SIGNIFICANT HABITATS
IN THE TOWN OF CLINTON, DUTCHESS COUNTY, NEW YORK

Report to the Town of Clinton, the Hudson River Estuary Program, the Millbrook Tribute Garden, and the Dutchess Land Conservancy

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EXECUTIVE SUMMARY

Hudsonia biologists identified and mapped ecologically significant habitats in the Town of Clinton during the period spanning June 2011 through November 2012. Through map analysis, aerial photograph interpretation, and field observations we created a large-format map showing the locations and configurations of these habitats in 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 22 rocky barrens; extensive calcareous ledges; three acidic bogs; three circumneutral bog lakes; 257 intermittent woodland pools; five heath swamps; ten kettle shrub pools and 23 buttonbush pools; many extensive wetland complexes; seven areas of contiguous meadow greater than 100 acres (ac) (40 hectares [ha]); and extensive areas of contiguous forest, including four larger than 500 ac (200 ha).

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 ten areas in Clinton 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 and policy-making, and for site-specific environmental reviews.

The habitat map and report, which contain ecological information unavailable from other sources, can help the Town of Clinton 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.

INTRODUCTION

Background

Rural landscapes in Dutchess County and surrounding areas have been undergoing rapid change as farms, forests, and other undeveloped lands are converted to residential uses. Most of this development has occurred without knowledge of the biological resources that may be lost or harmed. The consequences include widespread habitat degradation, habitat fragmentation, loss of native biodiversity, and loss of ecosystem services to the human community.

Although many land-use decisions in the region 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 townwide habitat maps of ten Dutchess County towns—Amenia, Beekman, Clinton, East Fishkill, North East, Pine Plains, Poughkeepsie, Rhinebeck, Stanford, and Washington—and of sections of Dover, Hyde Park, Fishkill, and LaGrange; of the Town of Woodstock and part of the Town of Marbletown in Ulster County; and of other large areas in several other counties. These projects have been funded by a variety of private and public sources. Funding for the Clinton project was provided by a grant to the Town of Clinton from the Hudson River Estuary Program of the New York State Department of Environmental Conservation and by a grant to Hudsonia from the Millbrook Tribute Garden (a local family

foundation) through the Dutchess Land Conservancy. The Educational Foundation of America provided programmatic support to Hudsonia to further this and other Hudsonia projects. We received endorsement and assistance from the Clinton Conservation Advisory Council (CAC), the Town Board, and from many landowners. In addition, members of the Clinton CAC and other volunteers created a preliminary map of the town's habitats, which was an important source of information during our mapping work.

Biologist Christopher Graham conducted most of the work on this project from June 2011 through November 2012; biologist Kristen Bell Travis contributed to preliminary mapping, proofreading of map data, and map and report preparation; and Gretchen Stevens, director of Hudsonia's Biodiversity Resources Center, participated in all aspects and supervised the project. Through map analysis, aerial photograph interpretation, and field observations, we created a map of ecologically significant habitats in the Town of Clinton. Some of these habitats are rare or declining in the region, some may support rare species of plants or animals, while others are high quality examples of 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.

Hudsonia hopes to extend the habitat mapping program to other parts of southeastern New York. 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 (Stevens and Broadbent 2002, Tollefson and Stevens 2004, Bell et al. 2005, Sullivan and Stevens 2005, Tabak et al. 2006, Reinmann and Stevens 2007, Knab-Vispo et al. 2008, Tabak and Stevens 2008, Bell and Stevens 2009, Deppen et al. 2009, McGlynn et al. 2009, Tabak and Stevens 2009, Meyer and Stevens 2010, Haeckel et al. 2012) without specific attribution. This report, however, addresses our findings and specific recommendations for the Town of Clinton. 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, townwide, 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 Town of Clinton 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. Healthy 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 collapses in other parts of the ecosystem. While we do not fully understand the roles of all organisms in an ecosystem and cannot fully predict the consequences of the 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?

For the purposes of this project, 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 extinction 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 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 both common and uncommon 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 Clinton, the habitat map that accompanies this report provides valuable ecological information that can be incorporated into local land-use planning and decision making.

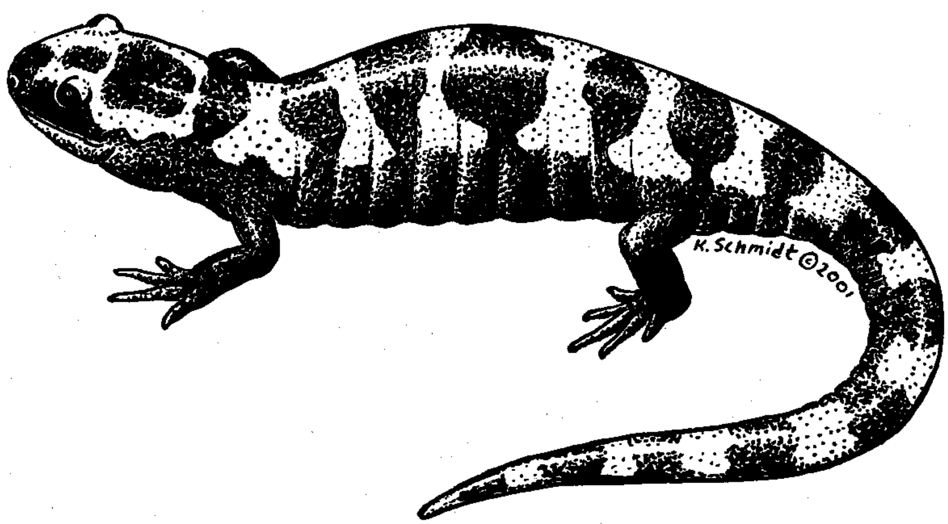
Study Area

The Town of Clinton is located in central Dutchess County in southeastern New York. It encompasses approximately 39 mi^2 (101 km^2) and has a population of roughly 4,300 residents

(2010 US Census). The town's landscape largely comprises rolling hills, low, rocky ridges, myriad wetlands, and stream valleys. All of the land in Clinton drains into the Hudson River, via one of four main tributaries (Figure 1). Little Wappinger Creek flows north to south, roughly dividing the town in half. A short stretch of Wappinger Creek flows through the southeast corner of Clinton and is joined by Little Wappinger Creek just south of the town line. Crum Elbow Creek forms much of the western town boundary. Several intermittent streams and one perennial stream in southwestern Clinton flow into Fallkill Creek, though the Fallkill itself does not flow through Clinton. Just west of Little Wappinger Creek in the northern half of town, a valley known as the Milan Window cradles three large natural water bodies: Long Pond, Mud Pond, and Silver Lake. The Elizaville thrust block, a layer of older metamorphic rocks that has been pushed up and over younger bedrock, underlies northwestern Clinton north of Schultz Hill Road. Elevations in Clinton range from 230 feet (ft) (70 meters [m]) above mean sea level along Little Wappinger Creek at the southern town boundary to 790 ft (240 m) at the top of Schultz Hill. Most areas with higher elevations (over 600 ft) are in the northeastern and northwestern parts of town. Large wetland complexes are scattered throughout the town, along streams and in glacial depressions.

The Milan Window is underlain by calcareous bedrock—limestone, dolostone, shale, and chert. This older bedrock has been exposed by erosion of the younger layers prevalent in the rest of Clinton. There is another strip of this older, calcareous bedrock in the southeast corner of town. Bedrock throughout the rest of town is potentially calcareous, and is composed of various combinations of shale, schist, argillite, chert, siltstone, slate, conglomerate, quartzite, and greywacke (Fisher et al. 1970); see Figure 2. The surficial material is primarily glacial till, and there are large areas of exposed or nearly exposed bedrock. Outwash sand and gravel occur in lower-lying areas (the southeast corner, the Milan Window, and some areas near Little Wappinger Creek), and recent alluvium along Wappinger and Little Wappinger creeks (Cadwell et al. 1989). Around the intersection of Hollow and Fiddlers Bridge roads, is a large kame—a glacially-deposited mound of sand, gravel, and till.

Primary land uses in Clinton are residential, equestrian uses, and agriculture (orchards, hayfields, pastures, and other farm uses). Other major uses include gravel mines, forestry for timber harvest, and hunting preserves for upland game and waterfowl. Residential development is fairly evenly distributed, with moderate concentrations around and south of the hamlet of Clinton Corners; around the intersection of Hollow Road and Route 9G; around the intersection of Centre, Bulls Head, and Slate Quarry roads; and in an area roughly bounded by Bulls Head Road, Nine Partners Road, and Centre Road in northeastern Clinton. Historical population centers—Frost Mills, Pleasant Plains, Clinton Hollow, Hibernia, Schultzville, and Bulls Head—were largely based around mills, and exist today as small clusters of houses. Agricultural activity is also distributed throughout the town, but is much more common south of Fiddlers Bridge Road, Schultzville Road, and Willow Lane. Most land parcels are fairly small (7 ac [2.8 ha] or less) and privately owned. There are 32 privately owned land parcels of 100 ac (40 ha) or more. About 380 ac (154 ha) are publicly owned (by the Town of Clinton and by New York State along the Taconic Parkway), and The Nature Conservancy, a private entity, owns 56 ac (23 ha; Zipfeldberg Bog).



Marbled salamander

Figure 1. Streams and primary watersheds in the Town of Clinton, Dutchess County, New York (Watershed data from Dutchess County Planning Department). Hudsonia Ltd., 2012.

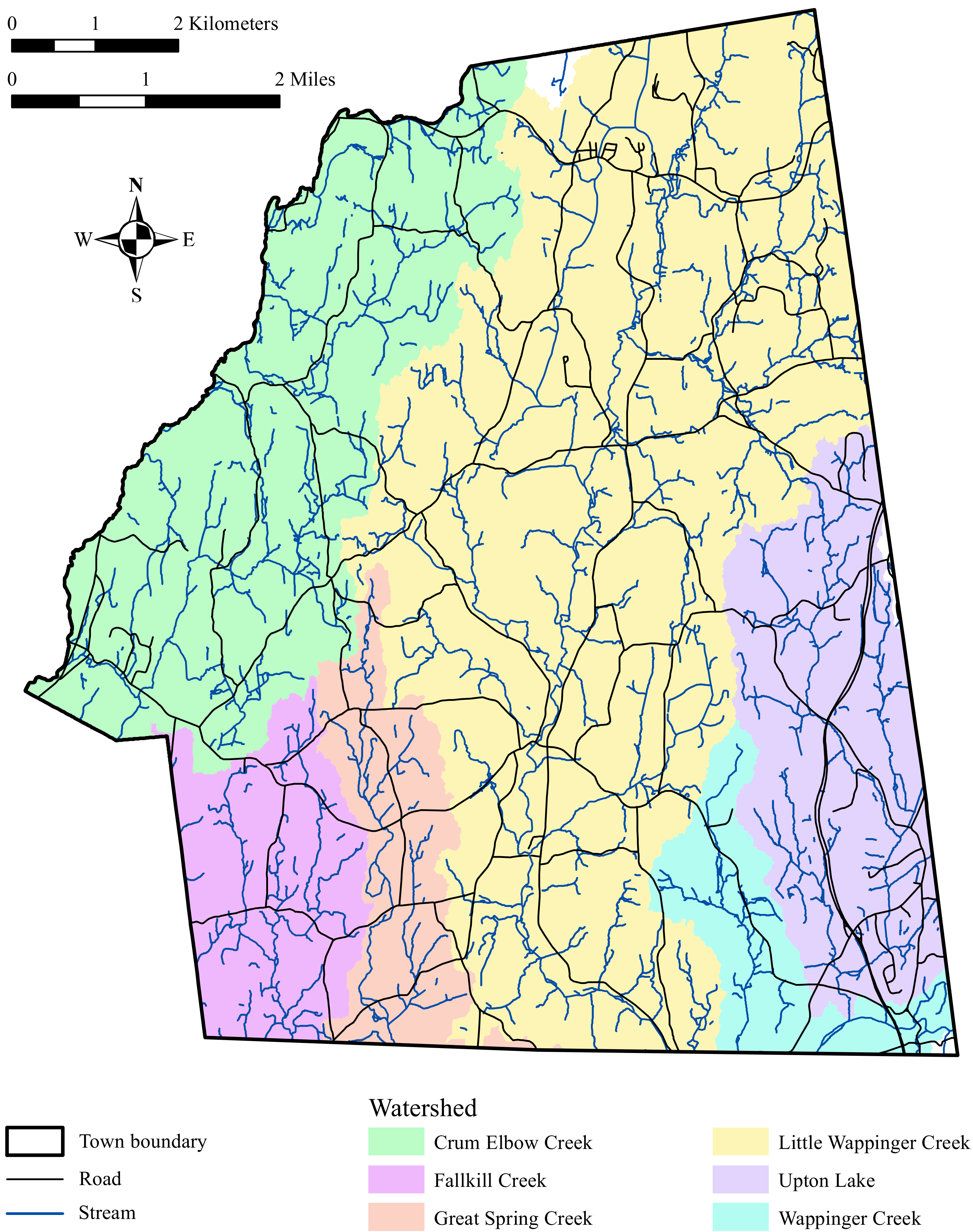
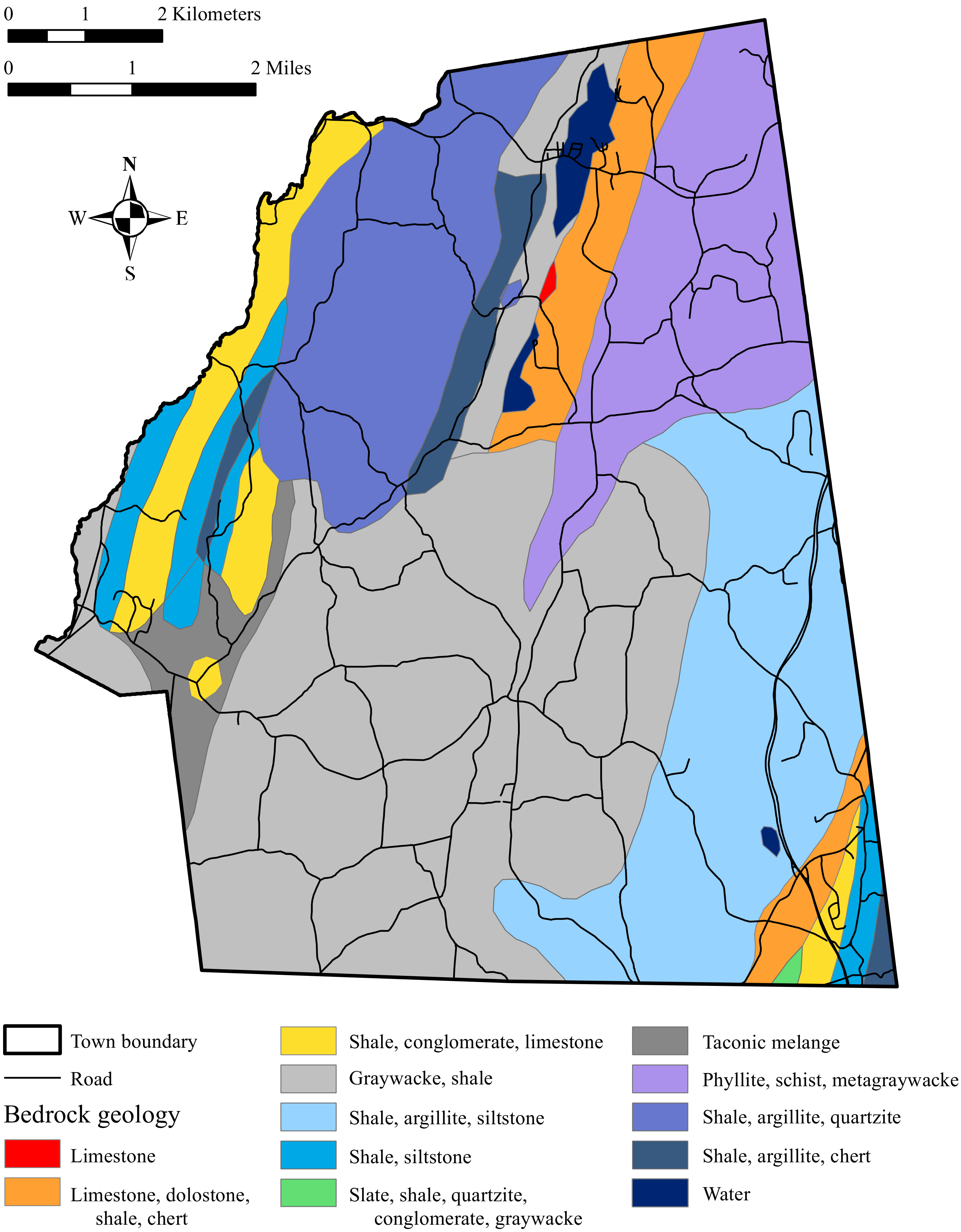


Figure 2. Generalized bedrock map of the Town of Clinton, Dutchess County, New York. Warm colors indicate bedrock that is likely to be calcareous (calcium carbonate-rich), and cool colors indicate bedrock that may be partially calcareous. Geology data from Fisher et al. (1970). Hudsonia Ltd., 2012.



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

During many years of habitat studies in the Hudson Valley, Hudsonia has found that, with careful analysis of map data and aerial photographs, we can accurately predict the occurrence of many habitats that are closely tied to topography, geology, and soils. We use combinations 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 and others in Clinton (such as Stevens and Kiviat 1991, Kiviat 2001, Tabak 2008), 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 and 1995, obtained from the U.S. 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 (1 pixel = 6 in [cm]) 4-band digital orthophotos* taken in spring 2009 and *true color and color infrared digital orthophotos (1 pixel = 12 in [19 cm])* taken in spring 2004, obtained from the New York State GIS Clearinghouse website (http://gis.ny.gov; accessed June 2011). We use these digital aerial photos for on-screen digitizing of habitat boundaries.

- *U.S. Geological Survey topographic maps* (Salt Point, Hyde Park, and Rock City 7.5 minute quadrangles). Topographic maps illustrate elevation contours, surface water features, and significant cultural features (e.g. roads, railroads, buildings). We use contour lines to predict the occurrence of such habitats as cliffs, wetlands, intermittent streams, and seeps.

- *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 hydrological features. The Dutchess County Environmental Management Council (EMC) provided us with bedrock geology, surficial geology, and state-regulated wetlands data. National Wetlands Inventory data prepared by the U.S. Fish and Wildlife Service were obtained from their website. We obtained soils data from the Natural Resources Conservation Service (NRCS) website. We also obtained 5 ft (1.5 m) contour data and hydrological data from the Dutchess County Planning Department; tax parcel data from the Dutchess County Office of Real Property Tax; and a draft habitat map prepared by the Town of Clinton CAC. We used ArcMap 9.2 and 10.0 software (Environmental Systems Research Institute 2006 and 2010) to examine these data layers and the orthophoto images, and to digitize the 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 the orthophoto images using ArcMap 9.2 and 10.0 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. Because the schedule of this project (and non-participating landowners) prevented us from conducting intensive field verification on every parcel in the town, this prioritization strategy contributed to our efficiency and accuracy in carrying out this work.

We field-checked approximately 57% of undeveloped land in the Town of Clinton. 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 areas of the habitat map that were field-checked are generally more accurate than areas we did not visit.

Defining Habitat Types

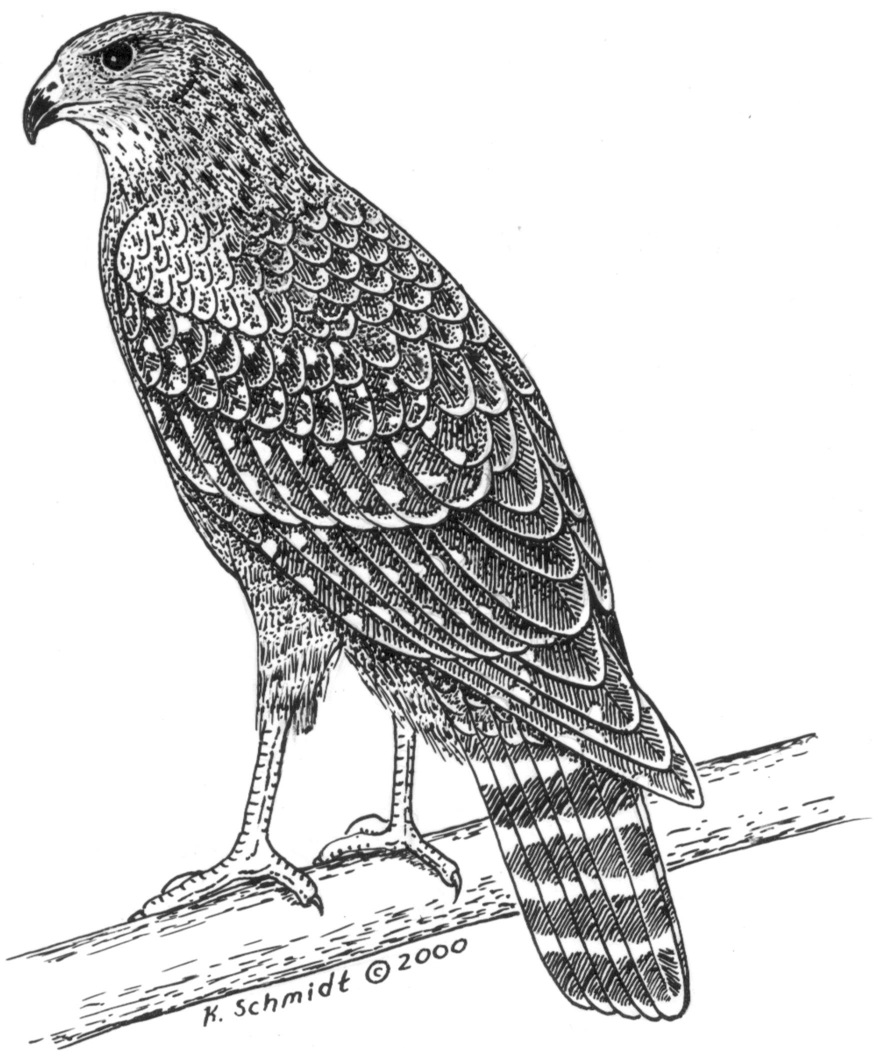
Habitats are useful for categorizing places according to apparent ecological function, and are manageable units for scientific inquiry and for land-use planning. For these townwide habitat mapping projects we classify broad habitat types that are identifiable largely by their vegetation and other visible 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 depict 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 Clinton 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 places that are included in 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 2009 (the orthophoto date) were identified as such only if we observed them in the field or consulted newer aerial photographs, 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 1:14,500. The GIS database that accompanies the map includes additional information about many of the mapped habitat units, such as plant and animal species observed in the field. The habitat map, GIS database, and this report have been conveyed to the Town of Clinton 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."*



Red-shouldered hawk

RESULTS

Overview

The large-format Town of Clinton habitat map illustrates the diversity of habitats that occur in 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 39 mi^2 (101 km^2; 24,846 ac) in the town, approximately 86% is undeveloped land (i.e. without structures, paved roads, manicured lawns, etc.). Existing development is dispersed along roads and at the ends of sometimes lengthy 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 cover extensive areas within these blocks. For example, approximately 57% of the town is forested (including both upland forest and swamp habitats), 18% is upland meadow (active agricultural areas and other managed and unmanaged grassland and forb-dominated habitats), and 13% is wetland. Some of the more unusual habitats we documented are acidic bogs, kettle shrub pools and buttonbush pools, heath swamps, circumneutral bog lakes, a fen, and rocky barrens. In total, we identified 29 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 250 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. 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 a few 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 Clinton, Dutchess County, New York, 2011-2012.

Upland Habitats	Wetland Habitats
Upland hardwood forest	Hardwood & shrub swamp
Upland conifer forest	Mixed forest swamp
Upland mixed forest	Conifer swamp
Floodplain forest	Acidic bog
Red cedar woodland	Intermittent woodland pool
Crest/ledge/talus	Kettle shrub pool
Calcareous crest/ledge/talus	Buttonbush pool
Rocky barren	Marsh
Upland shrubland	Wet meadow
Upland meadow	Calcareous wet meadow
Orchard/plantation	Fen
Cultural	Circumneutral bog lake
Waste ground	Constructed pond
	Open water
	Spring/seep
	Stream

Figure 3. A reduction of the map illustrating ecologically significant habitats in the Town of Clinton, Dutchess County, New York, identified and mapped by Hudsonia Ltd. in 2011-2012. Developed areas and non-significant habitats are shown in white. The large-format map is printed in three sections at a scale of 1:10,000.

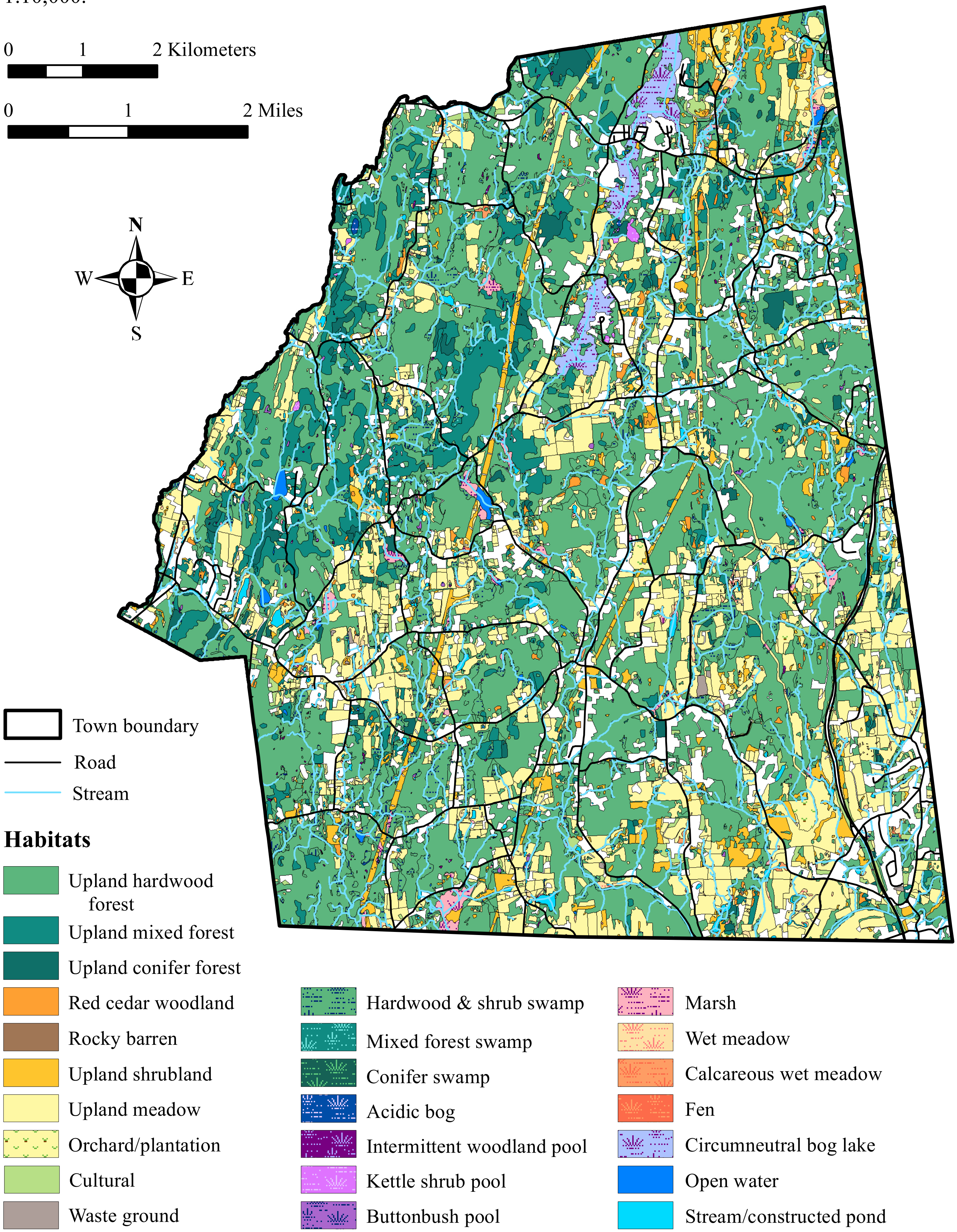
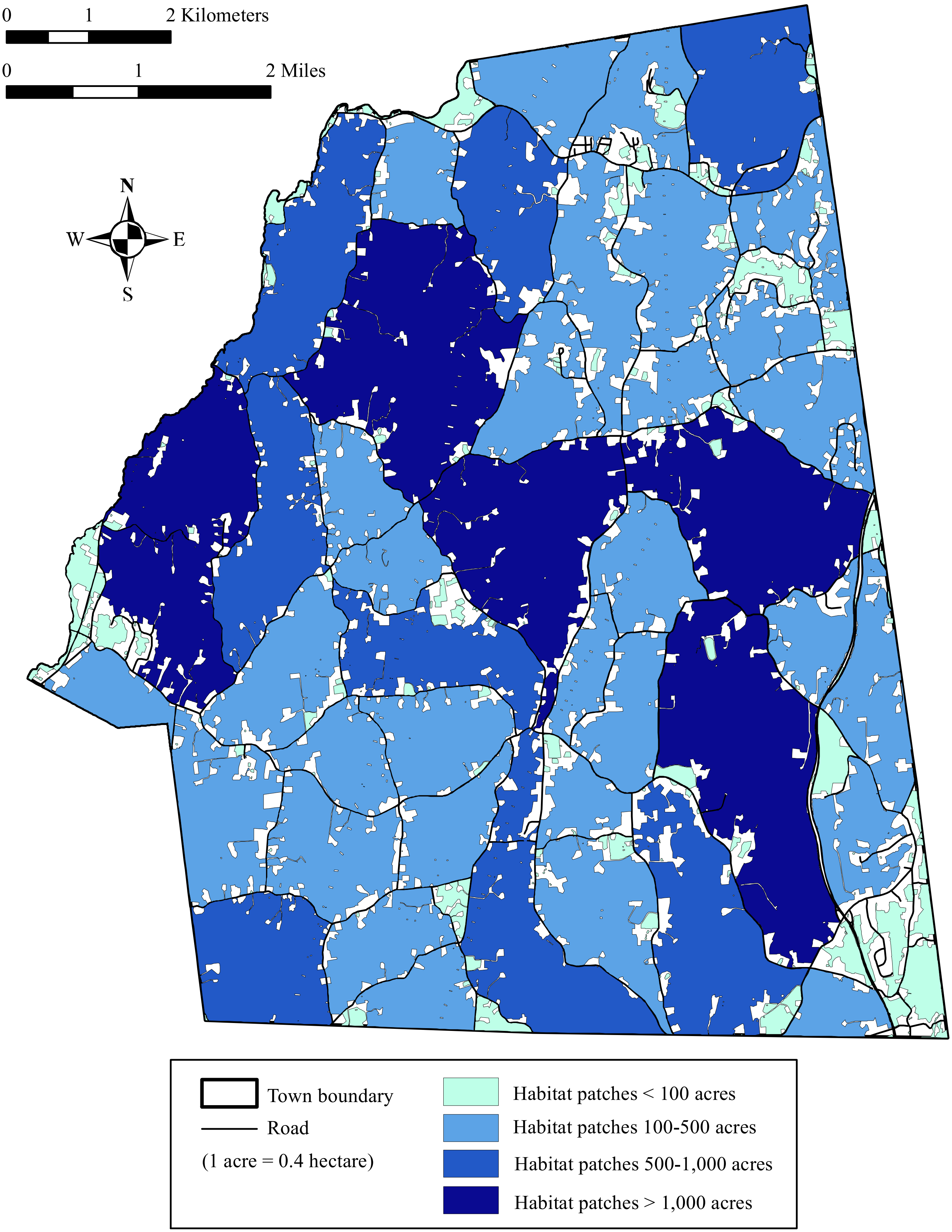


Figure 4. Contiguous habitat patches in the Town of Clinton, Dutchess County, New York. Developed areas and other non-significant habitat areas are shown in white. Hudsonia Ltd., 2012.



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 1:14,500) accompanying this report depicts 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-government 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 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 FORESTS

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 forest (which could be hardwood, conifer, or mixed, and was mapped as an overlay). All three 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 found in Clinton, in which the dominant canopy trees were 12-18 in (30-46 cm) dbh. 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.

Upland Hardwood Forest

Upland hardwood forest is the most common habitat type in 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.

Above: Mesic oak-birch forest

Below: Rich (calcareous) hardwood forest with blue cohosh

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 species include maple-leaf viburnum, witch-hazel, shadbush, Japanese barberry, common buckthorn, Bell's honeysuckle, lowbush blueberries, and a wide variety of wildflowers, sedges, ferns, and mosses.

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, while spotted turtle* and Blanding's turtle* use upland forests for aestivation (summer dormancy) and travel. Many snake species, such as eastern rat snake,* eastern racer,* and red-bellied snake, forage widely in upland forests and other habitats. 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 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. 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 copperhead, black rat snake, and black racer. Hardwood trees larger than 5 in (12.5 cm) dbh—especially those with loose, platy bark such as shagbark hickory, deeply furrowed bark such as black locust, or snags with peeling bark—can be used by Indiana bat* for summer roosting and nursery colonies. Clinton is within the summer migration distance (40 mi) of an Indiana bat hibernaculum in Ulster County.

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 min [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. Different kinds of conifer forests undergo different dynamics. For example, 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 or disease.

Conifer stands are used by many species of owls (e.g. barred owl,* great horned owl, long-eared owl,* short-eared owl*) and other raptors (e.g. Cooper's hawk* and sharp-shinned hawk*) for roosting and sometimes nesting. Pine siskin,* red-breasted nuthatch,* evening grosbeak,* 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, the distinction between conifer and mixed forest was made 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 species than pure conifer stands.

Floodplain forest

Floodplain forests occur along (usually perennial) streams 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 (e.g. sycamore, eastern cottonwood, green dragon,* ostrich fern). We mapped floodplain forests as an overlay atop upland forest polygons but not over wetlands. 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 Clinton

Upland hardwood forest was the predominant habitat type in Clinton, accounting for 41% of the total land area of the town. Though most were much smaller, seven patches of upland hardwood forest exceeded 200 ac (80 ha), and the largest was 500 ac (200 ha). In mature upland hardwood forests (dominant trees with dbh ≥ 12 in [30 cm]), red oak and sugar maple were by far the most common dominant trees, though pignut hickory and black, chestnut, and scarlet oaks were also frequent dominants. Younger hardwood forests were frequently dominated by some combination of red oak, sugar maple, red maple, black cherry, black locust, and white ash. Those on shallow, rocky soils of ridges and slopes were frequently dominated by chestnut oak and some combination of black oak, scarlet oak, red oak, and pignut hickory. Local areas of "rich forest" supporting calcium-associated plant species, such as early meadow-rue, rue-anemone, white baneberry, round-lobed hepatica, wild leek, and maidenhair fern were found throughout the town. In addition, while most of Clinton's smaller forest patches contained abundant invasive plant species, the interiors of larger stands, i.e., areas farther from forest edges, were often relatively free of invasive herbs and shrubs. 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 may have been logged selectively, but not completely cleared. There may be small stands of old-growth forest in the town that we did not observe during field work.

Upland conifer forest and upland mixed forest were much more abundant in northwestern Clinton, roughly north and west of a line formed by Silver Lake Road, Lake Drive, Fiddlers Bridge Road, and North Quaker Lane, than elsewhere, a distribution that corresponds with a high concentration of bedrock outcrops. While conifer forest accounted for a small fraction of Clinton's land area and the largest patch was only 40 ac (16 ha), mixed forest was much more extensive, totaling 6% of the land area, and the largest patch was 174 ac (70 ha). Eastern hemlock was by far the most common dominant tree of these forests, though it was mostly restricted to northwestern Clinton. Eastern white pine occurred in and dominated small stands throughout Clinton, as did eastern red cedar, stands of which are characteristic of early-successional forests on abandoned farmland. Small plantations of Norway spruce and red pine also occurred throughout the town.

There were 37 patches of upland forest (including hardwood, mixed, and conifer forest) larger than 100 ac (40 ha). Three of these patches exceeded 500 ac (200 ha)—two on the rugged

Elizaville thrust block north of Schultz Hill Road, and one in the eastern Clinton highlands (see the Conservation Areas section of this report) between Pumpkin Lane and Schultzville Road. Nine other upland forest blocks were between 250 and 500 ac (100-200 ha), though two of these were long and narrow and therefore had quite high edge-to-area ratios.

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 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 nest parasite), which reduce the reproductive success of many forest interior birds. Where dirt roads or trails cut through forest, vehicle, horse, and pedestrian traffic can harm tree roots and cause soil erosion. Runoff from roads and driveways can pollute nearby areas with road salt, heavy metals, and sediments (Trombulak and Frissell 2000). 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, and other vehicles.

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 overmature (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 insects. 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 the Hudson Valley. Of note is the hemlock woolly adelgid (HWA), a non-native aphid-like insect that has infested many eastern hemlock stands from Georgia to New England and has caused widespread loss of hemlock in the Hudson Valley. 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). While we frequently observed HWA on hemlocks in Clinton, we noted no stand-wide hemlock declines. The Conservation Priorities and Planning section of this report gives recommendations for protecting and fostering the habitat values of large forests, and Figure 5 illustrates locations of contiguous forest blocks in Clinton.

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.

Rare plants of red cedar woodlands on calcareous soils in the region include Carolina whitlow-grass,* yellow wild flax,* and Bicknell's sedge.* 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 reptiles 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,* short-eared owl,* 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 Clinton

Red cedar woodlands in the town ranged from less than 0.1 to 5 ac (< 0.04 - 2 ha), and most had developed on abandoned pastures and hayfields. They were scattered throughout the town, with highest concentrations in northeastern Clinton.

Sensitivities/Impacts

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. Wherever possible, measures should be taken to prevent the direct loss or degradation of these habitats and to maintain unfragmented connections with nearby wetlands, forests, and other important habitats. Red cedar woodlands are typically, however, a transitional habitat, and will ordinarily develop into young forest with the cedars gradually overtopped by deciduous trees.

CREST/LEDGE/TALUS

Ecological Attributes

Rocky crest, ledge, and talus habitats often (but not always) 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 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. We also included large glacial erratics (glacially-deposited boulders) in this habitat type. Some crest, ledge, and talus habitats support well-developed forests, while others have only sparse, patchy, and stunted vegetation. 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. Calcareous crests often have trees such as eastern red cedar, 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 harlequin,* 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.*

We mapped as “calcareous crest, ledge, and talus” those areas that we identified as such in the field and nearby areas with similar physiography. We mapped as simply “crest, ledge, and talus” those areas that we confirmed as noncalcareous in the field, as well as all other ledgy areas that we did not visit. Thus, the “crest, ledge, and talus” designation serves as a catch-all for noncalcareous outcrops and talus plus other such rocky habitats of unknown chemistry, and we expect some areas mapped as “crest, ledge, and talus” to in fact harbor calcareous ledge.

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 eastern hognose snake,* northern copperhead,* and other snakes of conservation concern. 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* is found in some rocky areas, and eastern small-footed bat* roosts in talus habitat.

Occurrence in the Town of Clinton

Crest, ledge, and talus habitats occurred throughout the town, mostly on hills and ridges. Extensive rocky areas occurred in northwestern Clinton, a region in which eastern hognose snake,* fisher,* and bobcat* were observed in recent years (Norene Coller, personal communication). Isolated smaller areas of outcrops occurred elsewhere in town, especially in eastern Clinton on either side of the Taconic Parkway. Calcareous crest and ledge areas were also extensive and widespread. Large areas of calcareous outcrops occurred, for example, on north-south-oriented hills and ridges on both sides of Browns Pond Road, and in an area of many small, rocky knolls east of Zipfeldberg Road. Furthermore, extensive ledgy areas occurred in scattered small calcareous formations embedded in more extensive acidic outcrops.

Wild columbine on calcareous ledge (left) and walking fern on calcareous glacial erratic (right)

We also found isolated, smaller areas of calcareous outcrops in eastern Clinton close to the Taconic Parkway, though outcrops were sparse across much of eastern Clinton. Common calcium-associated plants of such outcrops throughout the town included wild columbine, wild licorice, round-lobed hepatica, early meadow-rue, maidenhair fern, ebony and maidenhair spleenworts (ferns), and rose rhodobryum moss. Bladdernut, yellow harlequin,* bloodroot, fragile fern, and walking fern* were among less commonly encountered plants.

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, 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 Figure 6 illustrates generalized locations of crest, ledge, and talus habitat in Clinton.

ROCKY BARREN

Ecological Attributes

A subset of rocky crest habitat (see above), rocky barrens occur on knoll tops, hilltops, and steep slopes with exposed bedrock and shallow, often acidic soils. The vegetation may be predominantly grassy or woody or a combination thereof, but extensive exposed bedrock is the unifying features. The exposed bedrock can be of various types, but many of the barrens habitats in Clinton are on sandstone or shale. The soils are extremely shallow, excessively well drained, very nutrient poor, and susceptible to drought. Some of these ecosystems may be maintained by episodic fire events, which limit colonization by species that are not fire-adapted, help certain plant species such as pitch pine regenerate, return nutrients to the soil, and prevent the overgrowth of trees that can shade out typical barren 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 to which crests are fully exposed (Thompson and Sarro 2008); this exposure contributes to the sparse tree growth and shrubby, stunted character of barrens vegetation. Due to the open canopy, exposed rock, and dry soils, rocky barrens tend to have a much warmer microclimate in summer than the surrounding forested habitat, especially in the spring and fall, and a colder microclimate in winter.

Although these habitats seem inhospitable (in part because of exposure to extreme temperatures and short growing seasons [Thompson and Sarro 2008]), their plants and animals are adapted to harsh conditions. Dominant trees include pitch pine, chestnut oak, red oak, and scarlet oak; the shrub layer may include scrub oak, eastern red cedar, blueberries, black huckleberry, deerberry, and sweetfern. Common herbs include Pennsylvania sedge, poverty grass, common hairgrass, little bluestem, and bracken. Lichens and mosses are often abundant. Our definition of these habitats corresponds to Edinger et al.'s (2002) "pitch pine-oak forest," "pitch pine-oak-heath rocky summit," "red cedar rocky summit," and "rocky summit grassland." There may be a continuous canopy of pitch pine or pitch pine and oak with a scrub oak understory; the shrub layer (largely scrub oak and/or heath shrubs) may dominate, with only scattered pines or eastern red cedars; or the vegetation may be predominantly grassy with scattered shrubs and trees.

Rare plants of rocky barrens include clustered sedge,* mountain spleenwort,* and dwarf shadbush.* Rare butterflies that use scrub oak, little bluestem, lowbush blueberry, or pitch pine as their primary food plant tend to concentrate in rocky barrens, including Edward's hairstreak,* cobweb skipper,* and Leonard's skipper.* Woody barrens also provide habitat for several rare oak-dependent moths. Deep rock fissures can provide crucial shelter for northern copperhead* and other snakes of conservation concern, and the exposed ledges provide basking and breeding habitat in the spring and early summer. Birds of these habitats include common yellowthroat, Nashville warbler, prairie warbler,* field sparrow,* eastern towhee,* and whip-poor-will.*

Occurrence in the Town of Clinton

We mapped 22 small rocky barrens, 15 of these in northwestern Clinton, and seven in rocky areas of eastern Clinton. The largest, at 0.6 ac (0.2 ha), was an "oak-heath barren," corresponding to Edinger et al.'s "pitch pine-oak-heath rocky summit" (2002). It encompassed several smaller open patches interspersed with a sparse, dry oak forest. Chestnut oak, scarlet oak, and pignut hickory dominated the canopy of intermixed oak forest, while eastern red cedar, pitch pine, scrub oak, lowbush blueberries, sweetfern, and abundant mosses occurred in the open, barren patches. This barren may be a remnant of historically larger habitats once maintained by fire and now persisting because shallow soils inhibit establishment of taller tree species that would shade out the barren species. We also encountered one anthropogenic barren at the site of a former slate quarry, in which a layer of slate tailings supported a sparse birch woodland, little bluestem and other grasses, sweetfern, and abundant lichens. Most of the rocky barrens in Clinton were rocky summits or slopes dominated by grasses, heath shrubs, and/or lichens and mosses, roughly corresponding with the "rocky summit grassland" described in

Edinger et al. (2002). Because these communities are difficult to find remotely, we expect there are additional small, rocky barrens in the areas of exposed bedrock that we did not field-check.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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 or collected by poachers. Barrens tend to be disturbance-maintained ecosystems, but human suppression of wildfires eliminates one of the disturbances that maintains them. The scarcity of fires


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enables other, less specialized forest species to colonize these areas. The Conservation Priorities and Planning section of this report gives recommendations for protecting and fostering the habitat values of barrens habitats, and Figure 6 illustrates locations of these habitats and their conservation zones in Clinton.

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 honeysuckles, 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, sycamore) left as shade for livestock or for ornament may be present. Many non-native, invasive plants tend to thrive in places with a history of agricultural use (up to 40-80 years or more before present) and fine soil texture (Lundgren et al. 2004, Johnson et al. 2006), and in areas that were heavily grazed in the past. Recently-logged areas tend to develop a shrub layer including abundant tree saplings and northern blackberry.

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,* yellow-breasted chat,* clay-colored sparrow,* field sparrow,* eastern towhee,* and northern harrier.* 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 & 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.* The latter species, once common in the Northeast but now a candidate for federal threatened or endangered listing, seems to do best in large shrublands with dense shrub thickets. The Hudson Valley east of the Hudson River and northwestern Connecticut are believed to be a very important part of the remaining range of this species; we do not know if it is extant in Clinton.

Occurrence in the Town of Clinton

Upland shrublands were sparsely distributed throughout town, with high concentrations in two areas: a band between Allen Road and the Taconic Parkway in the southeast, and on both sides of Milan Hollow Road in far northeastern Clinton. They ranged from less than 0.1 ac to 35 ac (< 0.04 - 14 ha), totaling about 770 ac (310 ha) in the town. Common species included Bell's honeysuckle, multiflora rose, gray dogwood, Japanese barberry, eastern red cedar, goldenrods, and grasses.

Sensitivities/Impacts

Shrublands and meadows are closely related habitats. Having a diversity of 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, abandoned 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 comparatively little wildlife habitat value. 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 thin, 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 & 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 Blanding's turtle,* wood turtle,* spotted turtle,* box turtle,* painted turtle, and snapping turtle. Grassland-breeding birds such as northern harrier,* upland sandpiper,* grasshopper sparrow,* vesper sparrow,* savannah sparrow,* eastern meadowlark,* and bobolink* use extensive meadow habitats for nesting and/or foraging. 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 Clinton

Upland meadow accounted for 18% of the total town area. The highest densities of meadows were in the southeastern corner of town; in western Clinton in an area bounded by Hollow, Fiddlers Bridge, and Rhynders roads; and around the south end of Long Pond. Upland meadows were found throughout the town in places of recent or current agricultural land uses, the most common kinds being hayfields and pastures (mostly for horses); less intensively managed upland meadows were much less frequent.

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 Figure 7 illustrates the location and distribution of contiguous meadow habitat in Clinton (including both upland and wet meadows). This figure does not include areas of upland shrubland that in some cases had considerable patches of herbaceous cover.

We discuss management of large meadows for birds later in this report, but good management of small meadows can be critical for other groups, particularly butterflies. Different groups of butterflies depend on different meadow habitats (oldfields/ hayfields; stream margins; wet meadows/ pond margins; dry, thin-soiled fields; Vispo & Knab-Vispo 2012), and different species have variously timed life cycles. 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, personal communication).

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 more for its future ecological values after abandonment than its current 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 Clinton, orchard/plantation areas ranged from 0.1 to 30 ac (0.04 - 12 ha), including four units larger than 10 ac (4 ha) (one vineyard, one active and one abandoned apple orchard, and one Christmas tree farm). All other orchard/plantation areas occupied less than 5 ac (2 ha).

WASTE GROUND

Waste ground is an ecological 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 fill, landfill cover, 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,* Blanding's 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. The biodiversity value of waste ground will often increase over time as it develops more vegetation cover. Many waste ground sites, however, will have low habitat value compared to relatively undisturbed habitats. Waste ground sites were few and small in Clinton, and were mostly construction-related piles of soil, gravel, and waste. Several former or active quarries in town are mostly re-vegetated, with only small waste ground patches. The largest area of waste ground, an active sand and gravel mine, was approximately 8 ac (3 ha), but most occurrences of waste ground were smaller than 1 ac (0.4 ha).

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). 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," cemeteries are particularly well suited to provide habitat to a variety of species, since mature trees are often present, noise levels are 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 habitats in Clinton included playing fields, riding rings, cemeteries, large lawns, and manicured borders of ponds. They ranged from smaller than 0.1 to 11 ac (< 0.04 - 4.5 ha).

WETLAND HABITATS

SWAMPS

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. Red maple, green ash, American elm, slippery elm, pin oak, and swamp white oak are common trees of hardwood swamps in the region. Typical shrubs include silky dogwood, shrubby willows, northern arrowwood, winterberry holly, highbush blueberry, and spicebush. Common herbaceous species of swamps are tussock sedge, skunk-cabbage, sensitive fern, and cinnamon fern.

Green ash and red maple swamp with tussock sedge

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. Swamp cottonwood* is a very rare tree of deeply-flooding hardwood swamps and is known from only a handful of sites in the Hudson Valley. 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, overwintering, and travel corridors. Pools within swamps are used by several pool-breeding amphibian species, and are the primary 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,* prothonotary warbler,* Canada warbler,* and white-eyed vireo* nest in hardwood swamps.

Among hardwood and shrub swamps that we mapped, we noted two particular types worth distinguishing (denoted with stars on the habitat map): heath swamp and pool-like swamp. Both are pool-forming, usually hydrologically isolated wetlands that may have many of the same habitat values as intermittent woodland pools. *Heath swamps* typically have extensive, open, deep water; well-developed, moss-covered woody hummocks; little or no tree canopy; and a significant shrub layer dominated by highbush blueberry, swamp azalea, and/or black chokeberry. They are often found in depressions isolated from other wetlands, and can provide excellent habitat for uncommon plants, pool-breeding amphibians, and other species of conservation concern. Because heath swamps are difficult to identify remotely, those we mapped in Clinton should be considered examples of these habitats rather than a complete inventory.

Pool-like swamps have hydrological properties similar to intermittent woodland pools, in addition to woody vegetation 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. See the section on intermittent woodland pools (below) for additional ecological attributes and occurrence information.

Occurrence in the Town of Clinton

Hardwood and shrub swamp (or hardwood swamp, for short) was the most extensive wetland habitat type in the town, totaling more than 2,100 ac (850 ha), or about 9% of the town area. Swamps ranged from smaller than 0.1 to over 60 ac (< 0.04 - > 24 ha), and were often contiguous with other wetland habitats such as marsh, wet meadow, and open water (including beaver ponds). Most hardwood swamps were small (< 5 ac [2 ha]), but 35 exceeded 10 ac (4 ha), and five occupied more than 45 ac (18 ha). Two depressional hardwood swamps were about 60 ac (24 ha): one east of Horseshoe Trail surrounded largely by agricultural meadows, and one east of Mountain View Road bordered mostly by upland forest. Smaller swamps were abundant and widespread throughout the town. Water depth varied greatly in Clinton’s swamps, with some drying out completely in the summer months and others retaining relatively deep pools.

Mixed forest swamps and especially conifer swamps were uncommon and small, with only one larger than 3 ac (1.2 ha). This 8-ac (3-ha) mixed forest swamp surrounded Zipfeldberg Bog (see "Acidic Bog" section below). Most were in northwestern Clinton and were part of larger swamp complexes including hardwood swamps. The conifers of most mixed and conifer swamps were eastern hemlock or eastern red cedar (a calcium-associated plant when in wetlands), though a few contained eastern white pine.

Swamps occurred in a variety of settings: on seepy slopes, along streams, in depressions, and as part of large wetland complexes. Common species included red maple, slippery and American elms, green and black ashes, and swamp white oak (trees); winterberry holly, highbush blueberry, silky dogwood, spicebush, Bell's honeysuckle, and multiflora rose (shrubs); skunk-cabbage, beggar-ticks, false-nettle, common jewelweed, yellow iris, tussock sedge, wood reedgrass, and cinnamon, sensitive, and marsh ferns (herbaceous plants).

We classified five swamps in Clinton as heath swamps. These were all smaller than 1.3 ac (0.5 ha), had deep water and well-developed, *Sphagnum*-covered hummocks, and were dominated by highbush blueberry and sometimes swamp azalea or winterberry holly. Although we did not designate them as a separate habitat type, some other swamps were calcareous, with plants such as black ash, poison sumac, buttonbush, rough-leaf goldenrod, and *Riccia fluitans* (a liverwort).

Sensitivities/Impacts

While some swamps 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 are often 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. Connectivity between swamp habitats and nearby upland and wetland habitats is essential for amphibians that breed in swamps and for other resident and transient wildlife of swamps. 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. The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of swamps within larger wetland complexes, and Figure 11 illustrates the locations of wetlands throughout the town. Recommendations for preserving the habitat values of heath swamps and pool-like swamps are given in the Conservation Priorities and Planning section on intermittent woodland pools, and Figure 9 shows their conservation zones.

ACIDIC BOG

Ecological Attributes

An acidic bog is a rare wetland habitat that is perennially wet, 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 boreal relict 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-leaf and spoon-leaf 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 Nashville warbler,* golden-winged warbler,* northern waterthrush,* and eastern bluebird. Southern bog lemming* could occur in bogs and adjacent forests.

Occurrence in the Town of Clinton

We documented three acidic bogs in Clinton. The largest, Zipfeldberg Bog ([4 ac [1.6 ha]), is an exemplary "dwarf shrub bog" (Edinger et al. 2002)—dominated by peat mosses and low-growing heath shrubs. Two other acidic bogs in the town qualified as "highbush blueberry bog thickets" (Edinger et al. 2002), dominated by peat mosses and tall, deciduous highbush blueberry shrubs. One bordered Mud Pond, a circumneutral bog lake, and the other occurred along the edge of an isolated, heath-dominated swamp in southwestern Clinton (which may contain other small bog patches). All the bogs had an extensive, sometimes continuous carpet of *Sphagnum* mosses, often forming floating vegetation mats, and all were dominated by shrubs in the heath family. Small white pines were also a prominent component of Zipfeldberg Bog, while mountain holly* was an unusual co-dominant in the blueberry bog thicket of southwestern Clinton. Zipfeldberg Bog contained plants such as leatherleaf,* black huckleberry,* pale laurel,* bog-rosemary,* pitcher-plant,* pod-grass,* rose pogonia,* and Virginia chain fern.*

Sensitivities/Impacts

Acidic bogs are very rare in Dutchess County. The biological communities of acidic bog habitats seem to be 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, applications of fertilizers or 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 probably 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 Figure 8 illustrates the locations of bogs and their conservation zones in Clinton.

CIRCUMNEUTRAL BOG LAKE

Ecological Attributes

A circumneutral bog lake is a spring-fed, calcareous water body that commonly supports vegetation of both acidic bogs and calcareous marshes (Kiviat and Stevens 2001). These lakes typically have a deep organic substrate, mats of floating vegetation, drifting peat rafts (that sink in winter and rise to the surface in spring), and abundant submerged and floating-leaved plants such as fragrant pond-lily and water-shield.

Peat mats often have bog plant communities with extensive carpets of *Sphagnum* mosses, leatherleaf,* cranberries,* and pitcher-plant.* Shoreline areas may support cattails, purple loosestrife, water-willow, alder, buttonbush, and leatherleaf. The lakes may have swamps, calcareous wet meadows, and/or fens at their margins.

This is a rare habitat type in the region and is known to support many rare and uncommon species of plants and animals. Several species of rare sedges and submerged aquatic plants occur in circumneutral bog lakes in Dutchess County. Rare fauna associated with circumneutral bog lakes include eastern ribbon snake,* northern cricket frog,* spotted turtle,* blue-spotted salamander,* marsh wren,* and river otter.* These habitats have also been found to support diverse communities of mollusks, dragonflies, and damselflies. A circumneutral bog lake in the Town of Pine Plains is described in Busch (1976), and a flora survey of Long Pond in the Town of Clinton is described in Tabak (2008).

Occurrence in the Town of Clinton

We identified three circumneutral bog lakes in the Town of Clinton— Silver Lake, Long Pond, and Mud Pond—which together constituted 272 ac (110 ha). Long Pond and Mud Pond contained large floating mats, while Silver Lake had only occasional vegetation mats. Long Pond comprises a complex mosaic of open water, emergent marsh, drifting peat rafts, and well-developed, floating vegetation mats. Tabak (2008) found several regionally rare or scarce plant species, including twig-rush,* common bladderwort,* spiny coontail,* green spikerush,* rose pogonia,* and round-leaf sundew,* and in previous surveys Erik Kiviat (field notes) found subterminate bulrush* and buttonbush dodder.* Kiviat (field notes) also found pitcher-plant,* round-leaf sundew,* and lesser panicled sedge in a survey of Mud Pond.

Peat rafts and floating vegetation mats, in particular, are characteristic features of circumneutral bog lakes. In Long Pond, the former were usually composed of peat and pond-lily rhizomes, and many were colonized by plants such as bladderworts, purple loosestrife, green spikerush,* and other graminoids (grass-like plants). Floating mats, on the other hand, consisted of roots, rhizomes, *Sphagnum* mosses, and organic detritus up to 8 in (20 cm) thick, usually anchored to and extending outward from the shore. They were colonized by a wide variety of plants, both herbaceous (e.g. marsh fern, hard-stem bulrush, pickerelweed, broad-leaved arrowhead, arrow arum, water-purslane, marsh St. John's-wort, swamp milkweed) and woody (e.g. buttonbush, water-willow, steeplebush, maleberry, swamp rose, poison sumac) (Tabak 2008).

Sensitivities/Impacts

We believe that circumneutral bog lakes are extremely sensitive to changes in surface and groundwater chemistry and flows, and could be affected by any significant alterations to the watershed such as tree removal, soil disturbance, applications of fertilizers or pesticides, septic leachate, groundwater extraction, or altered drainage. Residential development along scenic lakeshores and agricultural uses within the watershed are common causes of these and other disturbances. Maintaining a forested buffer around the lake is critical for preserving habitat quality. Recreational uses such as boating, fishing, or hiking can be sources of trash, pollutants, and mechanical disturbance, and should be managed carefully; use of motorized watercraft should be avoided. Mechanical disturbances in the lake or changes in surface water levels or chemistry could disrupt the peat rafts and floating vegetation mats. The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of circumneutral bog lakes, and Figure 8 illustrates locations of these lakes and their conservation zones in Clinton.

INTERMITTENT WOODLAND POOL

Ecological Attributes

An intermittent woodland pool is a small wetland partially or entirely surrounded by forest, typically with no surface water inlet or outlet (or an ephemeral one), and with standing water during fall, 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 woody vegetation 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—i.e. they may provide a seasonal source of water with fewer aquatic predators, breeding habitat for pool-breeding amphibians, and refuge for turtles.

Intermittent woodland pools (and many heath swamps and 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 Blanding's turtle,* 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 in upland forest (McKinney & 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.* Springtime physa* is a regionally rare snail associated with intermittent woodland pools. Featherfoil* and false hop sedge* occur in intermittent woodland pools in the Hudson Valley. Large and small mammals use these pools for foraging and as water sources.

Occurrence in the Town of Clinton

We mapped 257 intermittent woodland pools and 89 pool-like swamps in Clinton. They were most abundant in western Clinton but occurred throughout the town. All the mapped intermittent woodland pools in the town were 0.8 ac (0.3 ha) or smaller**.** Common plant species included black gum, red maple, highbush blueberry, winterberry holly, marsh fern, and tussock sedge, mostly around pool edges. We discovered cattail sedge* growing in large, dense mats across several intermittent woodland pools and false hop sedge* in another; both are listed as Threatened in New York. Some intermittent woodland pools were part of larger hardwood swamps, but we mapped these only when the entire swamp was isolated from streams or larger water bodies. Because pools were small and often difficult to identify on aerial photographs, we expect there are additional such habitats that we did not map.

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 as dumping grounds, 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 Figure 9 illustrates locations of these pools and their conservation zones in Clinton.

BUTTONBUSH POOL/KETTLE SHRUB POOL

Ecological Attributes

Buttonbush pools are seasonally or permanently flooded shrubby pools 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, 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.

The kettle shrub pool, a specific type of buttonbush pool, has all the previous characteristics but is located in a glacial kettle—a depression formed by the melting of a stranded block of glacial ice. The pools are found in or adjacent to glacial outwash soils (e.g. Hoosic gravelly loam), and they have deep organic substrates. Hudsonia has found one state-listed rare plant (buttonbush dodder*), at least three regionally rare plants (the moss *Helodium paludosum*,* short-awn foxtail,* and pale alkali-grass*), and the regionally rare eastern ribbon snake* in kettle shrub pools in the region. Kettle shrub pools and buttonbush pools are used by spotted turtle,* wood duck,* mallard, and American black duck,* and are the core habitat of the Blanding's turtle,* a Threatened species in New York. Kettle shrub pools and other 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 Clinton

We documented 23 buttonbush pools and ten kettle shrub pools in Clinton, with an average size of 1.0 ac (0.4 ha). The largest, a kettle shrub pool of about 8 ac (3 ha), was one of at least five kettle shrub pools within 0.8 mile (mi) (1.3 kilometers [km]) of each other in the Milan Window. Three kettle shrub pools occurred on bands of outwash soil between the Elizaville thrust block and Crum Elbow Creek with several buttonbush pools nearby. In three other cases, two or more buttonbush pools occurred approximately 1,000 ft (300 m) apart. The remaining kettle shrub and buttonbush pools were scattered widely in the town. Erik Kiviat (personal communication) found spring peeper, green frog, gray tree frog, American bullfrog, and eastern painted turtle in or near kettle shrub pools in town, and heard or observed wood duck,* yellow-throated vireo, great crested flycatcher, rose-breasted grosbeak, green heron, killdeer, and American woodcock.* We identified several other wetlands as potential kettle shrub or buttonbush pools that require field verification. Because these pools were often difficult to

Buttonbush pool in spring

identify on aerial photographs, those that we mapped should be considered examples of such habitats rather than a complete inventory.

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 the Blanding's turtle, pool-breeding amphibians, and other wildlife. Like intermittent woodland pools, buttonbush pools and kettle shrub pools are occasionally excavated for ornamental ponds and they are often partly drained by means of ditches. The presence of glacial outwash soils make the areas around kettle shrub pools attractive places for gravel mining, which may alter the water chemistry or hydroperiod, or even extend into the pools themselves. More information about this habitat is found in Kiviat (1993), Kiviat and Stevens (2001; under "Kettle Shrub Pool" and "Blanding's Turtle"), and Kiviat and Stevens (2003). The Conservation Priorities section of this report provides recommendations for protecting the habitat values of buttonbush pools and kettle shrub pools, and Figure 10 illustrates locations of these pools and their conservation zones in Clinton.

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. Cattails, tussock sedge, common reed, arrow arum, broad-leaved arrowhead, water-plantain, and purple loosestrife are some typical emergent marsh plants in this region. Some marshes are dominated by floating-leaved plants such as pond-lilies, water-shield, 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,* monarch,* and northern pearly eye. Marshes are also important habitats for reptiles and amphibians, including northern water snake, eastern painted turtle, snapping turtle, spotted turtle,* green frog, pickerel frog, spring peeper, and northern cricket frog.* Numerous bird species, including marsh wren,* common moorhen,* American bittern,* least bittern,* great blue heron,* Virginia rail,* king rail,* sora,* American black duck,* and wood duck* use marshes for nesting or as 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 Clinton

We mapped 226 ac (91 ha) of marsh in the town, with the largest marsh, off Browning Road, accounting for more than one sixth of this total (39 ac [16 ha]), and five others occupying 10 to 12 ac (4 - 5 ha). Most marshes in the town were small (< 3 ac [1.2 ha]). One of the larger marshes occurred in a relatively undisturbed complex of wetlands (totaling 37 ac [15 ha]) near the intersection of Schoolhouse and Fiddlers Bridge roads and contained a great blue heron* rookery. Marshes were frequently contiguous with or embedded in hardwood swamps or wet meadows. Many of the marshes we observed in the field were

Marsh and shrub swamp along perennial stream dominated by common reed and cattails, and 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. Marshes were also major components of extensive wetland complexes, with substantial beaver activity, along two perennial streams in northeastern Clinton—Little Wappinger Creek and one of its tributaries. In addition, although we did not designate them as a separate habitat type, some marshes in the town were calcareous, containing calcium-associated plants such as rough-leaf goldenrod, lakeside sedge, halberd-leaved tearthumb, and golden Alexanders.

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 Clinton are very lake-like and could have similar sensitivities as open water habitats (see habitat description below). The Conservation Priorities and Planning section of this report provides recommendations for preserving the habitat values of marshes within larger wetland complexes, and Figure 11 illustrates the locations of marshes and other wetlands in Clinton.

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.

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 provide nesting and foraging habitat for songbirds such as sedge wren,* wading birds such as American bittern,* and raptors such as northern harrier.* 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 Clinton

Wet meadows were widely distributed in Clinton and commonly occurred within and along the margins of swamps and marshes and in low-lying areas within upland meadows. We mapped 243 ac (98 ha) of wet meadow. Most occurrences were smaller than 1 ac (0.4 ha). The two largest wet meadows (13 ac [5 ha] and 8 ac [3 ha]) occurred within extensive riparian wetland complexes adjacent to two perennial streams in northeastern Clinton—a tributary to Little Wappinger Creek and the Little Wappinger itself, respectively. Common plant species included purple loosestrife, common reed, reed canary-grass, sensitive fern, soft rush, goldenrods, and sedges.

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, is less damaging to the soils and the plant community, and postponing mowing until late August or September 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. Figure 11 illustrates the locations of wet meadows and other wetlands in Clinton.

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-leaf goldenrod, and blue vervain. 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 plant community.

High quality calcareous wet meadows with diverse native plant communities are likely to support species-rich invertebrate communities, including phantom cranefly* and rare butterflies such as Dion skipper,* two-spotted skipper,* and Baltimore.* 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 even 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 Clinton

We documented 49 calcareous wet meadows scattered throughout the town, totaling 43 ac (18 ha). Most were smaller than 1 ac (0.4 ha) and were scattered along streams or at the headwaters of streams. The largest calcareous wet meadow (4.6 ac [1.9 ha]) occurred off Stonehouse Road as part of a much larger wetland complex. Several small complexes of calcareous wet meadows also occurred in stream corridors near roads—one each along West Meadowbrook Lane, Fiddlers Bridge Road, and Mountain View Road and on both sides of North Creek Road. Common species in these wetlands included sensitive fern, sedges, soft rush, sweetflag, reed canary-grass, purple loosestrife, blue vervain, New York ironweed, and goldenrods. 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 noncalcareous 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 low 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-leaf 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-fruit sedge.

Fen is a rare habitat type 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 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.* The rare sedge wren* nests almost exclusively in shallow, sedge-dominated wetlands such as fens.

Occurrence in the Town of Clinton

We tentatively mapped only one fen in Clinton, through analysis of aerial photographs, views from an adjacent property, and inference based on the presence of calcareous soils and nearby calcareous habitats. We placed a question mark in another area that appears fen-like in aerial photographs. Because fens are difficult to identify by remote sensing, however, 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 & 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. 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.

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. Herbaceous plant diversity may be higher in seeps than in surrounding upland forest (Morley & Calhoun 2009). A few rare invertebrates are restricted to springs in the region, and 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 Clinton

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 almost anywhere in Clinton. About three quarters of the 87 mapped seeps measured less than 1 ac (0.4 ha), though several were 2 ac (0.8 ha), and one occupied 4 ac (1.6 ha), mostly on wet meadow. We also mapped 62 springs, including about 10 seeps that were too small to warrant boundary delineation. Many of the mapped springs and seeps occurred in clusters or loose groupings associated with the same physiographic feature; e.g. a particular hill with numerous springs. They were also usually associated with streams or wetlands. Seeps contained typical wetland vegetation or a mixture of wetland and upland plants; one seep in northwestern Clinton harbored a colony of rough sedge, a seep specialist.

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 and fish. Spotted turtle* uses ponds and lakes during both drought and non-drought periods, and wood turtle* may overwinter and mate in open water areas. Northern cricket frog* is known to use circumneutral ponds. 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 Clinton

Of the 71 open water habitat units we mapped in the town, most were smaller than 1 ac (0.4 ha). Browns Pond, at 14 ac (6 ha), was the largest “open water” area, and was surrounded by a combination of residential uses and forest. Of glacial origin, it reaches depths of over 100 ft (30 m) and holds freshwater jellyfish (Norene Coller, personal communication). Frost Pond (7 ac [3 ha]), west of Browns Pond Road, is of unknown origin and was mostly surrounded by forest. Another open water area, off Schoolhouse Road, was about 12 ac (5 ha) and was part of a chain of wetlands, including marshes and hardwood swamps, that totaled 37 ac (15 ha). It seemed to have been created by beaver activity, as were many of the other open water habitats in the town. 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, and 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 structure.

Occurrence in the Town of Clinton

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 500 constructed ponds, and most were smaller than 1 ac (0.4 ha). The largest constructed pond, about 9 ac (4 ha), occurred off Fox Run Rd. Two other large ponds, both 6-7 ac (2-3 ha), were located in active gravel mines in the only significant kame deposit in the town. 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 marsh.

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 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.

STREAMS, FLOODPLAIN FORESTS, & RIPARIAN CORRIDORS

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 & 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.

We also mapped *floodplain forest* along Wappinger, Little Wappinger, and Crum Elbow creeks and several of their larger perennial tributaries. We used a combination of topographic data, soils data, and aerial photographs to delineate floodplain forest as an overlay atop upland habitat layers, and, where possible, conducted field work to verify its presence. While floodplains may encompass any habitat, including both upland forest and swamp, we map and discuss only upland (i.e. non-wetland) floodplain forests in this report. Also, because floodplain forest is difficult to distinguish from floodplain swamp by remote sensing, we expect that we have missed or misidentified some of those areas that we were unable to visit.

Floodplain forests experience flooding at intervals ranging from frequent (yearly or several times per year) to occasional (every few years or decades). Typical floodplain forests include a mixture of upland and wetland plant species and floodplain specialists such as sycamore, eastern cottonwood, and pin oak. They tend to have high species diversity and high biological productivity, and 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,* winged monkeyflower,* and goldenseal.* 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 Clinton

Perennial streams occupied the major valleys in the town. The largest streams were Wappinger Creek, Wappinger East Branch (which flows north across Hibernia Road and into Wappinger Creek), Little Wappinger Creek, and Crum Elbow Creek. At 10 mi (16 km) and 8 mi (13 km), respectively, Little Wappinger and Crum Elbow creeks also had the greatest lengths in Clinton (the latter weaving across the northwestern town boundary), while Wappinger Creek itself only crossed the southeastern corner of town for about 1 mi (2 km). Numerous perennial tributaries flowed into these large creeks, and one perennial stream draining southwestern Clinton flowed into the Fallkill Creek (outside the town). Also noteworthy was a perennial tributary to Little Wappinger Creek, which ran parallel to the Little Wappinger for four miles in northeastern Clinton and through an extensive, beaver-influenced wetland complex. The combined length of perennial streams mapped in the town was 79 mi (126 km). Intermittent streams were myriad, with a combined length of 138 mi (222 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 Figure 12 illustrates the locations of streams and stream conservation zones in Clinton.

CONSERVATION PRIORITIES AND PLANNING

Most local land-use decisions in the Hudson Valley 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 do not respect property or municipal boundaries, the best approach to biodiversity conservation is from the perspective of whole landscapes. The Clinton habitat map facilitates this approach by illustrating the location and configuration of significant habitats throughout the town. The map, together with 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) developing general strategies for biodiversity conservation; 2) using the map to identify priorities for townwide conservation, land-use planning, and habitat enhancement; and 3) using the map as a resource for reviewing site-specific land-use proposals

General Guidelines for Biodiversity Conservation

We hope that the Town of Clinton 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 engage in proactive land-use and conservation planning to ensure that future development is planned with a view to long-term protection of the valuable biological resources that still exist within the town.

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 land-owners, master planning, zoning ordinances, tax incentives, land stewardship incentives, permit conditions, land acquisition, conservation easements, and public education. Section 4 in the

Biodiversity Assessment Manual (Kiviat and Stevens 2001) provides additional information about these and other conservation tools. Several publications of the Metropolitan Conservation Alliance, the Pace University Land-use Law Center, and the Environmental Law Institute describe some of the tools and techniques available to municipalities for conservation planning. For example, *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. A recent publication from Cornell and NYSDEC, *Conserving Natural Areas and Wildlife in Your Community* (Strong 2008) describes the tools and resources available to municipalities to help protect their natural assets.

In addition to regulations and incentives designed to protect specific types of habitat, the town can also apply some general practices on a townwide 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 Clinton to apply these measures to townwide 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.

- **Protect large, contiguous, undeveloped tracts** wherever possible.
- **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 avoiding development on Prime Farmland Soils or Farmland Soils of Statewide Importance, and avoiding fragmentation of active or potential farmland.
- **Encourage and provide incentives for developers to consider environmental concerns early in the planning process**, and to incorporate biodiversity conservation principles into their choice of development sites, their site design, and their construction practices.
- **Concentrate 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.
- **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 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 Clinton 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 in the Hudson Valley. 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 and nursery 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 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 those species. Corridors and habitat connectivity allow for the movement of organisms as they adapt to changing conditions, so will become 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 habitats for conservation, including those that are rare or support rare species, or that seem particularly important to regional biodiversity. For instance, kettle shrub pools and nearby wetland and upland habitats may support some of the few remaining populations of Blanding's 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 habitat (Figure 4).

Finally, we have delineated nine *conservation areas* (Figure 13) that may serve as suitable units for townwide 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—Rhinebeck, northern Hyde Park, Stanford, and Washington—for conservation planning across town boundaries.

Reviewing Site-Specific Land Use Proposals

In addition to townwide 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 proposal 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 habitats on and off the site.

Because the habitat map has not been 100% field-verified we emphasize that, at the site-specific scale, it should be used strictly 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.

PRIORITY HABITATS IN CLINTON

Only approximately 14% of land in the town has been developed for residential and other intensive uses, and large areas of high-quality habitat yet remain. These large areas are not only important locally but also contribute greatly to regional biodiversity. Two areas in Clinton are within the DEC-designated Dutchess County Wetlands Significant Biodiversity Area (Penhollow et al. 2006): the Milan Window complex, and the East Park/Hyde Park site, which comprises a corridor along Crum Elbow Creek. These complexes harbor large and diverse wetlands, including several regionally rare habitat types—circumneutral bog lake, kettle shrub pool, and acidic bog. They also support rare plants and provide critical habitat for the Blanding's turtle,* (Threatened in New York), and northern cricket frog,* (Endangered in New York). Other animals of conservation concern known to occur in these areas include blue-spotted salamander,* marbled salamander,* four-toed salamander,*spotted turtle,* wood turtle,* eastern box turtle,* red-bellied snake,* and eastern ribbon snake.* Pied-billed grebe* and great blue heron* nest nearby.

By employing a proactive approach to land-use and conservation planning, the Town of Clinton 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, however, municipal agencies must decide how best to direct those resources to maximize conservation results. While it may be impossible to protect all significant habitats, there are reasonable ways to prioritize conservation efforts using the best available scientific information. Important considerations in prioritizing such efforts include preserving sensitive habitat types, high quality habitat units, and a variety of habitats well-connected and well-distributed over the landscape. Below we highlight some habitat types that we consider "priority habitats" for conservation in the town. 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. The list of priority habitats below is a subset of those with more urgent conservation needs.

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. For each of the "priority habitat" types, we chose a species or group of species that have large home ranges, specialized habitat needs, or acute sensitivity to disturbance (see Table 2). 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 for other life history needs, and these habitats are typically located within a certain distance of the core habitat. This distance defines the extent of the species' habitat complex and, therefore, the minimum area that needs to be protected or managed in order to protect the local population and conserve the species. 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. (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 estimate the priority conservation zone for the species of concern (Table 2). If the habitats of the highly sensitive species of concern are protected, many other rare and common species that occur in the same habitats will also be protected.

River otter

Table 2. Priority habitats, species of concern, and associated priority conservation zones identified by Hudsonia in the Town of Clinton, Dutchess County, New York, 2011-2012.

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 (53-80 ha)	Required for high probability of supporting breeding hermit and wood thrush in a 60% forested landscape.	Rosenberg et al. 2003
Barrens and extensive crest/ledge/talus	Northern copperhead, eastern rat snake, eastern racer	Extensive crest/ledge/talus, and 3,300 ft (1,000 m) zone around barrens habitats	Includes habitat essential for denning, nesting, basking, foraging, and dispersal.	Fitch 1960, Todd 2000, Blouin-Demers and Weatherhead 2002
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
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
Buttonbush pool/ kettle shrub pool	Blanding's turtle	3,300 ft (1,000 m) from core habitat pool.	Encompasses most of the critical habitat, including nesting areas, summer foraging wetlands, drought refuge pools, and overland travel corridors.	Kiviat 1997, Hartwig et al. 2009, Congdon et al. 2011,
Circumneutral bog lake	Northern cricket frog	3,300 ft (1,000 m) from lake edge.	Represents the overland distance traveled between wetlands, and encompasses travel distance to overwintering sites.	Gray 1983
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

LARGE FORESTS

Target Areas

In general, forested areas (including both upland forest and swamp) with the highest conservation value include large forest tracts, mature and relatively undisturbed forests, 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. Four forests in Clinton exceeded 500 ac (200 ha), the largest being over 900 ac (350 ha). Three of these occurred northwest of Fiddlers Bridge Road, in a region of rugged topography and nearly ubiquitous outcrops. The fourth occurred in eastern Clinton, south of Pumpkin Lane, and was also characterized by frequent, albeit more localized, crest and ledge habitat. Twelve 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). In addition, several smaller blocks in Clinton were contiguous with much larger patches in neighboring towns. Two such forest patches exceeded 1,000 ac (400 ha) and another 500 ac (200 ha), all extending from western Clinton into neighboring towns.

Conservation Issues for Selected Focal Species

Loss of forest and fragmentation of remaining forest 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. Edge environments favor a set of disturbance-adapted species, including many nest predators and a nest 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. For example, 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 247 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 2,470 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 figures demonstrate the need to preserve large forests for these birds, some of which we observed during our field work in Clinton (e.g. red-shouldered hawk,* Louisiana waterthrush,* wood thrush*). Large forests with rocky crests also provide habitat for several reptiles of conservation concern such as northern copperhead,* eastern rat snake,* and eastern 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. One example is the hemlock woolly adelgid, an aphid-like insect that has caused widespread mortality of hemlock forests in the Hudson Valley. While we did not observe signs of stand-wide decline in most locations, most hemlock forests of this latitude are expected to be severely impacted in the near future. Other potential threats include the emerald ash borer and the Asian long-horned beetle. The emerald ash borer can infest all native ash species and can kill a tree in two to four years. It was recently discovered in Ulster County and in Rhinebeck. The Asian long-horned beetle threatens native maple, birch, and willow trees and has the potential to greatly affect the forestry, maple syrup, and nursery industries (APHIS 2008). It has been found in New York City and on Long Island, and there is a large invasion in Massachusetts. 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.

Recommendations

We recommend that the remaining blocks of large forest within the Town of Clinton be considered priority areas for conservation and that efforts be taken to fully protect these habitats 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 and should not divide the habitat into smaller isolated patches. Some general guidelines for forest conservation include the following:

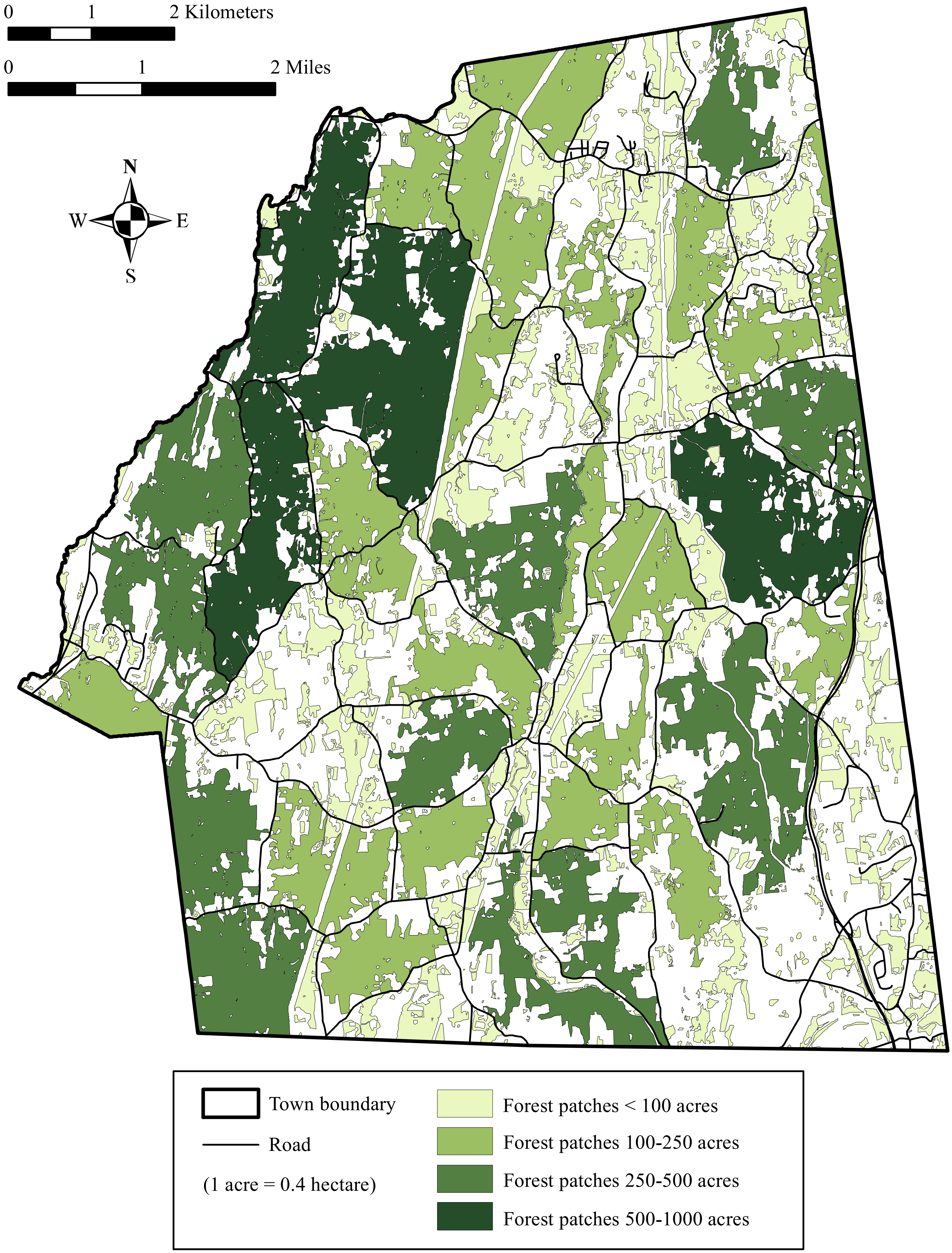
1. **Protect large, contiguous forested areas** wherever possible, and avoid development and logging in forest interiors.
2. **Protect patches of forest types that are less common in the town regardless of their size**. These include mature forests (and old-growth, if any is present), natural conifer stands, forests with an unusual tree species composition, or forests that have smaller, unusual habitats (such as calcareous crest, ledge, or talus) embedded in them.
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**. Consult with an invasive species expert if you think you have an infestation of an invasive insect species, as treatment procedures vary by species.

Upland mixed forest

Scarlet tanager, a bird of forest interiors

Figure 5. Contiguous forest patches (including hardwood, mixed, and conifer forests in uplands and swamps) in the Town of Clinton, Dutchess County, New York. Hudsonia Ltd., 2012.



CREST/LEDGE/TALUS and ROCKY BARREN

Target Areas

Crest and ledge habitat was unevenly distributed in the town (talus being rare), with most occurring in, and characterizing, northwestern Clinton. There, areas of abundant calcareous and non-calcareous outcrops sprawled to over 400 ac (160 ha) and 550 ac (220 ha), respectively, and covered more than 40% of the land surface. Smaller, more isolated areas of crest and ledge also occurred in southwestern Clinton and far eastern Clinton. There, such isolated areas often stood out in stark contrast to an otherwise gently rolling landscape, and served as refuges for numerous plant species not otherwise found in that part of town. We also found 22 small rocky barrens, most of these in northwestern Clinton. One was an oak-heath barren on acidic ledge, surrounded by otherwise calcareous crest and ledge habitat east of Browns Pond Road. The isolated patch was small (0.6 ac [0.2 ha]) and may have been a remnant of formerly larger and more numerous patches that have since grown up into forest, or might be associated with a small area of more acidic substrate.

Conservation Issues for Selected Focal Species

Some rare and vulnerable snakes depend on rocky habitats, including the exposed outcrops of crest/ledge and rocky barrens. Snakes such as northern copperhead,* eastern rat snake,* and eastern racer* den in crest, ledge, and talus habitats and 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). Eastern rat snakes and eastern racers travel similar distances from their den sites (Blouin-Demers and Weatherhead 2002; Todd 2000). Northern copperhead and other snakes are vulnerable to loss or disturbance of habitat, collection for live trade, and malicious killing (Klemens 1993). Perhaps one of the greatest threats to the sensitive animals associated with crest/ledge/talus and rocky barrens (including far-ranging rare reptiles) is the fragmentation of large rocky forested areas and associated habitat complexes. The construction of houses, roads, and other structures in these habitats can isolate populations 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.

Rocky barrens are uncommon in the Hudson Valley but are best represented in the high-elevation areas of the Catskills, Taconics, and other mountain ranges of the region. They are disturbance-maintained ecosystems (ice, fire, wind, ice); human suppression of wildfires has eliminated one of the disturbances that historically maintained them. The plant communities of some rocky barrens, such as oak-heath barrens, are especially adapted to episodic fires. Without fire events, other forest species can colonize these areas, and eventually barren specialists may be out-competed by the more typical species of rocky upland hardwood forests.

Recommendations

To help protect crest, ledge, and talus habitats, we recommend the following measures:

1. **Avoid direct alteration of crest, ledge, and talus habitats** wherever possible, and concentrate any unavoidable development in a manner that maximizes the amount and contiguity of undisturbed rocky habitat. Minimize the extent of new roads through undeveloped land with extensive crest, ledge, and talus. Take special measures to restrict the potential movement of snakes into developed areas, thereby minimizing the likelihood of human-snake encounters (which are often fatal for the snake) and road mortality.
2. **Maintain broad corridors** between crest, ledge, and talus habitats**.** Intervening areas between habitats provide travel corridors for species that migrate among different habitats for breeding, foraging, and dispersal.
3. **Protect large forested areas around crest, ledge, and talus habitats.**
4. **Consider the impacts of habitat disturbance** to crest, ledge, and talus when reviewing all applications for mined lands permits and other development proposals, keeping in mind that rare snakes typically travel long distances from their den sites.
5. **Educate construction workers and residents** about snake conservation and whom to contact to safely relocate snakes.

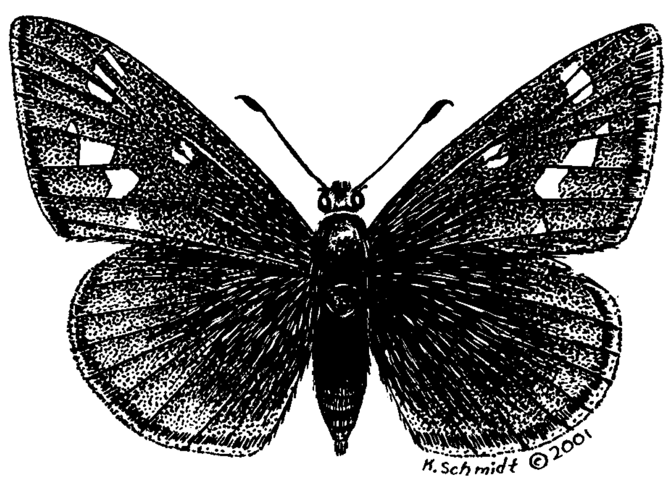
Particular measures for conservation of rocky barrens and their associated rare species include:

1. **Protect rocky barrens and associated crest, ledge, and talus habitats.** Avoid direct alterations including, but not limited to, the construction of communication towers; mining; house, road, and driveway construction; and high intensity human recreation. Protecting these habitats protects denning and basking areas for rare snakes and the habitat's specially adapted plants.

2. **Protect critical adjoining habitats within 100 ft (30 m) of the barrens** (and larger contiguous areas wherever possible)**.** Basking reptiles and other organisms that are sensitive to human disturbances use these barrens, but the paucity of similar habitat types on the landscape limits the ability of some organisms to avoid human activity. Disturbances in or near a rocky barren can force out sensitive species and provide an avenue for the establishment of invasive plants. Because these habitats have shallow soils, they are particularly sensitive to trampling or ATV use that can wear away soils and damage plant root systems. For these reasons we recommend that habitats within at least 100 ft (30 m) of a rocky barren be considered critical components of the barren habitat. Avoid new development of any kind, including roads and high-use hiking trails, within this 100-ft zone. Protecting larger areas of contiguous habitat surrounding rocky barrens will not only protect potential foraging habitats and travel corridors for rare species, but may also help support the ecological and natural disturbance processes (e.g. fire) that help sustain the rocky barren habitats.

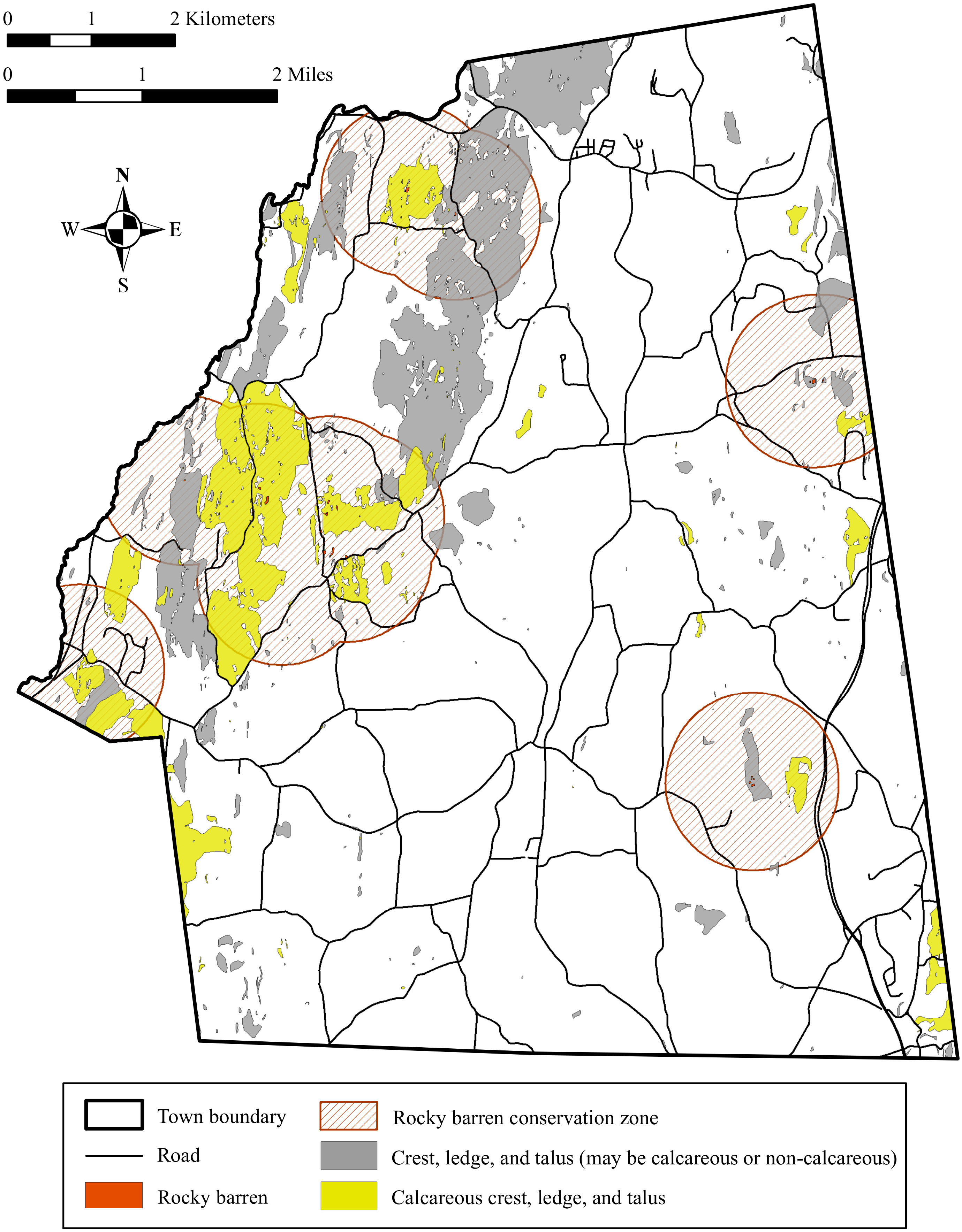
3. **Maintain broad corridors between rocky barrens and nearby crest, ledge, and talus habitats** to provide travel routes for species that migrate among different rocky habitats for breeding, foraging, and dispersal.

4. **Protect critical adjoining habitats (ledges, forests, meadows) within 3,300 ft (1,000 m) of the rocky barrens.** Habitats within this zone should be considered critical components of the barren habitat "complex" that may be used for foraging and travel by the rare and uncommon snakes of the barrens habitats. As much as possible, avoid new development of any kind, including roads and driveways within this 0.6-mi zone. If development cannot be avoided, it should be concentrated in a manner that maximizes the amount and contiguity of undisturbed habitat. Protecting large areas of contiguous habitat surrounding the barrens will not only protect potential foraging habitats and travel corridors, but may also help support the ecological and natural disturbance processes (e.g., fire) that help sustain the barrens habitats.



Dusted skipper

Figure 6. Rocky barrens and their 3,300-ft (1,000-m) conservation zones as well as generalized distribution of calcareous and non-calcareous crest, ledge, and talus habitats in the Town of Clinton, Dutchess County, New York. Crest, ledge, and talus locations identified by field observations and inferred from topography. Hudsonia Ltd., 2012.



LARGE MEADOWS

Target Areas

Large and contiguous meadow complexes (including upland, wet, and calcareous wet meadows), particularly lightly grazed pasture, carefully managed hayfields, or large meadows dominated by grasses, can be valuable nesting habitats for rare and uncommon grassland-breeding birds. Cultivated fields have little current value as nesting habitat, but may regain habitat value when used as pasture or hayfields and managed as grassland bird habitat, or if they are allowed to go fallow. Figure 7 illustrates the location and distribution of meadow habitats in the town (including upland meadow, wet meadow, and calcareous wet meadow), classified by size.

The largest individual meadows and meadow complexes were found in southeastern Clinton. For grassland breeding birds, fences and hedgerows may serve to fragment meadow areas into smaller patches. When fences and hedgerows are not treated as fragmenting features, the largest contiguous meadow complex in the town, located between the Taconic Parkway and Schultzville Road, measured 154 ac (62 ha) and included several small wet meadows. This and most of the largest meadow complexes in town, however, had very high edge-to-area ratios, due to numerous deep incursions by development and non-meadow habitat (Figure 7A). One exception was a 120-ac (50-ha) meadow complex just east of Allen Road, which had relatively little edge for its size. Most of the largest single meadows, when fences and hedgerows are treated as fragmenting features, also occurred in southeastern Clinton. The largest, at 85 ac (34 ha) was the only meadow in town to exceed 50 ac (20 ha) (Figure 7B). A large region west of Little Wappinger Creek also contained several large meadows and meadow complexes, and a relatively high abundance of meadow in general (see "Conservation Areas," below).

Smaller upland and wet meadows that could potentially serve as wildlife travel corridors or "stepping stones" between nearby habitats are also important, as are upland shrublands with relatively sparse shrub cover.

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 patches are especially important for grassland-breeding birds. There are eight state-listed grassland-breeding bird species: short-eared owl* (Endangered); upland sandpiper,* sedge wren,* Henslow's sparrow,* and northern harrier* (Threatened) and horned lark,* grasshopper sparrow,* and vesper sparrow* (Species of Special Concern). Most of these seem to require meadows larger than those in Clinton for successful nesting, but several grassland bird species of regional significance—bobolink, eastern meadowlark, savannah sparrow—could use some of Clinton's largest meadows. Northern harrier,* American kestrel,* and nesting eastern meadowlark* and bobolink* have been observed in recent years in large meadows of southeastern Clinton (Barbara Mansell, personal communication). While short-eared owl* is not known to breed in the Hudson Valley, it uses large grasslands in the region as foraging habitats during winter, as do other raptors, some birds that breed farther north, and many non-migratory birds.

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 & Litvaitis 2011). 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). Figure 7 illustrates how meadow patch sizes differ when hedgerows and fences are taken into account as fragmenting features.

Only six of Clinton's meadows are larger than 25 ac (10 ha) and just one is larger than 50 ac (20 ha). Meadows in Clinton may not be large enough to support breeding grasshopper sparrow,* Henslow's sparrow,* or upland sandpiper* populations (Vickery et al.1994), but may support breeding populations of species with smaller area requirements, such as savannah sparrow, eastern meadowlark,* and bobolink.* Because grassland birds have very specific habitat requirements for nesting, their survival in the northeastern U.S. 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 (http://www.massaudubon.org) has the following management suggestions for minimizing harm to grassland birds in meadows of the Northeast:

1. **Mow after August 1.** This will avoid much of the nesting, nursery, and fledging seasons; if mowing must occur before then, leave some unmowed strips or patches. Also, some birds need higher vegetation in spring when establishing territories, so mowing annually before the end of August (and removing hay) is optimal for those species (Nocera et al. 2007). Mowing in fall is even less disruptive (some birds continue breeding into August or September), and leaves vegetation short for those birds who select for low grasses in the spring.

2. **Mow each field only once every 1-3 years**, or mow in rotation mowing so that each part of a field is mowed once every 3 years, to maintain habitat for nesting birds and butterflies. Mowing should be frequent enough to prevent encroachment of woody vegetation.

3. **Remove fences or hedgerows between smaller fields** to enlarge the habitat area for grassland breeding birds.

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

5. **Pasture a few livestock,** keeping about 40% of grass knee-high to provide cover for nesting birds. This can be achieved through low stocking rates and rotation among fields.

6. With careful planning and execution, **burn grasslands every two to six years** to improve habitat quality for grassland 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 very little habitat value for birds or other wildlife. However, farming practices here 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 may be more bird-friendly.

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, the lower the protein content of the hay. However, lower-quality hay has uses: 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 for farmers 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 & 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 0.5 ha.**

3. **Rotate animals out of a paddock when they have grazed grass down to 5 inches**, 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.

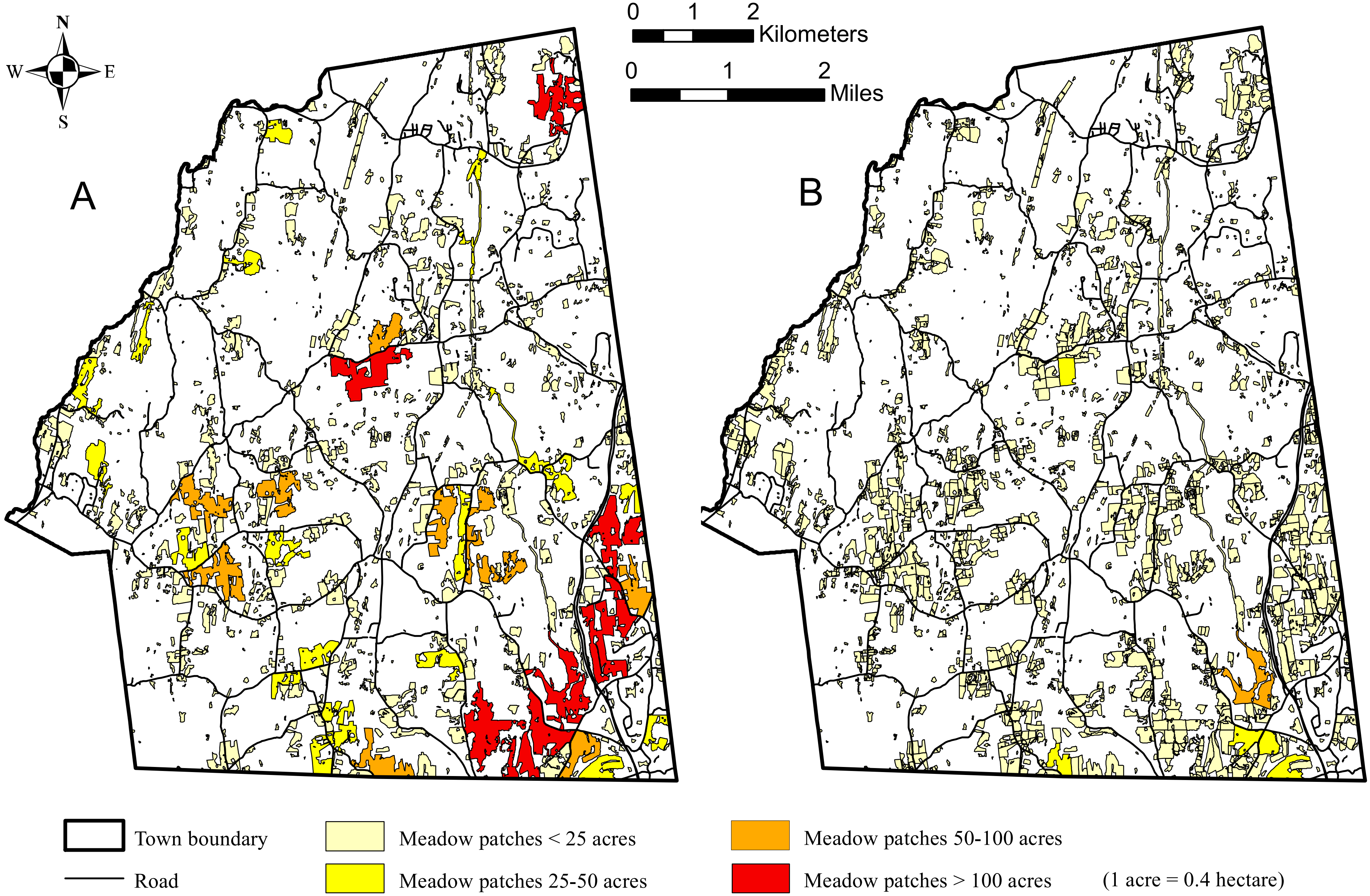
5. **Delay any mowing or clipping of grazed paddocks until mid-July.**

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, the town should also consider avoiding further conversion of forest to meadow and perhaps even allowing some meadows (particularly smaller ones, or those that are contiguous with areas of upland forest) to revert to forest cover.

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 in the face of unstable and unpredictable energy supplies, and the worldwide imperative to reduce carbon emissions. Active farms also contribute to the local economy and to the character of the town's landscape.

Figure 7. Contiguous meadow patches (including upland meadow, wet meadow, calcareous wet meadow, and fen) in the Town of Clinton, Dutchess County, New York. A) Contiguous meadow patches without consideration of fences and hedgerows; B) contiguous meadow patches with fences and hedgerows shown as fragmenting features. Both maps include active agricultural areas and other managed and unmanaged meadow habitats. Hudsonia Ltd., 2012.



ACIDIC BOGS

Target Areas

We found three acidic bogs in disjunct locations in Clinton. The largest was Zipfeldberg Bog (4 ac [1.5 ha]), a dwarf shrub bog within a Nature Conservancy site in northwestern Clinton. Another acidic bog abutted Mud Pond, and the third was a small strip along the edge of an isolated swamp in southwestern Clinton, embedded within a large, unfragmented matrix of high-quality upland and wetland habitats.

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 hydroperiod of the bog. Enrichment by nitrogen or phosphorus (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 carbon source in the atmosphere (Moore 2002). Perhaps the best way to preserve bog habitat intact is 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:

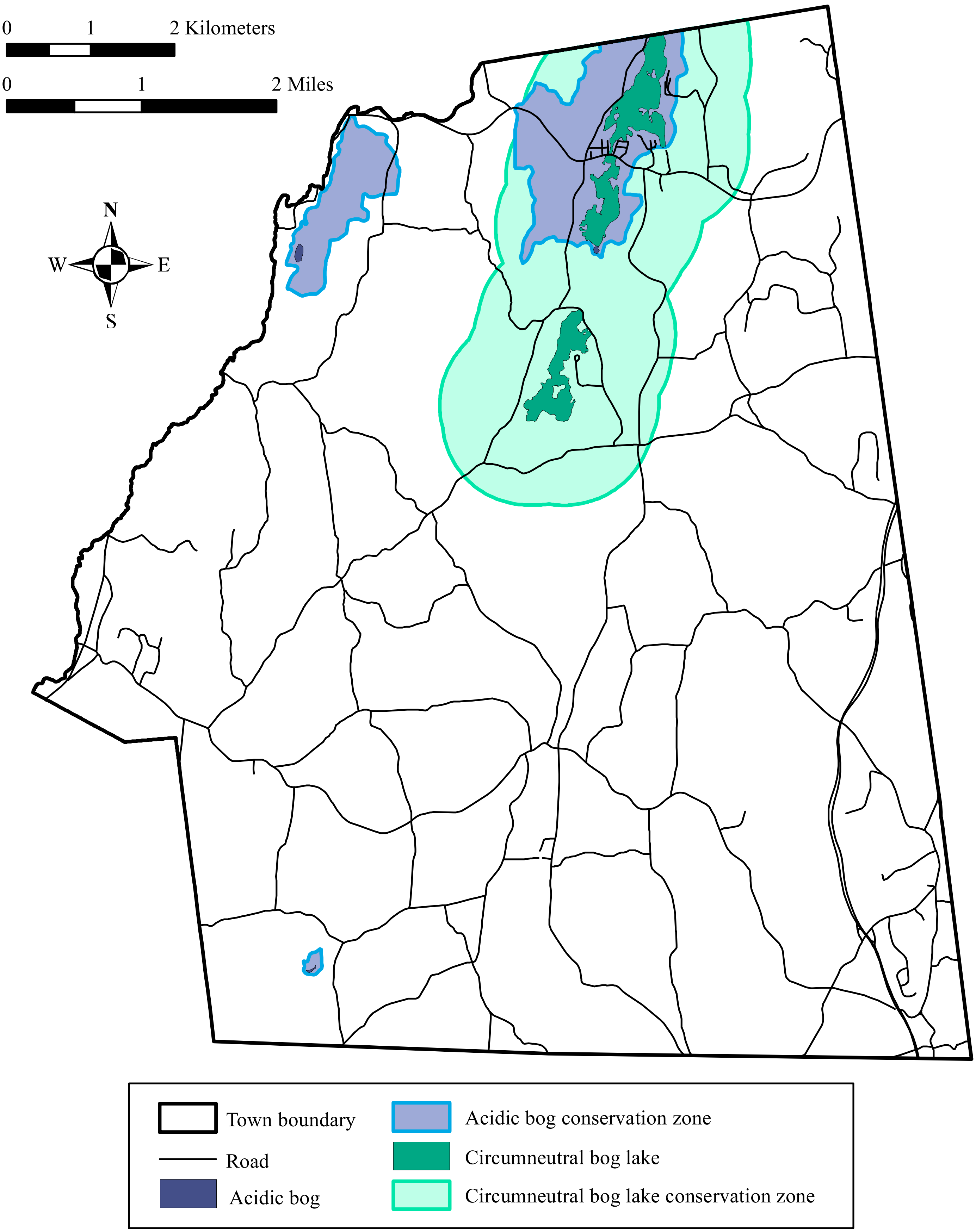
1. **Protect the bog itself.**
   Limit human trampling and other direct disturbance of acidic bogs. If hiking trail access to one of these special areas is necessary, locate the trail so that the bog can be observed from the

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 groundwater extraction (e.g. wells).
   - Maintain microclimate. Protect forest cover as much as possible.

Pitcher-plant and cranberry in acidic bog

Figure 8. Acidic bogs and circumneutral bog lakes with associated conservation zones in the Town of Clinton, Dutchess County, New York. Acidic bog conservation zones encompass the entire bog watershed within the Town of Clinton; circumneutral bog lake conservation zones measure 3,300 ft (1,000 m) from the lake edge. Hudsonia Ltd., 2012.



CIRCUMNEUTRAL BOG LAKES

Target Areas

The Milan Window contains three circumneutral bog lakes—Silver Lake, Mud Pond, and Long Pond. All three have some degree of residential development along their shores. Long Pond has the least developed shoreline, while Silver Lake is completely developed along its southern shore and has substantial development on its east side as well. Roads run very close to several other shores of these lakes. Nevertheless, much of the Mud Pond and Long Pond shorelines remains undeveloped and retains intact upland and wetland habitats.

Conservation Issues for Selected Focal Species

The unusual water chemistry, hydrology, and sediments of circumneutral bog lakes often combine to provide habitat for rare plants and animals. Northern cricket frog* (NYS Endangered) has been documented in Dutchess County (and in only two other counties in New York) and has been rapidly declining in the state (New York Natural Heritage Program 2011). In most of this region, circumneutral bog lakes are the critical breeding habitat for the species (Dickinson 1993). Males prefer gently-sloping banks and floating peat and aquatic vegetation to use as calling sites. The species seems to have greater reproductive success at sites with buffered (circumneutral) pH conditions (Sparling et al. 1995) and with abundant submerged vegetation which provides shelter for tadpoles (Beasley et al. 2005). This vegetation can be affected by herbicide application or herbicide-contaminated runoff into the lake, and water quality can be degraded by fertilizers and other nutrient additions, as well as sedimentation. Northern cricket frogs are sensitive to the insecticide imidacloprid—widely used in agriculture, arboriculture, and control of fleas, termites, and other insects—and to predation pressure from introduced fish such as grass carp (Ade et al. 2010).

Northern cricket frog may use a variety of overwintering sites, including deep cracks in moist soil at the perimeters of these lakes, which can be destroyed by pond dredging or clearing of surrounding vegetation (Irwin 2005). The frogs may also overwinter away from the lakes in small wetlands or forested upland sites as far from the lake as 1,475 ft (450 m) (New York Natural Heritage Program 2011; Jason Tesauro, personal communication). Individual cricket frogs have been known to disperse between ponds up to 0.8 miles (1.3 km) apart (Gray 1983) and, based on the distribution of suitable habitats in this region, they can probably disperse much farther (Dickinson 1993).

The clear water, diverse plant community, floating vegetation mats, and peat rafts of circumneutral bog lakes create unusual habitat for plants, fish, amphibians, reptiles, and invertebrates. Maintaining the quality and quantity of groundwater and surface water feeding the lake is critical to these very unusual lake habitats. Aquatic vegetation can be affected by herbicide application or herbicide-contaminated runoff into the lake, and water quality is degraded by fertilizers and other nutrient additions to the surrounding landscape, as well as sedimentation from silt-laden runoff.

Recommendations

In order to protect these rare habitats and the species they support, we recommend the following measures for circumneutral bog lakes:

1. **Maintain water quality**. Avoid the application of herbicides for the control of invasive aquatic plants. Consider mechanical harvesting of undesired species, such as Eurasian milfoil. (Dispose of harvested material outside of and distant from the wetland.) Reduce or eliminate use of fertilizers and pesticides on lawns and nearby agricultural fields; minimize soil disturbance within the watershed of the circumneutral bog lake; upgrade nearby septic systems to prevent nutrient enrichment of the lake; minimize runoff from roads and other impervious surfaces.

2. **Maintain hydrology**. Avoid changing water levels or patterns of inflow and outflow. This requires attention to activities in the lake watershed such as road and building construction, stormwater management infrastructure, and groundwater extraction (e.g. wells).

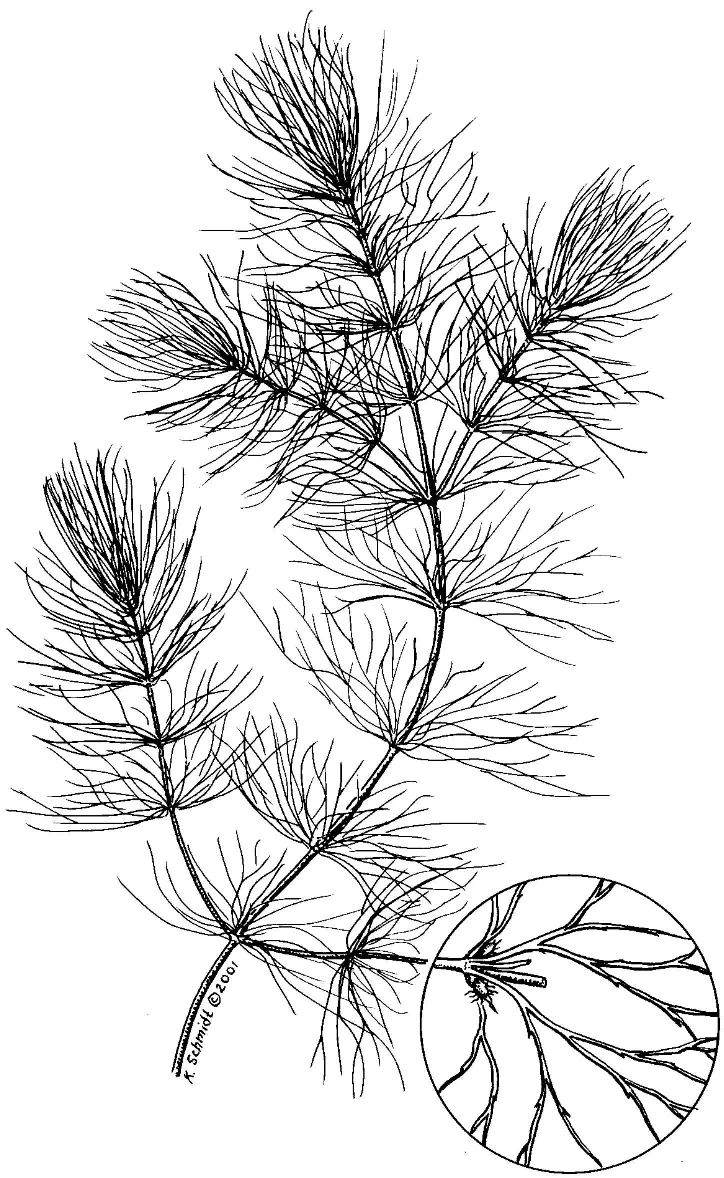
3. **Maintain or restore a vegetated buffer of 300 ft (90 m) from the lake edge**. Leaving a broad buffer of undisturbed soils and vegetation may be crucial to safeguarding wetland habitat quality, hydrology, and potential northern cricket frog overwintering sites. The buffer zones along stretches of the circumneutral bog lakes in the study area are currently compromised by residential development and roads. To protect the lake habitat, discourage new development in this buffer area and keep road treatments (such as salting or sanding) to a minimum.

4. **Protect habitats and assess potential impacts within 3,300 ft (1,000 m) of the lake edge.** Development within this area may sever important travel corridors between potential northern cricket frog breeding habitats, and between the lake and the cricket frog overwintering habitats. Conservation measures within this area will also protect hydrology and water quality for other rare species.

5. **If any significant land-use changes are proposed in the vicinity, conduct rare species surveys in the lake, adjacent wetlands, and surrounding forests early in the planning process**, so that development designs can accommodate the needs of sensitive species. Surveys should include rare plants, amphibians, reptiles, and breeding birds.

6. **Discourage use of motorized watercraft**. Motorized craft pollute water, create noise disturbance, physically damage plant and animal life, and may introduce non-native species.

7. **Avoid the introduction of non-native fish species that may disrupt the lake's food web**, including grass carp (used for biological weed control) or game fish.



Spiny coontail

INTERMITTENT WOODLAND POOLS

Target Areas

We identified and mapped 257 intermittent woodland pools in the town (Figure 9), and there are likely to be others that we missed. In addition, we mapped 89 pool-like swamps and five heath swamps with presumed ecological functions similar to those of intermittent woodland pools. Other wetlands that share some characteristics of intermittent woodland pools include small kettle shrub pools and buttonbush pools (see "Buttonbush Pool/Kettle Shrub Pool" habitat description). 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 "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.

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 and shelter. 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). 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 annual 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 (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 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 protective 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 (see below).

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 affects 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 appear at this time to 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 and (sometimes) short hydroperiod. Ruts, for example, may also serve as larval habitats for undesirable species of mosquitoes.

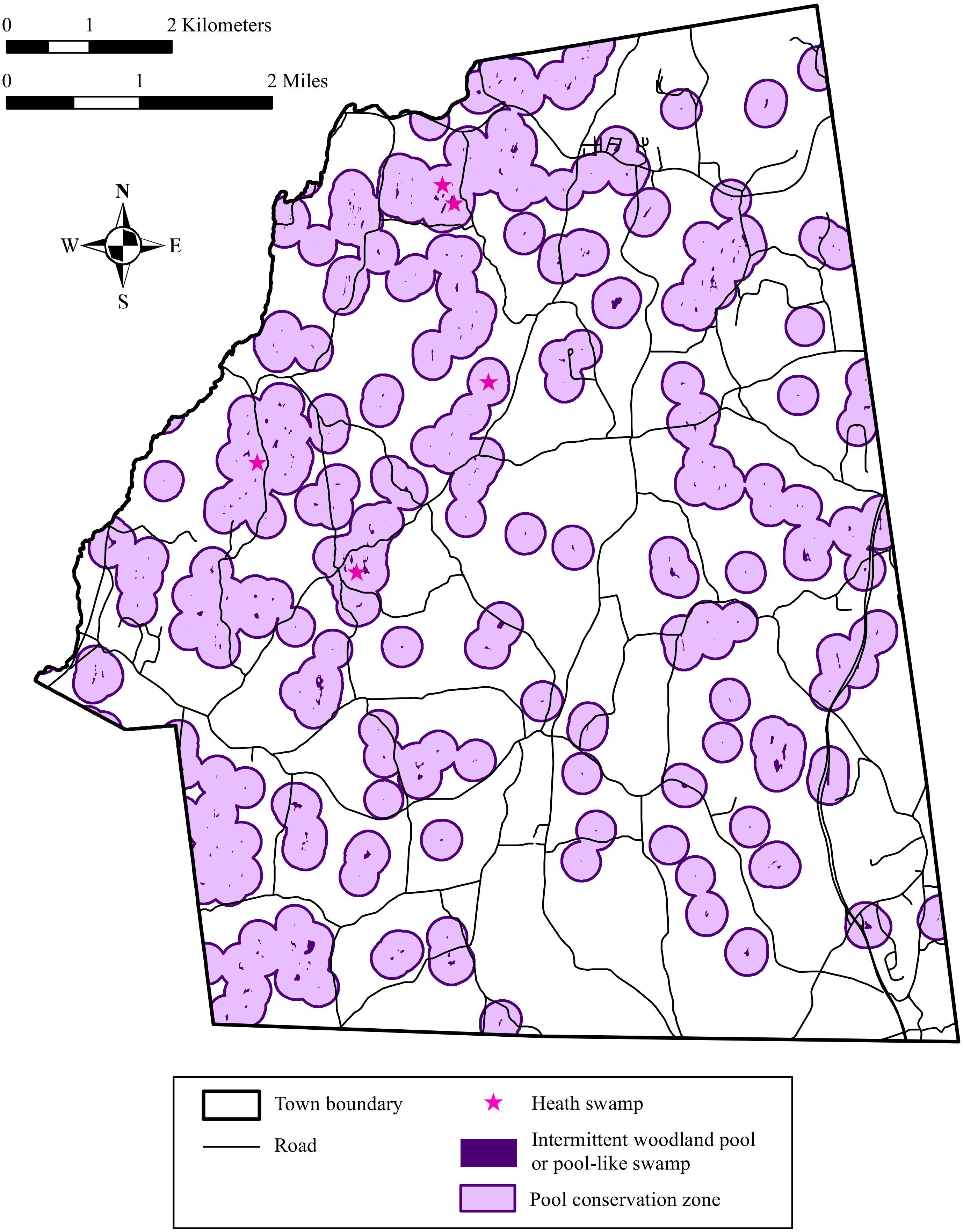
4. **Modify potential pitfall hazards** such as swimming pools, excavations, window wells, or storm drain catch basins to prevent the entrapment and death of migrating amphibians. Soil test pits should be backfilled immediately after tests are completed.

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 & 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).

Intermittent woodland pools, flooded (left), and dry (right)

Figure 9. Intermittent woodland pools, pool-like swamps, and heath swamps, with associated conservation zones, in the Town of Clinton, Dutchess County, New York. Conservation zones extend 750 ft (230 m) from edges of wetlands. Conservation zones of pools previously mapped in adjacent towns are shown where they extend into the Town of Clinton. Hudsonia Ltd., 2012.



BUTTONBUSH POOLS/KETTLE SHRUB POOLS

Target Areas

We identified 23 buttonbush pools and 10 kettle shrub pools scattered throughout the town (Figure 10). The largest were two kettle shrub pools south of Mud Pond (including one of 8 ac [3 ha]) and one west of Browns Pond Road. Kettle shrub pools are the typical core wetlands used by the Blanding's turtle* (NYS Threatened) in Dutchess County. Swamps with structural characteristics similar to kettle shrub pools (such as buttonbush pools and other deep-flooding shrub swamps) may also be used as core habitat. Blanding's turtle is known to occur at several locations in Clinton and has been studied within a habitat complex at one of these locations.

Conservation Issues for Selected Focal Species

The Blanding's turtle* typically spends winter, spring, and fall in its core wetland (Kiviat 1997), but during the active season (ca. April – October), it also uses other nearby wetlands, including emergent marshes, swamps, intermittent woodland pools, and lakes, for foraging, rehydrating, and resting. Females nest in open upland habitats with (usually) coarse-textured, well-drained soil (often gardens, agricultural fields, utility rights-of-way, soil mines, etc.), in late spring to early summer. During drought periods and during the nesting season migrations, individuals may move into constructed ponds or other water bodies that retain standing water. Maintaining a Blanding's turtle population requires protecting not only the core wetland habitat (i.e. kettle shrub pool or buttonbush pool), but also the associated foraging and drought refuge wetlands, the upland nesting areas, and the upland areas between these habitats.

The day-to-day and seasonal overland movements of the Blanding's turtles to reach important foraging areas, nesting sites, and refuge habitats extend to 3,300 ft (1,000 m) and sometimes farther from a core wetland habitat. In the Northeast and elsewhere in their range, movements of 6,600 ft (2,000 m) and more have been documented on numerous occasions (Joyal et al. 2000, 2001, Fowle 2001). A female in Ontario traveled over 3.7 mi (6000 m) to nest (Edge et al. 2010). These long distance movements enable turtles to select alternative habitats as habitat quality or social dynamics change, and to breed with individuals from neighboring populations. Therefore, to define the potential extent of the habitat complex used by a Blanding's turtle population, we delineated 3,300-ft (1,000-m) and 6,600-ft (2,000-m) zones around each core wetland habitat

(Figure 10; Hartwig et al. 2009). The 1,000-m “conservation zone” encompasses the wetlands that the turtles would use regularly on a seasonal basis, most of the nesting areas, and most of the travel corridors. One can expect turtles regularly in this zone throughout the active season (April - October). The 2000-m “area of concern” includes the landscape over which Blanding’s turtle makes long-distance movements to explore new wetlands, seek mates, or nest. One can expect a few turtles from a particular core wetland in this zone each year. Within these zones, potential Blanding’s turtle habitats include both wetlands and upland nesting habitats, as well as the travel corridors between them. The conservation zones of five kettle shrub or buttonbush pools in Rhinebeck and Hyde Park extend well into Clinton, as do the areas of concern of two pools east of Clinton (one each in Stanford and Washington) (Tollefson and Stevens 2004, Bell et al. 2005, Reinmann and Stevens 2007, Bell and Stevens 2009).

Land development and other human uses within this habitat complex can have significant adverse effects on the turtles and their habitats, including the direct loss of wetland habitat (small, unregulated wetlands are especially vulnerable); degraded water quality from surface runoff containing fertilizers, pesticides, and other toxic substances; altered wetland hydroperiod and water depth from groundwater extraction or stormwater diversion; habitat fragmentation from roads and developed land uses; collecting of turtles and their eggs; and increased nest predation by human-subsidized predators. Road mortality of nesting females and other individuals migrating between wetlands or dispersing to new habitats is one of the greatest threats to Blanding’s turtle populations (Kiviat and Stevens 2003).

Recommendations

The protection of habitats with the potential to support Blanding’s turtle* populations is crucial to the recovery of this species. To help protect Blanding’s turtles and the habitat complexes they require, we recommend the following measures adapted from Hartwig et al. (2009; see for more details):

Within the **6,600-ft (2,000-m) Area of Concern**:

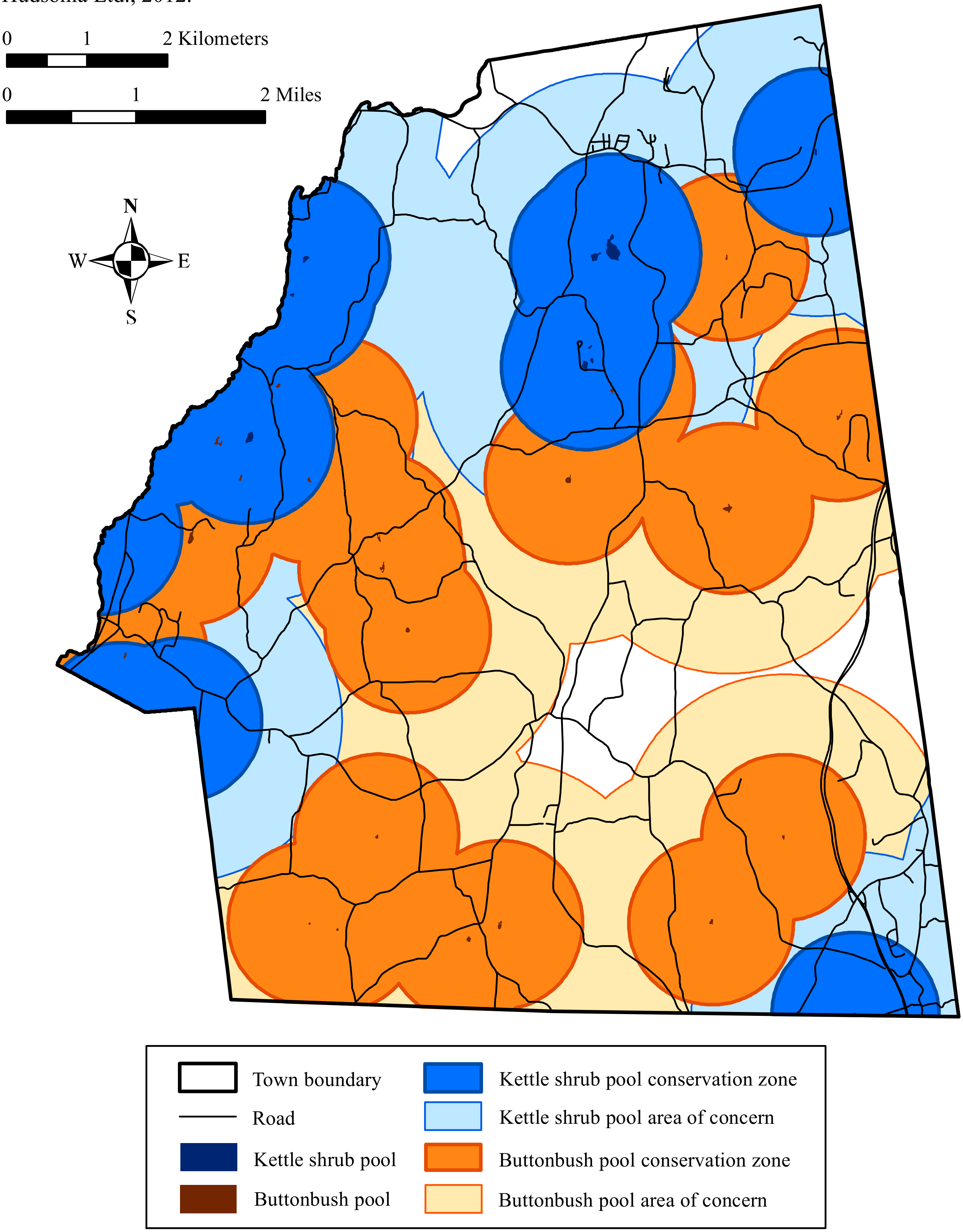
1. **Protect wetland habitats** from physical, chemical, or unnatural hydrological disturbance.
2. **Maintain the spatial and temporal patterns of surface water and groundwater** entering and leaving wetlands.
3. **Maintain broad corridors of undeveloped land** within the Area of Concern between all 1,000 m (3,300 ft) Conservation Zones.
4. **Minimize the extent of new roads**. Consider installing turtle crossing signs along existing roads, particularly during high activity periods (June and July; Beaudry et al. 2010).
5. **Maintain broad buffer zones** (e.g. at least 30 m [100 ft] width) of natural soil and vegetation around all wetlands, including unregulated wetlands.
6. **Minimize or eliminate pesticide use.**
7. **Educate landowners** about the Blanding's turtle and its conservation.

Further recommendations for the **3,300-ft (1,000-m) Conservation Zone** include:

1. **Protect nesting areas**. Blanding's turtles typically nest in upland meadow or open shrublands, habitats that also tend to be prime targets for development.
2. **Consider the impacts on water quality, hydrology, and habitat disturbance** to turtle habitat complexes when reviewing all applications for any permits or land-use changes.
3. **Identify high-priority areas for special protection,** e.g. for acquisition of land or establishment of conservation easements.
4. **Identify all potential pitfall hazards**, and design or modify them to prevent the entrapment of turtles.
5. **Identify potential barriers to turtle movement**, remove or modify them.
6. **Educate construction crews and eventual residents on how to look for and safely move turtles**.

In addition to the recommendations above, we recommend that **no buildings, pavement, roads, or other structures be constructed in undeveloped areas within 660 ft (200 m) of potential core habitats.** Blanding's turtle activity (basking, aestivation, short-distance travel) is most concentrated in this area. The vegetated buffer will also protect the wetland's ecological functions.

Figure 10. Buttonbush pools and kettle shrub pools with associated conservation zones and areas of concern in the Town of Clinton, Dutchess County, New York. Conservation zones extend 3,300 ft (1,000 m) from pool edges; areas of concern extend 6,600 ft (2,000 m) from pool edges. Conservation zones of pools previously mapped in adjacent towns are shown where they extend into the Town of Clinton. Hudsonia Ltd., 2012.



WETLAND COMPLEXES

Target Areas

A wetland complex is any group of adjacent and nearby swamps, marshes, wet meadows, ponds, other wetland types, or streams. 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. Large and varied wetland complexes occurred throughout the town, but were especially prominent in southwestern Clinton (where wetlands occupied fully 20% of the landscape), in crest- and ledge-dominated northwestern Clinton (Figure 11), and in the Milan Window. The latter contained multiple wetland complexes dominated by circumneutral bog lakes. Some of the town's largest wetland complexes also occurred along Little Wappinger Creek and other perennial streams. 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, more than ten complexes consisted of ten or more pools embedded in unfragmented upland habitat (mostly forest).

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, buttonbush pool, intermittent woodland pool, and open water habitats within a single year (Fowle 2001). Furthermore, although it depends on a large number 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

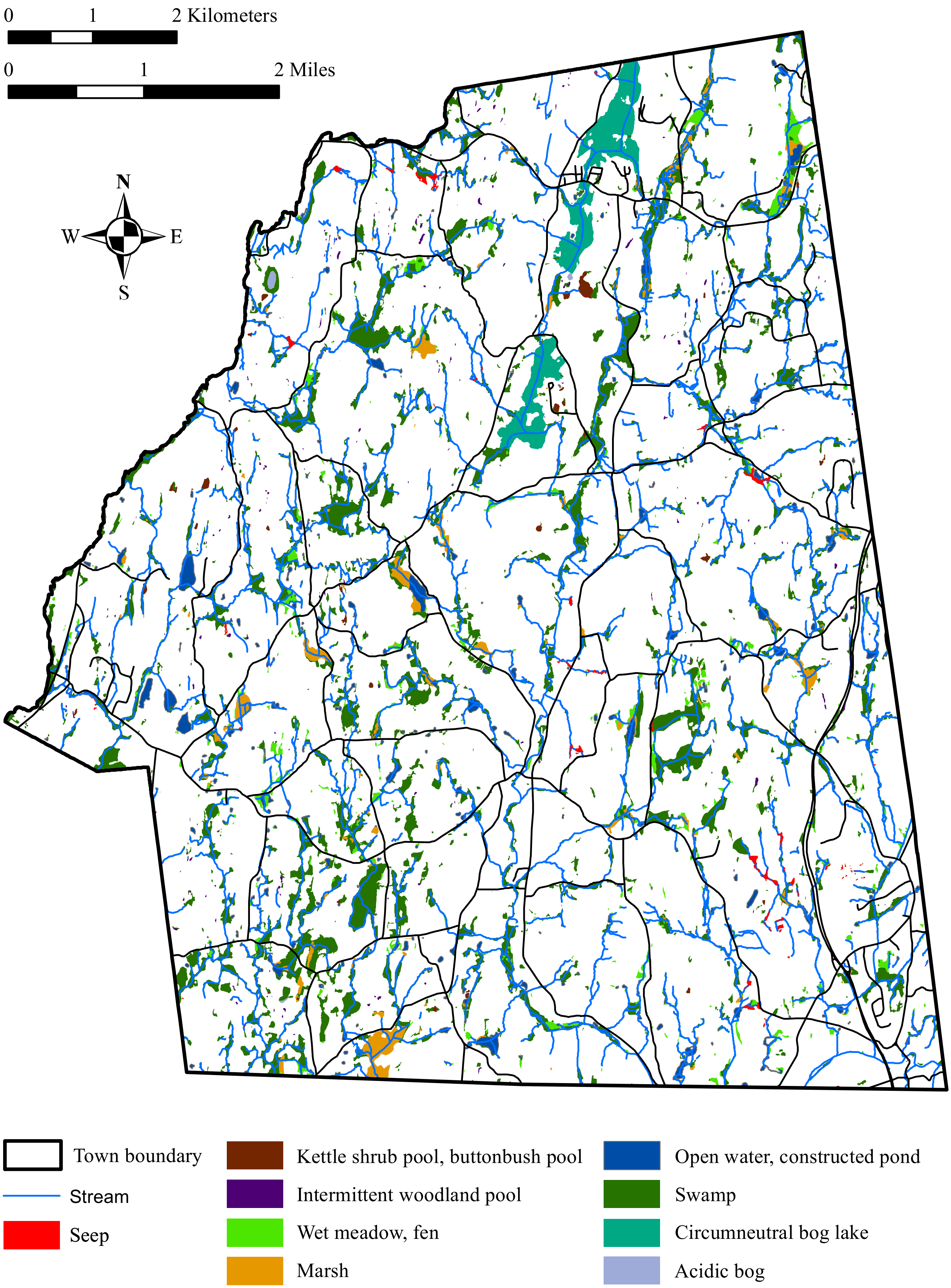
1. **Protect intermittent woodland pools, pool-like swamps, kettle shrub/buttonbush pools, circumneutral bog lakes, and their conservation zones** as described in previous sections of this report. These habitats are used by spotted turtle and many other species of conservation concern.

2. **When the above 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.

Swamp milkweed

Figure 11. Wetland habitats in the Town of Clinton, Dutchess County, New York. Hudsonia Ltd., 2012.



STREAMS, FLOODPLAIN FORESTS, AND RIPARIAN CORRIDORS

Target Areas

Wappinger Creek, its tributaries Wappinger East Branch and Little Wappinger Creek, and Crum Elbow Creek are the largest perennial waterways in Clinton. There are also numerous smaller perennial streams and myriad intermittent streams throughout the town. Floodplain forest occurs along the above named streams and a few of their larger tributaries and is by far most abundant in Clinton along Little Wappinger Creek. Both the streams themselves and associated floodplain forests provide habitat for many plants and animals (both resident and transient) and are important to the ecology of the entire stream watersheds (Figure 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.

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 in large part on the water quality and quantity of the smaller perennial and intermittent streams 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, the adjoining lands (soil and vegetation) should be protected 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).

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.
    - Avoid direct discharge of stormwater runoff, chlorine-treated wastewater, agricultural by-products, 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. These conservation zones should remain 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.** All riparian wetlands adjacent to known or potential wood turtle streams should be protected from filling, dumping, drainage, impoundment, incursion by construction equipment, siltation, polluted runoff, water withdrawals, and hydrological alterations. In addition, large, contiguous blocks of upland habitats (e.g. forests, meadows, and shrublands) within 820 ft (250 m) of a core wood turtle stream should be preserved 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 15 cm (this increases hay yield in the subsequent harvest as well), leaving an unmowed strip of at least 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 river 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, this overland route involves crossing a road or other developed area, often resulting in road mortality. 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:

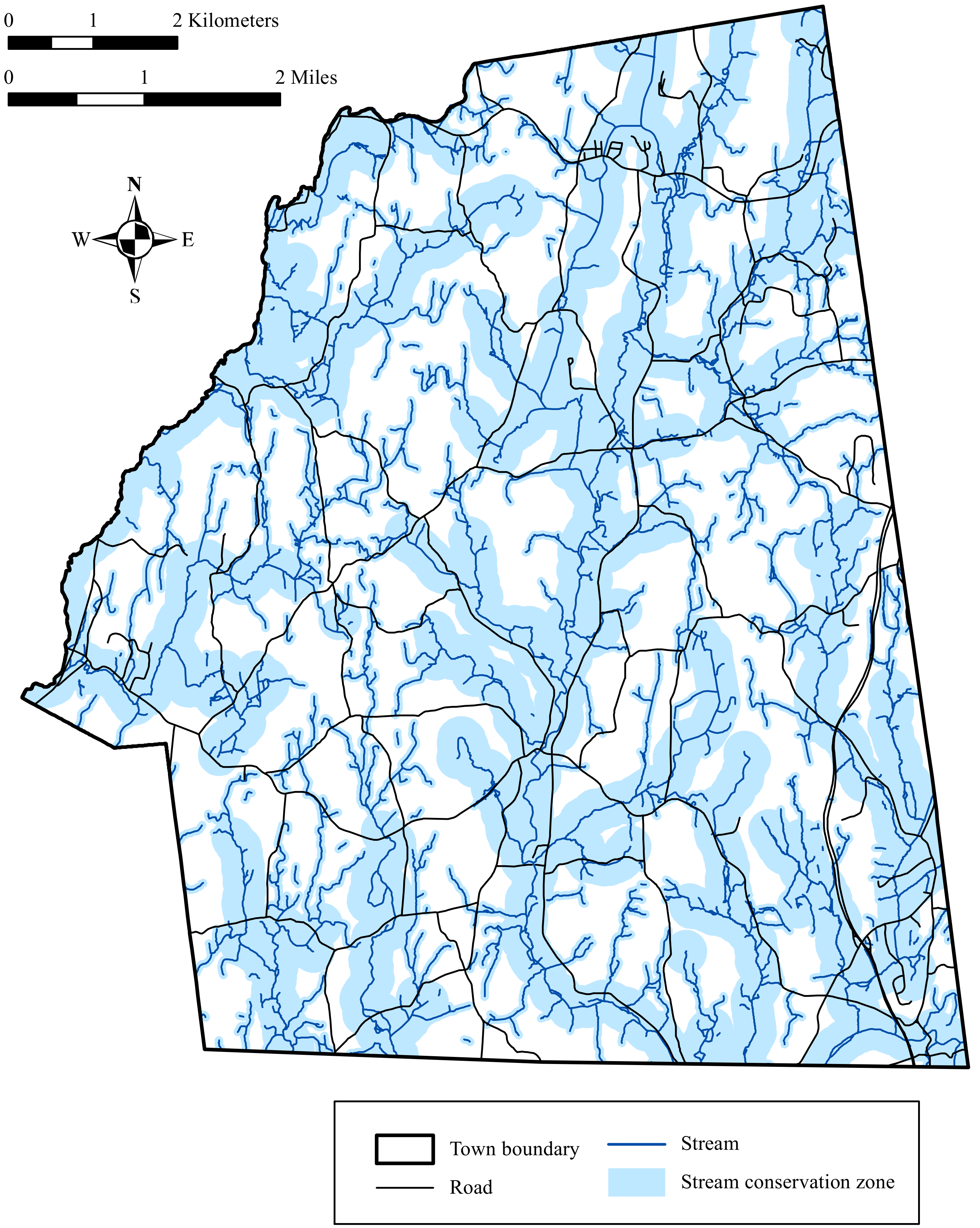
- Prohibit the building of new roads crossing or adjoining wood turtle habitat complexes. This applies to public and private roads of all kinds, including driveways.
- Keep vehicle speeds low on existing roads by installing speed bumps, low speed limit signs, and wildlife crossing signs.

5. **Maintain broad corridors between habitats and habitat complexes**. Broad, naturally vegetated travel corridors should be maintained 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.

Wood turtle near Little Wappinger Creek

Figure 12. Streams and associated conservation zones in the Town of Clinton, Dutchess County, New York. Conservation zones extend at least 160 ft (50 m) from stream edges and 820 ft (250 m) from edges of large, perennial streams. Hudsonia Ltd., 2012.



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. pigeon, 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. Blanding's turtles* (NYS Threatened) sometimes nest in lawns and gardens.

There are many landscape modifications and land-use practices that can be applied to the developed parts of Clinton 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 townwide 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. 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.

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 U.S. 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 U.S. Department of Agriculture and U.S. 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 be a deterrent to many wildlife species. 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.
    - Prohibit the use of fireworks in order to minimize wildlife disturbance.
    - 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."

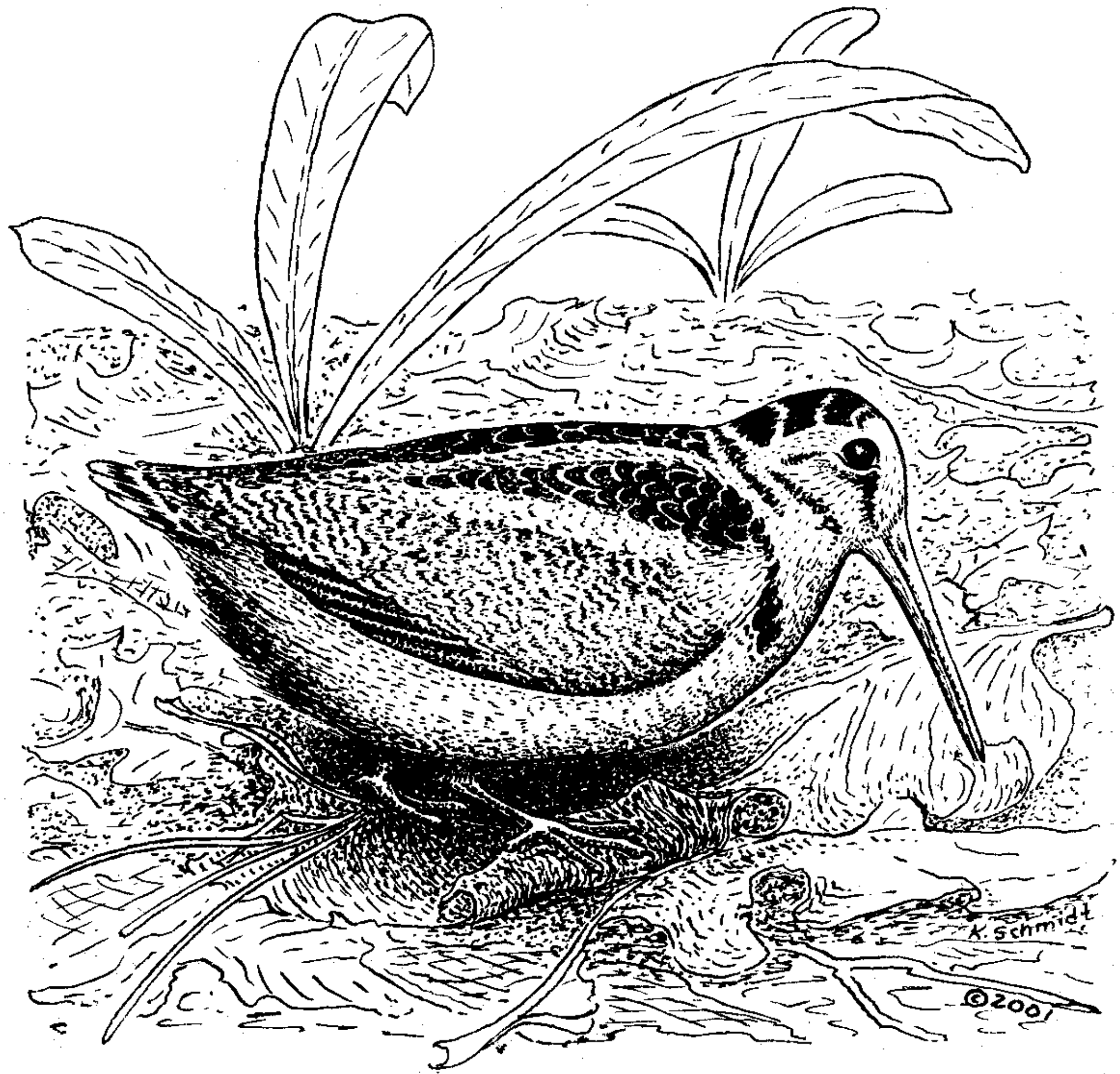
3. ***Discourage human-subsidized predators, including domestic cats and dogs.*** Human-sponsored predators are species such as raccoon, opossum, and striped skunk, whose populations often burgeon in response to conditions created by humans. These species are serious predators on bird eggs and nestlings,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



American woodcock

CONSERVATION AREAS IN CLINTON

To synthesize the information presented above and to facilitate discussion of conservation priorities, we have divided the town into nine "conservation areas" (CA's), plus the hamlet of Clinton Corners, each with a unique character and combination of priority habitats (Figure 14). We hope that this approach will help to illustrate the larger ecological context of particular locations and will 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.

Little Wappinger Conservation Area

This long, linear conservation area encompasses Little Wappinger Creek and its valley. Most of the area was either wetland or floodplain forest. Priority habitats included:

- Little Wappinger Creek. This perennial stream flowed from north to south through Clinton for 10 mi (16 km) before joining Wappinger Creek in the Town of Pleasant Valley. Most of the stream valley in Clinton was undeveloped, with significant exceptions around the intersection of Hollow, Centre, and Clinton Hollow roads and the intersection of Centre Road and Maple Lane. One 2-mi (3-km) stretch south of Fiddlers Bridge Road was notable for being almost entirely forested on both sides of the creek. We observed great blue heron,* belted kingfisher,* and Louisiana waterthrush* (a species associated with the healthy invertebrate communities of clean streams (Stucker 2000) using the creek as a flyway along this stretch, and wood duck doing so elsewhere. A ca 8 mi (12.5 km) reach below Shultzville is classified by NYSDEC as a trout stream, and a little-developed stretch north of Bulls Head Road may also offer suitable brook trout* habitat (Bill Relyea, personal communication).
- Floodplain forest. Most of the floodplain forest in town occurred along Little Wappinger Creek. A few locations had floodplain forest extending more than 260 ft (80 m) from the stream. Commonly observed species included pin oak, sugar maple, green and white ashes, ironwood, Bell's honeysuckle, spicebush, wood reedgrass, bottlebrush grass, wood-nettle, blue cohosh,* garlic mustard, and sensitive fern. We also encountered may-apple* and green dragon* in the Little Wappinger floodplain forest.

- Large wetlands and wetland complexes. While wetlands were abundant throughout the Little Wappinger valley in Clinton, they were especially so in northern Clinton. A 50-acre (20-ha) calcareous ash swamp (with green and black ashes) lined the stream between Fiddlers Bridge and Centre roads, including a portion within a property owned by the Town of Clinton. In this locale, red-shouldered hawk,* eastern screech owl,* American woodcock,* wood turtle,* (Barbara Mansell, personal communication) and a river otter* den (Norene Coller, personal communication) have been observed in recent years. Another extensive complex stretched north from Centre Road, across Bulls Head and Milan Hollow roads, and into the Town of Milan, exceeding 90 ac (35 ha) in Clinton. It embraced an even mixture of marsh and hardwood swamp as well as the second-largest wet meadow in town (8 ac [3 ha]). In a portion of hardwood swamp midway between Centre and Bulls Head roads, Cameron Rylance (personal communication) has seen river otter,* and Stevens and Kiviat (1991) found several rare plants— Bush's sedge,* hairy-fruited sedge, green spikerush,* bog yellow-cress,* and creeping spikemoss.* Beaver activity was common along the Little Wappinger in Clinton.

Milan Window Conservation Area

The Milan Window is a north-south oriented valley west of Little Wappinger Creek and north of Fiddlers Bridge Road that is underlain by a complex of calcareous bedrock—limestone, dolostone, chert, and shale. Its defining ecological feature in Clinton is a chain of three circumneutral bog lakes. Because of the biological richness of these lakes and the associated wetland complex, the Milan Window is part of the "Dutchess County Wetlands" Significant Biodiversity Area identified by the NYSDEC (Penhollow et al. 2006). Although it contains some of the most concentrated development in Clinton, much of the Milan Window retains its natural character and ecological richness. Further development should be undertaken carefully in order to preserve the remaining biodiversity. Priority habitats of this CA include:

- Circumneutral bog lakes. Silver Lake, Mud Pond, and Long Pond together occupied over 250 ac (100 ha). These lakes are spring-fed and underlain by calcareous bedrock, yet harbor plant communities of both calcareous marshes and acidic bogs. Circumneutral bog lakes of the region support numerous plant and animal species of conservation concern (see Circumneutral Bog Lakes subsection of Results, above).

- Kettle shrub and buttonbush pools. At least six examples of these uncommon, isolated wetlands occurred here. Such pools provide high-quality habitat for spotted turtle,* pool-breeding amphibians, and waterfowl such as wood duck* and American black duck.* Kettle shrub pools are the core winter and spring habitat for the Blanding's turtle* in Dutchess County.
- Acidic bog. A highbush blueberry bog thicket, a regionally rare habitat, could support rare plant species.
- Fen. Another regionally uncommon habitat, fens are associated with numerous species of conservation concern including spotted turtle,* eastern ribbon snake,* sedge wren,* and numerous rare plant species. The habitat value of a fen is greatly enhanced when, as was the case here, it is embedded within an extensive wetland complex. Fens are more common in the towns of the Harlem Valley in the eastern tier of Dutchess County towns, but are very rare in western Dutchess County.
- Intermittent woodland pools. Thirteen intermittent woodland pools and three pool-like swamps, including four tightly grouped intermittent pools in close proximity to several other wetland types, dotted the area.
- Wetland complexes. Wrapping around Mud Pond and Long Pond, these complexes together occupied more than 130 ac (50 ha). Especially important and intact components occurred at the south end of Mud Pond, where hardwood swamp, marsh, two kettle shrub pools, four intermittent woodland pools, an acidic bog, and the varied communities of Mud Pond itself lay in close proximity, separated only by undeveloped upland habitats; the south end of Long Pond, where a large swamp, an embedded fen, and Long Pond itself occurred next to mature, high-quality upland forest; and east of the center of Long Pond, where at least three kettle shrub pools and one intermittent woodland pool occurred within a small remnant patch of forest.
- Uncommon upland habitats. These comprised two patches of mature mixed hemlock-hardwood forest adjacent to Long Pond, which overlapped two small areas of high-quality calcareous outcrops, both unusual in northeastern Clinton. The calcareous

outcrops harbored calcium-associated plants such as wild columbine, maidenhair fern, walking fern,* bloodroot, nodding trillium,* and blue cohosh.*

- Contiguous habitat blocks. Despite intensive development, three large patches of contiguous habitat, ranging from nearly 300 ac (120 ha) to greater than 400 ac (160 ha), dominated the Milan Window in Clinton. These patches embraced not only extensive and rare wetlands, but also much intervening upland habitat of varied quality, which serves as important travel corridors and seasonal habitat for many wetland animals. Furthermore, narrow habitat corridors connected the three large blocks across the main roads (Slate Quarry and Long Pond roads) between them. Conservation of the upland-wetland habitat complexes within these three large blocks, and of the corridors between them, is critical to the success of the rare animal and plant species of the Milan Window.

Bulls Head Road Conservation Area

This conservation area in Clinton's northeastern corner is bounded by the Little Wappinger Valley to the west and by a major perennial tributary to the Little Wappinger along most of its southeastern boundary, and is bisected by Bulls Head Road. It is characterized by a ridge system that reaches some of the highest elevations in town and by the perennial tributary to the Little Wappinger and its associated wetland complex. Priority habitats of the Bulls Head Road area included:

- Large forests. Contiguous forest patches of at least 200 ac (80 ha) occurred on either side of Bulls Head Road; both contained significant areas of mature, high-quality upland hardwood forest, which was uncommon in northeastern Clinton. Both also contained rugged areas of very steep slopes. The high-elevation slopes of the northern patch harbored two of the only eastern hemlock stands in Clinton outside of the Western Clinton Outcrops Conservation Area (below).
- Large meadows. One meadow complex occupied 93 ac (38 ha), including a single meadow of 21 ac (9 ha), both among the largest in Clinton. These meadows were adjacent to the largest upland forest patch in the area and to one of the larger wetland complexes in town (see next item).
- Wetland complex. A large, mostly contiguous wetland complex (> 60 ac [20 ha]) occurred along a perennial tributary to the Little Wappinger; its diverse habitats included

a large open water body (where we saw hooded merganser*), hardwood and shrub swamps, marsh, a large calcareous wet meadow (2.5 ac [1.0 ha]), and, at 13 ac (5 ha), the largest wet meadow in Clinton. Beavers were active along this stretch of the stream, having built at least two dams in recent years.

- Kettle shrub pool. This pool was embedded in a much larger swamp across Bulls Head Road from the aforementioned wetland complex. The area of concern of a kettle shrub pool in the Town of Stanford also extends into this CA and subsumes the same large floodplain wetland complex. Given the diversity of upland and wetland habitats near these kettle shrub pools, including potentially high-quality nesting and active-season habitats, this area had the potential to support Blanding's turtle.*
- Intermittent woodland pools. At least 12 intermittent pools and six pool-like swamps were potential breeding pools for Jefferson,* blue-spotted,* and marbled salamanders* and wood frog.* Ten of the intermittent woodland pools and five of the pool-like swamps, along with one buttonbush pool, formed a large complex embedded mostly within upland hardwood forest. The pool complex, situated west of Pumpkin Lane and north of Maple Lane, was mostly intact in the west and south but had been somewhat fragmented by development in the east and north along Pumpkin Lane. This was the only woodland pool complex of its size in eastern Clinton, and further fragmentation or isolation of pools should be discouraged.

Eastern Clinton Highlands Conservation Area

The Eastern Clinton Highlands is an area of (relatively) high elevations and locally concentrated outcrops bounded by Breezy Hill Road, Sunset Trail, and Willow Lane to the south; the Little Wappinger Valley to the west; a perennial tributary of Little Wappinger Creek to the north; and the town boundary to the east. It was characterized by large, unbroken patches of undeveloped habitat, particularly forest, and abundant, small, hardwood swamps. Priority habitats included:

- Large forests. This area contained the second-largest patch of contiguous forest in Clinton, at over 650 ac (260 ha), as well as one patch of forest greater than 300 ac (120 ha) and two patches, separated only by a utility corridor, that together occupied 300 ac (120 ha). These four forest patches were separated from each other by relatively undeveloped roads (Schultzville Road and Pumpkin Lane), and contained large areas of mature, high-quality hardwood forest. The largest forest patch here, bounded by Schultzville Road, Pumpkin Lane, and Willow Lane, was also at the heart of the fourth-largest block of undeveloped land in Clinton (> 1,000 ac [400 ha]), which had a particularly low ratio of edge to area, i.e. few intrusions by long driveways or other development. We recommend preventing further intrusions of development into this area in order to preserve its ecological integrity.

- Rocky barrens. We found one complex of three small rocky barrens south of Nine Partners Road.
- Intermittent woodland pools. Twenty-five intermittent woodland pools and ten pool-like swamps dotted this area, including three complexes of six or more pools embedded within large blocks of upland hardwood forest. Two of these complexes occurred within the 1,000-ac (400-ha) habitat patch mentioned above.
- Buttonbush pools. Two buttonbush pools had conservation zones overlapping the large intermittent woodland pool complexes mentioned above.
- Wetland complexes. Numerous small wetland complexes included a variety of wetland types. One of these complexes lay along a perennial stream that winds northwest along Pumpkin Lane and meets a perennial tributary to Little Wappinger Creek at Maple Lane. Though highly fragmented by roads, this stream-valley wetland complex contained a mixture of hardwood and shrub swamp, wet meadow, and calcareous wet meadow. One of the wet meadows was among the largest in town, at more than 5 ac (2 ha), and was fed by the largest seep that we discovered. There were likely more seep-fed and calcareous wetlands in this complex that we were not able to see in the field.
- Ledges. Locally abundant rock outcrops, including three locales of frequent calcareous outcrops and rugged topography larger than 10 ac (4 ha), punctuated the area. Wild columbine, ebony spleenwort, round-lobed hepatica, bloodroot, and other calcium-associated herbs were abundant on these outcrops, which may also support plants such as purple cliff-brake* or walking fern.*

Clinton Fields and Forest (East) Conservation Area

This is the second-largest conservation area in the town, covering most of Clinton east of the Little Wappinger valley and south of Breezy Hill Road, Sunset Trail, and Willow Lane. All of the Taconic Parkway in Clinton lay in this CA. As its name suggests, the CA was characterized equally by upland meadow and upland forest. Numerous priority habitats occurred here:

- Large meadows. The majority of Clinton's large meadows and meadow complexes were found in southeastern Clinton. This CA contained the four largest undivided meadows in Clinton, all ≥34 ac (14 ha), including one of 85 ac (34 ha). Three of the five largest meadow complexes in town, all greater than 100 ac (40 ha), were here, including one just east of Allen Road with a particularly low edge-to-area ratio. Much of the upland meadow in this region consisted of pasture or intensively managed hayfield.
- Large forests. Two large blocks of forest, separated only by a gas pipeline corridor (a narrow corridor maintained as meadow), together comprised more than 650 ac and contained numerous high-quality swamps, seeps, and areas of mature, high-quality upland hardwood forest. This forest, bounded by Horseshoe Trail, Schultzville Road, Taconic Parkway, and Hollow Road, fell within the second-largest contiguous habitat block in Clinton, at nearly 1300 ac (500 ha) and with a low edge-to-area ratio.
- Rocky barrens. We found one complex of four small rocky barrens northeast of Hollow Road, within the second-largest forest block in eastern Clinton and the second-largest habitat block in the entire town.
- Perennial streams. Draining this CA were Wappinger Creek, which ultimately flows into the Hudson River, and several tributaries, largest among them the East Branch of the Wappinger.
- Wetland complex. Abutting Horseshoe Trail was a sizeable wetland complex whose main component was the largest unfragmented swamp in the Town of Clinton, a 62-ac (25-ha) red maple swamp.
- Marsh. The second-largest marsh in town (12 ac [5 ha]) occurred between Willow Lane and Schultzville Road.
- Intermittent woodland pools and shrub pools. The CA contained 20 intermittent woodland pools, 13 pool-like swamps, two buttonbush pools, and one kettle shrub pool.

Glacial outwash is extensive in this part of town, so there is some potential for kettle shrub pools that we did not see.

- Calcareous ledges. A significant area of calcareous outcrops (>30 ac [12 ha]), supporting abundant calcium-associated plants, occurs in mature hardwood forest west of the Taconic State Parkway.

Woodstock Road Conservation Area

This small conservation area is named for the adjoining conservation area previously identified by Hudsonia in the Town of Washington (Tollefson and Stevens 2004), which contains some of the larger unfragmented forest blocks in that town. In Clinton, the CA contained

- Calcareous crest and ledge.
- A 30-ac (12-ha) upland meadow complex.
- Two intermittent woodland pools.
- Part of the area of concern of a kettle shrub pool in the Town of Washington.

Fallkill and Wappinger Wetlands Conservation Area

The land within this conservation area in southeastern Clinton drains into Fallkill and Wappinger creeks, both tributaries of the Hudson River. It is bounded on the south by the Town of Pleasant Valley, to the west by the Town of Hyde Park, and to the north by Hollow Road; the eastern boundary runs along Sodom Road and just west of Spooky Hollow Road and Clinton Avenue. This CA was one of the most ecologically rich and least developed in Clinton. It held extensive blocks of forest and the highest density of wetlands in the town. Priority habitats included:

- Large marsh. The largest unfragmented marsh in Clinton (39 ac [16 ha]) lay south of Browning Road. We observed an active great blue heron* rookery there, one of two known in the town.
- Large swamp. A high-quality hardwood swamp west of Sodom Road was one of four swamps in town larger than 45 ac (18 ha).
- Large wetland complexes. Twenty percent of this CA was wetland; most fell within a large wetland complex that spanned the entire Conservation Area and continued into the Western Fields and Forest CA (see below). This and smaller-scale complexes embraced diverse wetland habitats interspersed with high-quality upland habitat. Large areas of

deep-water shrub swamp, offering potentially good core and active-season foraging habitats for Blanding's turtle,* also occurred here.

- Buttonbush pools. Three buttonbush pools may provide core habitat for Blanding's turtle.*
- Intermittent woodland pools. The CA contained 37 intermittent woodland pools and 10 pool-like swamps. One complex, north of Fallkill Road and west of Rymph Road, contained at least 15 pools (including three in Hyde Park) embedded in mostly undeveloped upland habitat. Another, south of Fallkill Road, harbored at least 19 pools within one of the largest, least-developed tracts of upland forest in town.
- Perennial streams. Tributaries to Fallkill and Wappinger creeks flowed mostly through large, intact expanses of forest.
- Crest and ledge. Areas of locally abundant crest and ledge, both calcareous and noncalcareous, occurred near the western town boundary.
- Large forests. Three blocks of contiguous forest each covered more than 200 ac (80 ha), and two additional blocks, separated only by a utility corridor, together covered more than 300 ac (120 ha). All five blocks contained mature, high-quality, sometimes extensive upland hardwood forest. The largest forest patch in the CA, in the southwestern corner of town, occupied about 430 ac (175 ha) in Clinton, and exceeded 500 ac (200 ha) when combined with contiguous forest in adjacent towns. It was also part of a block of undeveloped habitat in Clinton larger than 500 ac (200 ha).

This forest south of Fallkill Road, and the 350-ac (140-ha) forest across the road to the north, were two of the most biologically rich and intact units in town, and should be among the top conservation priorities. Both harbored diverse wetlands embedded within extensive, high-quality upland forest, and both had seen relatively little incursion by lengthy driveways or other development. However, they are more vulnerable to development than high-quality habitats in Clinton's rugged Western Outcrops CA (below), due to their comparatively gentle topography and fewer bedrock outcrops. We recommend limiting future development to infill along existing roads.

Clinton Fields and Forest (West) Conservation Area

Like Clinton Fields and Forest (East), this CA had extensive areas of meadow and forest, though the concentration of meadows was lower here, and that of wetlands much higher. It is bounded by Fiddlers Bridge Road to the north (with the exception of an area around Brownie (Hill), near Rhynders Road, which is included in the Western Outcrops CA, below); Hollow Road and the Town of Pleasant Valley to the south; and the Little Wappinger valley to the east, which separates this CA from Fields and Forest (East). Priority habitats included:

- Large wetlands and wetland complexes. Three of the largest marshes in Clinton, all off Fiddlers Bridge Road, occurred here. One of these, near the intersection of Fiddlers Bridge and Schoolhouse roads, contained an active great blue heron* rookery (one of two known in Clinton). The enormous wetland complex of the Fallkill and Wappinger Wetlands CA (above) extended across Hollow Road into this area. Two large, varied complexes occurred along perennial tributaries to Little Wappinger Creek. One of these included the great blue heron* rookery-marsh, adjacent to the largest undeveloped open water body in town (12 ac [5 ha]), where wood duck,* hooded merganser,* and nesting tree swallows were recently seen (Barbara Mansell, personal communication). Another complex, near the intersection of Fiddlers Bridge and Hollow roads, incorporated habitats of sufficient diversity and quality to be potentially good Blanding's turtle* habitat. Calcareous wet meadows were also frequent in this area and part of most wetland complexes.
- Buttonbush pools. Three of the five buttonbush pools in this area, flanking Clinton Avenue, were within 1,300 ft (400 m) of each other, and one was within 1,300 ft (400 m) of the largest marsh complex in town. These pools offer potential core habitat for the Blanding's turtle.*
- Intermittent woodland pools. We identified 17 intermittent woodland pools and 11 pool-like swamps in this area, including one complex of six pools south of Fiddlers Bridge Road and east of Schoolhouse Road.
- Large meadows. This area contained the second-highest concentration of large meadows and meadow complexes in Clinton. We mapped 12 meadow complexes larger than 25 ac (10 ha), six complexes larger than 50 ac (20 ha) (including one that spanned the southern town boundary), and two larger than 100 ac (40 ha) (including one that extended into

Pleasant Valley). The fourth-largest meadow complex (122 ac [49 ha]) in town occurred off Fiddler's Bridge Road. Three individual upland meadows were at least 30 ac (12 ha) each, including one that extended into Pleasant Valley.

- Large forests. One contiguous forest patch was larger than 400 ac (160 ha) and three others larger than 250 ac (100 ha). The former, bounded by Fiddlers Bridge, Schoolhouse, and Centre roads, was part of a contiguous block of undeveloped habitat larger than 1,000 ac (400 ha) (one of five in Clinton), reaching across Little Wappinger CA and into Clinton Fields and Forest (East) CA. It encompassed areas of high-quality, mature upland hardwood forest and a chain of marshes and hardwood swamps along a perennial tributary to Little Wappinger Creek.

Great blue heron rookery

Western Clinton Outcrops Conservation Area

The largest, most rugged and, not coincidentally, least developed of Clinton's conservation areas, this region lies north and west of a line formed by Silver Lake Road, Lake Drive, Fiddlers Bridge Road, and North Quaker Lane. The Elizaville thrust block underlies most of the land north of Schultz Hill Road, which bisects the area. This CA is a region characterized by nearly ubiquitous crest and ledge and by abundant, isolated wetlands that occupy the pockets and depressions within its rugged topography. It also contained most of Clinton's conifer forests. Probably because of the undeveloped nature of this part of town and the quality and quantity of unfragmented habitats, numerous species of conservation concern were sighted here in recent years—bobcat,* fisher,* black bear,* eastern hognose snake, * spotted turtle,* wood turtle,* eastern box turtle,* Cooper's hawk,* sharp-shinned hawk,* red-shouldered hawk,* eastern screech owl,* barred owl,* scarlet tanager,* wood thrush,* Louisiana waterthrush,* and ovenbird* were among them (Norene Coller, personal communication). Priority habitats included:

- Large habitat patches. Eight blocks of undeveloped habitat within Clinton are larger than 250 ac (100 ha), and two other patches that sprawl across the town boundary occupy well over 1,000 ac (400 ha). The largest and third-largest blocks of contiguous undeveloped habitat in Clinton, at more than 1300 ac (500 ha) and nearly 1100 ac (450 ha), were here. The largest block, bounded by Mountain View Road, Stonehouse Road, Kansas Road, Lake Drive, Fiddlers Bridge Road, and Schultz Hill Road, had numerous long driveways intruding deep into the forest, yet, by virtue of its overall size, still had extensive "interior" habitat.
- Large forests. Five blocks of contiguous forest were larger than 250 ac (100 ha) and three larger than 500 ac (200 ha), including the largest in town, at over 900 ac (350 ha). This largest block contained vast expanses of mature, high-quality forest and crest/ledge habitat, myriad knolls and ridges, and the highest elevations in town (up to 790 ft [241 m] on Schultz Hill, Traver Hill, and hills between). Several other large forest blocks spanned the town boundary and were largely located within adjoining towns: one of 1,000 ac (400 ha) south of Hollow Road (of which 200 ac [80 ha]) are in Clinton), another of over 1,100 ac (440 ha) north of Slate Quarry Road (part of the Hilltop Conservation Area identified by Hudsonia in Rhinebeck [Reinmann and Stevens 2007]), and a third of over 500 ac (200 ha) east of Eighmyville Road.
- Crest and ledge. Among the extensive calcareous- and non-calcareous crest and ledge areas here, we mapped five expanses of more than 50 ac (20 ha) of abundant calcareous outcrops, including the two largest such areas in town, on either side of Browns Pond Road, at nearly 200 ac (80 ha) and over 400 ac (160 ha).

- Rocky barrens. Fifteen rocky barrens were found, including an oak-heath barren (0.6 ac [0.2 ha]), the largest barren in town.
- Limestone hill. Brownie (Hill) is a distinctive limestone hill with extensive calcareous crest and a population of purple cliff-brake* (Erik Kiviat, personal communication).
- Large swamps. Davis Swamp, east of Mountain View Road, was the second-largest swamp in Clinton (59 ac [24 ha]) and was embedded within the largest habitat block in town. Between Deer Ridge and Schultz Hill roads lay Coller Swamp, a sprawling 50-ac (20 ha) red maple swamp near which red-shouldered hawks* were often seen by nearby residents (Norene Coller, personal communication). A calcareous swamp south of Hollow Road, in which we found mermaid-weed and poison sumac, occupied roughly 30 ac (12 ha), 20 ac (8 ha) of which lay in Clinton.
- Wetland complexes. One of the many major wetland complexes in this area totaled nearly 100 ac (40 ha) of mostly contiguous wetland and contained Davis Swamp, the third-largest marsh (11 ac [4 ha]) in town, and the largest calcareous wet meadow (5 ac [2 ha]) in town. Another complex, west of Deer Ridge Road, included a large area of wet meadow and may have a small fen.
- Kettle shrub and buttonbush pools. This area had three kettle shrub pools and nine buttonbush pools, plus large portions of the conservations zones of at least three kettle shrub pools over the border in Rhinebeck and Hyde Park. Two were within 800 ft (240 m) of each other, another pair were within 1,300 ft (400 m), and three others were within 1,500 ft (460 m) of each other.
- Heath swamps. All five of the heath swamps found in Clinton were in this area.
- Acidic bog. Zipfeldberg Bog, a 4-ac (1.5-ha) dwarf shrub bog, occurred on a Nature Conservancy preserve. Many would consider this one of the most ecologically special places in Dutchess County. It harbored numerous regionally- and state-listed rare plant species, including leatherleaf,* black huckleberry,* pale laurel,* bog-rosemary,* pitcher-plant,* pod-grass,* rose pogonia,* and Virginia chain fern.*
- Intermittent woodland pools. We mapped 130 intermittent woodland pools and 34 pool-like swamps scattered throughout the CA. Eight different complexes contained nine or more pools separated only by ecologically significant habitat. Another complex, crossed by Fiddlers Bridge Road, contained seven intermittent woodland pools, four pool-like

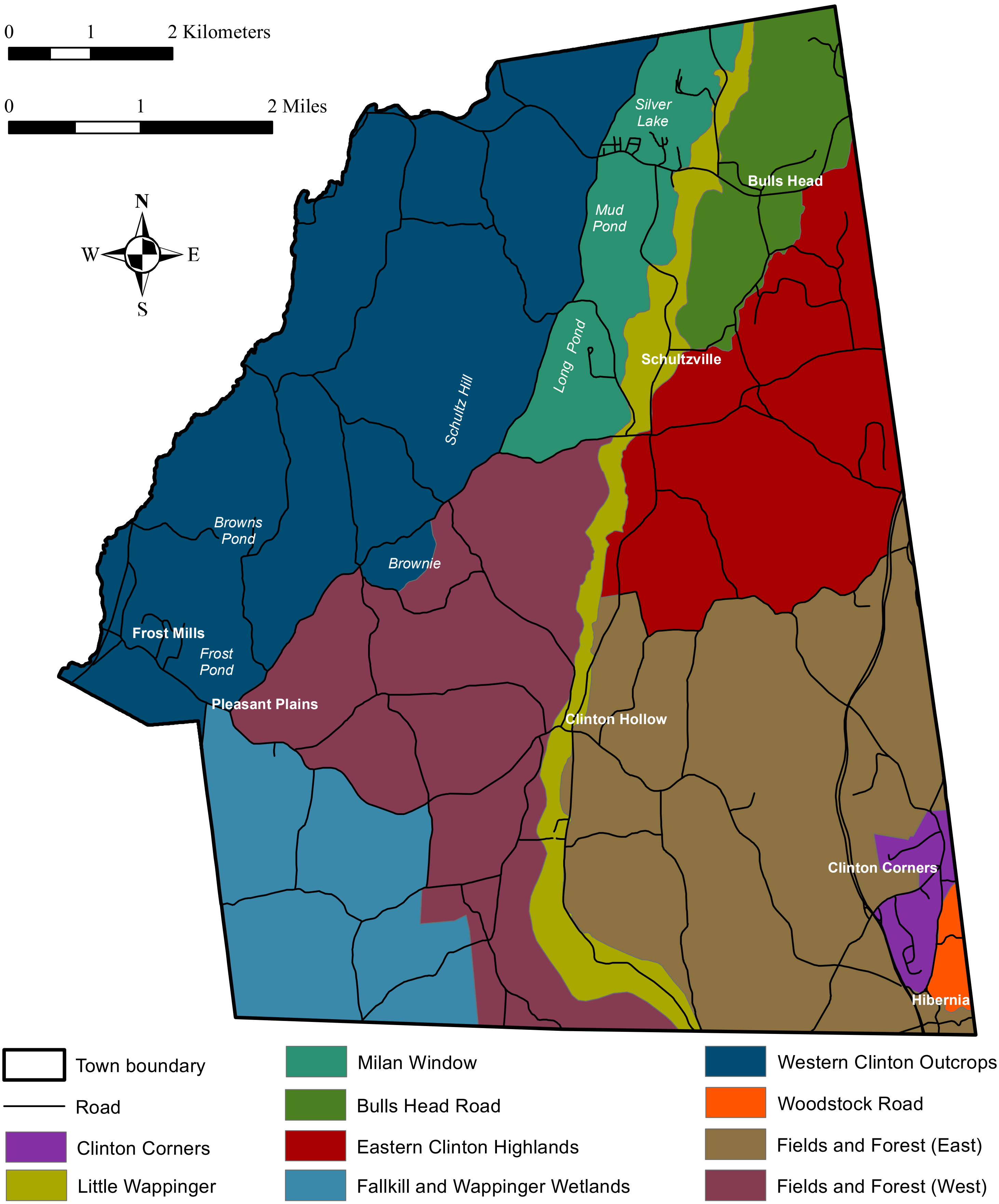
swamps, two buttonbush pools, and a heath swamp. High-quality upland habitat surrounded them, and there were several forested habitat corridors across Fiddlers Bridge Road. Each of these many complexes appeared to offer high quality, year-round habitat for pool-breeding amphibians.

- Perennial streams. Crum Elbow Creek and several perennial tributaries flowed through this CA. The Crum Elbow is known to support wood turtle, and is classified by NYSDEC as a trout stream from the vicinity of Schultz Hill Road and south.
- Seeps and springs. We discovered at least four areas of abundant seeps and springs—two within the expansive forest block (590 ac [240 ha]) west of Mountain View Road; one between Mountain View and Kansas; and one off Kansas Road just west of Lake Drive.

Clinton Corners

This is not a "conservation area" *per se*, but rather the most heavily settled portion of the town. Nevertheless, it did contain several swamps, including one of nearly 20 ac (8 ha); one pool-like swamp; a calcareous wet meadow in which we found leafy bulrush; and part of the area of concern of a kettle shrub pool located in the Town of Washington. From an ecological standpoint, further land development in Clinton may best be concentrated in this area, while simultaneously retaining some patches of ecologically significant habitat. See "Enhancement of Developed Areas" above, for suggestions regarding encouraging and integrating native biodiversity within densely developed areas.

Figure 13. Conservation areas in the Town of Clinton, Dutchess County, NY. These areas were identified by Hudsonia based on geographical, geological, and biological attributes of the town and are intended to aid in town-wide conservation planning. See section on conservation areas for descriptions of special features of each area. Hudsonia Ltd., 2012.



CONCLUSION

There are significant opportunities for biodiversity conservation in the rural landscapes of the Town of Clinton. In anticipation of future development pressure, however, strategic land-use and conservation planning are needed to ensure that species, communities, and ecosystems are protected for the long term. The habitat map and this report will equip town agencies, landowners, and others with 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 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, areas where uncommon and rare habitats occur, 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 Clinton, 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 Clinton plan wisely for future development while taking steps to protect biological 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.

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APPENDICES

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

Buttonbush pool and kettle shrub pool. Both of these wetlands are fairly deep-flooding, isolated from perennial streams, and have a shrub-dominated flora with buttonbush normally the dominant plant. The vegetation structure, plant communities, and hydroperiods of kettle shrub pools and buttonbush pools are often very similar, but kettles 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.) We identified buttonbush-dominated pools in glacial outwash terrain as kettle shrub pools, and those in or surrounded by other surficial material as buttonbush pools.

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 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 are 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 50 m (165 ft) 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. 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 are now 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 Clinton 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.

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 in 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. 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. Explanations of New York State Ranks and New York Natural Heritage Program Ranks are from the New York Natural Heritage Program website, accessed in December 2012 (http://www.dec.ny.gov/animals/29338.html).

NEW YORK STATE RANKS

For animals, categories of Endangered and Threatened 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. For plants, the categories below are defined in regulation 6NYCRR 193.3 and apply to New York State Environmental Conservation Law section 9-1503.

ANIMALS

E **Endangered Species**. Any species which meet one of the following criteria: 1) Any native species in imminent danger of extirpation; 2) Any species listed as endangered by the US Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T **Threatened Species**. Any species which meet one of the following criteria: 1) Any native species likely to become an endangered species within the foreseeable future in New York; 2) Any species listed as threatened by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.

SC **Special Concern Species**. Those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 11-0535 (Endangered and Threatened Species).

PLANTS

E **Endangered Species**. Listed species are those 1) with five or fewer extant sites, or 2) with fewer than 1,000 individuals, or 3) restricted to fewer than 4 USGS 7.5 minute map quadrangles, or 4) listed as endangered by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.

T **Threatened Species**. Listed species are those 1) with 6 to fewer than 20 extant sites, or 2) with 1,000 or fewer than 3,000 individuals, or 3) restricted to not less than 4 or more than 7 USGS 7.5 minute map quadrangles, or 4) listed as threatened by the US Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.

R **Rare Species**. Listed species are those with 1) 20-35 extant sites, or 2) 3,000 to 5,000 individuals statewide.

NEW YORK NATURAL HERITAGE PROGRAM RANKS – ANIMALS AND PLANTS

Each element is assigned a state rank reflecting the rarity within New York State as determined by the New York Natural Heritage Program. These ranks carry no legal weight.

S1 Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology making it especially vulnerable in New York State.

S2 Typically 6-20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in New York State.

S3 Typically 21-100 occurrences, limited acreage, or miles of stream in New York State.

S4 Apparently secure in New York State.

SH Historically known from New York State, but not seen in the past 15-20 years.

B,N These modifiers indicate when the breeding status of a migratory species is considered separately from individuals passing through or not breeding within New York State. B indicates the breeding status; N indicates the non-breeding status.

SPECIES OF GREATEST CONSERVATION NEED (SGCN) IN NEW YORK - ANIMALS

Species that meet one or more of the following criteria (NYSDEC 2005):

- Species on the current federal list of endangered or threatened species that occur in New York.
- Species which are currently state-listed as endangered, threatened, or of special concern.
- Species with 20 or fewer elemental occurrences in the New York Natural Heritage Program database.
- Estuarine and marine species of greatest conservation need as determined by New York Department of Environmental Conservation, Bureau of Marine Resources staff.
- Other species determined to be in great conservation need due to status, distribution, vulnerability, or disease.

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 or New York Natural Heritage Program 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.

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, and deteriorating habitats throughout their entire range. The most recent WatchList was updated in August 2003. We include birds from the lists for physiographic areas # 17 (Northern Ridge and Valley) and # 9 (Southern New England).

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

* Prothonotary warbler was not included in the watch lists for this region, but we have included this species with the PIF1 species because it is listed as "High Continental Priority" in PIF's national North American Landbird Conservation Plan (Rich et al. 2004).

Appendix C. Species of conservation concern potentially associated with habitats in the Town of Clinton. 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 given 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 **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.)***
pinesap (RG)	Blanding's turtle (T, S2S3, SGCN)	cerulean warbler (SC, PIF1, SGCN)
silvery spleenwort (RG)	eastern racer (SGCN)	Canada warbler (PIF1, SGCN)
Back's sedge (T)	eastern rat snake (SGCN)	Kentucky warbler (S2, PIF1, SGCN)
American ginseng (RG)	northern goshawk (SC, S3N, SGCN)	black-and-white warbler (PIF2)
red baneberry (RG)	red-shouldered hawk (SC, SGCN)	black-throated blue warbler (SGCN)
poke milkweed (RG)	Cooper's hawk (SC, SGCN)	black-throated green warbler (RG)
lopseed (RG)	sharp-shinned hawk (SC, SGCN)	worm-eating warbler (SGCN)
nodding trillium (TG)	broad-winged hawk (RG)	hooded warbler (RG)
leatherwood (RG)	ruffed grouse (SGCN)	ovenbird (RG)
hackberry (RG)	American woodcock (PIF1, SGCN)	scarlet tanager (PIF2, SGCN)
Vertebrates	barred owl (RG)	southern bog lemming (RG)
wood frog (RG)	whip-poor-will (SC, PIF2, SGCN)	Indiana bat (E, S1, SGCN)
spotted salamander (RG)	eastern wood-pewee (PIF2)	black bear (RG)
Jefferson salamander (SC, SGCN)	Acadian flycatcher (S3)	bobcat (RG)
blue-spotted salamander (SC, SGCN)	wood thrush (PIF1, SGCN)	New England cottontail (SC, S1S2, SGCN)
marbled salamander (SC, S3, SGCN)	hermit thrush (SGCN)	fisher (RG)
eastern box turtle (SC, S3, SGCN)		

UPLAND CONIFER FOREST		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
pinesap (RG)	American woodcock (PIF1, SGCN)	black-throated green warbler (RG)
Vertebrates	long-eared owl (S3, SGCN)	blackburnian warbler (PIF2)
blue-spotted salamander (SC, SGCN)	short-eared owl (E, S2, PIF1, SGCN)	pine siskin (RG)
Cooper's hawk (SC, SGCN)	barred owl (RG)	evening grosbeak (RG)
sharp-shinned hawk (SC, SGCN)	red-breasted nuthatch (RG)	purple finch (PIF2)

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

(CONTINUED)

Appendix C (cont.)

NON-CALCAREOUS CREST/LEDGE/TALUS		
Plants	***Invertebrates (cont.)***	***Vertebrates (cont.)***
mountain spleenwort (T, S2S3)	brown elfin (butterfly) (RG)	turkey vulture (RG)
Bicknell's sedge (T, S3)	olive hairstreak (butterfly) (RG)	whip-poor-will (SC, PIF2, SGCN)
bronze sedge (RG)	northern hairstreak (butterfly) (S1S3, SGCN)	black vulture
clustered sedge (T, S2S3)	gray hairstreak (butterfly) (RG)	common raven (RG)
reflexed sedge (E, S2S3)	Horace's duskywing (butterfly) (RG)	winter wren (RG)
whorled milkweed (RG)	swarthy skipper (butterfly) (RG)	eastern bluebird (RG)
blunt-leaf milkweed (RG)	Leonard's skipper (butterfly) (RG)	hermit thrush (RG)
rock sandwort (RG)	dusted skipper (butterfly) (S3)	blackburnian warbler (PIF2)
goat's-rue (RG)	***Vertebrates***	cerulean warbler (SC, PIF1, SGCN)
slender knotweed (R, S3)	Fowler's toad (SGCN)	worm-eating warbler (PIF1, SGCN)
dittany (RG)	northern slimy salamander (RG)	small-footed bat (SC, S2, SGCN)
Torrey's mountain-mint (E, S1)	marbled salamander (SC, S3, SGCN)	boreal redback vole (RG)
Allegheny-vine (RG)	eastern box turtle (SC, S3, SGCN)	fisher (RG)
stiff-leaf aster (RG)	eastern rat snake (SGCN)	bobcat (RG)
Invertebrates	eastern racer (SGCN)	
Edward's hairstreak (butterfly) (S3S4)	eastern hognose snake (SC, S3, SGCN)	
striped hairstreak (butterfly) (RG)	copperhead (S3, SGCN)	

CALCAREOUS CREST/LEDGE/TALUS		
Plants	***Plants (cont.)***	***Invertebrates***
purple cliffbrake (RG)	Carolina whitlow-grass (T, S2)	anise millipede (RG)
smooth cliffbrake (T, S2)	hairy rock-cress (RG)	olive hairstreak (butterfly) (RG)
walking fern (RG)	yellow harlequin (S3)	***Vertebrates***
wall-rue (RG)	Dutchman's breeches (RG)	eastern hognose snake (SC, S3, SGCN)
side-oats grama (E, S1)	pellitory (RG)	eastern racer (SGCN)
Emmons' sedge (S3)	northern blazing-star (T, S2)	eastern rat snake (SGCN)
Bicknell's sedge (T, S3)	small-flowered crowfoot (T, S3)	copperhead (S3, SGCN)
yellow wild flax (T, S2)	roundleaf dogwood (RG)	

ROCKY BARREN		
Plants	***Invertebrates (cont.)***	***Vertebrates (cont.)***
bronze sedge (RG)	Leonard's skipper (butterfly) (RG)	common raven (RG)
clustered sedge (T, S2S3)	Edward's hairstreak (butterfly) (S3S4)	hermit thrush (RG)
dwarf shadbush (RG)	***Vertebrates***	Nashville warbler (RG)
Invertebrates	copperhead (S3, SGCN)	prairie warbler (PIF1, SGCN)
brown elfin (butterfly) (RG)	turkey vulture (RG)	field sparrow (PIF2)
	whip-poor-will (SC, PIF2, SGCN)	vesper sparrow (SC, SGCN)
		eastern towhee (PIF2)

UPLAND SHRUBLAND		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
stiff-leaf goldenrod (RG)	wood turtle (SC, S3, SGCN)	blue-winged warbler (PIF1, SGCN)
shrubby St. Johnswort (T, S2)	Blanding's turtle (T, S2S3, SGCN)	golden-winged warbler (SC, PIF1, SGCN)
butterflyweed (RG)	northern harrier (T, S3B, S3N, SGCN)	prairie warbler (PIF1, SGCN)
Invertebrates	ruffed grouse (SGCN)	yellow-breasted chat (SC, S3, SGCN)
Aphrodite fritillary (butterfly) (RG)	black-billed cuckoo (SGCN)	clay-colored sparrow (S2)
dusted skipper (butterfly) (S3)	short-eared owl (E, S2, PIF1, SGCN)	vesper sparrow (SC, SGCN)
Leonard's skipper (butterfly) (RG)	northern saw-whet owl (S3)	field sparrow (PIF2)
Vertebrates	whip-poor-will (SC, PIF2, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
wood frog (RG)	willow flycatcher (SGCN)	eastern towhee (PIF2)
spotted turtle (SC, S3, SGCN)	brown thrasher (PIF2, SGCN)	New England cottontail (SC, S1S2, SGCN)
eastern box turtle (SC, S3, SGCN)	loggerhead shrike (E, S1B, SGCN)	
	white-eyed vireo (RG)	

(CONTINUED)

Appendix C (cont.)

UPLAND MEADOW		
Plants	***Invertebrates (cont.)***	***Vertebrates (cont.)***
small-flowered agrimony (S3)	swarthy skipper (butterfly) (RG)	sedge wren (T, S3B, PIF2, SGCN)
Bush's sedge (S3)	***Vertebrates***	eastern bluebird (RG)
Invertebrates	spotted turtle (SC, S3, SGCN)	savannah sparrow (RG)
Baltimore (butterfly) (RG)	eastern box turtle (SC, S3, SGCN)	vesper sparrow (SC, SGCN)
meadow fritillary (butterfly) (RG)	wood turtle (SC, S3, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
Aphrodite fritillary (butterfly) (RG)	Blanding's turtle (T, S2S3, SGCN)	bobolink (SGCN)
dusted skipper (butterfly) (S3)	northern harrier (T, S3B, S3N, SGCN)	eastern meadowlark (SGCN)
Leonard's skipper (butterfly) (RG)		

WASTE GROUND		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
hair-rush (RG)	slender knotweed (R, S3)	copperhead (S3, SGCN)
toad rush (RG)	***Vertebrates***	American black duck (PIF1, SGCN)
orangeweed (RG)	Fowler's toad (SGCN)	belted kingfisher (RG)
field dodder (S1)	spotted turtle (SC, S3, SGCN)	common nighthawk (SC, SGCN)
slender pinweed (T, S2)	wood turtle (SC, S3, SGCN)	common raven (RG)
rattlebox (E, S1)	Blanding's turtle (T, S2S3, SGCN)	bank swallow (RG)
blunt mountain-mint (T, S2S3)	eastern hognose snake (SC, S3, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)

SWAMP		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
swamp cottonwood (T, S2)	four-toed salamander (SGCN)	American woodcock (PIF1, SGCN)
swamp lousewort (T, S2)	spotted turtle (SC, S3, SGCN)	red-shouldered hawk (SC, SGCN)
winged monkey-flower (R, S3)	wood turtle (SC, S3, SGCN)	barred owl (RG)
wood horsetail (RG)	eastern box turtle (SC, S3, SGCN)	willow flycatcher (SGCN)
false hop sedge (R, S2)	Blanding's turtle (T, S2S3, SGCN)	white-eyed vireo (RG)
Invertebrates	great blue heron (RG)	eastern bluebird (RG)
phantom cranefly (RG)	American bittern (SC, SGCN)	prothonotary warbler (S2, PIF1, SGCN)
Vertebrates	wood duck (PIF2)	Canada warbler (PIF1, SGCN)
blue-spotted salamander (SC, SGCN)	Virginia rail (RG)	northern waterthrush (RG)

ACIDIC BOG		
Plants	***Plants (cont.)***	***Invertebrates (cont.)***
Virginia chain fern (RG)	spoon-leaf sundew (RG)	ringed bog haunter (dragonfly) (SH, SGCN)
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)
rose pogonia (RG)	bog copper (butterfly) (RG)	eastern bluebird (RG)
grass-pink (RG)	pitcher-plant borer (moth) (RG)	golden-winged warbler (P, SC, PIF1, SGCN)
white-fringed orchid (RG)	pitcher plant moth (RG)	Nashville warbler (RG)
pitcher-plant (RG)	subarctic darner (dragonfly) (S1, SGCN)	Canada warbler (RG, PIF1, SGCN)
round-leaf sundew (RG)	ebony bog haunter (dragonfly) (S1, SGCN)	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)
false hop sedge (R, S2)	Jefferson salamander (SC, SGCN)	Blanding's turtle (T, S2S3, SGCN)
featherfoil (T, S2)	marbled salamander (SC, S3, SGCN)	wood duck (PIF2)
Invertebrates	four-toed salamander	American black duck (PIF1, SGCN)
black dash (butterfly) (RG)	spotted salamander (RG)	northern waterthrush (RG)
mulberry wing (butterfly) (RG)	spotted turtle (SC, S3, SGCN)	
springtime physa (snail) (RG)		

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Appendix C (cont.)

BUTTONBUSH POOL/KETTLE SHRUB POOL		
Plants	***Vertebrates***	***Vertebrates (cont.)***
Helodium paludosum (moss) (RG)	wood frog (RG)	Blanding's turtle (T, S2S3, SGCN)
pale alkali-grass (RG)	blue-spotted salamander (SC, S3, SGCN)	spotted turtle (SC, S3, SGCN)
short-awn foxtail (RG)	Jefferson salamander (SC, S3, SGCN)	eastern ribbon snake (SGCN)
buttonbush dodder (E, S1)	marbled salamander (SC, S3, SGCN)	wood duck (PIF2)
	spotted salamander (RG)	American black duck (PIF1, SGCN)

MARSH		
Plants	***Vertebrates***	***Vertebrates (cont.)***
winged monkey-flower (R, S3)	northern cricket frog (E, S1, SGCN)	pied-billed grebe (T, S3B, S1N, SGCN)
buttonbush dodder (E, S1)	northern leopard frog (RG)	American black duck (PIF1, SGCN)
Invertebrates	spotted turtle (SC, S3, SGCN)	northern harrier (T, S3B, S3N, SGCN)
black dash (butterfly) (RG)	Blanding's turtle (T, S2S3, SGCN)	king rail (T, S1B, PIF1, SGCN)
bronze copper (butterfly) (RG)	American bittern (SC, SGCN)	Virginia rail (RG)
mulberry wing (butterfly) (RG)	least bittern (T, S3B, S1N, SGCN)	sora (RG)
	great blue heron (RG)	common moorhen (RG)
	wood duck (PIF2)	marsh wren (RG)

WET MEADOW		
Invertebrates	***Invertebrates (cont.)***	***Vertebrates (cont.)***
Baltimore (butterfly) (RG)	Milbert's tortoiseshell (butterfly) (RG)	northern harrier (T, S3B, S3N, SGCN)
mulberry wing (butterfly) (RG)	phantom cranefly (RG)	Virginia rail (RG)
black dash (butterfly) (RG)	***Vertebrates***	American woodcock (PIF1, SGCN)
two-spotted skipper (butterfly) (RG)	eastern ribbon snake (RG, SGCN)	sedge wren (T, S3B, PIF2, SGCN)
meadow fritillary (butterfly) (RG)	spotted turtle (SC, S3, SGCN)	southern bog lemming (RG)
bronze copper (butterfly) (RG)	American bittern (SC, SGCN)	
eyed brown (butterfly) (RG)		

FEN/CALCAREOUS WET MEADOW		
Plants	***Plants (cont.)***	***Invertebrates (cont.)***
wood horsetail (RG)	fringed gentian (RG)	silver-bordered fritillary (butterfly) (RG)
twig-rush (RG)	swamp lousewort (T, S2)	two-spotted skipper (butterfly) (RG)
Schweinitz's sedge (T, S2S3)	roundleaf sundew (RG)	Dion skipper (butterfly) (S3)
handsome sedge (T, S1)	small-flowered agrimony (S3)	Baltimore (butterfly) (RG)
Bush's sedge (S3)	bog valerian (E, S1S2)	mulberry wing (butterfly) (RG)
ovate spikerush (E, S1S2)	buckbean (RG)	black dash (butterfly) (RG)
slender lady's-tresses (RG)	swamp birch (T, S2)	***Vertebrates***
rose pogonia (RG)	alder-leaf buckthorn (RG)	northern leopard frog
showy ladyslipper (RG)	***Invertebrates***	bog turtle (E, S2, SGCN)
spreading globeflower (R, S3)	*Gammarus pseudolimnaeus* (amphipod) (RG)	spotted turtle (SC, S3, SGCN)
scarlet Indian paintbrush (E, S1)	*Pomatiopsis lapidaria* (snail) (RG)	eastern ribbon snake (SGCN)
grass-of-Parnassus (RG)	forcipate emerald (dragonfly) (S1, SGCN)	northern harrier (T, S3B, S3N, SGCN)
Kalm's lobelia (RG)	phantom cranefly (RG)	sedge wren (T, S3B, PIF2, SGCN)
bush aster (T, S2)	eyed brown (butterfly) (RG)	

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Appendix C (cont.)

CIRCUMNEUTRAL BOG LAKE		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
ovate spikerush (E, S1S2)	pipewort (RG)	pied-billed grebe (T, S3B, S1N, SGCN)
knotted spikerush (T, S2)	round-leaf sundew (RG)	American bittern (SC, SGCN)
green spikerush (RG)	pitcher-plant (RG)	least bittern (T, S3B, S1N, SGCN)
prairie sedge (RG)	globe-fruited ludwigia (S2, T)	great blue heron (RG)
twig-rush (RG)	southern dodder (E, S1)	wood duck (PIF2)
floating bladderwort (T, S2)	***Vertebrates***	American black duck (PIF1, SGCN)
hidden-fruit bladderwort (S3)	wood frog (RG)	osprey (SC, SGCN)
swollen bladderwort (E, S2)	blue-spotted salamander (SC, SGCN)	red-shouldered hawk (SC, SGCN)
horned bladderwort (RG)	four-toed salamander (SGCN)	sharp-shinned hawk (SC, SGCN)
spotted pondweed (T, S2)	northern cricket frog (E, S1, SGCN)	king rail (T, S1B, PIF1, SGCN)
water-thread pondweed (E, S1)	spotted turtle (SC, S3, SGCN)	sora (RG)
Hill's pondweed (T, S2)	Blanding's turtle (T, S2S3, SGCN)	common moorhen (RG)
Beck's water-marigold (T, S3)	eastern ribbon snake (SGCN)	marsh wren (RG)
rose pogonia (RG)		river otter (SGCN)

OPEN WATER/CONSTRUCTED POND		
Vertebrates	***Vertebrates (cont.)***	***Vertebrates (cont.)***
northern cricket frog (E, S1, SGCN)	American bittern (SC, SGCN)	pied-billed grebe (T, S3B, S1N, SGCN)
spotted turtle (SC, S3, SGCN)	great blue heron (RG)	osprey (SC, SGCN)
wood turtle (SC, S3, SGCN)	wood duck (PIF2)	bald eagle (T, S2S3B, SGCN)
Blanding's turtle (T, S2S3, SGCN)	American black duck (PIF1, SGCN)	river otter (SGCN)

SPRING/SEEP		
Plants	***Invertebrates***	***Vertebrates***
Bush's sedge (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)	wood turtle (SC, S3, SGCN)
riverweed (T, S2)	*Sphaerium fabale* (fingernail clam) (RG)	great blue heron (RG)
goldenseal (T, S2)	arrowhead spiketail (dragonfly) (S2S3, SGCN)	American black duck (PIF1, SGCN)
cattail sedge (T, S1)	mocha emerald (dragonfly) (S2S3, SGCN)	wood duck (PIF2)
Davis' sedge (T, S2)	sable clubtail (dragonfly) (S1, SGCN)	red-shouldered hawk (SC, SGCN)
small-flowered agrimony (S3)	ostrich fern borer (moth) (SGCN)	American woodcock (PIF1, SGCN)
false-mermaid (RG)	***Vertebrates***	bank swallow (RG)
swamp rose-mallow (RG)	creek chubsucker (fish) (RG)	winter wren (RG)
may-apple (RG)	bridle shiner (fish) (RG)	cerulean warbler (SC, PIF1, SGCN)
Invertebrates	brook trout (fish) (SGCN)	Louisiana waterthrush (SGCN)
Marstonia decepta (snail) (RG)	slimy sculpin (fish) (RG)	river otter (SGCN)
brook floater (mussel) (T, S1, SGCN)	northern leopard frog	Indiana bat (E, S1, SGCN)
	northern dusky salamander (RG)	

Appendix D. Common and scientific names of plants mentioned in this report. Most scientific names follow the nomenclature of Weldy and Werier (2012).

Common Name	Scientific Name	Common Name	Scientific Name
agrimony, small-flowered	*Agrimonia parviflora*	buckthorn, alder-leaf	*Rhamnus alnifolia*
alder	*Alnus*	buckthorn, common	*Rhamnus cathartica*
alkali-grass, pale	*Puccinellia distans*	bulrush, leafy	*Scirpus polyphyllus*
Alexanders, golden	*Zizea aurea*	bulrush, hard-stemmed	*Schoenoplectus acutus* var. *acutus*
Allegheny-vine	*Adlumia fungosa*	bulrush, subterminate	*Schoenoplectus subterminalis*
arrowhead, broad-leaved	*Sagittaria latifolia*	butterflyweed	*Asclepias tuberosa* ssp. *interior*
arrowwood, northern	*Viburnum dentatum* var. *lucidum*	butternut	*Juglans cinerea*
arum, arrow	*Peltandra virginica*	buttonbush	*Cephalanthus occidentalis*
ash, black	*Fraxinus nigra*	canary-grass, reed	*Phalaris arundinacea*
ash, green	*Fraxinus pennsylvanica*	cattail	*Typha*
ash, white	*Fraxinus americana*	cattail, broad-leaved	*Typha latifolia*
aspen, quaking	*Populus tremuloides*	cattail, hybrid	*Typha* x *glauca*
aster, bush	*Symphyotrichum boreale*	cedar, eastern red	*Juniperus virginiana* var. *virginiana*
aster, stiff-leaf	*Ionactis linariifolia*	cherry, black	*Prunus serotina*
azalea, swamp	*Rhododendron viscosum*	chokeberry	*Aronia*
baneberry, red	*Actaea rubra*	chokeberry, black	*Aronia melanocarpa*
baneberry, white	*Actaea pachypoda*	cinquefoil, shrubby	*Dasiphora fruticosa*
barberry, Japanese	*Berberis thunbergii*	cliffbrake, purple	*Pellaea atropurpurea*
basswood	*Tilia americana* var. *americana*	cliffbrake, smooth	*Pellaea glabella* ssp. *glabella*
beggar-ticks	*Bidens*	cohosh, blue	*Caulophyllum thalictroides*
birch, black	*Betula lenta*	columbine, wild	*Aquilegia canadensis*
birch, gray	*Betula populifolia*	coontail, spiny	*Ceratophyllum echinatum*
birch, swamp	*Betula pumila*	cottongrass, tawny	*Eriophorum virginicum*
bittersweet, Oriental	*Celastrus orbiculatus*	cottonwood, eastern	*Populus deltoides*
blackberry, northern	*Rubus allegheniensis*	cottonwood, swamp	*Populus heterophylla*
blackgum	*Nyssa sylvatica*	cranberry, large	*Vaccinium macrocarpon*
bladdernut	*Staphylea trifolia*	cranberry, small	*Vaccinium oxycoccus*
bladderwort, common	*Utricularia macrorhiza*	crowfoot, small-flowered	*Ranunculus micranthus*
bladderwort, floating	*Utricularia radiata*	deerberry	*Vaccinium stamineum*
bladderwort, hidden-fruit	*Utricularia geminiscapa*	devil's-bit	*Chamaelirium luteum*
bladderwort, swollen	*Utricularia inflata*	dittany	*Cunila origanoides*
bladderwort,horned	*Utricularia cornuta*	dodder, buttonbush	*Cuscuta cephalanthi*
blazing-star, northern	*Liatris aspera*	dodder, field	*Cuscuta campestris*
bloodroot	*Sanguinaria canadensis*	dodder, southern	*Cuscuta obtusiflora* var. *glandulosa*
blueberry, highbush	*Vaccinium corymbosum*	dogwood, gray	*Cornus foemina* ssp. *racemosa*
blueberry, early lowbush	*Vaccinium pallidum*	dogwood, red-osier	*Cornus sericea* ssp. *sericea*
blueberry, late lowbush	*Vaccinium angustifolium*	dogwood, roundleaf	*Cornus rugosa*
bluegrass, Kentucky	*Poa pratensis* ssp. *pratensis*	dogwood, silky	*Cornus amomum* ssp. *obliqua*
bluestem, little	*Schizachyrium scoparium* var. *scoparium*	dragon, green	*Arisaema dracontium*
bracken	*Pteridium aquilinum* var. *latiusculum*	duckweed, common	*Spirodela polyrrhiza*
breeches, Dutchman's	*Dicentra cucullaria*	duckweed, lesser	*Lemna minor*
buckbean	*Menyanthes trifoliata*	elm, American	*Ulmus americana*

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Appendix D (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
elm, slippery	*Ulmus rubra*	hickory, shagbark	*Carya ovata*
false-mermaid	*Floerkea proserpinacoides*	holly, mountain	*Nemopanthus mucronatus*
false-nettle	*Boehmeria cylindrica*	holly, winterberry	*Ilex verticillata*
featherfoil	*Hottonia inflata*	honeysuckle, Bell's	*Lonicera* x *bella*
fern, cinnamon	*Osmunda cinnamomea*	horsetail, wood	*Equisetum sylvaticum*
fern, fragile	*Cystopteris fragilis*	huckleberry, black	*Gaylussacia baccata*
fern, maidenhair	*Adiantum pedatum*	iris, yellow	*Iris pseudacorus*
fern, marsh	*Thelypteris palustris* var. *pubescens*	ironwood	*Carpinus caroliniana* ssp. *virginiana*
fern, ostrich	*Matteuccia struthiopteris*	ironweed, New York	*Vernonia noveboracensis*
fern, sensitive	*Onoclea sensibilis*	jewelweed, common	*Impatiens capensis*
fern, Virginia chain	*Woodwardia virginica*	Joe-Pye-weed, spotted	*Eutrochium maculatum* var. *maculatum*
fern, walking	*Asplenium rhizophyllum*	knotweed, Japanese	*Fallopia japonica* var. *japonica*
flag, blue	*Iris versicolor*	knotweed, slender	*Polygonum tenue*
flax, yellow wild	*Linum sulcatum*	lady's-tresses, slender	*Spiranthes lacera* var. *gracilis*
foxtail, short-awn	*Alopecurus aequalis* var. *aequalis*	ladyslipper, showy	*Cypripedium reginae*
garlic-mustard	*Alliaria petiolata*	laurel, pale	*Kalmia polifolia*
gentian, fringed	*Gentianopsis crinita*	leatherleaf	*Chamaedaphne calyculata*
ginseng, American	*Panax quinquefolius*	leatherwood	*Dirca palustris*
globeflower, spreading	*Trollius laxus*	leek, wild	*Allium tricoccum* var. *tricoccum*
goat's-rue	*Tephrosia virginiana*	licorice, wild	*Galium circaezans* var. *circaezans*
goldenrod, bog	*Solidago uliginosa*	lobelia, Kalm's	*Lobelia kalmii*
goldenrod, Canada	*Solidago canadensis* var. *canadensis*	locust, black	*Robinia pseudoacacia*
goldenrod, rough-leaf	*Solidago patula* ssp. *patula*	lopseed	*Phryma leptostachya*
goldenrod, smooth	*Solidago, gigantea*	loosestrife, purple	*Lythrum salicaria*
goldenrod, stiff-leaf	*Solidago rigida*	lousewort, swamp	*Pedicularis lanceolata*
goldenrod, tall	*Solidago altissima* ssp. *altissima*	ludwigia, globe-fruited	*Ludwigia sphaerocarpa*
goldenrod, wrinkle-leaved	*Solidago rugusa* var. *rugosa*	maleberry	*Lyonia ligustrina*
goldenseal	*Hydrastis canadensis*	mannagrass	*Glyceria*
grama, side-oats	*Bouteloua curtipendula* var. *curtipendula*	maple, red	*Acer rubrum*
grass, eastern bottle-brush	*Elymus hystrix* var. *hystrix*	maple, sugar	*Acer saccharum*
grass-of-Parnassus	*Parnassia glauca*	may-apple	*Podophyllum peltatum*
grass-pink	*Calopogon tuberosus* var. *tuberosus*	meadow-rue, early	*Thalictrum dioicum*
grass, reed-canary	*Phalaris arundinacea*	meadowsweet	*Spiraea alba* var. *latifolia*
grass, Indian	*Sorghastrum nutans*	mermaid-weed	*Proserpinaca palustris*
gum, black	*Nyssa sylvatica*	milkweed, blunt-leaf	*Asclepias amplexicaulis*
hackberry	*Celtis occidentalis*	milkweed, poke	*Asclepias exaltata*
hairgrass, common	*Avenela flexuosa*	milkweed, swamp	*Asclepias incarnata* ssp. *incarnata*
hair-rush	*Bulbostylis capillaris* ssp. *capillaris*	milkweed, whorled	*Asclepias verticillata*
harlequin, yellow	*Corydalis flavula*	monkey-flower, winged	*Mimulus alatus*
hawthorn	*Crataegus*	(a moss)	*Helodium paludosum*
hemlock, eastern	*Tsuga canadensis*	moss, peat	*Sphagnum*
hepatica, round-lobed	*Hepatica americana*	mountain-mint, blunt	*Pycnanthemum muticum*
hickory, pignut	*Carya glabra*	mountain-mint, Torrey's	*Pycnanthemum torrei*

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Appendix D (cont.)

Common Name	Scientific Name
oak, black	*Quercus velutina*
oak, chestnut	*Quercus montana*
oak, pin	*Quercus palustris*
oak, red	*Quercus rubra*
oak, scarlet	*Quercus coccinea*
oak, scrub	*Quercus ilicifolia*
oak, swamp white	*Quercus bicolor*
oak, white	*Quercus alba*
orangeweed	*Hypericum gentianoides*
orchid, dragon's mouth	*Arethusa bulbosa*
orchid, white-fringed	*Platanthera blephariglottis* var. *blephariglottis*
paintbrush, scarlet Indian	*Castilleja coccinea*
pellitory	*Parietaria pennsylvanica*
pickerelweed	*Pontederia cordata*
pine, pitch	*Pinus rigida*
pine, red	*Pinus resinosa*
pine, eastern white	*Pinus strobus*
pinesap	*Monotropa hypopithys*
pinweed, slender	*Lechea tenuifolia*
pipewort	*Eriocaulon aquaticum*
pitcher-plant	*Sarracenia purpurea*
pod-grass	*Scheuchzeria americana*
pogonia, rose	*Pogonia ophioglossoides*
polypody, rock	*Polypodium virginianum*
pond-lily, yellow	*Nuphar advena* ssp. *advena*
pond-lily, fragrant	*Nymphaea odorata* ssp. *odorata*
pondweed, Hill’s	*Potamogeton hillii*
pondweed, spotted	*Potamogeton pulcher*
pondweed, water-thread	*Potamogeton diversifolius*
poverty-grass	*Danthonia spicata*
prickly-ash, American	*Zanthoxylum americanum*
raspberry, red	*Rubus idaeus* ssp. *strigosus*
raspberry, black	*Rubus occidentalis*
rattlebox	*Crotalaria sagittalis*
reed, common	*Phragmites australis*
reedgrass, wood	*Cinna arundinacea*
riverweed	*Podostemum ceratophyllum*
rock-cress, hairy	*Arabis hirsuta* var. *pycnocarpa*
rosemary, bog	*Andromeda polifolia* var. *glaucophylla*
rose-mallow, swamp	*Hibiscus moscheutos* ssp. *moscheutos*
rose, multiflora	*Rosa multiflora*
rose, swamp	*Rosa palustris*
rue-anemone	*Thalictrum thalictroides*
rush, soft	*Juncus effusus*
rush, toad	*Juncus bufonius* var. *bufonius*
sandwort, rock	*Minuartia michauxii* var. *michauxii*
sarsaparilla, bristly	*Aralia hispida*
saxifrage, golden	*Chrysosplenium americanum*
sedge, Back’s	*Carex backii*
sedge, Bicknell’s	*Carex bicknellii*
sedge, bronze	*Carex foenea*
sedge, Bush’s	*Carex bushii*
sedge, cattail	*Carex typhina*
sedge, clustered	*Carex cumulata*
sedge, Davis’	*Carex davisii*
sedge, Emmons’	*Carex albicans* var. *emmonsii*
sedge, false hop	*Carex lupuliformis*
sedge, hairy-fruited	*Carex trichocarpa*
sedge, handsome	*Carex formosa*
sedge, lakeside	*Carex lacustris*
sedge, lesser panicled	*Carex diandra*
sedge, Pennsylvania	*Carex pensylvanica*
sedge, porcupine	*Carex hystericina*
sedge, prairie	*Carex prairea*
sedge, reflexed	*Carex retroflexa*
sedge, rough	*Carex scabrata*
sedge, Schweinitz’s	*Carex schweinitzii*
sedge, sterile	*Carex sterilis*
sedge, tussock	*Carex stricta*
sedge, woolly-fruit	*Carex lasiocarpa* ssp. *americana*
sedge, yellow	*Carex flava*
shadbush	*Amelanchier*
shadbush, dwarf	*Amelanchier stolonifera*
sheep-laurel	*Kalmia angustifolia*
skunk-cabbage	*Symplocarpus foetidus*
spicebush	*Lindera benzoin*
spike-moss, creeping	*Selaginella apoda*
spike-muhly	*Muhlenbergia glomerata*
spikerush, green	*Eleocharis flavescens* var. *olivacea*
spikerush, knotted	*Eleocharis equisetoides*
spikerush, ovate	*Eleocharis obtusa* var. *ovata*
spleenwort, ebony	*Asplenium platyneuron* var. *platyneuron*
spleenwort, maidenhair	*Asplenium trichomanes* ssp. *trichomanes*
spleenwort, mountain	*Asplenium montanum*
spleenwort, silvery	*Deparia acrostichoides*
spruce, Norway	*Picea abies*
steeplebush	*Spiraea tomentosa* var. *tomentosa*
St. Johnswort, marsh	*Triadenum fraseri*
St. Johnswort, shrubby	*Hypericum prolificum*
sumac, poison	*Toxicodendron vernix*

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Appendix D (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
sundew, round-leaf	*Drosera rotundifolia*	water-marigold, Beck's	*Bidens beckii*
sundew, spoon-leaf	*Drosera intermedia*	water-plantain	*Alisma triviale*
sweetfern	*Comptonia peregrina*	water-shield	*Brasenia schreberi*
sweetflag	*Acorus*	water-purslane	*Ludwigia palustris*
sycamore	*Platanus occidentalis*	water-willow	*Decodon verticillatus*
tearthumb, halberd-leaved	*Persicaria arifolia*	whitlow-grass, Carolina	*Draba reptans*
trillium, nodding	*Trillium cernuum*	willow	*Salix*
twig-rush	*Cladium mariscoides*	willow, autumn	*Salix serissima*
valerian, bog	*Valeriana uliginosa*	willow, sage-leaved	*Salix candida*
vervain, blue	*Verbena hastata* var. *hastata*	witch-hazel	*Hamamelis virginiana*
viburnum, maple-leaf	*Viburnum acerifolium*	wood-nettle	*Laportea canadensis*
violet	*Viola*	woolgrass	*Scirpus cyperinus*
wall-rue	*Asplenium ruta-muraria*	yellow-cress, bog	*Rorippa palustris* ssp. *palustris*