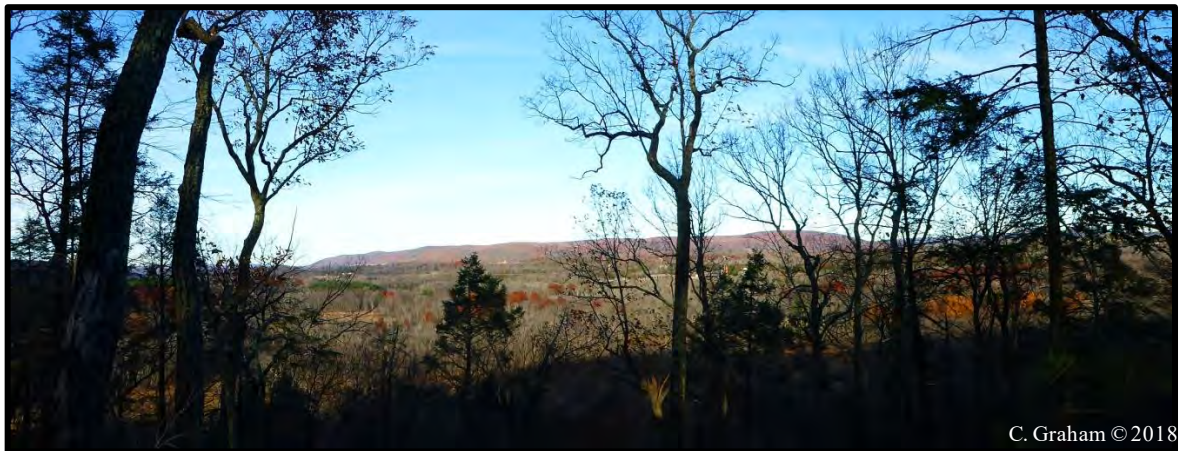
boundaries of any particular land parcel, and considering the size and juxtaposition of habitats in the landscape, the kinds of biological communities and species they support, and the ecological processes that help to maintain those habitats and species.

The map accompanying this report provides a bird's-eye view of the landscape, illustrating the location and configuration of ecologically significant habitats. At the printed scale of 1:10,000, many interesting ecological and land-use patterns emerge, such as the location and extent of remaining unfragmented habitat blocks, concentrations of rare habitats such as fens, and the patterns of habitat fragmentation caused by roads and private residential development. This kind of general information can help the town consider where future development should be concentrated and where future conservation efforts should be targeted. An understanding of the significant ecological resources in the town will enable local decision makers to focus limited conservation resources where they will have the greatest impact.

At the site-specific scale, we hope the map will be used as a resource for routine deliberations over development proposals and other proposed land-use changes. The map and report provide an independent body of information for environmental reviews, and will help raise questions about important biological resources that might otherwise be overlooked.

We strongly emphasize, however, that the map has not been exhaustively field-verified and should therefore be used only as a source of general information. In an area proposed for development, for example, the habitat map can provide basic ecological information about the site and the surrounding lands, but the map should not be considered a substitute for site visits by qualified professionals. During site visits, the presence and boundaries of important habitats should be verified, changes that have occurred since our mapping should be noted, and additional ecological values should be assessed. Based on this information, decisions can be made about the need for rare species surveys or other assessments of biological resources. Detailed, up-to-date ecological information is essential to making informed decisions about specific development proposals. Because the natural landscape and patterns of human land use are dynamic, the town should consider refining and/or updating the habitat map over time.

After presenting the completed habitat map, database, and report to the Town of Dover, Hudsonia hopes to assist town officials, landowners, and other interested individuals and groups in interpreting the map, understanding the ecological resources of the town, and devising ways to integrate this new information into land-use planning and decision-making. Conservation of habitats is one of the best ways to protect biological resources. We hope that the information contained in the habitat map and in this report will help the Town of Dover plan wisely for future development while taking steps to protect biological and water resources. Incorporating this approach into planning and decision making will help to minimize the adverse effects of human activities on the landscape, integrate the needs of the human community with those of natural communities, and protect the ecological patterns and processes that support us and the rest of the living world.



East Mountain in the distance

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APPENDICES

Appendix A. Mapping conventions for defining and delineating habitat types.

Buttonbush pool (including kettle shrub pools). Buttonbush pools are fairly deep-flooding, isolated from perennial streams, and have a shrub-dominated flora with buttonbush normally the dominant plant. Kettle shrub pools are a special type of buttonbush pool that only occur in glacial outwash terrain. (A glacial kettle is a depression formed by the melting of a stranded block of glacial ice that has been partially or entirely covered by outwash.)

Crest, ledge, and talus. Because crest, ledge, and talus habitats are usually embedded within other habitat types (most commonly upland forest), we depicted them as an overlay on the base habitat map. Except for the most exposed ledges, these habitats have no distinct signatures on aerial photographs and were therefore mapped based on a combination of field observations and inference based on topographic signature. The final overlay of crest, ledge, and talus habitats is therefore an approximation; we expect that there are additional bedrock exposures and talus outside the mapped areas. The precise locations and boundaries of these habitats should be determined in the field as needed. The distinction between calcareous and non-calcareous crest, ledge, and talus habitats can only be made in the field. Rocky areas not known to be calcareous (i.e., of both non-calcareous and unknown bedrock) were mapped simply as "crest, ledge, and talus."

Cultural. We define "cultural" habitats as areas that are significantly altered and intensively managed (e.g., mowed) but not otherwise developed with wide pavement or structures. These include playing fields, cemeteries, large gardens, and large lawns, if surrounded by developed areas on fewer than three sides. It was sometimes difficult to distinguish extensive lawns from upland meadows using aerial photos, so in the absence of field verification some large lawns may have been mapped as upland meadow.

Developed area. Habitats surrounded by or intruding into developed land (buildings, paved and gravel roads, and parking areas) were identified as ecologically significant and mapped only if their dimensions exceeded 165 ft (50 m) in all directions, or if they seemed to provide important connections to other large habitat areas. Exceptions to this protocol were wetlands within developed areas. Even though such wetlands may lack many of the habitat values of wetlands in more natural settings, they still may serve as important drought refuges for rare species and other species of conservation concern. Most lawns near buildings and roads were mapped as developed; large lawns adjacent to significant habitats were mapped as "cultural" habitats.

Floodplain forest. Floodplain forests were identified based on aerial photographs, soil surveys, topographic data, and, when possible, field observation. Because floodplain forest is often difficult to distinguish from hardwood swamp in aerial photographs, and even in the field without site-specific soil data, we expect that the two categories have in some cases been confused in our mapping. We mapped floodplain forest as an overlay atop upland forest habitats but not atop wetland habitats.

Intermittent woodland pool and pool-like swamp. Intermittent woodland pools are generally recognizable throughout the year (except under deep snow cover), but are most obvious in the spring when the pools are full of water and occupied by invertebrates and breeding amphibians. For those intermittent woodland pools we visited in late summer and fall, we relied on general physical features of the site to distinguish them from isolated swamps. We classified hydrologically isolated wetlands with an open basin as intermittent woodland pools and those dominated by trees or shrubs as pool-like swamps (a subcategory of swamps), but the two often serve similar ecological functions. A few wetlands that had only an ephemeral (very brief and minor) stream connection to water bodies were classified as isolated pools, as they may be free of fish in many years. Many intermittent woodland pools can also be mapped remotely since they have a distinct signature on aerial photographs and are readily visible within areas of deciduous forest on photographs taken in a leaf-off season. Intermittent woodland pools located within areas of conifer forest, however, are not easily identified on aerial photographs, and we may have missed some of these in areas we were unable to visit.

Open water and constructed pond. We distinguish between the habitat categories "open water" and "constructed pond" based mostly on the degree to which the water body and its shorelines are managed. Most small to medium open water bodies in our region were probably created by damming or excavation and were mapped as constructed ponds because of shoreline development and/or likely management. Those that we mapped as "open water" habitats included natural lakes and ponds with unmanaged shorelines; large, substantially unvegetated pools within marshes and swamps; and ponds that were probably constructed but now appear to be unmanaged and are surrounded by unmanaged vegetation.

Springs & seeps. Springs and seeps are difficult to identify by remote sensing. We mapped only those we happened to see in the field and the few that were either identified on soils maps or had an identifiable signature on topographic maps or aerial photographs. We expect there were many more springs and seeps in the Town of Dover that we did not map. The presence of most seeps and springs must be determined by site visits. Seeps were mapped as an overlay atop other habitats, either upland or wetland (based on vegetation).

Streams. We created a stream map in our GIS that was based on field observations and interpretation of topographic maps and aerial photographs. We depicted streams as continuous where they flowed through ponds, impoundments, or large wetlands, and when they flowed underground for relatively short distances (e.g., under roads or small developed areas). We expect there were additional intermittent streams that we did not map, and we recommend these be added to the database as information becomes available. Because it was often difficult to distinguish between perennial and intermittent streams based on aerial photograph and map interpretation, these distinctions were made using our best judgment. Streams that were channelized or diverted by humans (i.e., ditches) were mapped when observed in the field or on aerial photos; we mapped ditches as "streams" because they function as such from a hydrological perspective.

Subcategories. In some places we identified habitats to a more specific category than the mapped habitat type. These included rocky barren as a type of oak-heath barren, crest hickory woodland as a type of crest oak woodland, marble knoll as a type of calcareous crest, and

cinquefoil shrubland as a type of upland shrubland. These more specific habitats are denoted with stars on the map. These distinctions can generally only be made by visiting sites, so there were likely more of these specific habitats in Dover that are not shown on the map.

Upland forest. We mapped just three types of upland forests: hardwood, mixed, and conifer forest. Although these forests are extremely variable in species composition, size and age of trees, vegetation structure, soil drainage and texture, and other factors, we used these broad categories for practical reasons. Hardwood and coniferous trees are generally distinguishable on aerial photos taken in the spring, although dead and deciduous conifers can be mistaken for hardwoods. Different forest communities and ages are not easily distinguished on aerial photographs, however, and we could not consistently and accurately separate forests according to dominant tree species or size of overstory trees. Our "upland forest" types include non-wetland forests of all ages, at all elevations, and of all species mixtures. Grass and dirt roads within forest (where identifiable) were mapped as boundaries of adjacent forested habitat areas, since they can be significant fragmenting features.

Upland meadow and upland shrubland. We mapped upland meadows divided by fences, tree-lines, and hedgerows as separate polygons (to the extent that these features were visible on aerial photographs or observed in the field), because such dividing features can serve as perching sites for birds of prey and shelter for other predators that reduce success rates of grassland-breeding bird species. Because old-fields often have a substantial shrub component, the distinction between upland meadows and upland shrubland habitats is somewhat arbitrary. We defined upland shrubland habitats as those with widely distributed shrubs that accounted for more than 20% of the cover.

Wetland. We mapped wetlands remotely using topographic maps, soils data, and stereoscopic aerial photographs. In the field, we identified wetlands primarily by the predominance of hydrophytic vegetation and easily visible indicators of surface hydrology (Environmental Laboratory 1987). We did not examine soil profiles. All wetland boundaries on the habitat map should be treated as approximations, and should not be used for jurisdictional determinations. Wherever the actual locations of wetland boundaries are needed to determine jurisdictional limits, the boundaries must be identified in the field by a wetland scientist and mapped by a land surveyor. We attempted to map all wetlands in the town, including those that were isolated from other habitats by development. These include wetlands that do and do not fall under state or federal jurisdiction. Along stream corridors and in other low-lying areas with somewhat poorly drained soils, it was often difficult to distinguish between upland forest and hardwood swamp without the benefit of site-specific soil data. These areas were characterized by moist, fine-textured soils with common upland and wetland trees in the canopy, often dense thickets of vines and shrubs (e.g., Japanese barberry, Bell's honeysuckle) in the understory, and facultative wetland and upland species of shrubs, forbs, and graminoids.

Appendix B. Explanation of ranks of species of conservation concern listed in Appendix C.

A. ANIMALS

Categories of Endangered and Threatened animal species are defined in New York State Environmental Conservation Law section 11-0535. Endangered, Threatened, and Special Concern species are listed in regulation 6NYCRR 182.5.

The explanation below is from the New York Natural Heritage Program Rare Animal Status List (Schlesinger 2017). Explanation of all NYNHP ranks are given here, but the NRI lists none of the global (G) ranks and considers only the ranks of S1, S2, and S3 to denote species of conservation concern.

STATE & FEDERAL LISTINGS

NY Natural Heritage tracks a selected subset of New York's animals. The species tracked are chosen based on their degree of rarity or imperilment within the state, and as new information comes in, new species are sometimes added while others are discontinued. Information on the species and communities tracked by NY Natural Heritage are used for conservation, research, and regulatory purposes.

Many of the species tracked by NY Natural Heritage are listed as "endangered" or "threatened" under the state Environmental Conservation Law (ECL). Listing is a legal process that is conducted by the state agency with authority over the species in question, and for animals confers important protection requirements. See http://www.dec.ny.gov/animals/7494.html for all state-listed animals.

The NYSDEC Division of Fish, Wildlife, and Marine Resources has jurisdiction over rare animal species listed as "endangered," "threatened," or of "special concern" under ECL §11-0535. Animals listed as endangered or threatened receive notable legal protection, as it is illegal to take or possess any of these species or their parts without a permit from NYSDEC. Species of special concern warrant attention and consideration but current information does not justify listing them as either endangered or threatened.

A subset of the animal species listed under New York state law is also recognized under federal law. These species are so seriously imperiled across their entire range that they face the very real prospect of extinction. Species are listed as federally endangered or threatened by the US Fish and Wildlife Service in consultation with state agencies and other experts, and the Service works closely with NYSDEC on the protection of federally listed species in New York.

Ultimately, protection of New York's biodiversity lies with landowners and land managers regardless of state or federal listings. How private and public landowners manage their properties will determine what species and natural communities persist into the future. This situation is both a great opportunity and a serious challenge.

(continued)

A. ANIMALS (cont.)
State legal listings are identified with the following codes:

E endangered
T threatened
SC special concern

Federal legal listings are identified with the following codes:

E listed endangered
T listed threatened
C candidate

NY Natural Heritage tracks all species listed as endangered and threatened. While they track many of the species listed as being of special concern, a subset of special concern species are currently not rare or imperiled enough to merit tracking at our precise scale. In addition, they track many species that are biologically rare and imperiled but that have not gone through the review process necessary for state listing.

Active Inventory and Watch List
The NY Natural Heritage Program keeps two lists of rare animal species: the Active Inventory List and the Watch List. Species on the Active Inventory List are ones they currently track in our database; for the most part these are the most rare or most imperiled species in the state. Species on the Watch List are those that could become imperiled enough in the future to warrant being actively inventoried, or are ones for which the Heritage Program does not have enough data to determine whether they should be actively inventoried. Species are moved between lists, or off the lists entirely, as available information warrants.

Global and State Status Ranks
NY Natural Heritage's statewide inventory efforts revolve around lists of rare species and all types of natural communities known to occur, or to have historically occurred, in the state. These lists are based on a variety of sources including museum collections, scientific literature, information from state and local government agencies, regional and local experts, and data from neighboring states.

Each rare species is assigned a rank based on its rarity, population trends, and threats. Like those in all state Natural Heritage Programs, NY Natural Heritage's ranking system assesses rarity at two geographic scales: global and state. The global rank (G-rank) reflects the status of a species or community throughout its range, whereas the state rank (S-rank) indicates its status within New York. Global ranks are maintained and updated by NatureServe, which coordinates the network of Natural Heritage programs. Both global and state ranks are usually based on the range of the species or community, the number of occurrences, the viability of the occurrences, and the vulnerability of the species or community around the globe or across the state. As new data become available, the ranks may be revised to reflect the most current information. Subspecific taxa are also assigned a taxon rank which indicates the subspecies' rarity rank throughout its range.

A. ANIMALS (cont.)

For the most part, global and state ranks follow a straightforward scale of 1 (rarest/most imperiled) to 5 (common/secure). This report refers only to the three ranks—S1, S2, S3—that indicate rarity or limited occurrence in the state, as follows:

- **S1** Critically imperiled in New York State because of rarity (5 or fewer occurrences, or few remaining acres or miles of stream) or factors making it especially vulnerable to extinction rangewide (global) or in the state;
- **S2** Imperiled in New York State because of rarity (6-20 occurrences, or few remaining acres or miles of stream) or factors demonstrably making it very vulnerable to extinction (global) or extirpation from New York (state);
- **S3** Either uncommon or local in New York State, typically with 21 to 100 occurrences, limited acreage, or miles of stream rangewide (global) or in New York (state).

Additional species lists and codes are at https://www.acris.nynhp.org/.

Codes sometimes have qualifiers attached:

- **T1**, **T2**, etc. These ranks, which like global and state ranks run from 1 (rarest/most imperiled) to 5 (common/secure), are attached to global ranks to indicate the status of a subspecies or variety.
- **Q** Indicates that the species, subspecies, or variety is in taxonomic dispute.
- **?** Indicates that the state or global rank is uncertain and more information is needed.
- **N** Indicates the migratory status of a migratory species when it is not breeding in NY (for example, populations that are overwintering in the state).
- **B** Indicates the state status of a migratory species when it has breeding populations in NY.

Species of Greatest Conservation Need

The list of Species of Greatest Conservation Need was developed for the *New York State Wildlife Action Plan* (NYSDEC 2015).

High-Priority Species of Greatest Conservation Need
The status of these species is known, and conservation action is needed in the next ten years. These species are experiencing a population decline, or have identified threats that may put them in jeopardy and are in need of timely management intervention, or they are likely to reach critical population levels in New York.

Species of Greatest Conservation Need
The status of these species is known and conservation action is needed. These species are experiencing some level of population decline, have identified threats that may put them in jeopardy, and need conservation actions to maintain stable population levels or sustain recovery.

Species of Potential Conservation Need
The status of these species are poorly known, but there is an identified threat to the species or features of its life history that make it particularly vulnerable to threats. The species may be declining or begin to experience declines within the next ten years, and studies are needed to determine their actual status.

BIRDS - PARTNERS IN FLIGHT PRIORITY SPECIES LISTS

The Partners in Flight (PIF) WatchList is a list of landbirds considered to be of highest conservation concern, excluding those already designated as endangered under the federal Endangered Species Act. The WatchList is compiled jointly by several federal and private associations, including the Colorado Bird Observatory, the American Bird Conservancy, Partners in Flight, and the U.S. Fish and Wildlife Service. The current PIF WatchList is based on a series of scores assigned to each species for seven different aspects of vulnerability: population size, breeding distribution, non-breeding distribution, threats to breeding, threats to non-breeding, population trend, and "area importance" (relative abundance of the species within a physiographic area compared to other areas in the species' range). Scores for each of these factors range from 1 (low priority) to 5 (high priority), and reflect the degree of the species' vulnerability associated with that factor. Species are assigned "**High Regional Priority**" if their scores indicate high vulnerability in a physiographic area (delineated similarly to the physiographic areas used by the Breeding Bird Survey), and "**High Continental Priority**" if they have small and declining populations, limited distributions, or deteriorating habitats throughout their entire range. We used data from the Avian Conservation Assessment Database (2017), available online at http://pif.birdconservancy.org/acad/. We referred to Bird Conservation Areas #28-Appalachian Mountains and #30- New England/Mid-Atlantic Coast for setting regional priorities.

PIF1* High continental priority (Tier IA and IB species)
PIF2 High regional priority (Tier IIA, IIB, and IIC species)

Regional Status (Hudson Valley) – Animals and Plants

RG Hudsonia has compiled lists of native plants and animals that are rare in the Hudson Valley but do not appear on statewide or federal lists of rarities (Kiviat and Stevens 2001). We use ranking criteria similar to those used by the NYNHP, but we apply those criteria to the Hudson Valley below the Troy Dam. Our regional lists are based on the extensive field experience of biologists associated with Hudsonia and communications with other biologists working in the Hudson Valley. These lists are subject to change as we gather more information about species occurrences in the region. In this report, we denote all regional ranks (rare, scarce, declining, vulnerable) with a single code (RG). Species with New York State, New York Natural Heritage Program, or one of the national ranks are presumed to also be regionally rare, but are not assigned an "RG" rank. For birds, the RG code sometimes refers specifically to their breeding status in the region.

B. PLANTS

New York State Legal Status

The following categories are defined in regulation 6NYCRR part 193.3 and apply to New York State Environmental Conservation Law section 9-1503. Part (f) of the law reads as follows: "It is a violation for any person, anywhere in the state to pick, pluck, sever, remove, damage by the application of herbicides or defoliants, or carry away, without the consent of the owner, any protected plant. Each protected plant so picked, plucked, severed, removed, damaged or carried away shall constitute a separate violation." Violators of the regulation are subject to fines of $25 per plant illegally taken. The list and contact information for questions about the list may be accessed at the DEC Protected Plants website. This list is updated only every 10 years so legal status ranks may not reflect the current Heritage rank.

E = Endangered Species: listed species are those with
1) 5 or fewer extant sites, or
2) fewer than 1,000 individuals, or
3) restricted to fewer than 4 U.S.G.S. 7 1/2 minute topographical maps, or
4) species listed as endangered by the U. S. Department of Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T = Threatened: listed species are those with
1) 6 to fewer than 20 extant sites, or
2) 1,000 to fewer than 3,000 individuals, or
3) restricted to not less than 4 or more than 7 U.S.G.S. 7 1/2 minute topographical maps, or
4) listed as threatened by the U. S. Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

R = Rare: listed species have
1) 20 to 35 extant sites, or
2) 3,000 to 5,000 individuals statewide.

New York Natural Heritage Program Ranks

The explanation below is from the New York Natural Heritage Program Rare Plant Status Lists (Young 2017). This report refers only to the three ranks —S1, S2, S3—that indicate rarity or limited occurrence in the state, as follows:

- **S1** Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological or human factors.

- **S2** Imperiled in New York State because of rarity (6 - 20 sites or few remaining individuals) or highly vulnerable to extirpation from New York State due to biological or human factors.

- **S3** Vulnerable in New York State. At moderate risk of extinction or elimination due to very restricted range, very few populations (usually 21 - 35 extant sites), steep declines, or other factors.

Double Ranks (S1S2, S2S3, S1S3)

The first rank indicates rarity based upon current documentation. The second rank indicates the probable rarity after all historical records and likely habitat have been checked. Double ranks denote species that need additional field surveys.
Codes sometimes have qualifiers attached, such as "Q" or "?":

- **Q** indicates a question exists whether or not the taxon is a good taxonomic entity.
- **?** indicates that an identification question exits about known occurrences. It also indicates the rank presumably corresponds to actual occurrences even though the information has not yet been documented in heritage files or historical records. It serves to flag species that need more field studies or specimen identification.

Regional Status (Hudson Valley)

RG Hudsonia has compiled lists of native plants and animals that are rare in the Hudson Valley but do not appear on statewide or federal lists of rarities (Kiviat and Stevens 2001). We use ranking criteria similar to those used by the NYNHP, but we apply those criteria to the Hudson Valley below the Troy Dam. Our regional lists are based on the extensive field experience of biologists associated with Hudsonia and communications with other biologists working in the Hudson Valley. These lists are subject to change as we gather more information about species occurrences in the region. In this report, we denote all regional ranks (rare, scarce, declining, vulnerable) with a single code (RG). Species with New York State, New York Natural Heritage Program, or one of the national ranks are presumed to also be regionally rare, but are not assigned an "RG" rank. For birds, the RG code sometimes refers specifically to their breeding status in the region.

Appendix C. Species of conservation concern potentially associated with habitats in the Town of Dover. These are not comprehensive lists, but merely a sample of the species of conservation concern known to use these habitats in the region. The letter codes with each species name denote its conservation status. Codes include **New York State ranks** (E, T, R, SC), **New York Natural Heritage Program ranks** (S1, S2, S3), **NYSDEC Species of Greatest Conservation Need** (SGCN) and **High Priority SGCN** ($SGCN^{HP}$), and **Hudsonia's regional ranks** (RG). For birds, we also indicate those species listed by **Partners in Flight** as **high conservation priorities** at the continental (PIF1) and regional (PIF2) level. These ranks are explained in Appendix B.

UPLAND HARDWOOD FOREST

Plants	***Vertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
yellow giant-hyssop (T, S2S3)	eastern box turtle (SC, S3, $SGCN^{HP}$)	cerulean warbler (SC, PIF1, S3?B, SGCN)
silvery spleenwort (RG)	northern black racer (SGCN)	Canada warbler (PIF1, $SGCN^{HP}$)
Back's sedge (T, S2S3)	eastern ratsnake (SGCN)	Kentucky warbler (S2, PIF1, $SGCN^{HP}$)
American ginseng (S3S4)	northern goshawk (SC, S3S4B,S3N, SGCN)	black-and-white warbler (PIF2)
red baneberry (RG)	red-shouldered hawk (SC, S4B, SGCN)	black-throated blue warbler (SGCN)
Davis's sedge (T, S2)	Cooper's hawk (SC, S4)	black-throated green warbler (RG)
lopseed (RG)	sharp-shinned hawk (SC, S4)	worm-eating warbler (PIF2, SGCN)
nodding trillium (S1, E, RG)	broad-winged hawk (RG)	hooded warbler (RG)
leatherwood (RG)	ruffed grouse (SGCN)	ovenbird (RG)
northern hackberry (RG)	American woodcock (SGCN)	scarlet tanager (PIF2, SGCN)
Vertebrates	barred owl (RG)	southern bog lemming (RG)
wood frog (RG)	whip-poor-will (SC, PIF1, S3, $SGCN^{HP}$)	Indiana bat (E, S1, $SGCN^{HP}$)
spotted salamander (RG)	eastern wood-pewee (PIF2)	black bear (RG)
Jefferson salamander (SC)	Acadian flycatcher (PIF2, S3)	bobcat (RG)
blue-spotted salamander (SC, $SGCN^{HP}$)	wood thrush (PIF1, SGCN)	New England cottontail (SC, S1S2, $SGCN^{HP}$)
marbled salamander (SC, S3, SGCN)	hermit thrush (RG)	fisher (RG)

UPLAND CONIFER FOREST

Plants	***Vertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
red pinesap (S3?, RG)	American woodcock (SGCN)	Blackburnian warbler (RG)
Vertebrates	long-eared owl (S2S3, SGCN)	pine siskin (RG)
blue -spotted salamander (SC, $SGCN^{HP}$)	barred owl (RG)	evening grosbeak (RG)
Cooper's hawk (SC, S4)	red-breasted nuthatch (RG)	purple finch (RG)
sharp-shinned hawk (SC, S4)	black-throated green warbler (RG)	

COOL RAVINE

Plants	***Plants*** *(cont.)*	***Vertebrates*** *(cont.)*
purple cliffbrake (RG)	hobblebush (RG)	winter wren (RG)
walking fern (RG)	mountain maple (RG)	black-throated green warbler (RG)
plantain sedge (RG)	leatherwood (RG)	Blackburnian warbler (RG)
spikenard (RG)	American yew (RG)	Louisiana waterthrush (PIF2, SGCN)
American ginseng (RG)	***Vertebrates***	dark-eyed junco (RG)
bunchberry (RG)	Acadian flycatcher (PIF2, S3)	woodland jumping mouse (RG)
fly honeysuckle (RG)	blue-headed vireo (RG)	

(continue)

Appendix C. (cont.)

RED CEDAR WOODLAND

Plants	***Vertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
Carolina whitlow-grass (T, S2)	wood turtle (SC, S3, SGCN^{HP})	short-eared owl (E, S2, SGCN^{HP})
yellow wild flax (T, S2)	spotted turtle (SC, S3, SGCN^{HP})	whip-poor-will (SC, PIF1, S3, SGCN^{HP})
rough pennyroyal (T, S2S3)	eastern box turtle (SC, S3, SGCN^{HP})	eastern bluebird (RG)
Bicknell's sedge (R, S3)	eastern hognose snake (SC, S3, SGCN^{HP})	brown thrasher (PIF2, S3S4B, SGCN^{HP})
American alumroot (R, S3)	ruffed grouse (SGCN)	golden-winged warbler (SC, PIF1, S3, SGCN^{HP})
Invertebrates	black-billed cuckoo (PIF1, SGCN)	blue-winged warbler (PIF2, SGCN)
olive hairstreak (butterfly) (RG)	northern saw-whet owl (PIF2, S3)	eastern towhee (PIF2)
	long-eared owl (S3, SGCN)	

NON-CALCAREOUS CREST/LEDGE/TALUS

Plants	***Invertebrates*** *(cont.)*	***Vertebrates*** (cont.)
mountain spleenwort (T, S2S3)	brown elfin (butterfly) (RG)	northern copperhead (S3, SGCN)
Bicknell's sedge (R, S3)	olive hairstreak (butterfly) (RG)	turkey vulture (RG)
bronze sedge (RG)	northern hairstreak (butterfly) (S2S4, SGCN)	whip-poor-will (SC, PIF1, S3, SGCN^{HP})
clustered sedge (T, S2S3)	gray hairstreak (butterfly) (RG)	black vulture
reflexed sedge (T, S2S3)	Horace's duskywing (butterfly) (RG)	common raven (RG)
blunt-leaf milkweed (RG)	swarthy skipper (butterfly) (RG)	winter wren (RG)
rock sandwort (RG)	Leonard's skipper (butterfly) (RG)	eastern bluebird (RG)
goat's-rue (RG)	dusted skipper (butterfly) (S2S3)	hermit thrush (RG)
slender knotweed (R, S3)	***Vertebrates***	blackburnian warbler (RG)
dittany (RG)	Fowler's toad (SGCN)	cerulean warbler (SC, PIF1, S3?B, SGCN)
Torrey's mountain-mint (E, S1)	northern slimy salamander (RG)	worm-eating warbler (PIF1, SGCN)
stiff-leaf aster (RG)	marbled salamander (SC, S3, SGCN)	small-footed bat (SC, S1S3, SGCN)
Invertebrates	eastern box turtle (SC, S3, SGCN^{HP})	boreal redback vole (RG)
Edward's hairstreak (butterfly) (S3S4)	eastern ratsnake (SGCN)	fisher (RG)
striped hairstreak (butterfly) (RG)	northern black racer (SGCN)	bobcat (RG)
	eastern hognose snake (SC, S3, SGCN^{HP})	

CALCAREOUS CREST/LEDGE/TALUS

Plants	***Plants*** *(cont.)*	***Invertebrates***
purple cliffbrake (RG)	Carolina whitlow-grass (T, S2)	anise millipede (RG)
smooth cliffbrake (T, S2)	whorled milkweed (R, S3)	olive hairstreak (butterfly) (RG)
walking fern (RG)	Allegheny-vine (RG)	***Vertebrates***
wall-rue (RG)	yellow corydalis (R, S3)	eastern hognose snake (SC, S3, SGCN^{HP})
side-oats grama (E, S2)	basil mountain-mint (E, S1)	northern black racer (SGCN)
Emmons's sedge (R, S3)	pellitory (RG)	eastern ratsnake (SGCN)
Bicknell's sedge (R, S3)	northern blazing-star (T, S2)	northern copperhead (S3, SGCN)
yellow wild flax (T, S2)	small-flowered crowfoot (R, S3)	
	roundleaf dogwood (RG)	

CREST OAK WOODLAND, CREST HICKORY WOODLAND, AND TALUS SLOPE WOODLAND

Plants	***Invertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
mountain spleenwort (T, S2S3)	Leonard's skipper (butterfly) (RG)	Nashville warbler (RG)
bronze sedge (RG)	Edward's hairstreak (butterfly) (S3S4)	prairie warbler (PIF1, SGCN)
clustered sedge (T, S2S3)	***Vertebrates***	worm-eating warbler (PIF1, SGCN)
bearberry (RG)	five-lined skink (RG)	eastern towhee (PIF2)
three-toothed cinquefoil (RG)	copperhead (S3, SGCN)	field sparrow (PIF2)
dwarf shadbush (RG)	timber rattlesnake (T, S3, SGCN^{HP})	vesper sparrow (SC, PIF2, S3, SGCN^{HP})
rusty woodsia (RG)	turkey vulture (RG)	small-footed bat (SC, S1S3, SGCN)
Invertebrates	whip-poor-will (SC, PIF1, S3, SGCN^{HP})	fisher (RG)
brown elfin (butterfly) (RG)	common raven (RG)	bobcat (RG)
northern hairstreak (RG)	hermit thrush (RG)	

(continued)

Appendix C. (cont.)

OAK-HEATH BARREN

Plants
bronze sedge (RG)
clustered sedge (T, S2S3)
Greene's rush (RG)
Appalachian cherry (RG)
dwarf shadbush (RG)
rusty woodsia (RG)
winged sumac (RG)
Invertebrates
brown elfin (butterfly) (RG)
cobweb skipper (butterfly) (RG)
Leonard's skipper (butterfly) (RG)
Edward's hairstreak (butterfly) (S3S4)
Vertebrates
copperhead (S3, SGCN)
timber rattlesnake (T, S3, SGCN^{HP})
turkey vulture (RG)
golden eagle (E, SHB, S1N, SGCN)
whip-poor-will (SC, PIF1, S3, SGCN^{HP})
common raven (RG)
hermit thrush (RG)
Nashville warbler (RG)
prairie warbler (PIF1, SGCN)
eastern towhee (PIF2)
field sparrow (PIF2)
vesper sparrow (SC, PIF2, S3, SGCN^{HP})

MARBLE KNOLL AND RED CEDAR BARREN

Plants
purple cliffbrake (RG)
walking fern (RG)
side-oats grama (E, S2)
Indian grass (RG)
Bicknell's sedge (R, S3)
Virginia false gromwell (E, S1)
Carolina whitlow-grass (T, S2)
yellow wild flax (T, S2)
green milkweed (T, S2)
northern blazing star (T, S2)
lily-leaved twayblade (E, S1)
Torrey's mountain mint (E, S1)
Vertebrates
eastern spadefoot toad (SC, S2S3, SGCN)
eastern box turtle (SC, S3, SGCN^{HP})
eastern hognose snake (SC, S3, SGCN^{HP})
northern saw-whet owl (PIF2, S3)

UPLAND SHRUBLAND

Plants
stiff flat-topped goldenrod (T, S2)
shrubby St. Johnswort (T, S2)
butterflyweed (RG)
Invertebrates
Aphrodite fritillary (butterfly) (RG)
dusted skipper (butterfly) (S2S3)
Leonard's skipper (butterfly) (RG)
Vertebrates
wood frog (RG)
spotted turtle (SC, S3, SGCN^{HP})
Vertebrates (cont.)
eastern box turtle (SC, S3, SGCN^{HP})
wood turtle (SC, S3, SGCN^{HP})
northern harrier (T, PIF2, S3, S3N, SGCN)
ruffed grouse (SGCN)
black-billed cuckoo (PIF1, SGCN)
short-eared owl (E, S2, SGCN^{HP})
northern saw-whet owl (PIF2, S3)
whip-poor-will (SC, PIF1, S3, SGCN^{HP})
brown thrasher (PIF2, S3S4B, SGCN^{HP})
loggerhead shrike (E, S1, SGCN^{HP})
Vertebrates (cont.)
white-eyed vireo (RG)
blue-winged warbler (PIF2, SGCN)
golden-winged warbler (SC, PIF1, S3, SGCN^{HP})
prairie warbler (PIF1, SGCN)
vesper sparrow (SC, PIF2, S3, SGCN^{HP})
field sparrow (PIF2)
grasshopper sparrow (SC, PIF2, S3, SGCN^{HP})
eastern towhee (PIF2)
New England cottontail (SC, S1S2, SGCN^{HP})

UPLAND MEADOW

Plants
small-flowered agrimony (R, S3)
Bush's sedge (R, S3)
Invertebrates
Baltimore checkerspot (butterfly) (RG)
meadow fritillary (butterfly) (RG)
Aphrodite fritillary (butterfly) (RG)
dusted skipper (butterfly) (S2S3)
Invertebrates (cont.)
swarthy skipper (butterfly) (RG)
Leonard's skipper (butterfly) (RG)
Vertebrates
spotted turtle (SC, S3, SGCN^{HP})
eastern box turtle (SC, S3, SGCN^{HP})
wood turtle (SC, S3, SGCN^{HP})
northern harrier (T, PIF2, S3N, SGCN)
Vertebrates (cont.)
golden eagle (E, SHB, S1N, SGCN)
eastern bluebird (RG)
savannah sparrow (RG)
vesper sparrow (SC, PIF2, S3, SGCN^{HP})
grasshopper sparrow (SC, PIF2, S3, SGCN^{HP})
bobolink (PIF1, SGCN^{HP})
eastern meadowlark (PIF2, SGCN^{HP})

WASTE GROUND

Plants
hair-rush (RG)
toad rush (RG)
orangeweed (RG)
field dodder (E, S1)
slender pinweed (T, S2)
rattlebox (E, S1)
blunt mountain-mint (T, S2S3)
Plants (cont.)
slender knotweed (R, S3)
Vertebrates
Fowler's toad (SGCN)
spotted turtle (SC, S3, SGCN^{HP})
wood turtle (SC, S3, SGCN^{HP})
eastern hognose snake (SC, S3, SGCN^{HP})
northern copperhead (S3, SGCN)
Vertebrates (cont.)
American black duck (S3, SGCN^{HP})
belted kingfisher (RG)
common nighthawk (SC, S2S3, SGCN^{HP})
common raven (RG)
bank swallow (RG)
grasshopper sparrow (SC, PIF2, S3, SGCN^{HP})

(continued)

Appendix C. (cont.)

SWAMP

Plants	***Vertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
swamp cottonwood (T, S2)	four-toed salamander (RG, SGCN^{HP})	American woodcock (SGCN)
swamp lousewort (T, S2S3)	spotted turtle (SC, S3, SGCN^{HP})	white-eyed vireo (RG)
winged monkey-flower (R, S3)	wood turtle (SC, S3, SGCN^{HP})	eastern bluebird (RG)
wood horsetail (RG)	eastern box turtle (SC, S3, SGCN^{HP})	Canada warbler (PIF1, SGCN^{HP})
false hop sedge (T, S2)	great blue heron (RG)	northern waterthrush (RG)
Invertebrates	American bittern (SC, S4, SGCN)	
phantom cranefly (RG)	Virginia rail (RG)	
Vertebrates	red-shouldered hawk (SC, S4B, SGCN)	
blue-spotted salamander (SC, SGCN^{HP})	barred owl (RG)	

ACIDIC BOG

Plants	***Plants*** *(cont.)*	***Invertebrates*** *(cont.)*
Virginia chain fern (RG)	spatulate-leaved sundew (RG)	ringed bog haunter (dragonfly) (SH)
tawny cottongrass (RG)	small cranberry (RG)	***Vertebrates***
pod-grass (R, S3)	large cranberry (RG)	wood frog (RG)
dragon's mouth orchid (T, S2)	***Invertebrates***	four-toed salamander (RG, SGCN^{HP})
rose pogonia (RG)	bog copper (butterfly) (RG)	eastern bluebird (RG)
grass-pink (RG)	pitcher-plant borer (moth) (RG)	golden-winged warbler (SC, PIF1, S3, SGCN^{HP})
white-fringed orchid (RG)	pitcher plant moth (RG)	Nashville warbler (RG)
pitcher-plant (RG)	subarctic darner (dragonfly) (S1, SGCN^{P})	Canada warbler (RG, PIF1, SGCN^{HP})
round-leaved sundew (RG)	ebony bog haunter (dragonfly) (S1, SGCN^{P})	northern waterthrush (RG)
		southern bog lemming (RG)

INTERMITTENT WOODLAND POOL

Plants	***Vertebrates***	***Vertebrates*** *(cont.)*
Virginia chain fern (RG)	wood frog (RG)	wood turtle (SC, S3, SGCN^{HP})
false hop sedge (T, S2)	Jefferson salamander (SC)	American black duck (S3, SGCN^{HP})
featherfoil (T, S2)	marbled salamander (SC, S3, SGCN)	northern waterthrush (RG)
Invertebrates	four-toed salamander (RG, SGCN^{HP})	
black dash (butterfly) (RG)	spotted salamander (RG)	
mulberry wing (butterfly) (RG)	spotted turtle (SC, S3, SGCN^{HP})	
springtime physa (snail) (RG)		

BUTTONBUSH POOL

Plants	***Vertebrates***	***Vertebrates*** *(cont.)*
Helodium paludosum (moss) (RG)	wood frog (RG)	spotted salamander (RG)
pale alkali-grass (RG)	blue-spotted salamander (SC, SGCN^{HP})	spotted turtle (SC, S3, SGCN^{HP})
short-awned foxtail (RG)	Jefferson salamander (SC)	common ribbon snake (SGCN)
buttonbush dodder (E, S1)	marbled salamander (SC, S3, SGCN)	American black duck (S3, SGCN^{HP})

MARSH

Plants	***Vertebrates***	***Vertebrates*** *(cont.)*
winged monkey-flower (R, S3)	northern cricket frog (E, S1, SGCN^{HP})	pied-billed grebe (T, S3, S1N, SGCN)
smartweed dodder (E, S1)	northern leopard frog (RG)	American black duck (S3, SGCN^{HP})
Invertebrates	spotted turtle (SC, S3, SGCN^{HP})	northern harrier (T, PIF2, S3, S3N, SGCN)
black dash (butterfly) (RG)	American bittern (SC, S4, SGCN)	Virginia rail (RG)
bronze copper (butterfly) (RG)	least bittern (T, S3, S1N, SGCN)	common moorhen (RG)
mulberry wing (butterfly) (RG)	great blue heron (RG)	marsh wren (RG)

(continued)

Appendix C. (cont.)

WET MEADOW

Invertebrates	***Invertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
Baltimore checkerspot (butterfly) (RG)	eyed brown (butterfly) (RG)	American bittern (SC, S4, SGCN)
mulberry wing (butterfly) (RG)	Milbert's tortoiseshell (butterfly) (RG)	northern harrier (T, PIF2, S3, S3N, SGCN)
black dash (butterfly) (RG)	phantom cranefly (RG)	Virginia rail (RG)
two-spotted skipper (butterfly) (RG)	***Vertebrates***	
meadow fritillary (butterfly) (RG)	common ribbon snake (RG, SGCN)	American woodcock (SGCN)
bronze copper (butterfly) (RG)	spotted turtle (SC, S3, SGCN^{HP})	southern bog lemming (RG)

FEN/CALCAREOUS WET MEADOW

Plants	***Plants*** *(cont.)*	***Invertebrates*** *(cont.)*
wood horsetail (RG)	prairie loosestrife (E, S1)	phantom cranefly (RG)
twig-rush (RG)	swamp lousewort (T, S2S3)	eyed brown (butterfly) (RG)
Schweinitz's sedge (T, S2S3)	round-leaved sundew (RG)	silver-bordered fritillary (butterfly) (RG)
handsome sedge (T, S2)	southern yellow flax (T, S2)	two-spotted skipper (butterfly) (RG)
Bush's sedge (R, S3)	bog valerian (E, S1S2)	Dion skipper (butterfly) (S3)
ovate spikerush (E, S1S2)	buckbean (RG)	Baltimore checkerspot (butterfly) (RG)
slender lady's-tresses (RG)	swamp birch (T, S2)	mulberry wing (butterfly) (RG)
rose pogonia (RG)	alder-leaf buckthorn (RG)	black dash (butterfly) (RG)
showy ladyslipper (RG)	hidden spikemoss (E, S1)	***Vertebrates***
spreading globeflower (R, S3)	prairie wedge-grass (E, S1)	northern leopard frog
scarlet Indian paintbrush (E, S1)	***Invertebrates***	bog turtle (E, S2, SGCN^{HP})
grass-of-Parnassus (RG)	*Gammarus pseudolimnaeus* (amphipod) (RG)	spotted turtle (SC, S3, SGCN^{HP})
Kalm's lobelia (RG)	*Pomatiopsis lapidaria* (snail) (RG)	common ribbon snake (SGCN)
bushy aster (T, S2)	forcipate emerald (dragonfly) (S1, SGCN^{P})	northern harrier (T, PIF2, S3, S3N, SGCN)

OPEN WATER/CONSTRUCTED POND

Vertebrates	***Vertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
northern cricket frog (E, S1, SGCN^{HP})	American bittern (SC, S4, SGCN)	pied-billed grebe (T, S3, S1N, SGCN)
spotted turtle (SC, S3, SGCN^{HP})	great blue heron (RG)	osprey (SC, SGCN)
wood turtle (SC, S3, SGCN^{HP})	American black duck (S3, SGCN^{HP})	bald eagle (T, S2S3, SGCN)
		river otter (SGCN)

SPRING/SEEP

Plants	***Invertebrates***	***Vertebrates***
Bush's sedge (R, S3)	Piedmont groundwater amphipod (SGCN)	northern dusky salamander (RG)
devil's-bit (T, S1S2)	gray petaltail (dragonfly) (SC, S2, SGCN)	tiger spiketail (dragonfly) (S1, SGCN)

STREAM & RIPARIAN CORRIDOR

Plants	***Invertebrates*** *(cont.)*	***Vertebrates*** *(cont.)*
winged monkey-flower (R, S3)	*Pisidium adamsi* (fingernail clam) (RG)	northern dusky salamander (RG)
riverweed (T, S2)	*Sphaerium fabale* (fingernail clam) (RG)	wood turtle (SC, S3, SGCN^{HP})
goldenseal (T, S2)	arrowhead spiketail (dragonfly) (S2S3, SGCN)	great blue heron (RG)
cattail sedge (T, S1)	mocha emerald (dragonfly) (S2S3, SGCN)	American black duck (S3, SGCN^{HP})
Davis's sedge (T, S2)	sable clubtail (dragonfly) (S1, SGCN)	American woodcock (SGCN)
smartweed dodder (E, S1)	ostrich fern borer (moth) (SGCN)	bank swallow (RG)
false-mermaid (RG)	***Vertebrates***	winter wren (RG)
swamp rose-mallow (RG)	creek chubsucker (fish) (RG)	cerulean warbler (SC, PIF1, SGCN)
may-apple (RG)	bridle shiner (fish) (RG)	Louisiana waterthrush (SGCN)
Invertebrates	brook trout (SGCN)	river otter (SGCN)
Marstonia decepta (snail) (RG)	slimy sculpin (fish) (RG)	Indiana bat (E, S1, SGCN)
brook floater (mussel) (T, S1, SGCN)	northern leopard frog	

Appendix D. Common and scientific names of plants mentioned in this report. Most scientific names follow the nomenclature of Weldy et al. (2020).

Common Name	Scientific Name	Common Name	Scientific Name
agrimony, small-flowered	*Agrimonia parviflora*	buckthorn, common	*Rhamnus cathartica*
alder	*Alnus*	bulrush, pendulous	*Scirpus pendulus*
alkali-grass, pale	*Puccinellia distans*	bur-reed	*Sparganium*
Alexanders, golden	*Zizea aurea*	butterflyweed	*Asclepias tuberosa* ssp. *interior*
Allegheny-vine	*Adlumia fungosa*	butternut	*Juglans cinerea*
alumroot, American	*Heuchera americana*	buttonbush	*Cephalanthus occidentalis*
arrowhead, broad-leaved	*Sagittaria latifolia*	canary-grass, reed	*Phalaris arundinacea*
arrowwood, northern	*Viburnum dentatum* var. *lucidum*	campion, bladder	*Silene vulgaris*
arum, arrow	*Peltandra virginica*	cattail	*Typha*
ash, black	*Fraxinus nigra*	cedar, eastern red	*Juniperus virginiana* var. *virginiana*
ash, green	*Fraxinus pennsylvanica*	cherry, Appalachian	*Prunus susquehanae*
ash, white	*Fraxinus americana*	cherry, black	*Prunus serotina*
aspen, quaking	*Populus tremuloides*	chokeberry	*Aronia*
aspen, big-toothed	*Populus grandidentata*	chokeberry, black	*Aronia melanocarpa*
aster, northern bog	*Symphyotrichum boreale*	cinquefoil, shrubby	*Dasiphora fruticosa*
aster, purple stemmed	*Symphyotrichum patens*	cliffbrake, purple	*Pellaea atropurpurea*
aster, stiff-leaved	*Ionactis linariifolia*	cliffbrake, smooth	*Pellaea glabella* ssp. *glabella*
aster, white wood	*Eurybia divaricata*	clover, white sweet	*Melilotus albus*
autumn-olive	*Elaeagnus umbellata*	cohosh, blue	*Caulophyllum thalictroides*
azalea, swamp	*Rhododendron viscosum*	columbine, wild	*Aquilegia canadensis*
baneberry, red	*Actaea rubra*	corydalis, yellow	*Corydalis flava*
baneberry, white	*Actaea pachypoda*	cottongrass, tawny	*Eriophorum virginicum*
barberry, Japanese	*Berberis thunbergii*	cottongrass, tussock	*Eriophorum vaginatum*
basswood, American	*Tilia americana* var. *americana*	cottonwood, eastern	*Populus deltoides*
beak-sedge, hair	*Rhynchospora capillacea*	cottonwood, swamp	*Populus heterophylla*
beggar-ticks	*Bidens*	cow-wheat	*Melampyrum lineare*
birch, black	*Betula lenta*	cranberry, large	*Vaccinium macrocarpon*
birch, gray	*Betula populifolia*	cranberry, small	*Vaccinium oxycoccus*
birch, swamp	*Betula pumila*	crowfoot, small-flowered	*Ranunculus micranthus*
birch, yellow	*Betula allegheniensis*	cut-grass, rice	*Leersia oryzoides*
bittersweet, oriental	*Celastrus orbiculatus*	dandelion, Virginia dwarf	*Krigia virginica*
blackberry, northern	*Rubus allegheniensis*	deerberry	*Vaccinium stamineum*
black tupelo	*Nyssa sylvatica*	devil's-bit	*Chamaelirium luteum*
bladdernut	*Staphylea trifolia*	dittany	*Cunila origanoides*
blazing-star, northern	*Liatris scariosa* var. *novae-angliae*	dodder, buttonbush	*Cuscuta cephalanthi*
bloodroot	*Sanguinaria canadensis*	dodder, field	*Cuscuta campestris*
blueberry, highbush	*Vaccinium corymbosum*	dodder, smartweed	*Cuscuta polygonorum*
blueberry, early lowbush	*Vaccinium pallidum*	dogwood, gray	*Cornus foemina* ssp. *racemosa*
blueberry, late lowbush	*Vaccinium angustifolium*	dogwood, red-osier	*Cornus sericea* ssp. *sericea*
bluegrass, Kentucky	*Poa pratensis* ssp. *pratensis*	dogwood, roundleaf	*Cornus rugosa*
bluestem, big	*Andropogon gerardii*	dogwood, silky	*Cornus amomum* ssp. *obliqua*
bluestem, little	*Schizachyrium scoparium* var. *scoparium*	dragon, green	*Arisaema dracontium*
breeches, Dutchman's	*Dicentra cucullaria*	duckweed, common	*Spirodela polyrrhiza*
brome, fringed	*Bromus ciliatus*	duckweed, lesser	*Lemna minor*
buckbean	*Menyanthes trifoliata*	elder, red-berried	*Sambucus racemosa*
buckthorn, alder-leaved	*Rhamnus alnifolia*	elm, American	*Ulmus americana*

(continued)

Appendix D (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
elm, slippery	*Ulmus rubra*	hair-rush	*Bulbostylis capillaris* ssp. *capillaris*
enchanter's-nightshade, dwarf	*Circaea alpina* ssp. *alpina*	harebell	*Campanula rotundifolia*
fairywand	*Chamaelirium luteum*	hawthorn	*Crataegus*
false-mermaid	*Floerkea proserpinacoides*	hemlock, eastern	*Tsuga canadensis*
false-nettle	*Boehmeria cylindrica*	hempweed, climbing	*Mikania scandens*
featherfoil	*Hottonia inflata*	hickory, pignut	*Carya glabra*
fern, bracken	*Pteridium aquilinum* var. *latiusculum*	hickory, shagbark	*Carya ovata*
fern, broad beech	*Phegopteris hexagonoptera*	hobblebush	*Viburnum lantanoides*
fern, cinnamon	*Osmunda cinnamomea*	holly, mountain	*Nemopanthus mucronatus*
fern, fragile	*Cystopteris fragilis*	holly, winterberry	*Ilex verticillata*
fern, maidenhair	*Adiantum pedatum*	honeysuckle, Bell's	*Lonicera* x *bella*
fern, marginal wood	*Dryopteris marginalis*	honeysuckle, fly	*Diervilla lonicera*
fern, marsh	*Thelypteris palustris* var. *pubescens*	horsetail, wood	*Equisetum sylvaticum*
fern, New York	*Thelypteris noveboracensis*	huckleberry, black	*Gaylussacia baccata*
fern, ostrich	*Matteuccia struthiopteris*	iris, yellow	*Iris pseudacorus*
fern, royal	*Osmunda regalis*	ironweed, New York	*Vernonia noveboracensis*
fern, sensitive	*Onoclea sensibilis*	Jack-in-the-pulpit	*Arisaema triphyllum*
fern, Virginia chain	*Woodwardia virginica*	jewelweed, common	*Impatiens capensis*
flag, blue	*Iris versicolor*	Joe-Pye-weed, spotted	*Eutrochium maculatum* var. *maculatum*
flax, yellow wild	*Linum sulcatum*	knapweed, spotted	*Centaurea stoebe* ssp. *micranthos*
foxtail, short-awned	*Alopecurus aequalis* var. *aequalis*	knotweed, Japanese	*Fallopia japonica* var. *japonica*
garlic-mustard	*Alliaria petiolata*	knotweed, slender	*Polygonum tenue*
gentian, fringed	*Gentianopsis crinita*	lady's-tresses, slender	*Spiranthes lacera* var. *gracilis*
ginseng, American	*Panax quinquefolius*	lady's-slipper, showy	*Cypripedium reginae*
globeflower, spreading	*Trollius laxus*	laurel, mountain	*Kalmia latifolia*
goat's-rue	*Tephrosia virginiana*	leatherleaf	*Chamaedaphne calyculata*
goldenrod	*Solidago*	leatherwood	*Dirca palustris*
goldenrod, bog	*Solidago uliginosa*	lobelia, common spiked	*Lobelia spicata*
goldenrod, Canada	*Solidago canadensis* var. *canadensis*	lobelia, Kalm's	*Lobelia kalmii*
goldenrod, downy	*Solidago puberula*	locust, black	*Robinia pseudoacacia*
goldenrod, rough-leaved	*Solidago patula* ssp. *patula*	lopseed	*Phryma leptostachya*
goldenrod, smooth	*Solidago gigantea*	looking-glass, Venus's	*Triodanis perfoliata*
goldenrod, stiff flat-topped	*Solidago rigida*	loosestrife, purple	*Lythrum salicaria*
goldenrod, tall	*Solidago altissima* ssp. *altissima*	lousewort, eastern	*Pedicularis canadensis*
goldenrod, wrinkle-leaved	*Solidago rugusa* var. *rugosa*	lousewort, swamp	*Pedicularis lanceolata*
goldenseal	*Hydrastis canadensis*	maleberry	*Lyonia ligustrina*
goldthread	*Coptis trifolia*	mannagrass	*Glyceria*
grama, side-oats	*Bouteloua curtipendula* var. *curtipendula*	maple, mountain	*Acer spicatum*
grass-of-Parnassus	*Parnassia glauca*	maple, red	*Acer rubrum*
grass-pink	*Calopogon tuberosus* var. *tuberosus*	maple, striped	*Acer pensylvanicum*
grass, Indian	*Sorghastrum nutans*	maple, sugar	*Acer saccharum*
grass, sweet vernal	*Anthoxanthum odoratum*	marigold, marsh	*Caltha palustris*
hackberry, northern	*Celtis occidentalis*	may-apple	*Podophyllum peltatum*
hairgrass, common	*Avenela flexuosa*	meadow-rue, early	*Thalictrum dioicum*

(continued)

Appendix D (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
meadowsweet	*Spiraea alba* var. *latifolia*	rock-cress, hairy	*Arabis hirsuta* var. *pycnocarpa*
milkweed, blunt-leaved	*Asclepias amplexicaulis*	rock-cress, lyre-leaved	*Arabidopsis lyrata* ssp. *lyrata*
milkweed, green	*Asclepias viridiflora*	rose-mallow, swamp	*Hibiscus moscheutos* ssp. *moscheutos*
milkweed, poke	*Asclepias exaltata*	rose, multiflora	*Rosa multiflora*
milkweed, swamp	*Asclepias incarnata* ssp. *incarnata*	rush, Greene's	*Juncus greenei*
milkweed, whorled	*Asclepias verticillata*	rush, soft	*Juncus effusus*
mitrewort, two-leaved	*Mitella diphylla*	sandwort, rock	*Sabulina michauxii* var. *michauxii*
monkey-flower, winged	*Mimulus alatus*	sarsaparilla, wild	*Aralia nudicaulis*
(a moss)	*Helodium paludosum*	saxifrage, golden	*Chrysosplenium americanum*
moss, peat	*Sphagnum*	scouring rush, variegated	*Equisetum variegatum*
mountain-mint, blunt	*Pycnanthemum muticum*	Appalachian sedge	*Carex appalachica*
mountain-mint, Torrey's	*Pycnanthemum torrei*	sedge, Back's	*Carex backii*
oak, black	*Quercus velutina*	sedge, Bicknell's	*Carex bicknellii*
oak, bur	*Quercus macrocarpa*	sedge, bristle-leaved	*Carex eburnea*
oak, chestnut	*Quercus montana*	sedge, bronze	*Carex foenea*
oak, chinquapin	*Quercus muehlenbergii*	sedge, Bush's	*Carex bushii*
oak, pin	*Quercus palustris*	sedge, cattail	*Carex typhina*
oak, red	*Quercus rubra*	sedge, clustered	*Carex cumulata*
oak, scarlet	*Quercus coccinea*	sedge, Davis's	*Carex davisii*
oak, scrub	*Quercus ilicifolia*	sedge, Emmons's	*Carex albicans* var. *emmonsii*
oak, swamp white	*Quercus bicolor*	sedge, false hop	*Carex lupuliformis*
oak, white	*Quercus alba*	sedge, glaucous	*Carex flacca*
orange-grass	*Hypericum gentianoides*	sedge, hairy-fruited	*Carex trichocarpa*
orchid, dragon's mouth	*Arethusa bulbosa*	sedge, handsome	*Carex formosa*
orchid, large purple-fringed	*Platanthera grandiflora*	sedge, hop	*Carex lupulinus*
orchid, little club spur	*Platanthera clavellata*	sedge, inland	*Carex interior*
orchid, northern green bog	*Platanthera aquilonis*	sedge, lakeside	*Carex lacustris*
orchid, showy	*Galearis spectabilis*	sedge, Pennsylvania	*Carex pensylvanica*
orchid, white-fringed	*Platanthera blephariglottis* var. *blephariglottis*	sedge, plantain	*Carex plantaginifolia*
paintbrush, scarlet Indian	*Castilleja coccinea*	sedge, porcupine	*Carex hystericina*
pellitory	*Parietaria pennsylvanica*	sedge, reflexed	*Carex retroflexa*
pine, pitch	*Pinus rigida*	sedge, ribbed	*Carex virescens*
pine, eastern white	*Pinus strobus*	sedge, rigid	*Carex tetanica*
pinesap, red	*Hypopithys lanuginosa*	sedge, Schweinitz's	*Carex schweinitzii*
pinweed, slender	*Lechea tenuifolia*	sedge, sterile	*Carex sterilis*
pitcher-plant	*Sarracenia purpurea*	sedge, Swan's	*Carex swanii*
plaintain, Robin's	*Erigeron pulcheris*	sedge, tussock	*Carex stricta*
pod-grass	*Scheuchzeria americana*	sedge, woolly-fruited	*Carex lasiocarpa* ssp. *americana*
pogonia, rose	*Pogonia ophioglossoides*	sedge, yellow	*Carex flava*
polypody, rock	*Polypodium virginianum*	serviceberry, downy	*Amelanchier arborea*
poplar, tulip	*Liriodendron tulipifera*	shadbush, dwarf	*Amelanchier spicata*
poverty-grass	*Danthonia spicata*	sheep-laurel	*Kalmia angustifolia*
prickly-ash, American	*Zanthoxylum americanum*	skunk-cabbage	*Symplocarpus foetidus*
privet	*Ligustrum*	snowberry, creeping	*Gaultheria procumbens*
pussytoes, field	*Antennaria neglecta*	Solomon's-seal, hairy	*Polygonatum pubescens*
ragwort, round-leaved	*Packera obovata*	Solomon's-seal, false	*Maianthemum racemosum*
raspberry, dwarf	*Rubus pubescens*	spicebush	*Lindera benzoin*
rattlebox	*Crotalaria sagittalis*	spike-moss, hidden	*Selaginella eclipes*
reed, common	*Phragmites australis*	spike-muhly	*Muhlenbergia glomerata*
reedgrass, wood	*Cinna arundinacea*	spikenard	*Aralia racemosa*
riverweed	*Podostemum ceratophyllum*	spikerush, ovate	*Eleocharis obtusa* var. *ovata*

(continued)

Appendix D (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
spleenwort, ebony	*Asplenium platyneuron* var. *platyneuron*	twayblade, lily-leaved	*Liparis liliifolia*
spleenwort, maidenhair	*Asplenium trichomanes* ssp. *trichomanes*	twig-rush	*Cladium mariscoides*
spleenwort, mountain	*Asplenium montanum*	valerian, bog	*Valeriana uliginosa*
spleenwort, silvery	*Deparia acrostichoides*	vervain, blue	*Verbena hastata* var. *hastata*
spruce, black	*Picea mariana*	viburnum, maple-leaved	*Viburnum acerifolium*
St. Johnswort, shrubby	*Hypericum prolificum*	violet	*Viola*
starflower	*Lysimachia borealis*	violet, marsh blue	*Viola cucullata*
sumac, winged	*Rhus copallinum*	wall-rue	*Asplenium ruta-muraria*
sundew, round-leaved	*Drosera rotundifolia*	water-plantain	*Alisma triviale*
sundew, spatulate-leaved	*Drosera intermedia*	water-shield	*Brasenia schreberi*
Susan, black-eyed	*Rudbeckia hirta*	wedge-grass, prairie	*Sphenopholis obtusata*
sweetfern	*Comptonia peregrina*	whitlow-grass, Carolina	*Tomostima reptans*
sweetflag	*Acorus*	willow	*Salix*
sycamore, eastern	*Platanus occidentalis*	willow, autumn	*Salix serissima*
tamarack	*Larix laricina*	willow, sage-leaved	*Salix candida*
toothwort, two-leaved	*Cardamine diphylla*	witch-hazel	*Hamamelis virginiana*
trillium, nodding	*Trillium cernuum*	woodsia, rusty	*Woodsia ilvensis*
trillium, purple	*Trillium erectum*	woolgrass	*Scirpus cyperinus*
tupelo, black	*Nyssa sylvatica*	yew, Canada	*Taxus canadensis*
twayblade, large	*Liparis loeselii*		