SIGNIFICANT HABITATS
IN THE TOWN OF PINE PLAINS, DUTCHESS COUNTY, NEW YORK


Photo: Nava Tabak

Report to the Town of Pine Plains, the Millbrook Tribute Garden, the Dyson Foundation, and the Dutchess Land Conservancy

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CONTENTS

APPENDICES

FIGURES

TABLES

EXECUTIVE SUMMARY

Hudsonia biologists identified and mapped ecologically significant habitats in the Town of Pine Plains during the period April through December 2008. Through map analysis, aerial photograph interpretation, and field observations we created large-format maps showing the locations and configurations of these habitats in the study area. 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 21 fens, 64 intermittent woodland pools, three circumneutral bog lakes, many extensive wetland complexes, large areas of contiguous upland meadow including five areas greater than 200 ac (80 ha), a forested area of nearly 2,900 ac (1170 ha) on Stissing and Little Stissing mountains, and nine additional areas of contiguous forest greater than 200 ac (80 ha) each.

In this report we describe each of the mapped habitat types, including their ecological attributes, some of the species of conservation concern they may support, and their sensitivities to human disturbance. We address conservation issues associated with these habitats, provide specific conservation recommendations, and delineate eight areas in Pine Plains that may serve as suitable units for conservation and 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, which contains ecological information unavailable from other sources, can help the Town of Pine Plains 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 are undergoing rapid change as farms, forests, and other undeveloped lands are converted to residential and commercial uses. The consequences of rapid land development 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. The availability of general biodiversity information for large areas such as entire towns, watersheds, or counties will enable landowners, developers, municipal planners, and others to better incorporate biodiversity protection into day-to-day decision making.

To address this need, Hudsonia Ltd., a nonprofit scientific research and education institute, 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 have been identifying important biological resources over large geographic areas and informing local communities about effective measures for biodiversity conservation.

After Hudsonia completed its first townwide habitat map for the Town of East Fishkill (Stevens and Broadbent 2002), we received funding from the Dyson Foundation and the Millbrook Tribute Garden (through the Dutchess Land Conservancy) to produce habitat maps for five northeastern Dutchess County towns. Over the last several years we have completed the mapping of four of these towns—Washington (Tollefson and Stevens 2004), Stanford (Bell et al. 2005), Amenia (Tabak et al. 2006), and North East (Knab-Vispo et al. 2008) — and Pine Plains is the fifth. With other funding, we have also completed habitat maps for the towns of Rhinebeck, Poughkeepsie, and the northern part of Hyde Park, and expect to complete Beekman later in 2009. We received strong endorsements for this project from the Pine Plains Town Board and Conservation Advisory Council, as well as from many landowners. The

Educational Foundation of America provided programmatic support to Hudsonia to further this and other projects of Hudsonia's Biodiversity Resources Center.

Catherine A. McGlynn (Biologist), Nava Tabak (Biodiversity Mapping Coordinator), and Gretchen Stevens (Director of Hudsonia's Biodiversity Resources Center) conducted the work on this project from April 2008 through June 2009. Through map analysis, aerial photograph interpretation, and field observations we created a map of ecologically significant habitats in the Town of Pine Plains, excluding the properties belonging to 1133 Taconic LLC (where natural communities have been mapped by a consultant to the landowner as part of an ongoing development proposal). 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.

Hudsonia hopes to extend the habitat mapping program to other parts of southeastern New York. To facilitate inter-municipal planning, we strive for consistency in the ways that we define and identify habitats and present the information for town use, but we also expect that our methods and products will improve as the program evolves. Many passages in this report on general habitat descriptions, general conservation and planning concepts, and other information applicable to the region as a whole are taken directly from the East Fishkill (Stevens and Broadbent 2002), Washington (Tollefson and Stevens 2004), Stanford (Bell et al. 2005), Fishkill and Sprout Creek Corridors (Sullivan and Stevens 2005), Amenia (Tabak et al. 2006), Rhinebeck (Reinmann and Stevens 2007), North East (Knab-Vispo et al. 2008) and Poughkeepsie (Tabak and Stevens 2008) reports without specific attribution. This report, however, addresses our findings and specific recommendations for the Town of Pine Plains. 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 measures voluntarily. We also hope that the Town of Pine Plains 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. It includes ecosystems, biological communities, populations, species, and gene pools, 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, lacking harmful invasive species, or those that provide connections between other important habitat units).
4. Complexes of connected habitats that, by virtue of their size, composition, or configuration, have significant biodiversity value.

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 location and configuration of ecologically significant habitats throughout the Town of Pine Plains, 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 Pine Plains is located in northeastern Dutchess County in southeastern New York. It encompasses approximately 31 mi^2 (80 km^2) and has a population of roughly 2,700 residents (2007 US Census estimate). By agreement with the Pine Plains Town Board, our study area for this project—28 mi^2 (73 km^2)—excluded the properties owned by 1133 Taconic LLC (2.9 mi^2) where a large development proposal is under review by the town. Throughout this report the portion of Pine Plains exclusive of the 1133 Taconic LLC properties is referred to as “the study area.”

All of the land in Pine Plains ultimately drains into the Hudson River via the Roeliff Jansen Kill and Wappinger Creek. The Bean River drains a southeastern portion of Pine Plains, flowing south into the Shekomeko Creek, which in turn flows north through the central part of the town into the Roeliff Jansen Kill. Ham Brook drains much of the northwestern part of Pine

Plains, flowing north into the Roeliff Jansen Kill. The headwaters of Wappinger Creek are above Thompson Pond. The creek drains the large valley east of Stissing Mountain, and flows through several towns before reaching the Hudson River at the southern boundary of the Town of Poughkeepsie. An unnamed perennial tributary of Wappinger Creek flows between Stissing Mountain and Hicks Hill in the southeast part of Pine Plains. Punch Brook drains the northeastern portion of Pine Plains, flowing north through the Drowned Lands Swamp into the Roeliff Jansen Kill in Columbia County. Elevations in Pine Plains range from 300 ft (91 m) above mean sea level along the Roeliff Jansen Kill in the northwestern corner of the town to 1403 ft (428 m) on the top of Stissing Mountain. Other high elevation areas include the summits of Little Stissing Mountain, Schultz Hill, and Prospect Hill, and hills in the southeast (northern extension of Silver Mountain) and northeast of the town. Large wetland complexes occur along the Bean River, in the Wappinger Creek Valley, along Shekomeko Creek east of the hamlet of Pine Plains, and along Punch Brook and its tributaries north and south of Route 199.

The landscape of hills and valleys in Pine Plains reflects the strong influences of bedrock geology and glacier activity. The bedrock of the western portion of the town (including Stissing and Little Stissing Mountains) is predominantly of gneiss, schist, phyllite, metagraywacke, and quartzite, while the bedrock underlying the central and eastern valleys and hills includes large areas of limestone, dolostone, and shale (Fisher et al. 1970, Warthin 1976; Figure 1). The surficial material is primarily glacial till with areas of exposed or nearly exposed bedrock on the hills. Recent alluvial and kame deposits occur along the perennial streams (including Roeliff Jansen Kill, Bean River, and Shekomeko Creek). The Wappinger Creek valley is largely underlain by outwash and gravel deposits, with swamp deposits in the southern portion of the valley in the town, and kames surrounding the three lakes (a kame is a small hill composed of pulverized rock and other material transported and deposited by a glacier) (Warthin 1976, Cadwell et al. 1989).

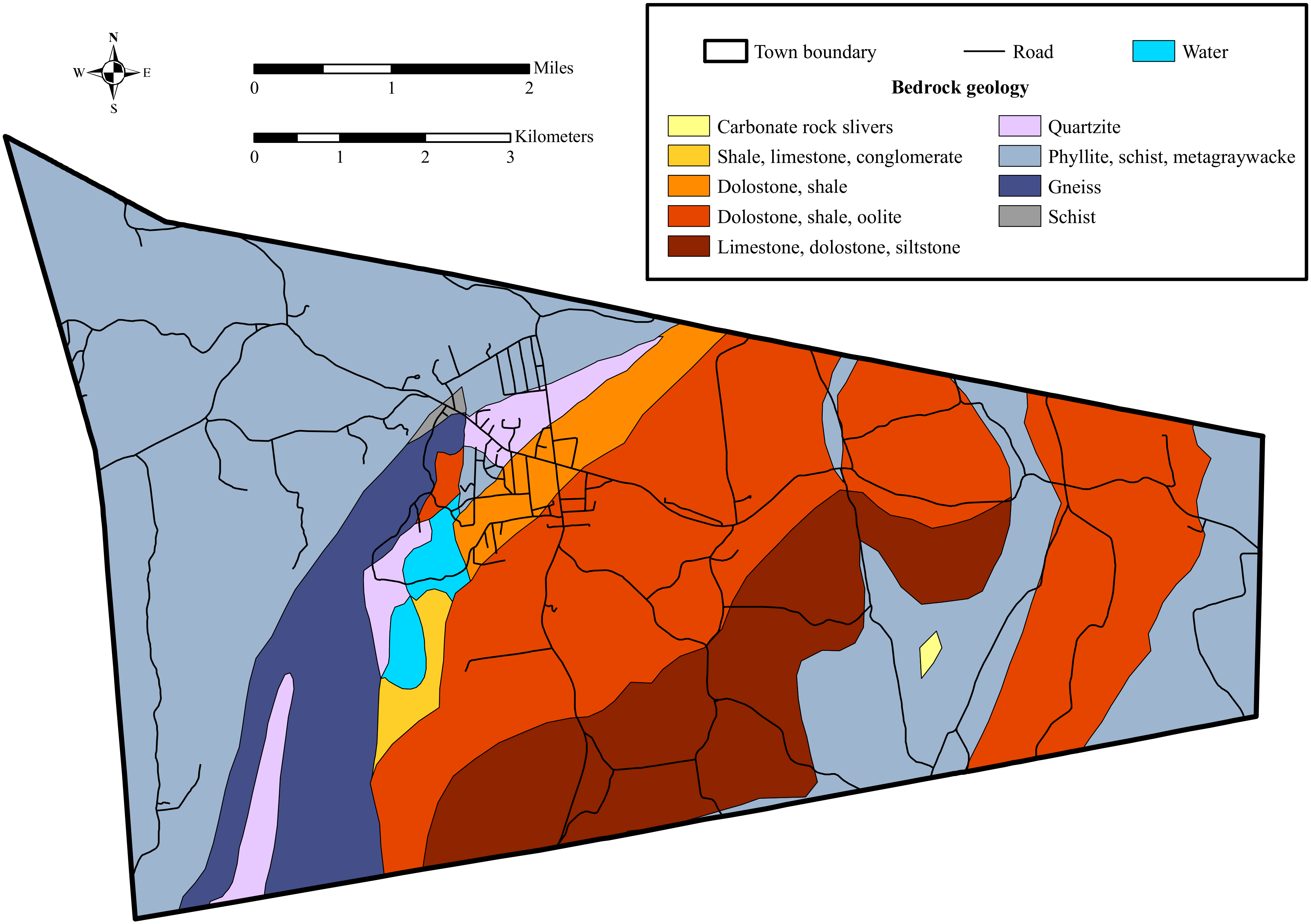
Land uses in the Town of Pine Plains include farming, horse stables and pastures, nature preserves, hunting preserves, forestry, and residential and commercial uses. More than 370 ac (150 ha) are owned by the state, mostly in the Stissing Mountain Multiple Use Area. The

Nature Conservancy owns over 500 ac (200 ha) around Thompson Pond and Stissing Mountain. Most privately owned parcels are 5 ac (2 ha) or smaller. Forty six private landowners own more than 100 ac (40 ha) each; twelve landowners own over 300 ac (120 ha) each; and two landowners own more than 1000 ac (400 ha) (with the largest private landholding totaling approximately 1,800 ac [730 ha]). Residences and their immediate surroundings are the most common type of developed area in Pine Plains. These are mainly concentrated in the hamlet of Pine Plains and along the roads throughout the town.

Pine Plains has large areas of undeveloped open space (see Figure 3), and its natural resources have long been the subject of studies by scientists and naturalists including Lyman Hoysradt and Rogers McVaugh (botanists) (McVaugh 1958) and Eleonora Knopf (geologist) (Knopf 1962). The Wappinger Creek valley and neighboring Stissing Mountain are now recognized by the New York State Department of Environmental Conservation (NYS DEC) as a Significant Biodiversity Area of southeastern New York, collectively referred to as the Stissing Mountain Wetlands Complex (Penhollow et al. 2006).


Photo: Catherine McGlynn

Figure 1. Generalized bedrock geology of the Town of Pine Plains, Dutchess County, New York. Warm colors indicate bedrock types that are at least partially calcareous and cool colors indicate predominantly acidic bedrock types. Geology data from Fisher et al. 1970. Hudsonia Ltd., 2009.



METHODS

Hudsonia employs a combination of laboratory and field methods in the habitat identification and mapping process. Below we describe each phase in the Town of Pine Plains habitat mapping project.

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 data previously collected by Hudsonia and other biologists in the Town of Pine Plains 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 aerial photograph prints* from the National Aerial Photography Program series taken in spring 1994, obtained from the U.S. Geological Survey. Viewed in pairs with a stereoscope, these prints ("stereo pairs") provide a three-dimensional view of the landscape and are extremely useful for identifying vegetation cover types, wetlands, streams, and cultural landscape features. The especially poor quality of the stereoscopic images available for Pine Plains, however, may have impaired the accuracy of our remote sensing on this project.

- *High-resolution (1 pixel = 7.5 in [19 cm]) true color and color infrared digital orthophotos* taken in spring 2004, obtained from the New York State GIS Clearinghouse website (http://www.nysgis.state.ny.us; accessed March 2008). These digital aerial photos were used for on-screen digitizing of habitat boundaries.

- *U.S. Geological Survey topographic maps* (Ancram, Millerton, and Pine Plains 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 about the types of habitats that are likely to occur in an area. Shallow soils, for example, may indicate the location of crest, ledge, and talus habitats. Poorly and very poorly drained soils support 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 System (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 was obtained from their website. We obtained soils data from the Natural Resources Conservation Service (NRCS) website. We also obtained 10 ft (3 m) contour data from the Dutchess Land Conservancy, and tax parcel data from the Dutchess County Office of Real Property Tax. We used ArcView 9.2 software (Environmental Systems Research Institute 2006) to examine these data layers together with the orthophoto images.

Preliminary Habitat Mapping and Field Verification

Our study area encompassed the entire Town of Pine Plains except for the properties owned by the 1133 Taconic LLC at and near the existing Thomas Carvel Country Club. (Those properties are part of a proposed development that is currently under review by the town; ecological communities have been identified and mapped by Rudikoff Associates Inc., consultants to the developer). We prepared a preliminary map of predicted habitats for the study area based on map analysis and stereo interpretation of aerial photographs. We digitized the predicted habitats onscreen over the orthophoto images using ArcView 9.2 mapping software. With these draft maps in hand we conducted field visits to as many of the mapped habitat units as possible to verify their presence and extent, to correct our predictions as necessary, and to assess habitat quality.

We identified landowners using tax parcel data, and before going to field sites we contacted property owners for permission to visit their land. We prioritized sites for field visits based both on opportunity (i.e., willing landowners) and our need to answer questions regarding habitat identification or extent that could not be answered remotely. For example, distinctions between habitats such as wet meadow and calcareous wet meadow, and wet meadow and fen, can only be made in the field. In addition to conducting fieldwork on private land, we also 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.

Ultimately we field-checked approximately 50% of the undeveloped land area in the study area (8960 ac [3625 ha]). We used remote sensing alone to map habitats in areas that we did not see in the field. We assume that areas of the habitat map that were field-checked are generally more accurate than areas we did not visit. Once we have conducted fieldwork in one area, however, we were able to extrapolate our findings to adjacent parcels and similar settings.

Defining Habitat Types

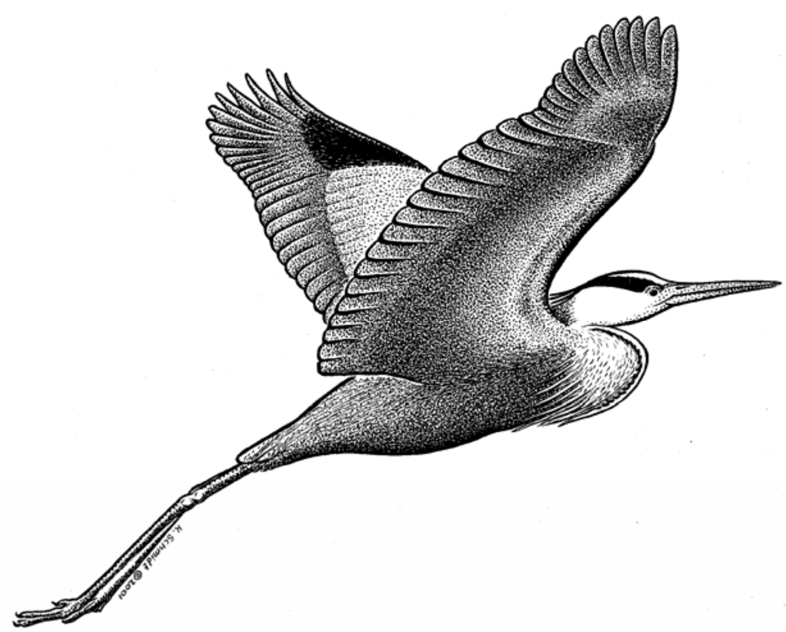
Habitats are useful for categorizing places according to apparent ecological function, and are manageable units for scientific inquiry and land use planning. For these townwide habitat mapping projects we classify broad habitat types that are identifiable primarily by their vegetation and visible physical properties. In reality, habitats exist as part of a continuum of intergrading resources and conditions, and drawing a line to separate two "habitats" often seems quite arbitrary. Furthermore, some distinct habitats are intermediates between two defined habitat types, and some habitat categories can be considered complexes of several habitat types. At least one of our habitat categories (crest/ledge/talus) typically occurs within other habitats such as forest or meadow. In order to maintain consistency within and among habitat mapping projects, we have developed certain mapping conventions (or rules) 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 Pine Plains study area 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 ecological attributes of places that are categorized as that particular habitat. Developed areas and other areas that we consider non-significant habitats (e.g., structures, paved roads and driveways, other impervious surfaces, and small lawns and woodlots) are shown as white (no symbol or color) on the habitat map. Areas that have been developed since 2004 (the orthophoto date) were identified as such only if we observed them in the field. For this reason, it is likely that we have somewhat underestimated the extent of developed land in the study area.

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 produced the final large-format habitat map on two sheets (36 x 44 inches) at a scale of 1:10,000, using a Hewlett Packard DesignJet 800PS plotter. We also printed the entire town map on a single sheet (36 x 42 inches) at a scale of 1:17,000. For display purposes we included the ecological community data provided to us by 1133 Taconic LLC for their properties, and provide comparisons between these community types and our habitat types in Table 1. The GIS database that accompanies the habitat map includes additional information about many of the mapped habitat units, such as the dates of field visits (including observations from adjacent properties and roads) and some of the plant and animal species observed in the field. The habitat map, GIS database, and this report have been presented to the Town of Pine Plains and the Dutchess Land Conservancy 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."*



Great blue heron

Table 1. Cross-reference for “ecological communities” mapped by Rudikoff Associates on the 1133 Taconic LLC property and “habitats” mapped by Hudsonia in the remainder of the Town of Pine Plains.

Hudsonia’s habitat categories and definitions differ from those used by Rudikoff Associates to describe the 1133 Taconic LLC properties, which follow the classifications in Edinger et al. (2002). The cross-reference below is based on our understanding of the ecological communities as described by Edinger et al., and a cursory visual inspection of the ecological communities map and aerial orthophotos of the 1133 Taconic LLC properties. Letter-codes for both classification systems are those appearing on the maps (with exception of “developed,” “clt,” and “stream,” which are not labeled on the maps). Hudsonia habitats are those that correspond to Edinger et al.’s descriptions of ecological communities. Hudsonia habitat codes in parentheses indicate habitat types that vary from the cross-referenced ecological community description, but which Hudsonia may have assigned to some places on 1133 Taconic LLC properties based on aerial photo inspection and on our own classification protocols. For example, “conifer stands” as used by Edinger et al. would generally correspond to Hudsonia’s ‘upland conifer forest’ category, but in Rudikoff Associates’ map may also correspond to “upland mixed forest.”

1133 Taconic LLC ecological community		**Hudsonia habitat**	
Name	**Code**	**Name**	**Code**
Appalachian oak-pine	AO	Upland hardwood forest, upland mixed forest	uhf, umf
Conifer stands	C	Upland conifer forest (upland mixed forest)	ucf (umf)
Mixed conifer hardwoods	CH	Upland hardwood forest, upland mixed forest	uhf, umf
Chestnut oak	CO	Upland hardwood forest	uhf
Conifer plantation	CP	Upland conifer forest	ucf
Ditch/ Artificial intermittent stream	D	Intermittent stream (marsh)	stream (ma)
Eutrophic pond	EP	Marsh, constructed pond (open water)	ma, cp (ow)
Farm pond - artificial pond	FP	Constructed pond, open water	cp, ow
Hardwoods	H	Upland hardwood forest	uhf
Red maple - hardwood swamp	HS	Hardwood and shrub swamp, stream, (possibly buttonbush pool)	hs, stream (possibly bp)
Mowed lawn with trees	L	Cultural, developed	c, developed
Inland non-calcareous lake shore	LS	N/A	N/A
Freshwater marsh	M	Marsh, wet meadow (hardwood and shrub swamp)	ma, wm (hs)
Wet meadow - shrub wetland complex	MS	Wet meadow, hardwood and shrub swamp	wm, hs
Successional old field	OF	Upland meadow (upland shrubland)	um (us)
Pitch pine-oak-heath rocky summit	PP	Oak-heath barren with crest/ledge/talus	ohb with clt
Quarry	Q	Waste ground (developed)	wg (developed)
Reservoir-artificial impoundment	R	Constructed pond	cp
Red cedar rocky summits	RR	Red cedar woodland with crest/ledge/talus	rcw with clt
Successional red cedar woodland	RW	Red cedar woodland (upland mixed/hardwood forest, upland shrubland)	rcw (umf, uhf, us)
Shrubland	SL	Upland shrubland (upland meadow)	us (um)
Shrub thicket wetland	ST	Hardwood & shrub swamp (stream)	hs (stream)
Vernal pool	VP	Intermittent woodland pool (hardwood & shrub swamp, possibly buttonbush pool)	iwp, (hs, possibly bp)
Wet meadow	WM	Wet meadow, calcareous wet meadow	wm, cwm

RESULTS

Overview

The large-format Town of Pine Plains 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 2. Of the total 28 mi^2 (73 km^2) in the study area, approximately 91% is undeveloped (i.e., without structures, paved roads, manicured lawns, etc.). The existing development is somewhat dispersed throughout the study area so that undeveloped land has been fragmented into discontinuous patches. Figure 3 shows blocks of contiguous undeveloped habitat within the town that are less than 100, 100-500, 500-1,000, and greater than 1,000 ac (<40, 40-200, 200-400, and >400 ha). Several types of common habitats cover extensive areas within these blocks. For example, approximately 48% of the study area is forested (including both upland forest and hardwood and shrub swamp habitat types), 31% is upland meadow (active agricultural areas and other managed and unmanaged grassland and forb-dominated habitats), and 12% is wetland. Some of the more unusual habitats we documented include circumneutral bog lakes, fens, kettle shrub pools, and oak-heath barrens. In total, we identified 25 different habitat types in the study area that we consider to be of potential ecological importance (Table 2).

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 mature forests. The hydrology of many wetlands in the town has been extensively altered by filling, draining, and construction of dams and roads. Purple loosestrife, which was introduced to the region in the 1800s, was one of the most frequently observed plants in marshes and wet meadows throughout the town (though was not dominant in most cases). Non-native common reed, another introduced plant that is widespread in wetlands and along wetter roadside areas throughout the town, was introduced to the region in the 1940s. Although we have documented the location and extent of important habitats within most of the Town of Pine Plains, only in a few cases have we provided information on the quality and condition of the habitat units.

Table 2. Ecologically significant habitats identified by Hudsonia in the Town of Pine Plains, Dutchess County, New York, 2008.

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

Figure 2. A reduction of the map illustrating ecologically significant habitats in the study area in the Town of Pine Plains, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white. The large format map is printed in two sections at a scale of 1:10,000. Hudsonia Ltd., 2009.

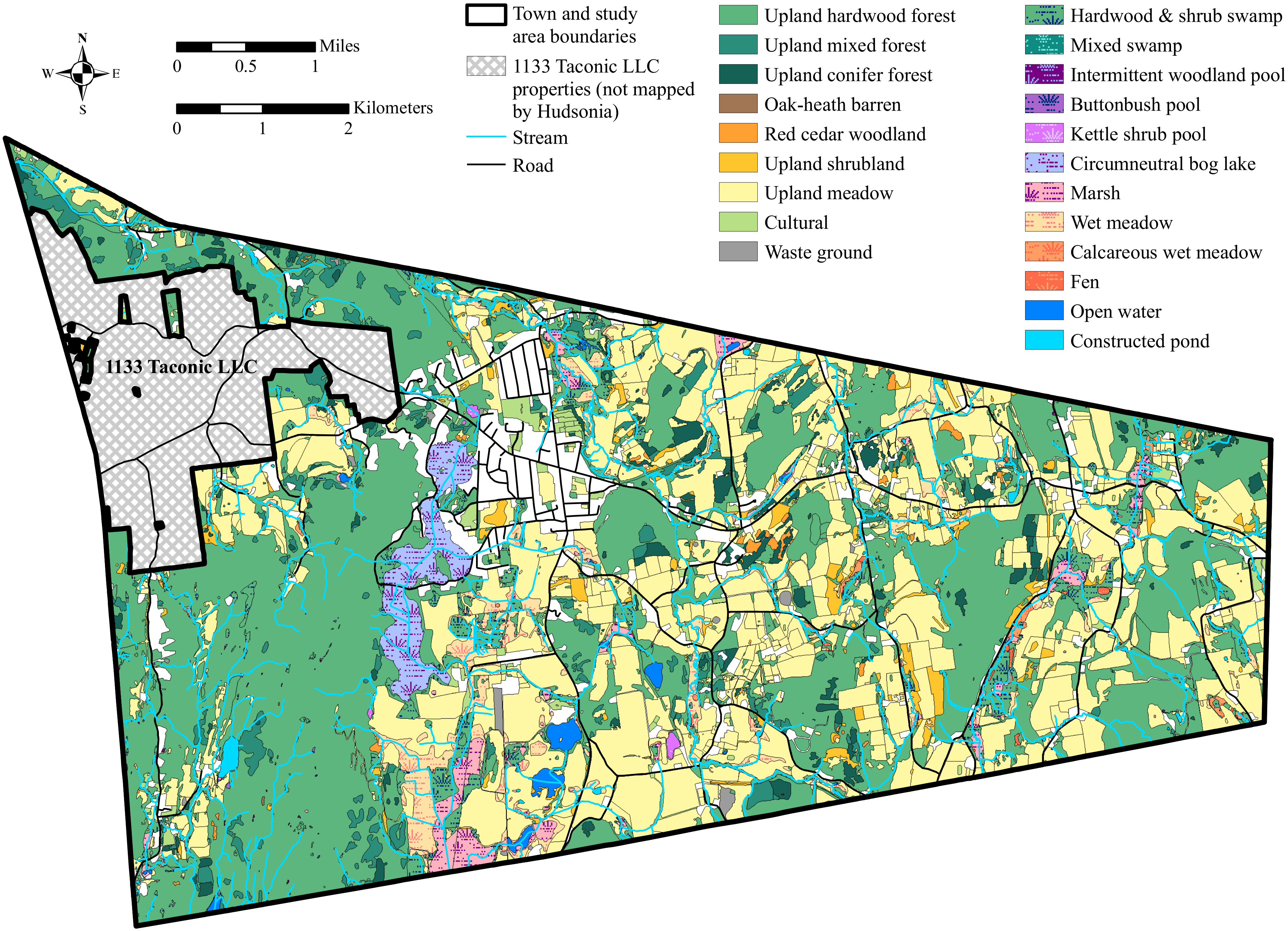
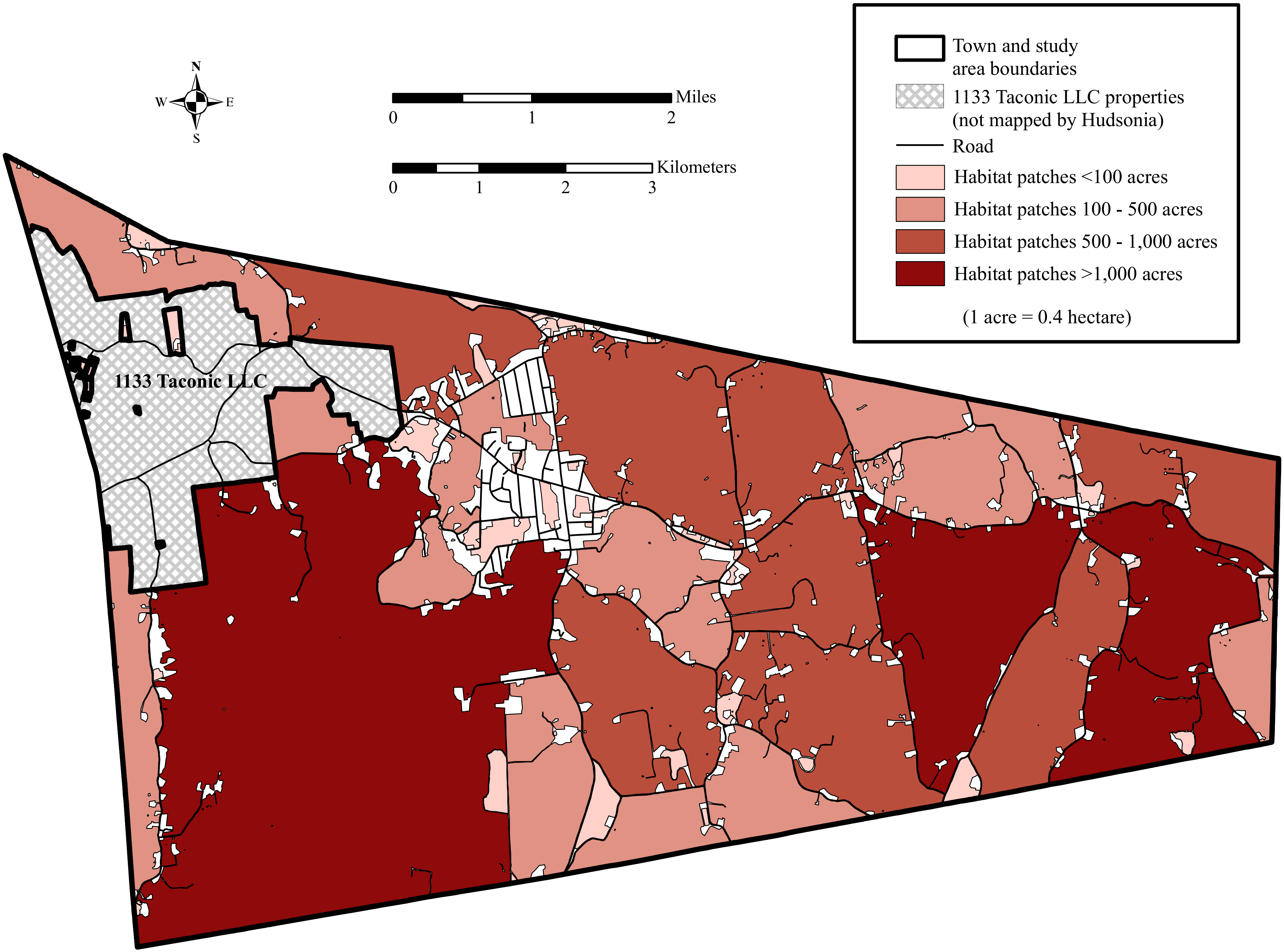


Figure 3. Contiguous habitat patches in the study area in the Town of Pine Plains, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white. Hudsonia Ltd., 2009.



HABITAT DESCRIPTIONS

In the following pages we describe some of the ecological attributes of the habitats identified in the study area, and discuss some conservation measures that can help to protect these habitats and the species of conservation concern they may support. We have assigned a code to each habitat type (e.g., upland conifer forest = ucf; marsh = ma) that corresponds with the codes appearing on the large-format (1:10,000 scale) Town of Pine Plains habitat map sheets. We have indicated 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 more detailed list of rare species associated with each habitat, including their statewide and regional conservation status. 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 forests into three general types for this project: hardwood forest, conifer forest, and mixed forest. We recognize, however, that upland forests are in fact very variable, with each of these three types encompassing many distinct biological communities. However, our broad forest types are useful for general planning purposes, and are also the most practical for our remote mapping methods.

<u>Upland Hardwood Forest (uhf)</u>

Upland hardwood forest is the most common habitat type in the region, and includes many different types of deciduous forest communities. Upland hardwood forests are used by a wide range of common and rare species of plants and animals. Common trees of upland hardwood forests include maples (sugar, red, Norway), oaks (black, red, white, chestnut), hickories (shagbark, pignut), white ash, black birch and black locust. Common understory species include maple-leaf viburnum, witch-hazel, serviceberry (or shadbush), lowbush blueberries, and a wide variety of wildflowers, sedges, ferns, lichens, and mosses. Rocky forests at higher elevations are often dominated by chestnut oak, red oak, and hickory species. Eastern box turtle* spends most of its time in upland forests and meadows, finding shelter under logs and organic litter, and spotted turtle* and Blanding's turtle* use upland forests for aestivation (summer dormancy) and travel. Many snake species, such as eastern ratsnake,* eastern racer,* and red-bellied snake, forage widely in upland forests and other habitats. Upland hardwood forests provide important nesting habitat for raptors, including bald eagle*, 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. Golden eagle* overwinters in some upland hardwood forests. American woodcock* forages and nests in young hardwood forests. 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, white-footed mouse, eastern cottontail, and New England cottontail.* Hardwood trees greater than 5 inches (12.5 cm) in diameter (especially those with loose platy bark such as shagbark hickory and black locust) can be used by Indiana bat* for summer roosting and nursery colonies. Upland hardwood forests are extremely variable in their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other habitat factors. Smaller or more localized habitats, such as intermittent woodland pools and areas of crest, ledge, or talus, are frequently embedded within areas of upland hardwood forest.

<u>Upland Conifer Forest (ucf)</u>

This habitat includes naturally occurring upland forests with more than 75% cover of conifer trees, and pole-sized (approximately 5-10 in [12-25 cm] diameter at breast height) to mature conifer plantations. Eastern hemlock, white pine, and eastern red cedar are typical species of naturally occurring conifer stands in the area. Different kinds of conifer forests play different ecological roles in the landscape. For example, forests of eastern red cedar are short-lived and are typically replaced by hardwoods over time, while eastern hemlock forests are long-lived and capable of perpetuating themselves in the absence of significant disturbance.

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). Some 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 (umf)

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. These areas are less densely shaded at ground level and support a higher diversity and greater abundance of understory species than pure conifer stands.

Occurrence in the Town of Pine Plains

Figure 4 illustrates the location of forested areas (including both forested wetlands and uplands) in the study area, and the distribution of forest patches that were less than 100, 100-500, 500-1,000, and greater than 1,000 ac (<40, 40-200, 200-400, and >400 ha). By far the largest area of forest was on and around Stissing Mountain (2900 ac [1170 ha]). Schulz Hill had a contiguous forest area of more than 500 ac (200 ha), and fourteen other forest areas of 100-500 ac (40 and 200 ha) each were throughout the town.

Upland hardwood forest was the most widespread habitat type, accounting for 39% of the total study area. Localized areas of "rich forest," supporting calcium-associated plant species, were found throughout the study area. At some high elevation, exposed areas on Stissing and Little

Stissing mountains the forest was dominated by chestnut oak, red oak, and white pine, with blueberries and black huckleberry in the understory. We identified two of the most exposed and rocky areas on Stissing Mountain as "oak-heath barrens," an uncommon habitat type described below. We presume that virtually all forests in the study area have been cleared or logged in the past and that no "virgin" stands remain. Forested areas on the steepest slopes of Stissing Mountain and Little Stissing Mountain may have been logged selectively, but were not completely cleared. There may be small stands of old-growth forest in the study area that were not observed during fieldwork. Large areas of the forest on Stissing Mountain were remarkably free of invasive plant species.

Most upland conifer and mixed forest patches were relatively small (<5 ac [2 ha]) and were distributed throughout the study area within upland hardwood tracts. Most of the natural conifer forests were composed of white pine, eastern hemlock, and/or eastern red cedar, and these were often embedded within more extensive areas of mixed forest. Eastern hemlock stands were most commonly found on acidic slopes, in ravines, and along perennial streams. White pine was widespread and occurred in a variety of ecological settings (but generally on well-drained upland soils). Eastern red cedar stands were characteristic of early-successional forests on abandoned pasture or farmland.

Sensitivities/Impacts

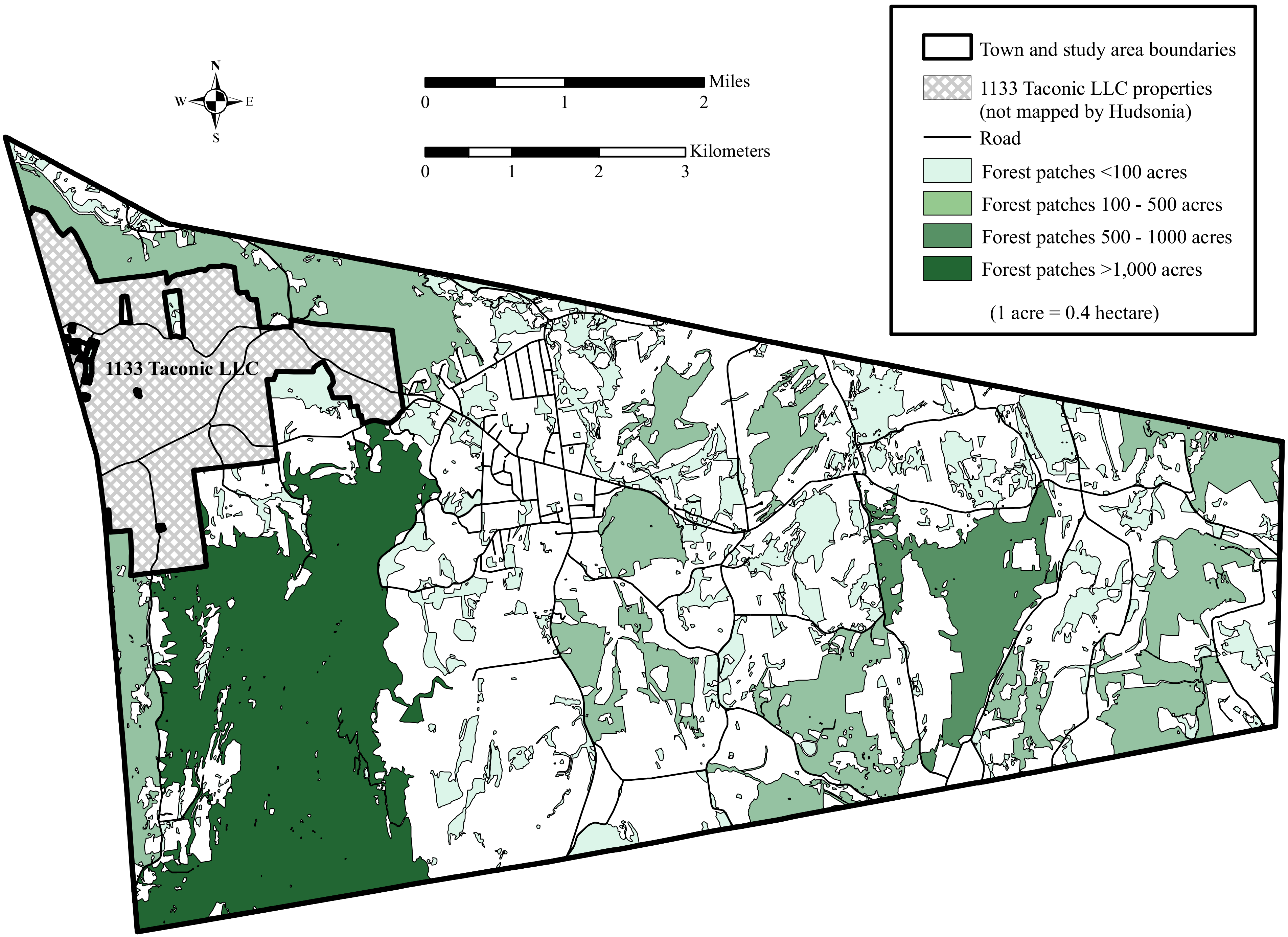
Forests of all kinds are important habitats for wildlife. Extensive forested areas that are unfragmented by roads, trails, utility corridors, or developed lots are especially important for certain organisms, but are increasingly rare in the region. Primary sources of forest fragmentation include roads and driveways, residential lots, and agricultural areas. New houses set back from roads by long driveways cause significant fragmentation of core forest areas. New development located along roads may also block important wildlife travel corridors between forested patches. Both paved and unpaved roads act as barriers that many species either do not cross or cannot safely cross, and many animals avoid breeding near traffic noise (Forman and Deblinger 2000, Trombulak and Frissell 2000).

In addition to fragmentation, forest habitats can be degraded in several 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* which nests on the forest floor. Selective logging can also damage the understory and cause soil erosion and sedimentation of streams. Soil compaction and removal of dead and downed wood and debris has several negative impacts, including the elimination of habitat for mosses, lichens, fungi, cavity-users, amphibians, reptiles, small mammals, and insects. Where dirt roads or trails cut through forest, vehicle, horse, and pedestrian traffic can harm tree roots and cause soil erosion, and the roadway itself can provide access to interior forest areas for nest predators (such as raccoon and opossum) and the brown-headed cowbird (a nest parasite). Runoff from roads can pollute nearby areas with road salt, heavy metals, and sediments (Trombulak and Frissell 2000), and mortality from vehicles can significantly reduce the population densities of amphibians (Fahrig et al. 1995). Forests are also susceptible to invasion by shade-tolerant non-native herbs and shrubs, and this susceptibility is increased by development-related disturbances. Human habitation has also led to the suppression of naturally occurring wildfires which can be important for some forest species and the forest ecosystem as a whole. See the Conservation Priorities section for recommendations on preserving the habitat values of large forests.


Photo: Nava Tabak

Dry, rocky oak woodland

Figure 4. Contiguous forest patches (including hardwood, conifer, and mixed forests in uplands and swamps) in the study area in the Town of Pine Plains, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white. Hudsonia Ltd., 2009.



RED CEDAR WOODLAND (rcw)

Ecological Attributes

A “woodland” (as used here) is more open than a “forest,” and can be described as a grassy area with widely-spaced trees. “Red cedar woodlands” feature an overstory dominated by 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 cedar trees are often widely spaced in young stands and denser in more mature stands. They tend to grow in particularly dense stands in areas with calcareous (calcium carbonate-rich) soils. Other, less common saplings and small trees of this habitat include gray birch, red maple, quaking aspen, and red oak. The understory vegetation is similar to that of upland meadow. 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. We mapped areas where abundant red cedar occurs under a canopy of hardwoods as “upland mixed forest.”

Rare plants of red cedar woodlands 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. 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 Pine Plains

Red cedar woodlands in the study area were relatively small, ranging in size from 0.3 to 6 ac (0.1-2 ha). The distribution of red cedar woodlands in the study area was closely related to the agricultural history of the town and the timing of pasture abandonment. Thus these woodlands were most commonly found in valley and low hill areas.

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. Except where a red cedar woodland habitat is known to support one or more rare species that depends on the semi-open woodland conditions, we do not recommend maintaining the habitat artificially (e.g., by selective cutting of competing 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 rock fragments of various sizes that often accumulate at the bases of 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 mapped 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, hairgrass, bristly sarsaparilla, and rock polypody. Rare plants of non-calcareous crests include mountain spleenwort,* clustered sedge,* and slender knotweed.*

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,* eastern wormsnake,* and northern copperhead.* Ledge areas with southern to southeastern and southwestern exposure may provide winter den and spring "basking rocks" for timber rattlesnake* and other snakes of conservation concern. Northern slimy salamander* occurs in non-calcareous wooded talus areas. Breeding birds of crest habitats include Blackburnian warbler,* worm-eating warbler,* and cerulean warbler.* Bobcat* and fisher* use high-elevation 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 Pine Plains

Crest, ledge, and talus habitats occurred throughout the study area in close association with hills and ridges (Figure 5). Extensive rocky areas were found on Stissing Mountain, Little Stissing Mountain, Schultz Hill, other hills throughout the town, and were scattered in the valley areas. The steep eastern sides of Stissing and Little Stissing mountains have extensive ledges and talus slopes. Two small areas on Stissing Mountain were identified as oak-heath barrens (a rocky habitat described below). Calcareous ledge and talus were generally interspersed with acidic rocky areas in the study area; large areas of calcareous talus were found along the eastern slope of Stissing Mountain, northwest of the intersection of Route 83 and Carpenter Hill Road, and west of Route 82 near the northern boundary of the town.

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 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. See the Conservation Priorities section for recommendations on preserving the habitat values of crest, ledge, and talus habitats.

Figure 5. General distribution of calcareous and non-calcareous crest, ledge, and talus habitats and oak-heath barrens in the study area in the Town of Pine Plains, Dutchess County, New York. Locations were identified by field observation and inferred from areas of shallow soils on steep slopes. Hudsonia Ltd., 2009.

OAK-HEATH BARREN (ohb)

Ecological Attributes

A special subset of rocky crest habitat (see above), oak-heath barren occurs on hilltops and shoulders with exposed noncalcareous bedrock, shallow, acidic soils, and vegetation dominated by some combination of pitch pine, scrub oak, other oaks, and heath (Ericaceae) shrubs. Schist, gneiss, and quartzite are among the common types of exposed bedrock. The soils are extremely thin, excessively well drained, and very nutrient poor. Due to the open canopy, oak-heath barrens tend to have a much warmer microclimate than the surrounding forested habitat, especially in the spring and fall. The exposed nature of these habitats also makes them particularly susceptible to wind, ice, and, at least historically, fire disturbance. The droughty, infertile, and exposed conditions have a strong influence on the composition and structure of the plant community; trees are often sparse and stunted. Our definition of this habitat corresponds to Edinger et al.'s (2002) "pitch pine-oak forest" and "pitch pine-oak-heath rocky summit." There may be a continuous canopy of pitch pine or pitch pine-oak with a scrub oak understory, or the shrub layer (predominately scrub oak and heath shrubs) may dominate, with only scattered pines. 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 sometimes abundant.

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

Occurrence in the Town of Pine Plains

We mapped two small oak-heath barren areas on Stissing Mountain (Figure 5); both were smaller than 1 ac (0.4 ha). Several other rocky areas on Stissing and Little Stissing mountains supported some of the species typical of oak-heath barrens (such as scrub oak), but had a hardwood forest canopy so were not classified as oak-heath barren.

Sensitivities/Impacts

The most immediate threats to these fragile habitats are human foot traffic; barrens near trails are often visited for scenic views and for 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 oak-heath 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 oak-heath barrens and other exposed crests at certain times of the year, the snakes are highly susceptible to killing or collecting by poachers. See the Conservation Priorities section for recommendations on protecting the habitat values of oak-heath barrens.

UPLAND SHRUBLAND (us)

Ecological Attributes

We use the term “upland shrubland” to describe 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 where forest clearing was recent. 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, Eurasian honeysuckles, Oriental bittersweet, and multiflora rose, or they may be more diverse, including grasses and forbs; native shrubs such as meadowsweet, gray dogwood, northern blackberry, and raspberries; and scattered seedlings and saplings of eastern red cedar, hawthorns, white pine, gray birch, red maple, quaking aspen, and oaks. 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 (Johnson et al. 2006, Lundgren et al. 2004). Occasional large, open-grown trees (e.g., sugar maple, red oak, sycamore) left as shade for livestock or for ornament may be present in abandoned pastures. 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 host plants are present (the fritillary uses violets and the skippers reproduce on native grasses such as little bluestem). Upland shrublands and other non-forested upland habitats may be used by turtles (e.g., painted turtle, wood turtle,* spotted turtle,* and eastern box turtle*) for nesting or aestivation. 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.* Extensive upland shrublands and those that form large complexes with meadow habitats may be particularly important for these breeding birds. Several species of hawks and falcons use upland shrublands and adjacent meadows for hunting small mammals such as meadow vole, deer mouse, eastern cottontail, and New England cottontail.*

Occurrence in the Town of Pine Plains

Upland shrublands were widely distributed throughout agricultural parts of the study area, and ranged from less than 0.1 ac (0.04 ha) to 20 ac (8 ha), totaling just over 300 ac (120 ha). The largest shrublands were groups of abandoned pastures.

Sensitivities/Impacts

Shrublands and meadows are closely related plant communities. 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., September and later) and only take place every few years, if possible. 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 (um)

Ecological Attributes

This broad category includes active cropland, hayfields, pastures, equestrian fields, abandoned fields, and other upland areas dominated by herbaceous (non-woody) vegetation. Upland meadows are typically dominated by grasses and forbs, with 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, for example, may support grassland-breeding birds (depending on the mowing schedule or intensity of grazing), while intensively cultivated crop fields may 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, reptiles, mammals, and birds. It is for both present and potential ecological values that we consider all types of meadow habitat to be ecologically significant.

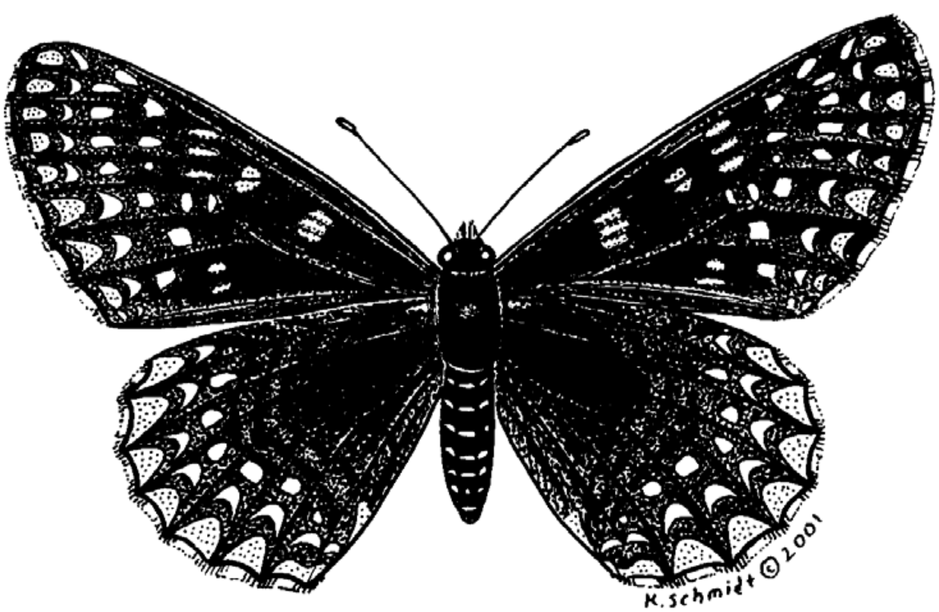
Several species of rare butterflies, such as Aphrodite fritillary,* dusted skipper,* Leonard's skipper,* swarthy skipper,* meadow fritillary,* striped hairstreak, and Baltimore* use upland meadows that support their particular host plants (violets for the fritillary, and native grasses such as little bluestem for the skippers). Upland meadows can be used for nesting by 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,* Henslow's sparrow,* eastern meadowlark,* and bobolink,* use extensive meadow habitats for nesting and 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 coyote.

Occurrence in the Town of Pine Plains

Upland meadow was the second most common habitat type in the study area, accounting for 31% of the total area. Figure 6 illustrates the location and distribution of contiguous meadow habitat in the town (including upland meadow, wet meadow, and fen), showing those areas that were less than 25, 25-50, 50-100, 100-200, and greater than 200 ac (<10, 10-20, 20-40, 40-80, and >80 ha). This figure does not include areas of upland shrubland that in some cases had large patches of herbaceous cover. The central and eastern parts of the study area had many large upland meadows. They were most abundant in the large valleys (e.g., along Wappinger Creek, Shekomeko Creek, Bean River, and several of their tributaries), but were found throughout the study area in places where agricultural land uses were extensive. Fences and hedgerows that divide fields can significantly alter the habitat value for many birds; if these are treated as fragmenting features, then the largest contiguous meadows measured 350 ac and 300 ac (140 and 120 ha; Figure 6B). The most common kinds of upland meadow in the study area were row crops, hayfields, pastures, and equestrian fields. Less intensively managed upland meadows were much less common. Although we did not designate them as a separate habitat, some upland meadows in Pine Plains were calcareous, with species such as wild bergamot, wild thyme, and marjoram.

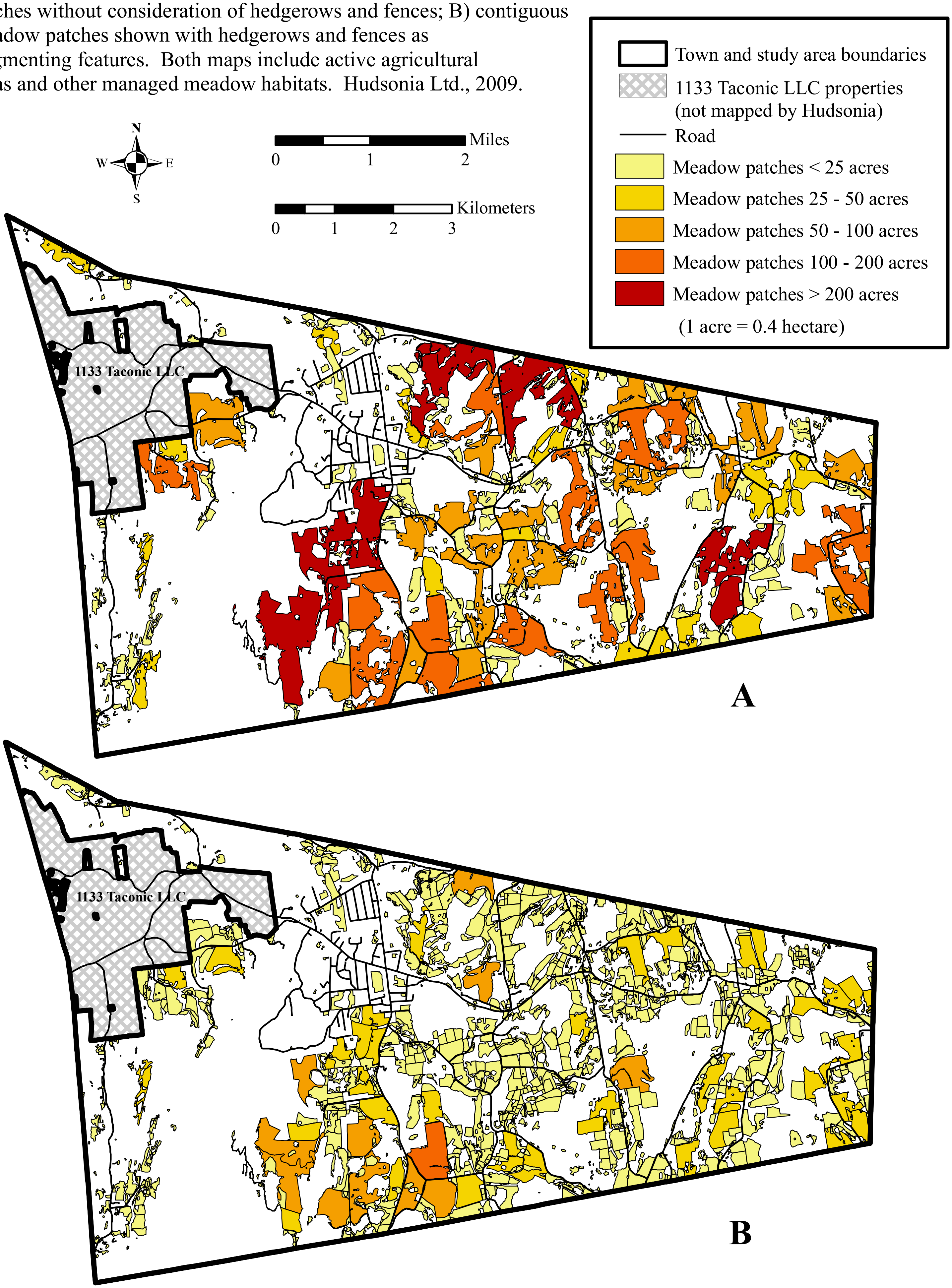
Sensitivities/Impacts

Principle causes of meadow habitat loss in the region are the intensification of agriculture, regrowth of shrubland and forest after abandonment, 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). 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, and mowing of upland meadows during the bird nesting season can cause extensive mortality of eggs, nestlings, and fledglings. Farmlands where pesticides and artificial fertilizers are used may have a reduced capacity to support biodiversity. See the Conservation Priorities section for recommendations for maintaining high-quality large meadow habitats.



Baltimore

Figure 6. Contiguous meadow patches (including upland meadows, wet meadows, calcareous wet meadows, and fens) in the study area in the Town of Pine Plains, Dutchess County, New York. A) Contiguous meadow patches without consideration of hedgerows and fences; B) contiguous meadow patches shown with hedgerows and fences as fragmenting features. Both maps include active agricultural areas and other managed meadow habitats. Hudsonia Ltd., 2009.



CULTURAL (c)

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 not entirely surrounded by developed areas). We mapped this as an ecologically significant habitat type more for its potential ecological values than its current values, which are reduced by frequent mowing, application of 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* may nest here. Large individual ornamental or fruit trees can provide habitat for cavity-nesting birds such as eastern bluebird,* roosting bats (including Indiana bat* and eastern small-footed bat*), and many other animals, as well as supporting 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 traffic is infrequent and slow. Many cultural areas have "open space" values for the human community, 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. In the study area, cultural habitats included large gardens, playing fields, riding rings, cemeteries, large lawns, and small orchards adjacent to residences. They ranged from less than 0.1 ac (.04 ha) to 25 ac (10 ha).

WASTE GROUND (wg)

Waste ground is a botanists' 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, but remain unvegetated or sparsely vegetated. This category encompasses a variety of highly impacted areas such as active and abandoned sand and gravel mines, rock quarries, mine tailings, dumps, unvegetated fill, landfill cover, construction sites, and abandoned lots. 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* 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 inactive 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 but this habitat might support rare species. The biodiversity value of waste ground will often increase over time as it develops more vegetation cover. However, on sites where species of conservation concern are absent or unlikely, waste ground may have a low habitat value compared to relatively undisturbed habitats. Relatively small areas of waste ground were scattered throughout the study area.

WETLAND HABITATS

SWAMPS

Ecological Attributes

A swamp is a wetland dominated by woody vegetation (trees or shrubs). We mapped two general types of swamp habitat in the study area: hardwood and shrub swamp, and mixed forest swamp. Kettle shrub pools and buttonbush pools are specific types of swamp habitats that are discussed separately.

Hardwood and Shrub Swamp (hs)

We combined deciduous forested and shrub swamps into a single habitat type because the two often occur together and can be difficult to separate using remote sensing techniques. Red maple, green ash, American elm, slippery elm, and swamp white oak are common trees of hardwood swamps in the region. Typical shrubs include silky dogwood, alder, shrubby willows, nannyberry, winterberry holly, highbush blueberry, buttonbush, and northern arrowwood. Tussock sedge and skunk cabbage are two common herbaceous species of these swamps.

Mixed Forest Swamp (ms)

Mixed forest swamps have a canopy composed of 25-75% conifers. Mixed forest swamps with areas of dense conifer canopies may have deeply shaded areas with a cooler 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. Conifer species that can tolerate wetland conditions in our region include eastern red cedar, eastern hemlock, and tamarack.

Swamps are important to a wide variety of birds, mammals, amphibians, reptiles, and invertebrates, especially when swamp habitats 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 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 and abundant moss-covered downed wood or woody hummocks. Red-shouldered hawk,* barred owl,* great blue heron,* wood duck,* prothonotary warbler,* Canada warbler,* and white-eyed vireo* nest in hardwood swamps.

Occurrence in the Town of Pine Plains

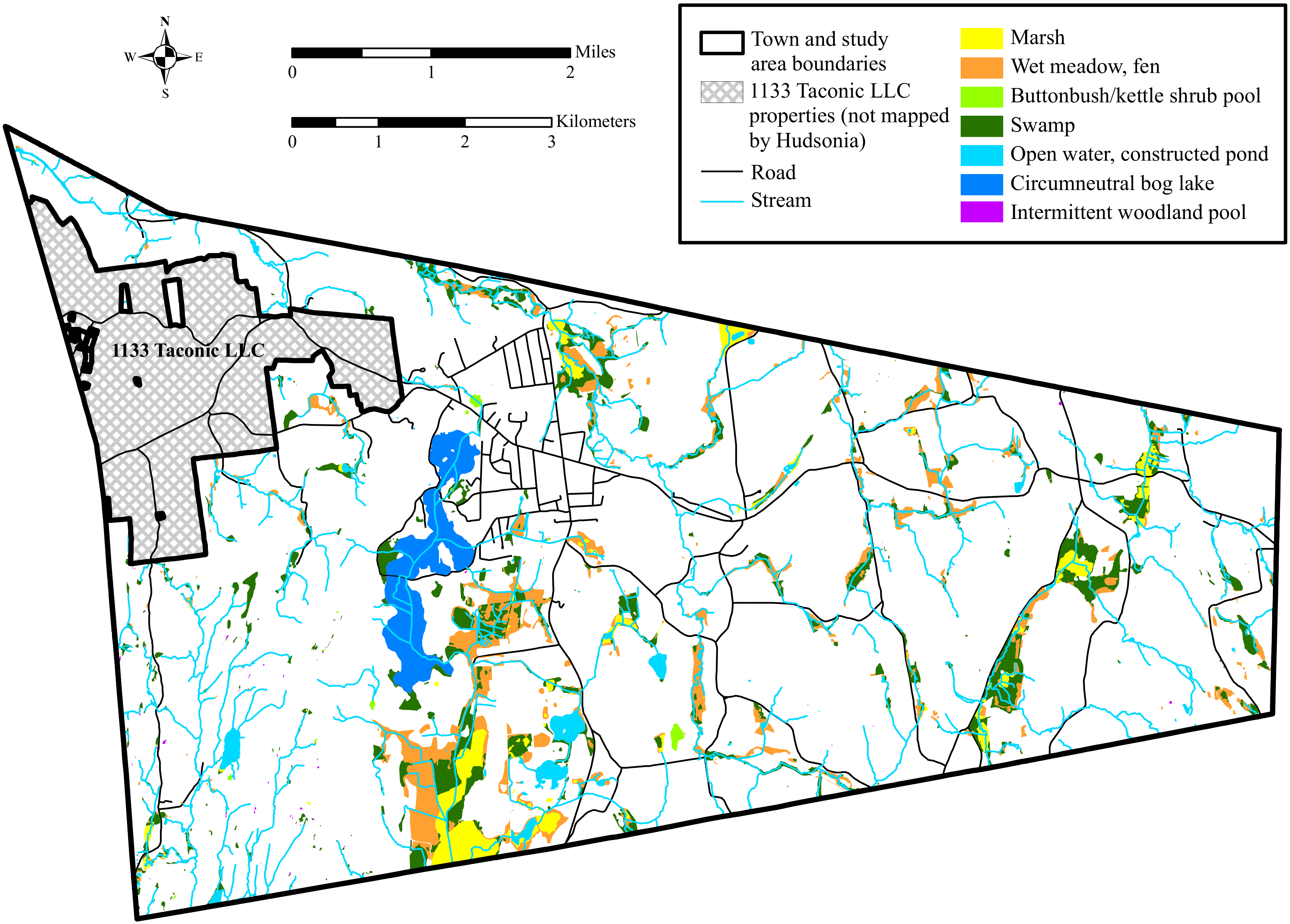
Hardwood and shrub swamp was the most extensive wetland habitat type in the study area (Figure 7), totaling nearly 770 ac (310 ha). The many swamps found in Pine Plains ranged from less than 0.1 to 50 ac (<0.04 to 20 ha), with an average size of 1.5 ac (0.6 ha). They were often contiguous with other wetland habitats such as marsh, wet meadow, and open water (including beaver ponds). Large swamps were located along Bean River, Shekomeko Creek, and Wappinger Creek, and east of Skunks Misery Road. Smaller swamps were widely scattered throughout the study area. Mixed forest swamps were uncommon in the study area (and relatively small), and eastern red cedar was the conifer species most commonly mixed in with hardwoods.

Swamps occurred in a variety of settings, such as on seepy slopes, along streams, in depressions, and as part of large wetland complexes. Some were shrub-dominated (native or exotic), while others were dominated by red maple and green ash. The range of water depths was wide, with some swamps drying up completely in the summer months and others retaining relatively deep pools. Swamps that were isolated from streams and other wetlands may have ecological roles similar to those of intermittent woodland pools—e.g., providing a seasonal source of water with fewer aquatic predators, breeding habitat for amphibians, and refuge for turtles. Many of the small swamps on Stissing Mountain can be classified as "heath swamps," with highbush blueberry, swamp azalea, blackgum, and sphagnum mosses dominant in their flora. Although we did not designate them as a separate habitat type, some swamps in the study area were calcareous and supported plant species of calcareous wetlands.

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 wetland protection, but can have extremely high biodiversity, 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 volume 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 in 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 loss of the habitat value of the pre-existing swamp usually far outweighs any habitat value gained in the new, artificial pond environment. See the Conservation Priorities section for recommendations on preserving the habitat values of isolated pools and swamps within larger wetland complexes.

Figure 7. Wetland habitats in the study area in the Town of Pine Plains, Dutchess County, New York. Hudsonia Ltd., 2009.



BUTTONBUSH POOL/KETTLE SHRUB POOL

Ecological Attributes

A buttonbush pool is a type of swamp that is seasonally or permanently flooded, and has a shrub-dominated flora with buttonbush normally the dominant plant (although 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. In other cases the shrub stands may occupy the outer portions of the pool while the center has open water. 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 of the characteristics described above 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, mucky substrates. Hudsonia has found two state-listed rare plants (spiny coontail* and 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 nearby towns. 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 buttonbush pools also have many of the habitat attributes of intermittent woodland pools, and are used by many intermittent woodland pool species (see below).

Occurrence in the Town of Pine Plains

We documented six buttonbush pools, all smaller than 1 ac (0.4 ha), and four kettle shrub pools ranging from 0.4 to 8 ac (0.2 to 3 ha) in the study area (Figure 8). All of the buttonbush pools and kettle shrub pools were found in the western section of the study area.

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 or alteration of surface water entering or leaving the pool could change the pool's hydroperiod and drastically alter its character. These pools are also sensitive to changes in water chemistry, particularly those resulting from runoff from roads, agricultural fields, lawns, or construction sites. Development and habitat fragmentation in the surrounding landscape threaten the habitat connections between buttonbush pools and other wetland and upland habitats that are essential to 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 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 operations, which may extend into the pools and/or alter water chemistry or hydroperiod. More information about this habitat is found in Kiviat (1993), Kiviat and Stevens (2001; under "Kettle Shrub Pool" and "Blanding's Turtle"), Kiviat and Stevens (2003), and Hartwig et al. (2009). See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of buttonbush pools and kettle shrub pools.

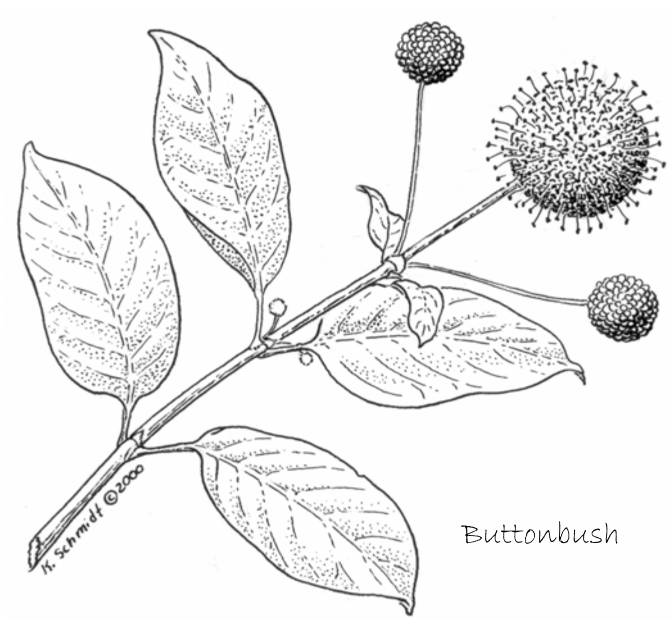
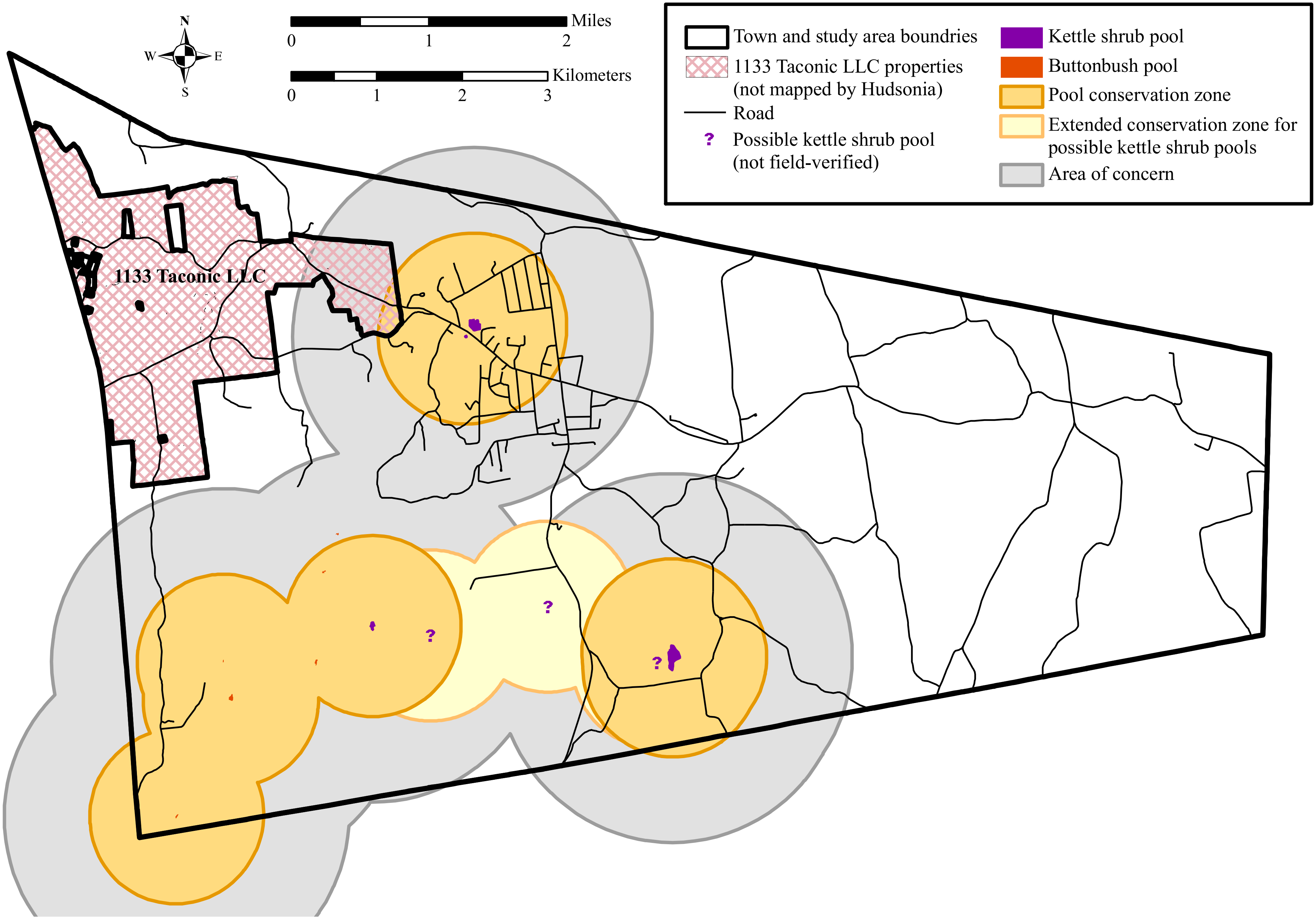


Figure 8. Buttonbush pools, kettle shrub pools, possible (not field-verified) kettle shrub pools, their conservation zones, and areas of concern in the study area in the Town of Pine Plains, Dutchess County, New York. Conservation zones and areas of concern extend 3,300 ft (1,000 m) and 6,600 ft (2000 m), respectively, from pool edges. Conservation zones are not shown for buttonbush pools at high elevations, where Blanding's turtles are unlikely to occur. Hudsonia Ltd., 2009.



MARSH (ma)

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. Cattail, tussock sedge, common reed, arrow arum, broad-leaved arrowhead, water-plantain, and purple loosestrife are some typical emergent marsh plants in this region.

Several rare plant species are known from marshes in the region, including spiny coontail* and buttonbush dodder.* 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 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,* pied-billed grebe,* American black duck,* and wood duck* use marshes for nesting or as nursery habitat. Many raptor, wading birds, and mammal species use marshes for foraging.

Occurrence in the Town of Pine Plains

We mapped 103 marsh areas in the study area, covering a total of 290 ac (120 ha). Marshes were frequently contiguous with or embedded in hardwood and shrub swamps or wet meadows. Because it was sometimes difficult to distinguish marsh from shrub swamp or wet meadow on aerial photographs, all mapped marsh boundaries should be considered approximate. Many of the marshes we observed in the field were dominated by cattail, and a few 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 areas is likely to change from year to year. The largest marsh area, covering approximately 115 ac (46 ha), was mapped in the Wappinger Creek Valley, and continues south of the town boundary into the Town of Stanford. Additional large marsh areas were found west of Route 82 at the northern town boundary, and in the Bean River, Shekomeko Creek, and Punch Brook valleys. Most of the mapped marshes within the study area were small (less than 4 ac [1.6 ha]).

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, toxins, 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 marshes habitats of our region in recent decades, and are found in several marshes in the study area. 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 ecological functions of surrounding habitats. See the Conservation Priorities section for recommendations on preserving the habitat values of marshes within larger wetland complexes.

Marsh

WET MEADOW (wm)

Ecological Attributes

A wet meadow is a wetland dominated by herbaceous (non-woody) vegetation and lacking standing water for most of the year. Its 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. Bluejoint, mannagrasses, woolgrass, soft rush, blue flag, sensitive fern, and marsh fern are some typical 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 a number of 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 Pine Plains

Wet meadows were widely distributed primarily in the valleys in the study area, and commonly occurred along the margins of swamps and marshes and in low-lying areas within upland meadows. We mapped 372 wet meadows, for a total of 612 ac (248 ha) in the study area. Most wet meadows were smaller than 2 ac (0.8 ha). The largest wet meadows in the study area (as large as 90 ac [36 ac]) were in the Wappinger Creek Valley south of Thompson Pond.

Sensitivities/Impacts

Some wet meadows are able to withstand light grazing by livestock, but heavy grazing can destroy the structure of the surface soils, eliminate sensitive plant species, and invite non-native weeds. Frequent mowing causes similar negative consequences. It is less damaging to the plant community to mow when soils are dry, e.g., in late summer (for general recommendations about mowing practices see the discussion on large meadows in the Conservation Priorities section). 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 section for recommendations on preserving the habitat values of wet meadows within larger wetland complexes.

CALCAREOUS WET MEADOW (cwm)

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 calcicolous 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 and may include some fen plant species, but can be supported by water sources other than groundwater seepage (see below). 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.* Eastern ribbonsnake* 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 Pine Plains

We documented 49 calcareous wet meadows in the study area **(**Figure 9**),** totaling nearly 40 ac (16 ha). Most of the calcareous wet meadows were smaller than 1 ac (0.4 ha). The largest (9 ac [4 ha]) was located along the Bean River. Calcareous wet meadows cannot be distinguished from other wet meadows by remote sensing because indicator plants must be identified in the field. Therefore it is likely that some of the mapped “wet meadows” we did not visit were actually calcareous wet meadows. Most of the calcareous wet meadows in the study area were contiguous with swamps, upland meadows, or fens.

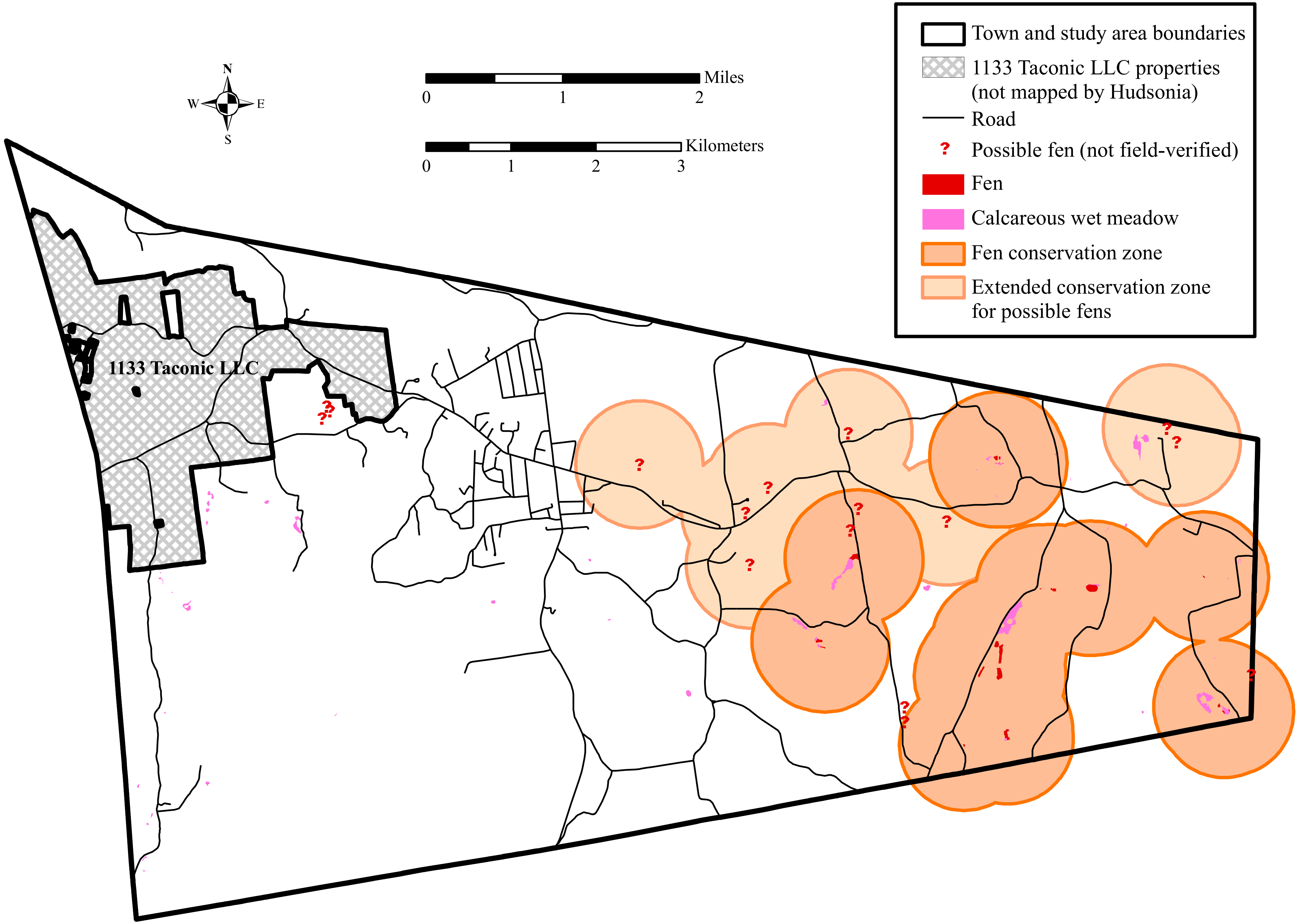
Sensitivities/Impacts

Calcareous wet meadows have sensitivities to disturbance similar to those of 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 review of development proposals. Where calcareous wet meadows occur adjacent to fens used by bog turtles,* the turtles use both habitats. Therefore, calcareous wet meadows near suitable fens deserve the same level of protection as fens for potential bog turtle* habitat. See the Conservation Priorities section for recommendations on preserving the habitat values of fens and calcareous wet meadows.

Photo: Nava Tabak

Sweetflag flower spike

Figure 9. Fens, possible (not field-verified) fens, fen conservation zones, and calcareous wet meadows in the study area in the Town of Pine Plains, Dutchess County, New York. Fen conservation zones extend 2,500 ft (750 m) from the fen edge. Conservation zones are shown for "possible fens" only in areas of mapped calcareous bedrock. Hudsonia Ltd., 2009.



FEN (f)

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 and 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, soils, and 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 ribbonsnake.* The rare sedge wren* nests almost exclusively in shallow, sedge-dominated wetlands such as fens. Large open fens, especially those associated with extensive meadow complexes, can also be important hunting grounds and potential nesting areas for northern harrier.*

Occurrence in the Town of Pine Plains

We mapped 21 fens in the eastern portion of the study area (Figure 9). Most were smaller than 1 ac (0.4 ha); the largest was slightly larger than 2 ac (0.8 ha). The quality of fens varied greatly—some were exemplary while others were overgrown with tall forbs and shrubs. They were generally located in valleys within or along the margins of larger swamps, marshes, wet meadows, or calcareous wet meadows. Because fens are difficult to identify by remote sensing we expect there are additional fens that we did not map. Unmapped fens could occur in low-elevation areas with calcareous bedrock or soils, including edges or interiors of calcareous wet meadows, swamps, marshes, or wet meadows habitats, or upper edges of stream floodplains and 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 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. Fens appear to be somewhat resilient if their chemical and hydrologic conditions are maintained, which may make restoration of these habitats possible in some cases. See the Conservation Priorities section for recommendations on preserving the habitat values of fens and calcareous wet meadows.

INTERMITTENT WOODLAND POOL (iwp)

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 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 or may not be surrounded by forest. 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 amphibians during the non-breeding season.

Intermittent woodland pools provide critical breeding and nursery habitat for wood frog,* Jefferson salamander,* marbled salamander,* and spotted salamander.* Reptiles such as spotted turtle* 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. 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* occurs in intermittent woodland pools in the lower Hudson Valley. Large and small mammals use these pools for foraging and as a water sources.

Occurrence in the Town of Pine Plains

We mapped 64 intermittent woodland pools in the study area (Figure 10), and they were particularly abundant on and around Stissing Mountain. All the mapped intermittent woodland pools in the study area were 0.3 ac (0.1 ha) or smaller, with an average size of less than 0.1 ac (0.04 ha). Because these pools are small and often difficult to identify on aerial photographs, we expect there are additional intermittent woodland pools that we did not map.

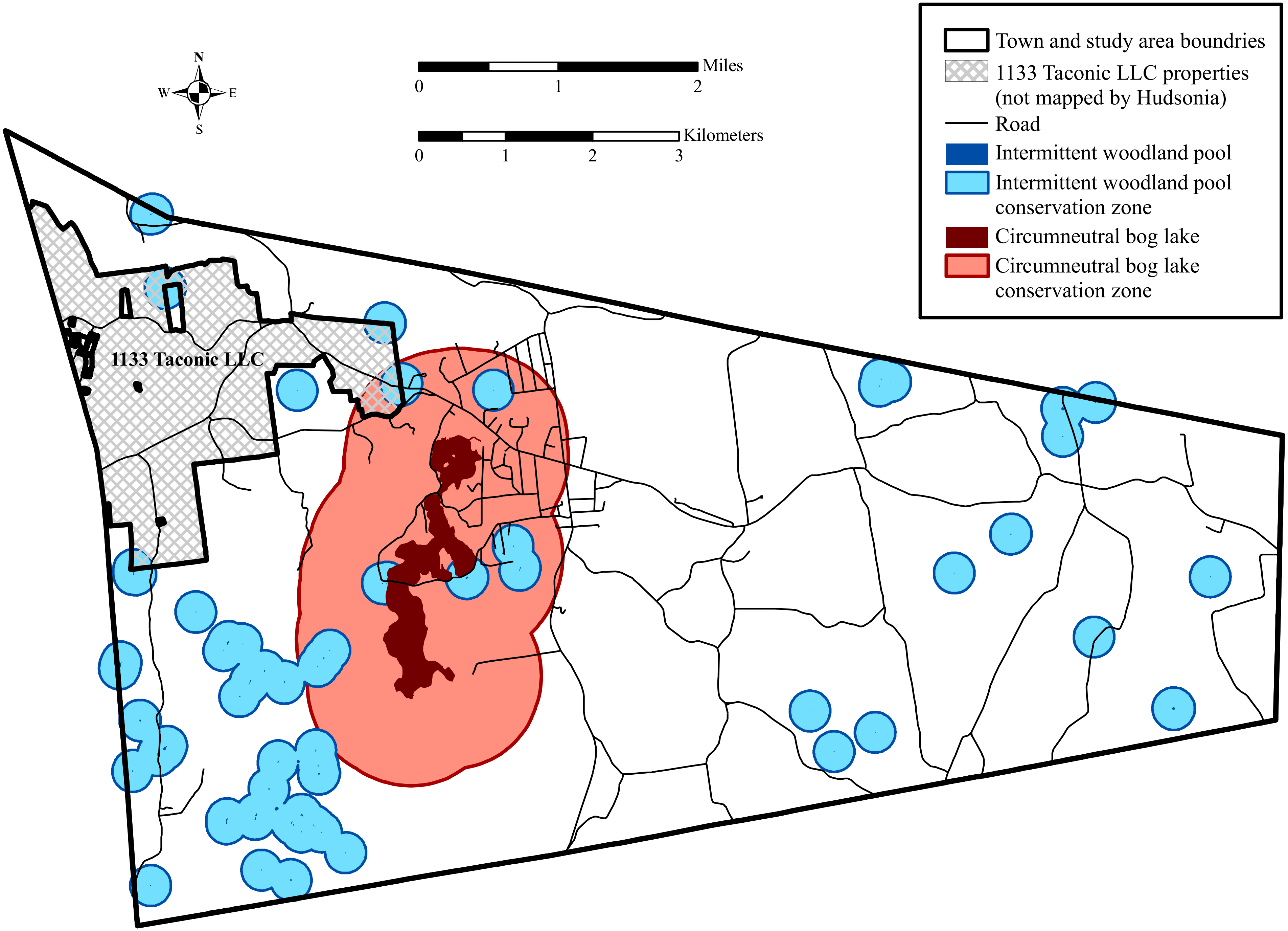
Sensitivities/Impacts

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. 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 other wetland habitats. 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. See the Conservation Priorities section for recommendations on preserving the habitat values of intermittent woodland pools.


Photo: Nava Tabak

Intermittent woodland pool in fall

Figure 10. Intermittent woodland pools, circumneutral bog lakes, and their associated conservation zones in the study area in the Town of Pine Plains, Dutchess County, New York. Intermittent woodland pool conservation zones extend 750 ft (230 m) from the pool edge; circumneutral bog lake conservation zones extend 3,300 ft (1000 m) from the wetland edge. Hudsonia Ltd., 2009.



CIRCUMNEUTRAL BOG LAKE (cbl)

Ecological Attributes

A circumneutral bog lake is a spring-fed, calcareous water body that commonly supports vegetation of both acidic bogs and calcareous marshes. The bottom has a deep organic layer, and floating vegetation mats and drifting peat rafts are often present. The floating mats and rafts are partially insulated from the calcareous lake water, and thus may develop herbaceous and shrubby vegetation characteristic of acidic bogs, or dense stands of cattail or purple loosestrife. Open water areas often support abundant pond-lilies and submerged aquatic vegetation; peat rafts and shoreline areas may support cattails, purple loosestrife, water-willow, alder, or leatherleaf. The lake may have swamps, calcareous wet meadows, or fens at its margin.

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, spikerushes, and submerged aquatic plants occur in circumneutral bog lakes in Dutchess County. Rare fauna associated with circumneutral bog lakes include eastern ribbonsnake,* northern cricket frog,* spotted turtle,* Blanding's turtle, blue-spotted salamander,* marsh wren,* and river otter.* These habitats have also been found to support diverse communities of mollusks, dragonflies, and damselflies.

Occurrence in the Town of Pine Plains

Mud Pond, Stissing Lake, and Thompson Pond are circumneutral bog lakes (Figure 10). Thompson Pond has long been recognized and studied as a circumneutral bog lake (Busch 1976), supporting well developed peat mats and typical flora and fauna including occurrences of prairie sedge,* twig rush,* pipewort,* bronze copper* (butterfly), Baltimore* (butterfly), spotted turtle,* blue-spotted salamander,* American black duck,* bald eagle,* greater yellowlegs,* and a number of other songbirds, shorebirds and waterfowl (Kiviat 1976). The typical vegetation structure of circumneutral bog lakes is less evident at Stissing Lake and Mud Pond, perhaps due to shoreline development and vegetation management activities. However, the hydrological characteristics of these two lakes appear similar to those of Thompson Pond.

In Mud Pond we observed young peat rafts with olivaceous spikerush* and cone-spur bladderwort,* several calcicolous plant species such as spiny coontail* and bulb-bearing water-hemlock, and an abundant cover of pond-lilies and watershield across much of the pond.

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 garbage, pollutants, and 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. See the Conservation Priorities section for recommendations on preserving the habitat values of circumneutral bog lakes.


Photo: Nava Tabak

Thompson Pond, a Circumneutral bog lake

CONSTRUCTED POND (cp)

Ecological Attributes

Constructed ponds include those 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 deliberately 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. We also include the water bodies created during mining operations in the constructed pond category. 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). Conversely, naturally formed bodies of water that are now intensively managed by humans may be classified as constructed ponds to better represent their habitat values.

Occurrence in the Town of Pine Plains

The majority of the water bodies we mapped in the study area were constructed ponds. These ponds were most commonly agricultural or ornamental ponds, the latter usually located within landscaped areas in close proximity to residences. We mapped 111 constructed ponds in total and all but four were smaller than 2 ac (0.8 ha). Miller Pond (east of Hicks Hill Road), the largest water body mapped as a constructed pond (20 ac [8 ha]), may also be categorized as an open water area (see below). Because of the potential value of constructed ponds as drought refuge and forage areas for turtles 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 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 toxins, or contain introduced fish such as grass carp and various game and forage fishes. Since constructed ponds serve as potential 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 new artificial environments.

OPEN WATER (ow)

Ecological Attributes

"Open water" habitats include naturally formed ponds and lakes, pools lacking floating or emergent vegetation within marshes and swamps, and 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 additional aquatic invertebrates and fish. Spiny coontail* is known from many calcareous ponds in Dutchess County. 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* may use circumneutral ponds. American bittern,* osprey,* bald eagle,* wood duck,* American black duck,* pied-billed grebe,* and great blue heron* may use open water areas as foraging habitat. Bats and river otter* also forage at open water habitats.

Occurrence in the Town of Pine Plains

Open water

Of the 43 open water habitat units we mapped in the study area, most were smaller than 1 ac (0.4 ha). The three large, well-known lakes in the town (Mud Pond, Stissing Lake, and Thompson Pond) were classified as circumneutral bog lakes (see above). One of the two large ponds west of Route 82 and south of Briarcliff Road is Halcyon Lake (Buttermilk Lake), which is one of only two marl lakes in Dutchess County (suspended limestone gives the lake water a milky appearance). Other large open water areas include a pond between Route 82 and Route 83 north of Bethel Cross Road, a pond straddling the town's southern border in the Stissing Mountain Multiple Use Area, and areas within the large marshes in the town. Some of the open water areas we mapped were created by beaver activity. Areas of open water within beaver wetlands are dynamic habitats that expand or contract depending on the degree of beaver activity, and these areas are often transitional to emergent marshes or wet meadows.

Sensitivities/Impacts

The habitat values of natural open water areas can be greater than those of constructed ponds if the areas are less intensively managed, less disturbed by human activities, and surrounded by undeveloped land. However, open water habitats are vulnerable to human impacts such as shoreline development, aquatic weed control, 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). Because open water areas are often located within larger wetland and stream complexes, any disturbance to the open water habitat may have far-reaching impacts 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 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. See the Conservation Priorities section for recommendations on preserving the habitat values of open water within wetland complexes.

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, we mapped only springs and seeps that discharged conspicuously into upland locations. Springs and seeps originating from deep groundwater sources flow more or less continuously, while those from shallower sources flow intermittently. 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 emerging. 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 some rare and declining fish species. They also serve as water sources for animals during droughts and cold winters, when other water sources freeze over.

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

Occurrence in the Town of Pine Plains

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 signature on one of our map sources. We expect there are many more springs and seeps in the study area that we did not map. More detailed surveys of these habitats should be conducted as needed on a site-by-site basis. We did not map springs and seeps within fens, but all mapped fens were substantially fed by groundwater seepage. The majority of mapped springs and seeps were found in upland hardwood forests in the western part of the town, often in association with a stream or small wetland.

Sensitivities/Impacts

Springs are easily disrupted by disturbance to upgradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltrating waters. Many springs are modified for water supply, with constructed or excavated basins sometimes covered with spring houses. In many areas, groundwater has been polluted or drawn-down by pumping for human or livestock water supply, affecting the quality or quantity of water issuing from seeps and springs.

STREAMS & 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. We did not map actual riparian corridors but have illustrated them in this report as zones of a set width on either side of streams. These zones represent a minimum area surrounding the stream that is needed for effective protection of stream water quality and wildlife (see streams & riparian corridors in the Priority Habitats section, and Figure 11). These do not necessarily cover the whole riparian corridor for any stream, however, which varies in width depending on local topography, soil characteristics and land uses in the watershed, and the size of the stream's catchment area.

Riparian areas 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. They can support a variety of wetland and non-wetland forests, meadows, and shrublands. Typical floodplain forests include a mixture of upland species and floodplain specialists such as sycamore and eastern cottonwood.

Rare plants of riparian areas in the region include cattail sedge,* Davis' sedge,* goldenseal,* and false-mermaid.* 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 is 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 flow only during the wettest times of the year or after rains. 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 can be important local water sources for wildlife, and 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 monkey-flower* 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 Pine Plains

Perennial streams and their riparian corridors occupy the major valleys in the study area. The largest streams in Pine Plains are the Roeliff Jansen Kill, Shekomeko Creek, Wappinger Creek, and Bean River. Portions of Ham Brook, Punch Brook, and a handful of unnamed streams are also perennial. Bean River, Shekomeko Creek, Ham Brook, and Punch Brook are all tributaries of the Roeliff Jansen Kill, which ultimately flows into the Hudson River. A small perennial stream east of Hicks Hill Road that flows south to join the Wappinger Creek is known to support slimy sculpin* and wild-spawning native brook trout* (Kiviat 1990). Intermittent streams were numerous, flowing for a combined length of 90 miles (145 km) in the study area (Figure 11).

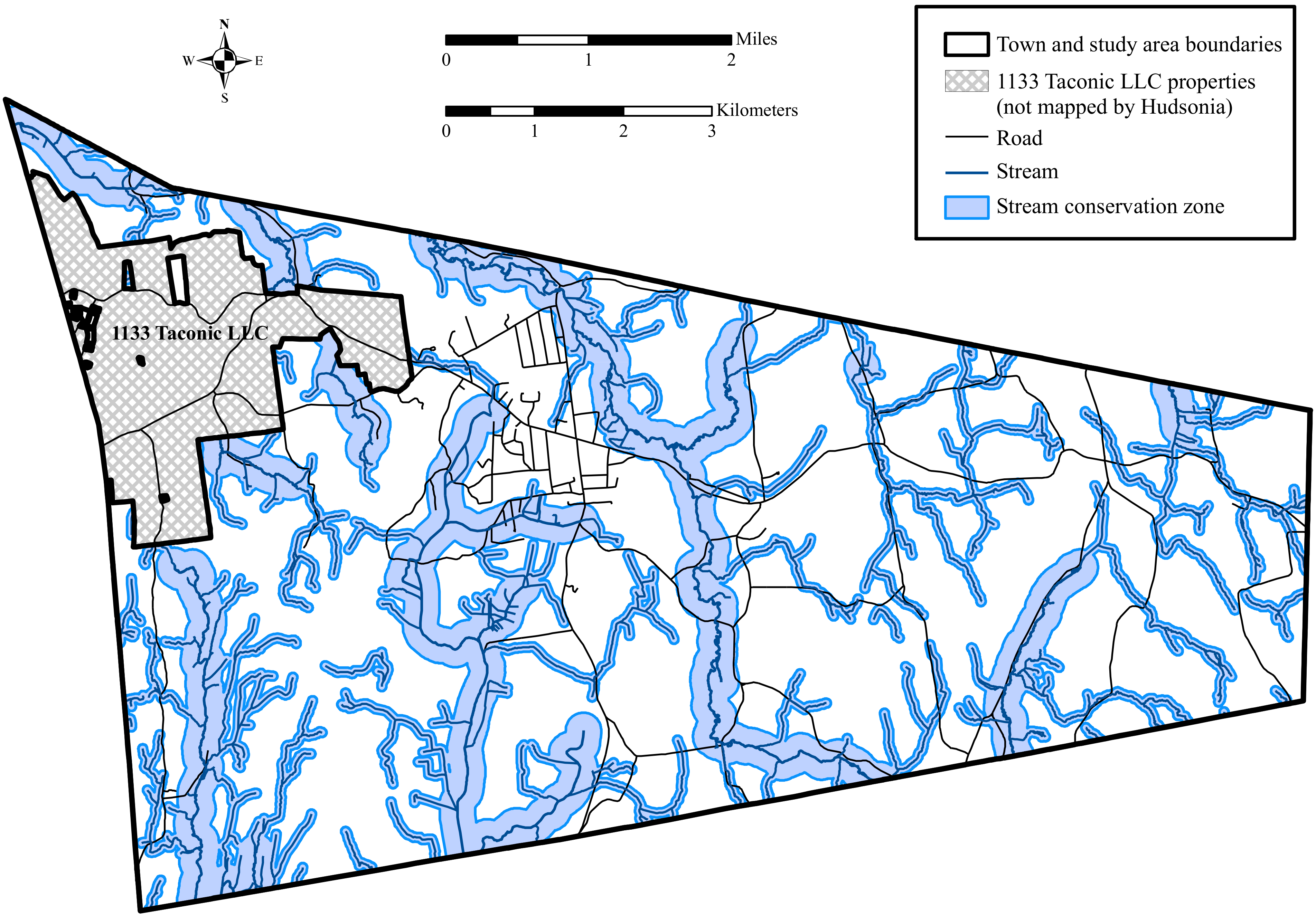
Sensitivities/Impacts

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 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 is the entire land area that drains into a given waterbody). 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, and 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. See the Conservation Priorities section for recommendations on preserving the habitat values of streams and riparian corridors.

Roeliff Jansen Kill

Figure 11. Streams and their associated conservation zones in the study area in the Town of Pine Plains, Dutchess County, New York. Conservation zones extend at least 160 ft (50 m) from stream edges, and 660 ft (200 m) from edges of large, perennial streams. Hudsonia Ltd., 2009.



CONSERVATION PRIORITIES AND PLANNING IN PINE PLAINS

PLANNING FOR BIODIVERSITY

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 making decisions on a site-by-site basis 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 Pine Plains habitat map facilitates this approach by illustrating the location and configuration of significant habitats in a large part of 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) using the map to identify priorities for townwide conservation and land use planning; 2) using the map as a resource for reviewing site-specific land use proposals; and 3) developing general strategies for achieving conservation goals.

Using the Habitat Map for Town-wide Conservation Planning

The Pine Plains 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 on a global scale (Davies et al. 2001). While some species and habitats may be adequately protected at a relatively small scale, 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, railroads, 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. The study area in Pine Plains contains many large habitat patches (see Figure 3) and careful siting of new development can protect these patches and maintain corridors between them.

The habitat map can also be used to locate priority habitats for conservation, including those that are rare or support rare species, or that are particularly important to regional biodiversity. For instance, fens and associated wetlands in the study area may support some of the few remaining populations of bog turtle* in the region. Circumneutral bog lakes are regionally rare and are known to support rare plants and animals that occur exclusively in this habitat. Figures 4-11 illustrate some of 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 3).

Finally, we have delineated Conservation Areas (Figure 12) that may serve as suitable units for townwide or local conservation planning. The map and report are practical tools that will facilitate selecting areas for protection and identifying sites for new development where the ecological impacts will be minimized. The map can also be used with the completed habitat maps of adjacent towns—North East and Stanford—for conservation planning across town boundaries.

Using the Habitat Map to Review Site-Specific Land Use Proposals

In addition to town-wide land use and conservation planning, the habitat map and report can be used for reviewing site-specific development proposals, providing ecological information about both the proposed development site and the surrounding areas that might be affected. We recommend that reviewers considering a new land use proposal at a particular site take the following steps to evaluate the impact of the proposed land use 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.
3. Consult figures 3-11 to see if any of the "Priority Habitats" or their conservation zones occurs 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, 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, fens, circumneutral bog lakes, or other wetlands fed by groundwater.
    - Channeling storm water runoff from paved areas or fertilized turf through oil-water separators and into detention basins or "rain gardens" instead of directly into 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.

General Strategies for Achieving Conservation Goals

We hope that the Town of Pine Plains 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 tremendous 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, 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 adapted to the local zoning ordinance. The *Local Open Space Planning Guide* (NYS DEC and NYS Department of State 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 NYS

DEC, *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).

- Protect large, contiguous, undeveloped tracts wherever possible.
- Plan landscapes with interconnected networks of undeveloped habitats (preserve links and create new 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 drawdowns, 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 perimeter 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 potential wherever possible.
- 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 the area of impervious surfaces (roads, parking lots, sidewalks, driveways, roof surfaces) and maximize onsite runoff retention and infiltration to help protect groundwater, and surface water quality, volumes, and patterns of flow and fluctuation.
- 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.

Priority Habitats in Pine Plains

Although a certain amount of land in the study area has been developed for residential, transportation, and other uses (about 9%), large areas of high-quality habitat still remain. These large areas are not only important locally, but also contribute greatly to regional biodiversity. For example, Stissing Mountain and the Mud Pond-Stissing Lake-Thompson Pond valley are part of an area extending south into Stanford that is recognized by the NYS DEC as a Significant Biodiversity Area of Southeastern New York (Penhollow et al. 2006).

By employing a proactive approach to land use and conservation planning, the Town of Pine Plains has the opportunity to protect the integrity of its remaining biological resources for the long term. With limited financial resources 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 habitats, 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 study area (for this project we have not identified or evaluated the habitats on the 1133 Taconic LLC properties for their conservation significance). 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, however, is a subset of these 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. We chose several species or groups of species that have large home ranges, specialized habitat needs, or acute sensitivity to disturbance (see Table 3). Many are rare or declining in the region or statewide. Each of these species or groups requires a particular habitat type for a crucial stage in its life cycle (e.g., hibernation, breeding), and those “core habitats” typically form the hub of the animal’s habitat complex. The various habitats required during other life cycle stages 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 conserve the species. We call this the "conservation zone" and discuss the size of this zone in the "Recommendations" subsection for each priority habitat. We used findings in scientific literature to estimate the priority conservation zone for the species or species group of concern (Table 3). 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.

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

Priority Habitat	Associated Species or Group of Concern	Priority Conservation Zone	Rationale	References
Large forest	Forest interior-breeding birds	Unfragmented patches of greater than 200 ac (80 ha).	Required for high probability of supporting breeding forest thrushes in a <50% forested landscape.	Rosenberg et al. 1999, Rosenberg et al. 2003
Large meadow	Grassland-breeding birds	Unfragmented patches of 25-500+ ac (10-200+ ha).	Required for successful breeding and maintenance of viable populations.	Vickery et al. 1994
Oak-heath barren	Plants, reptiles, and invertebrates of conservation concern	100 ft (30m) and unfragmented connections to other crest habitats	Protection from disturbance from human activities, and competition from invasive species.	Fitch 1960, Klemens 1993, Edinger et al. 2002
Buttonbush pool/kettle shrub pool	Blanding's turtle	3300 ft (1000 m)	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
Fen (and calcareous wet meadow)	Bog turtle	2500 ft (750 m) from fen.	Represents the reported overland distance traveled between wetlands within a habitat complex; encompasses the recommended "Bog turtle Conservation Zone" aimed at protecting habitat integrity.	Eckler and Breisch 1990, Klemens 2001
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
Circumneutral bog lake	Northern cricket frog	3300 ft (1000 m) from shore.	Represents the reported overland distance traveled between wetlands.	Gray 1983
Wetland complex	Spotted turtle	Minimum upland buffer of 395 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	650 ft (200 m) from stream.	Encompasses most of the critical habitat including winter 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

LARGE FORESTS

Target Areas

In general, forested areas 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 linear 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 4. By far the most extensive continuous forest, approximately 2,900 ac (1,170 ha), was on Stissing Mountain and Little Stissing Mountain. This area is particularly valuable for conservation because it is contiguous with large forested areas beyond the southern boundary of the town. These forests and the adjacent large wetland complex are part of the Stissing Mountain Critical Environmental Area in Pine Plains. One large forest area of approximately 590 ac (240 ha), was located on Schultz Hill (between Schultz Hill Road and Bean River Road). Seven other large forest areas of more than 200 ac (80 ha) each were located between Skunks Misery Road and Tripp Road (two areas), in the northeast corner of the town (north of Route 199 and east of Bean River Road), north of Route 83 (south of Johnny Cake Hollow Road), in the northwest corner of the town (areas east and west of Mount Ross Road), and west of Hicks Hill Road.

Extensive areas of crest, ledge, and talus occurred in most of the forests on mountains or hills, with smaller areas of exposed calcareous bedrock generally interspersed within these. Figure 4 does not take into account the total size of forest patches that extend beyond the study area boundary, which is an important consideration in understanding the habitat value of these patches. For example, the largest contiguous forest patch in the study area is on and around Stissing Mountain (nearly 2,900 ac [1,170 ha]), but this forest extends into the Town of Stanford for more than 2,200 (890 ha) additional acres, and to a lesser extent northward onto 1133 Taconic LLC property. Also, the relatively small (approximately 100 ac [40 ha]) patch of forest shown between Carpenter Hill Road and Route 83 at the southern boundary of Pine Plains is, in fact, part of a contiguous forest patch larger than 1,000 ac (400 ha) extending into the towns of North East and Stanford. Hudsonia has published habitat maps for the adjacent towns of North East and Stanford, as well as the nearby towns of Washington and Amenia. This growing regional map will enable town officials and private landowners to plan strategically across town boundaries to conserve large forested areas.

Conservation Issues

Loss of forest area 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 survive and successfully reproduce in the long term. 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). In addition to reduced total area, fragmented forest has an increased proportion of edge habitat. Temperature, humidity, and light are altered near forest edges. The nesting success of many species of forest birds is reduced by forest fragmentation (Lampila et al. 2005). 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, only forest patches larger than 200 ac (80 ha) are considered highly suitable for wood thrush breeding populations in our region (Rosenberg et al. 2003). In landscapes with less than 50% overall forest cover (such as large parts of the study area), smaller forest patches are less suitable for scarlet tanager and hermit thrush breeding than larger ones (e.g., only forest patches larger than 200 ac are highly suitable for hermit thrush breeding in this landscape) (Rosenberg et al. 1999, Rosenberg et al. 2003). Forested rocky crests provide habitat for several rare reptiles such as the timber rattlesnake and the northern copperhead (see section on oak-heath barrens and other crest, ledge, and talus below).

Forest fragmentation can also hamper 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). Additionally, road mortality of migrating amphibians and reptiles can result in decreased population densities (Fahrig et al. 1995) or changes in sex ratios in nearby 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. We did not encounter any large scale adelgid infestations during our field work in Pine Plains, but did observe it in at least one locality in the study area. A large infestation could eliminate hemlock forests in Pine Plains within a few years, with devastating consequences to the biological communities of hemlock-associated habitats. It is important to protect healthy hemlock stands, both as refuge populations from adelgid infestation and to provide a seed source for regeneration. This protection may help buy time for the hemlock while the recently-released biological control (a species of lady beetle that feeds only on hemlock woolly adelgid) is becoming established. Other potential threats include species such as the Asian longhorned beetle (which threatens maple trees) and the emerald ash borer.

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), 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 Pine Plains be considered priority areas for conservation and that efforts be taken to fully protect these habitats wherever possible. If new development in 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 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**. Also leave in place any hemlocks infested with woolly adelgid; cutting these trees does not slow the infestation's spread, but does interfere with natural forest processes.

LARGE MEADOWS

Target Areas

Large and contiguous patches of meadow, particularly pasture, hayfields, and old fields, 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 land use changes.) The largest contiguous meadow complex in the study area (345 ac [140 ha]) was located in the Wappinger Creek valley (east of Stissing Mountain and south of Thompson Pond), and included large areas of both upland and wet meadow. Four additional large meadow complexes measured more than 200 ac (80 ha) each (Figure 6A), and one of these was in the same valley as the largest complex. The largest single meadow measured 105 ac (42 ha; Figure 6B). 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

While there can be significant habitat value in small patches of upland meadow (e.g., for invertebrates and small mammals), large patches are especially important for grassland-breeding birds. Grassland-breeding birds have declined dramatically in the Northeast in recent decades due to habitat loss, as meadows are lost and fragmented by regrowth of forest, conversion of grasslands to row crops, and residential and commercial development (Askins 1993, Brennan and Kuvlesky 2005). These birds require large, undivided meadows (25 to 500+ ac [10-200+ ha]) to reproduce successfully (Vickery et al. 1994). 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 6 illustrates how meadow patch sizes differ when hedgerows and fences are taken into account. Although the study area has over 1,300 areas of wet and upland meadows in total, only 49 of these are larger than 25 ac (10 ha), the minimum preferred area for nesting savannah sparrow, and just 12 are large enough to support nesting vesper sparrow (50+ ac [20+ ha]). The largest single upland meadow is 105 ac (40 ha) which is below the typical size requirement for grasshopper sparrow and upland sandpiper, for example, which prefer meadows of at least 250 and 500 ac (100 and 200 ha), respectively (Vickery et al. 1994). Because grassland birds have very specific habitat requirements for breeding, their survival in the northeastern U.S. may ultimately depend on active farmland and open space management (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 usually small and have much lower biodiversity. Development around meadows can promote increased predation on grassland-breeding bird nests by human-subsidized predators such as raccoons and domestic cats. Grasslands and the rare species they support are also highly susceptible 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/Birds_and_Birding/grassland) has the following management suggestions for maximizing the success of grassland birds in meadows in the northeastern U.S.:

1. **Mowing after August 1** helps to ensure fledging of nestling birds; if mowing must occur before then, leave some unmowed strips or patches. Mowing in fall is even less disruptive (some birds continue breeding into August or September).
2. **Mowing each field only once every 1-3 years**, or doing rotational mowing so that each part of a field is mowed once every 3 years, can maintain habitat for nesting birds and butterflies.
3. **On an active farm, leaving some fields out of production each year** provides wildlife habitat. Alternatively, hayfields mowed early in the season can be rotated annually with those that are mowed late in the season.
4. **Removing fences or hedgerows between smaller fields** enlarges the habitat area for grassland breeding birds.
5. **Raising mower blades six inches or more, using flushing bars, and avoiding night mowing** when birds are roosting all help reduce bird mortality.
6. **Light grazing**, if livestock are rotated among fields throughout the season, can be beneficial.
7. **If planned and executed carefully, burning grasslands every two to six years** can improve habitat quality.

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.

The Town of Pine Plains has an opportunity to conserve large expanses of upland meadow habitat. Beyond the ecological values, there are many other compelling reasons to conserve active and potential farmland. From a cultural and economic standpoint, maintaining our 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.

OAK-HEATH BARREN, and other CREST/LEDGE/TALUS

Target Areas

We mapped two small patches of oak-heath barren on Stissing Mountain, the only area in the town where this habitat was found. Nearby and other high elevation areas on Stissing and Little Stissing mountains can be characterized as "crest oak woodlands," which are dry, rocky, relatively open-canopy forests. Extensive areas of other crest, ledge, and talus occur on Stissing Mountain and Little Stissing Mountain, and on many hills throughout the study area. Calcareous talus was found in upland hardwood forest habitat along the eastern slopes of Stissing Mountain and in other scattered locations (e.g., crest, ledge, and talus west of Route 82 near the northern border of town) (Figure 5).

Conservation Issues

Oak-heath barrens are uncommon in the Hudson Valley and may provide core habitat for several rare reptile species that use unshaded rocky outcrops at crucial stages in their life cycles. Timber rattlesnakes* den in ledge and talus areas in somewhat open deciduous forests, such as oak-heath barrens and crest oak woodlands. Their populations have been declining in the northeastern U.S. due to loss or disturbance of habitat, collection of the snakes for live trade, and malicious killing (Brown 1993, Klemens 1993). Northern copperhead* may use these open rocky habitats at key times of the year for spring basking and breeding, and use other ledgy habitats for winter hibernacula. Several invertebrates of conservation concern rely on the plant species found in oak-heath barrens. For example, little bluestem, a plant often found in oak-heath barrens, is a host plant for dusted skipper* caterpillars. Many wildlife species need to move among barrens, crests, forests, and other habitats to forage, bask, and breed; thus both the oak-heath barrens and the surrounding habitat matrix are important to the long-term viability of such species.

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

Because of their landscape position (at lower elevations) and bedrock composition, calcareous crest, ledge, and talus areas have generally been subjected to more regular disturbances and development pressures than the high ridges. Both forested and exposed calcareous rocky areas provide habitat for rare plants and animals, but in disturbed places they often support dense populations of non-native plants.

Recommendations

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

1. **Protect oak-heath barren habitats.** All oak-heath barrens and their closely associated crest, ledge, and talus habitats should be protected from disturbances including, but not limited to, the construction of communication towers; mining; house, road, and driveway construction; and high intensity human recreation.
2. **Protect critical adjoining habitats within 100 ft (30 m) of the barrens** (and larger areas wherever possible)**.** Basking reptiles and other organisms that are sensitive to disturbances associated with human activities use these barrens. The paucity of similar habitat types on the landscape limits the ability of some organisms to evade human activity. Further, some non-native invasive plants can outcompete native flora, impairing the habitat quality for rare invertebrates that may rely on the native plants. Disturbances in or near an oak-heath barren can force out sensitive species, and provide an avenue for the establishment of invasive plants. For these reasons we recommend that habitats within at least 100 ft (30 m) of an oak-heath barren be considered critical components of

the barren habitat. New development of any kind, including roads and high-use hiking trails, should be avoided within this 30-m zone. If development cannot be avoided, it should be concentrated in a manner that maximizes the amount and contiguity of undisturbed habitat. Special measures may also need to be taken to restrict the potential movement of rare snakes into the newly developed areas, thereby minimizing the likelihood of human-snake encounters (which are often fatal for the snake) and road mortality. Protecting large areas of contiguous habitat surrounding oak-heath barrens will not only protect potential foraging habitats and travel corridors, but may also help support the ecological and natural disturbance processes (e.g., fire) that help sustain the oak-heath barren habitats.

3. **Maintain corridors between oak-heath barrens and other crest habitats.** Intervening areas between habitats provide travel corridors for species that migrate among different habitats for breeding, dispersal, and foraging.

BUTTONBUSH POOLS/KETTLE SHRUB POOLS

Target Areas

We identified six buttonbush pools and four kettle shrub pools, all in the western part of the study area. The buttonbush pools were located on and west of Stissing Mountain. The kettle shrub pools were in the outwash valley of Wappinger Creek, east of Stissing Mountain (Figure 8).

Conservation Issues

Kettle shrub pools are the typical core wetlands used by the Blanding's turtle* (NYS Threatened) in Dutchess County. We believe that buttonbush pools also provide core habitat for Blanding's turtles because they are similar in structure and vegetation to kettle shrub pools. Populations of this turtle have not yet been documented in the Town of Pine Plains, but are known to occur in nearby areas of the towns of Milan and Stanford. Due to their long distance dispersal potential (see below), we consider kettle shrub pools and buttonbush pools in the valleys of western Pine Plains to have considerable potential for supporting populations of this species (Figure 8). The Blanding's turtle* typically spends winter, spring, early summer, and fall in its core wetland, which is used for overwintering, thermoregulation, and foraging (Kiviat 1997). During the active season, Blanding's turtles also use other nearby wetlands, including emergent marshes, swamps, intermittent woodland pools, and circumneutral bog 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, 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 (e.g., 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.

Blanding's turtles travel overland on a day-to-day and seasonal basis to reach important foraging areas, nesting sites, overwintering areas, and refuge habitats within the surrounding landscape. These regular movements 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 feet (2,000 m) and more have been documented on numerous occasions (Joyal et al. 2000, 2001; Fowle 2001). 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 buttonbush pool (Figure 8) (Hartwig et al. 2009). The 1000-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 through October). The 2000-m "Area of Concern" includes the landscape in 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 the pools in the southwestern corner of Pine Plains are contiguous with the conservation zones of pools mapped in the adjacent Town of Stanford.

Development activity within this habitat complex can have significant adverse effects on the turtles and their habitats, including the direct loss of wetland habitat (especially small, unregulated wetlands); degraded water quality from pesticides, fertilizers, and toxic substances;

altered wetland hydroperiod and water depth from groundwater extraction or stormwater diversion; habitat fragmentation from roads and developed land uses; and increased nest predation by human-subsidized predators. Road mortality of nesting females and 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):

Within the 2000-m Area of Concern:

1. **Protect wetland habitats** from filling, dumping, drainage, incursion of wheeled or tracked equipment, siltation, polluted runoff, groundwater contamination, and alterations to surface or groundwater hydrology.
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 1000 m (3300 ft) Conservation Zones.
4. **Minimize the extent of new roads** through undeveloped land.
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** on lawns, gardens, and agricultural fields, and prevent movement of soil and nutrients into wetlands.
7. **Educate landowners** about the Blanding's turtle and its conservation.

Additional recommendations for the 1000-m Conservation Zone include:

1. **Protect nesting areas**. Blanding's turtles traditionally nest in upland meadow or open shrublands, habitats that also tend to be prime targets for development. We recommend that large areas of potential nesting habitat within the Conservation Zone (e.g., upland meadows, upland shrublands, and waste grounds with exposed gravelly soils) be permanently protected from development and other disturbance. These areas, however, may need to be managed as part of an approved management plan to maintain suitable nesting conditions.
2. **Consider the impacts on water quality, hydrology, and habitat disturbance** to turtle habitat complexes when reviewing all applications for Freshwater Wetlands permits,

Stormwater Management permits, Mined Lands permits, site plant approvals, and siting of water supply wells, septic systems, and sewage treatment systems.

3. **Identify high-priority areas for special protection**, e.g., for acquisition of conservation land by public or private entities, or for establishment of conservation easements on privately-owned land. Keep in mind that the turtles need broad corridors in the Area of Concern to move between Conservation Zones. Potential pitfall hazards such as window wells, storm drains, catch basins, swimming pools, and silt fencing should be designed or modified to prevent the entrapment of turtles.
4. **Identify potential barriers to turtle movement either on land or in the water**, 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 turtle passage. Spaces must be no less than 4 in (10 cm) high and no more than 82 ft (25 m) apart to allow turtles to move freely across the landscape.
5. **Educate construction crews and eventual residents should be educated on how to look for and safely move turtles** from under cars, construction equipment, or mowing machines before operating or driving.
6. Under certain circumstances (to be determined on a case-by-case basis by the New York State Department of Environmental Conservation or a Blanding's turtle specialist), **erect temporary exclusion fencing around a construction site to keep Blanding's turtles out of the work area.**

Finally, within 660 ft (200 m) of buttonbush pools and kettle shrub pools, we recommend that no buildings, pavement, roads, or other structures be constructed. Blanding's turtle activity (basking, aestivation, short-distance travel) is most concentrated within 660 ft (200 m) of their core wetland. A 200-m buffer of natural vegetation and soil will minimize direct impacts to the turtles, help maintain wetland hydrology and water temperature, and filter runoff containing silt and other pollutants.

FENS AND CALCAREOUS WET MEADOWS

Target Areas

We mapped 21 fens and 49 calcareous wet meadows in the study area (Figure 9). These habitats can only be confidently distinguished from other wet meadow habitats in the field, however, and we suspect that there are additional fens and calcareous wet meadows on properties that we did not visit. We have flagged some possible (not confirmed) fen locations with question marks on the map. Because calcareous bedrock underlies some of the large valleys in the study area, the town has a high number of these regionally uncommon habitats. In particular, the Wappinger Creek Valley, which is part of a Significant Biodiversity Area designated by the NYS DEC (Penhollow et al. 2006), is underlain by calcareous bedrock and is likely to have more calcareous wetlands than our map shows.

Conservation Issues

Fens and calcareous wet meadows are uncommon in the northeastern U.S. and many provide important habitat for plant and animal species of conservation concern (see Appendix C). One of the most imperiled species associated with fens in Dutchess County is the bog turtle,* listed as Endangered in New York and Threatened on the federal list. Fens are the core habitat of bog turtle in Dutchess County, and the entire wetland matrix in which some fens occur is considered part of the bog turtle's habitat. Few of the remaining fens in this region currently support bog turtle populations, apparently due to degradation of the fens and the surrounding landscapes (and perhaps due to illegal collecting). Bog turtle has been rediscovered recently in Orange County, but is believed to be extinct (or nearly so) in Westchester and Rockland counties. Any of the high-quality fens in the study area could serve as bog turtle habitat. We recommend, therefore, that all fens and calcareous wet meadows be considered potential bog turtle habitat and that the special protective measures discussed below be implemented to safeguard the integrity of these sensitive areas.

Fens are maintained by calcareous groundwater seepage. Alterations to the quality or quantity of groundwater or surface water feeding the fen can alter the soil characteristics, vegetation structure, or plant community composition, and can render the habitat unsuitable for bog turtle and other species of conservation concern. Thus, even if the fen itself is not disturbed directly, it can be severely affected by activities in surrounding areas. Furthermore, although bog turtles spend most of their lives in fens and associated wetlands, they also require safe travel corridors between fens for dispersal and other long-term movements. In New York, bog turtles may travel overland 2,500 ft (760 m), or nearly one-half mile, between individual wetlands within a habitat complex (Eckler and Breisch 1990). Maintaining connections to other wetland habitats within a one-half mile radius of a known or potential bog turtle habitat may be crucial to sustaining the long-term genetic viability of bog turtle populations and the ability of individuals to relocate as habitat quality changes.

Recommendations

The Town of Pine Plains has many fens, and, along with neighboring towns, is in a position to implement a conservation plan with far-reaching consequences for biodiversity in the region. Conservation of fens requires attention both to the fen itself and to surrounding land uses. Because some of the high quality fen complexes (and their associated conservation zones) in the study area cross multiple privately-owned parcels, fen conservation also requires coordinating across property boundaries. Fens that are known to harbor the bog turtle, or may serve as potential habitat for the turtle, require special protective measures. The U.S. Fish and Wildlife Service (Klemens 2001) recommends not only protecting the actual wetland complex, but also prohibiting disturbance and development within a 300 ft (90 m) distance from the wetland boundary. This buffer may be crucial to safeguarding wetland habitat quality, hydrology, and turtle travel corridors. Moreover, we believe that maintaining safe travel corridors between suitable fen habitats is important for population dispersal and to accommodate turtles displaced from degraded habitats. The U.S. Fish and Wildlife Service recommends the following (adapted from Klemens 2001):

1. **Protect the wetland habitat**. The entire wetland, not just those portions that have been identified as, or appear to be, optimal for nesting, basking, or hibernating, should be protected from direct destruction and degradation. The following activities (not an inclusive list) should be avoided within the wetland:
    - development of any kind;
    - wetland draining, ditching, tiling, filling, excavation, stream diversion, or construction of impoundments;
    - herbicide, pesticide, or fertilizer application (except as part of approved bog turtle management plan);
    - mowing or cutting of vegetation (except as part of approved bog turtle management plan);
    - delineation of lot lines for development, even if the proposed building or structure will not be in the wetland.
2. **Establish a 300 ft (90 m) buffer zone**. A protective "buffer" around known or potential bog turtle wetlands will help prevent or minimize the effects of human activities. Activities in this zone could indirectly destroy or degrade the fen habitat over the short or long term and should be thoroughly evaluated in consultation with the US Fish and Wildlife Service

and the NYS DEC. Activities in this zone that may adversely impact bog turtles and their habitats include but are not limited to:

- construction of roads, residences, driveways, parking lots, sewer lines, utility lines, stormwater or sedimentation basins, or other structures;
- mining;
- herbicide, pesticide, or fertilizer application;
- farming (with the exception of light to moderate grazing);
- stream bank stabilization (e.g., rip-rapping).

3. **Assess potential impacts within at least 2500 ft (750 m) of the fen**. Despite the distance, development activities occurring within the drainage basin of the fen or at least one-half mile (800 m) from the boundary of the buffer zone may adversely affect bog turtles and their habitat. Development within this area may also sever important travel corridors between wetlands occupied or likely to be occupied by bog turtles, thereby isolating populations and increasing the likelihood of road mortality as turtles attempt to disperse.
    - Activities such as the construction of roads and other impervious surfaces, groundwater extraction (e.g., wells), septic/sewer facilities, and mining have a high potential to alter the hydrology and chemistry of the fen habitat.
    - Construction of new roads and bridges should be avoided within this area.
    - Existing roads with medium to high volume traffic may be ideal candidates for "turtle underpasses" that may provide safer travel corridors for this species.

Blue vervain

INTERMITTENT WOODLAND POOLS

Target Areas

We identified and mapped 64 intermittent woodland pools in the study area (Figure 10), and there are likely to be others that we missed. Each intermittent pool is important to preserve, but groups or networks of pools, as found on Stissing Mountain for instance, are particularly valuable from a habitat perspective. Groups of pools can support amphibian and reptile metapopulations–groups of small populations that are able to exchange individuals and recolonize sites where species have recently disappeared.

Conservation Issues

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, deep 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). 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-breeding species at different times. Also, different pools provide better or worse habitat each year, due to variations in precipitation and air temperatures. To preserve the full assemblage of species, a variety of pools must be present for animals to choose from (Zedler 2003). 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 complex they require, we recommend the following protective measures (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 advise 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. **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 emerged 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 system. This organic debris constitutes the base of the pool food web and provides attachment sites for amphibian egg masses.
3. **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.
4. **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 changes pool water quantity (see below).

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:
   - Roads and driveways with projected traffic volumes in excess of 5-10 vehicles per hour should not be sited within 750 ft (230 m) of the pool.
   - Regardless of traffic volumes, the total length of roads and driveways within 750 ft of a woodland pool should be limited to the greatest extent possible. This can be achieved, among other ways, by clustering development to reduce the amount of needed roadway.
   - Gently sloping curbs or no-curb alternatives should be used to reduce barriers to amphibian movement.

- Oversized square box culverts (2 ft wide by 3 ft high [0.6 m x 0.9 m]) should be used near wetlands and known amphibian migration routes to facilitate amphibian movements under roads. These culverts should be spaced at 20 ft (6 m) intervals. Special "curbing" should also be used 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 drainage basin 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 storm water 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, herbicides, and fertilizers within the woodland pool's drainage basin. If mosquito control is necessary it should be limited to the application of bacterial larvicides, which appear at this time to have lesser negative impacts on non-target pool biota than other methods. De-icing salts such as sodium chloride cannot be removed by means of treatment methods currently in use; thus it may be appropriate to avoid use of certain de-icing compounds where they will pollute surface runoff into amphibian breeding pools.
    - 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 pool depth, volume, and hydroperiod.
    - 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 short hydroperiod.

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**. If construction activity during this time period cannot be avoided, temporary exclusion fencing should be installed around the entire site to keep amphibians out of the active construction areas.

CIRCUMNEUTRAL BOG LAKES

Target Areas

We identified three circumneutral bog lakes in the study area: Mud Pond (Twin Island Lake), Stissing Lake, and Thompson Pond (Figure 10). Much of the western and eastern shores of Mud Pond are in residential use, as are the east and a small part of the west shores of Stissing Lake. The three lakes are hydrologically connected, but separated by Lake Road between Thompson Pond and Stissing Lake and Beach Road between Stissing Lake and Mud Pond. The Nature Conservancy owns Thompson Pond and maintains a public trail around it, and the Town of Pine Plains provides public access to Stissing Lake on its eastern shore.

Conservation Issues

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) occurs in only three counties in New York, and is rapidly declining in the northern part of its range. 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 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 away from the lake as 1,475 feet (450 m) (New York Natural Heritage Program 2009, Jason Tesauro, pers. comm.).

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). While cricket frogs have not been documented in the circumneutral bog lakes in the Town of Pine Plains, some populations are found in the nearby Town of Clinton, and the frogs may be able to disperse to the Pine Plains wetlands.

Many other rare species are known from circumneutral bog lakes in the region. We observed olivaceous spikerush,* cone spur bladderwort,* and spiny coontail* at Mud Pond. Thompson Pond has an abundant and diverse flora and fauna, including twig rush,* prairie sedge,* pipewort* (Kiviat and Zeising 1976), eastern ribbon snake,* and river otter* (Kiviat 1976). One of the waterbodies on the 1133 Taconic LLC property (outside of the study area) has also been classified as a circumneutral bog lake, with species such as sora* and great egret observed there (Erik Kiviat, pers. comm). The clear water, diverse plant community, floating vegetation mats, and peat rafts of circumneutral bog lakes create unusual habitat for 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

1. **Maintain water quality**. Avoid the application of herbicides for controlling invasive aquatic plants. Consider mechanical harvesting of undesired species, such as Eurasian milfoil. 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**. Gasoline-powered watercraft pollute water and create noise disturbance, and motorized watercraft of all kinds (including electric outboard motors) can 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.

WETLAND COMPLEXES

Target Areas

A wetland complex is any group of adjacent and nearby swamps, marshes, wet meadows, 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. Examples of large, varied wetlands that form a complex can be found in the Bean River Valley (including hardwood and shrub swamp, marsh, wet meadow, calcareous wet meadow, fen, open water, and constructed pond habitats) and on the outwash plains in the Wappinger Creek Valley (including large areas of swamp, marsh, and wet meadow). The groups of small, often isolated wetlands (mostly swamps and intermittent woodland pools) on Stissing Mountain exemplify wetland complexes with intact intervening upland habitats (Figure 7).

Conservation Issues

Many animals move among several types of wetland and upland habitats throughout the year. For instance, spotted turtle* (a 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, shrub 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 areas between those habitats.

Recommendations

1. **Protect intermittent woodland pools, fens, and 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), especially in the summer.
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.

STREAMS AND RIPARIAN CORRIDORS

Target Areas

The Roeliff Jansen Kill, Shekomeko Creek, Wappinger Creek, and Bean River were the major perennial waterways in Pine Plains. The town's widespread network of smaller perennial and intermittent streams is also very important both to the organisms that depend on the streams and to the ecology of their entire watersheds (Figure 11).

Conservation Issues

Low gradient, perennial streams can be essential core habitat for the wood turtle,* a Species of Special Concern in New York State. 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 the surrounding 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 turtles requires protecting not only their core habitat (the perennial stream), but also their riparian wetland and upland foraging habitats, upland nesting areas, and the upland migration corridors between these habitats. The wood turtle habitat complex can encompass the wetland and upland habitats within 660 ft (200 m) or more of a core stream habitat (Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997). Development activity 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 small, 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 intermittent streams, the adjoining lands 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 help by filtering sediment, nutrients, and contaminants from runoff, stabilizing stream banks, contributing organic material, preventing channel erosion, regulating microclimate, and preserving other ecosystem processes (Saunders et al. 2002).

Recommendations

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

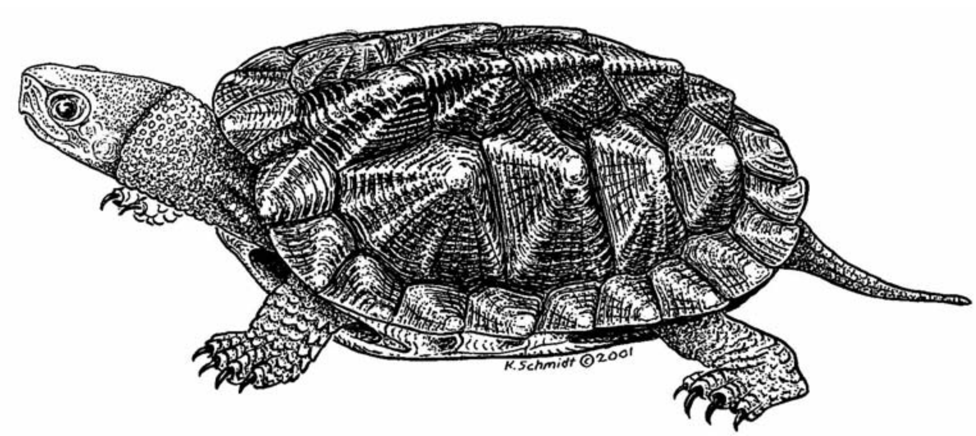
1. **Protect the integrity of stream habitats**.
    - prohibit engineering practices that alter the physical structure of the stream channel such as stream channelization, artificial stream bank stabilization (e.g., rock rip-rap, concrete), construction of dams or artificial weirs, vehicle crossing (e.g., construction or logging equipment, ATVs), and the clearing of natural stream bank vegetation. These activities can destroy key hibernation and basking habitats;
    - 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 tributary 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, agriculture 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 of construction equipment, siltation, polluted runoff, and hydrological alterations. In addition, large, contiguous blocks of upland habitats (e.g., forests, meadows, and shrublands) within 660 ft (200 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.

3. **Minimize impacts from new and existing stream crossings**. Stream crossings, particularly undersized bridges and narrow culverts, may be significant barriers to wood turtle movement along their core stream habitats. Wood turtles may shy away from entering such structures and 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, although not specifically designed for wood turtles, may be an important first step 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 promote the overland 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, measured in meters). 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 wood turtle passage.
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 660 ft (200 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 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 660 ft (200 m) stream conservation zone (e.g., upland meadows, upland shrublands, waste ground with exposed gravelly soils) be protected from development and other disturbance.



Wood turtle

CONSERVATION AREAS IN PINE PLAINS

The Town of Pine Plains has a great diversity of high quality of habitats distributed throughout the town. To synthesize the information presented in preceding chapters, and to facilitate discussion of conservation priorities, we have divided the town into eight "conservation areas," each with a unique combination of priority habitats (Figure 12). We hope that this presentation of geographic groupings of priority habitats will help to put specific locations in Pine Plains within a larger ecological context, to assist with townwide planning, and 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.

Roeliff Jansen Kill/Ham Brook Valley

This area includes the hills and valleys in the northwestern corner of the town, including some of the foothills of Stissing Mountain south of Route 199. We have included the part of the town that is outside of our study area (i.e., the properties owned by 1133 Taconic LLC) in this Conservation Area based on its geographic location and general character. Priority habitats within our study area included:

- The Roeliff Jansen Kill—one of the largest tributaries of the Hudson River. This stream provides spawning habitat for Hudson River fishes such as alewives, smallmouth bass, and brown trout, and is a fishery stream for brown trout. The six miles upstream of its confluence with the Hudson River are designated a Significant Coastal Fish and Wildlife Habitat (NYS Department of State 1987).
- Large contiguous forested patches east and west of Mount Ross Road, including rocky hemlock slopes and dry crests south of the Roeliff Jansen Kill
- Five intermittent woodland pools
- Large upland meadows
- A variety of wetlands including calcareous wet meadows

Stissing Mountain/Hicks Hill

This area includes the northern portion of Stissing Mountain, the eastern portion of Hicks Hill, the intervening valley, and Little Stissing Mountain and its foothills. Stissing Mountain and Little Stissing Mountain are biologically unique. Knopf found local variations in the bedrock of Stissing Mountain (1962), which likely contributes to the area being one of several places in New York State where rare plant occurrences are concentrated (McVaugh 1958, Mitchell and Sheviak 1981). The terrain is very steep and rocky, with many exposed ledges, rocky crests, and talus slopes. The isolated wetlands on Stissing Mountain tend to be very acidic because they are fed primarily by rainwater and not buffered by calcareous bedrock. Many of the steep slopes may never have been completely cleared by humans and support forest communities with very few invasive species. Stissing and Little Stissing Mountains are included in a Significant Biodiversity Area called the Stissing Mountain Wetlands complex, as designated by the New York State Department of Environmental Conservation (Penhollow et al. 2006). A large portion of the approximately 1,300 ac (530 ha) Stissing Mountain area in the town is owned by New York State (Stissing Mountain Multiple Use Area) and The Nature Conservancy, but approximately one half of the area is in private ownership. We recommend that the town strongly discourage further development within this area because of its exceptional importance for regional biological diversity.

Priority habitats in the Stissing Mountain/Hicks Hill Conservation Area are:

- The largest (approximately 2,900 ac/1,170 ha) contiguous forest patch in the study area, including extensive upland hardwood, mixed, and conifer forests. A variety of forest types were represented in this area, differing according to altitude and aspect, the depth and chemistry of the soils, and the disturbance history. In general, the forests in the valley and foothills and on Hicks Hill had a higher abundance of invasive species, probably due to more intensive or more recent disturbance from human activities (e.g., logging, grazing). The forests on the steeper slopes and crests, on the other hand, are relatively free of invasive species and are high quality examples of the different forest types. The large forest on Stissing and Little Stissing Mountains provides habitat for many vertebrates and plants. Back’s sedge,* northern goshawk,* Cooper’s hawk,* golden eagle,* bald eagle,* whip-poor-will,* common raven,* Blackburnian warbler,* worm-eating warbler,* scarlet tanager,* black and white warbler,* orchard oriole,* northern waterthrush,* and red-bellied snake are known to use this area. Red-shouldered hawk* and eastern box turtle* were observed at the nearby 1133 Taconic LLC property and are likely to use this neighboring area as well. Uncommon mammals such as black bear,* bobcat,* and fisher* inhabit the forest on Stissing Mountain. We observed a great blue heron* rookery near a waterbody in this forest.

- Two small patches of oak-heath barren. This is a rare habitat type in southeastern New York, occurring only in relatively high elevation areas with exposed bedrock or shallow soils, and droughty conditions. Stissing Mountain is the only place in the study area where this habitat occurs. Oak-heath barrens are of particular importance as core habitat for the timber rattlesnake* and northern copperhead* in the region and are likely to be used by other snakes of conservation concern for basking and breeding.
- Extensive ledge and talus formations. The ledge and talus areas on Stissing Mountain are the most extensive in Dutchess County and between New York City and Albany east of the Hudson River (Kiviat 1990). As with oak-heath barrens, many of the rocky areas on Stissing and Little Stissing mountains may provide suitable habitat for rare snakes and plants such as three-toothed cinquefoil.* The large talus slope on the east side of Stissing Mountain supports one of only two populations of the boreal redback vole* known in Dutchess County (Kiviat 1990). In addition, calcareous talus supports rare and uncommon plants such as Allegheny vine.*
- Many intermittent streams and one perennial stream in the valley between Stissing Mountain and Hicks Hill. The perennial stream has historically had excellent water quality and supported wild-spawning native brook trout* and slimy sculpin* (Kiviat 1990).
- Twenty-six intermittent woodland pools and other small, isolated swamps. These are potential breeding pools for Jefferson,* blue-spotted,*and marbled salamanders,* as well as for wood frog. Marbled salamanders associated with these wetlands south of the tower on Stissing Mountain represent the highest elevation population of this species in the northeastern corner of its geographic range. Complexes of small wetlands and their

intervening woodland habitats are important for spotted turtle,* one of which we observed in this area.

- Six buttonbush pools. The three pools found in the valley area are potential core habitat for Blanding's turtle.* The turtle may use the pools in conjunction with foraging and drought refuge wetlands, upland nesting areas, and intervening habitat.

Wappinger Creek Valley

This area includes the glacial outwash plain east of Stissing and Little Stissing mountains, extending east almost to Carpenter Hill Road to include a slightly hillier area that is also underlain by outwash. This Conservation Area is characterized by a mosaic of intergrading wetland types, upland meadows, and open water areas. The outwash is underlain primarily by calcareous bedrock (limestone, dolostone, and siltstone), creating the potential for fen and other calcareous habitats.

Historically, this valley has been a "hotspot" of botanical and avian diversity. About 200 bird species have been observed in this area over the last 35 years, including breeding species such as least bittern,* king rail,* common moorhen,* sora,* dark-eyed junco,* cerulean warbler,* golden-winged warbler,* and willow flycatcher,* and migrants such as short-billed dowitcher,* Tennessee warbler,* and American golden plover* (DeOrsey and Butler 2006, Kiviat 1976, Kiviat 1977). High plant diversity, including rarities, has also been documented by previous studies in this valley (McVaugh 1958, Kiviat and Zeising 1976).

Priority habitats in the Wappinger Creek Conservation Area include:

- Large, aggregated wetlands that are part of the Significant Biodiversity Area recognized by the NYS Department of Environmental Conservation because of the high quality habitat it provides for many wetland-dependent species, including at least six species of turtles (Penhollow et al. 2006). The wetlands in Wappinger Creek Valley cover nearly 1,100 ac (450 ha) within the Town of Pine Plains, which is close to half the wetland acreage found in the entire study area. The wetlands include over 300 ac (120 ha) of wet meadow, 245 ac (100 ha) of hardwood and shrub swamp, 150 ac (60 ha) of marsh, and many lakes, ponds, and other open water areas.

- Three circumneutral bog lakes (Mud Pond, Stissing Lake, and Thompson Pond), a regionally rare habitat type. These three lakes form a single lake-wetland complex occupying some 300 ac (120 ha) near the northern end of the plain. We observed rare or uncommon species such as olivaceous spikerush,* cone-spur bladderwort,* spiny coontail,* and solitary* and least sandpipers* in Mud Pond. A large variety of fish, phytoplankton, and zooplankton species have been recorded from Thompson Pond (Williams 1976), along with several rare plants including: pipewort,* twig-rush,* and prairie sedge* (Kiviat and Zeising 1976).
- Halcyon Lake (Buttermilk Lake), one of only two marl lakes in Dutchess County.
- Wappinger Creek, a medium-sized, perennial stream and the largest tributary to the Hudson River.
- Four kettle shrub pools, which can potentially support Blanding's turtle* populations. There may be additional kettle shrub pools and other kettle wetlands in this area.

Pine Plains Hamlet

The hamlet of Pine Plains is the most densely populated part of the town with a concentration of commercial and residential development. From a landscape perspective, the hamlet would be included in the Wappinger Creek Valley Conservation Area (and perhaps in part with the Shekomeko Creek Valley Area), but is treated separately here due to its developed character. The conservation zones of priority habitats such as circumneutral bog lakes, kettle shrub pools, an intermittent woodland pool, and streams extend into the hamlet area. We strongly recommend concentrating future development in Pine Plains within the hamlet area as much as possible, practicing "infill" development and the re-use of existing structures wherever feasible, and applying strict conservation measures to safeguard the integrity of the surrounding habitats.

Shekomeko Creek Valley

This area includes the Shekomeko Creek Valley and some of the surrounding hills (generally extending east from the valley, the hamlet of Pine Plains, and the southern portion of Route 82 to the foot of the larger hills associated with Schultz and Prospect Hills). Hoysradt reported rare plant occurrences on Mill Hill in the 1870s (McVaugh 1958), but these occurrences have not been verified in recent times. Bisecting the town from north to south through the center of town, this area includes the following noteworthy habitats:

- Shekomeko Creek—a large perennial stream with snags, large streambank willows and undercut banks that provide high quality habitat for brook trout,* brown trout, wood turtle,* muskrat, and mink (Petokas 1988).
- A large (nearly 1,000 ac [400 ha]) contiguous area of significant habitats that includes wetlands, forest patches, and upland meadows north of Route 199 and west of Route 82.
- Extensive wetland complexes associated with the Shekomeko Creek and its tributaries. We observed great egret and spotted sandpipers in streamside wetlands in this area.
- Extensive upland meadows
- Karst features (mini-caverns, disappearing streams) near Shekomeko Creek

Schultz & Prospect Hills

This Conservation Area includes Schultz Hill and Prospect Hill, and is bounded on the west by the Shekomeko Valley Conservation Area and on the east by the Bean River Valley Conservation Area. Schultz Hill has an elevation of over 1000 ft (305 m) and provides extensive scenic views of the town. Priority habitats within this area include:

- The second largest areas of contiguous habitat (1,100 ac [450 ha]) and contiguous forest (590 ac [239 ha]) in the study area
- Eight fens and numerous associated calcareous wet meadows
- Numerous intermittent streams and associated wetland complexes
- Eleven intermittent woodland pools
- Extensive upland meadows

Bean River Valley

This Conservation Area corresponds closely to lowlands in the east part of the town that are underlain by calcareous bedrock (dolostone, shale, and oolite), and includes the Bean River Valley between Tripp Road and Bean River Road, and the relatively low-lying lands along Punch Brook north and south of Route 199. This part of the town is particularly scenic, and includes the following priority habitats:

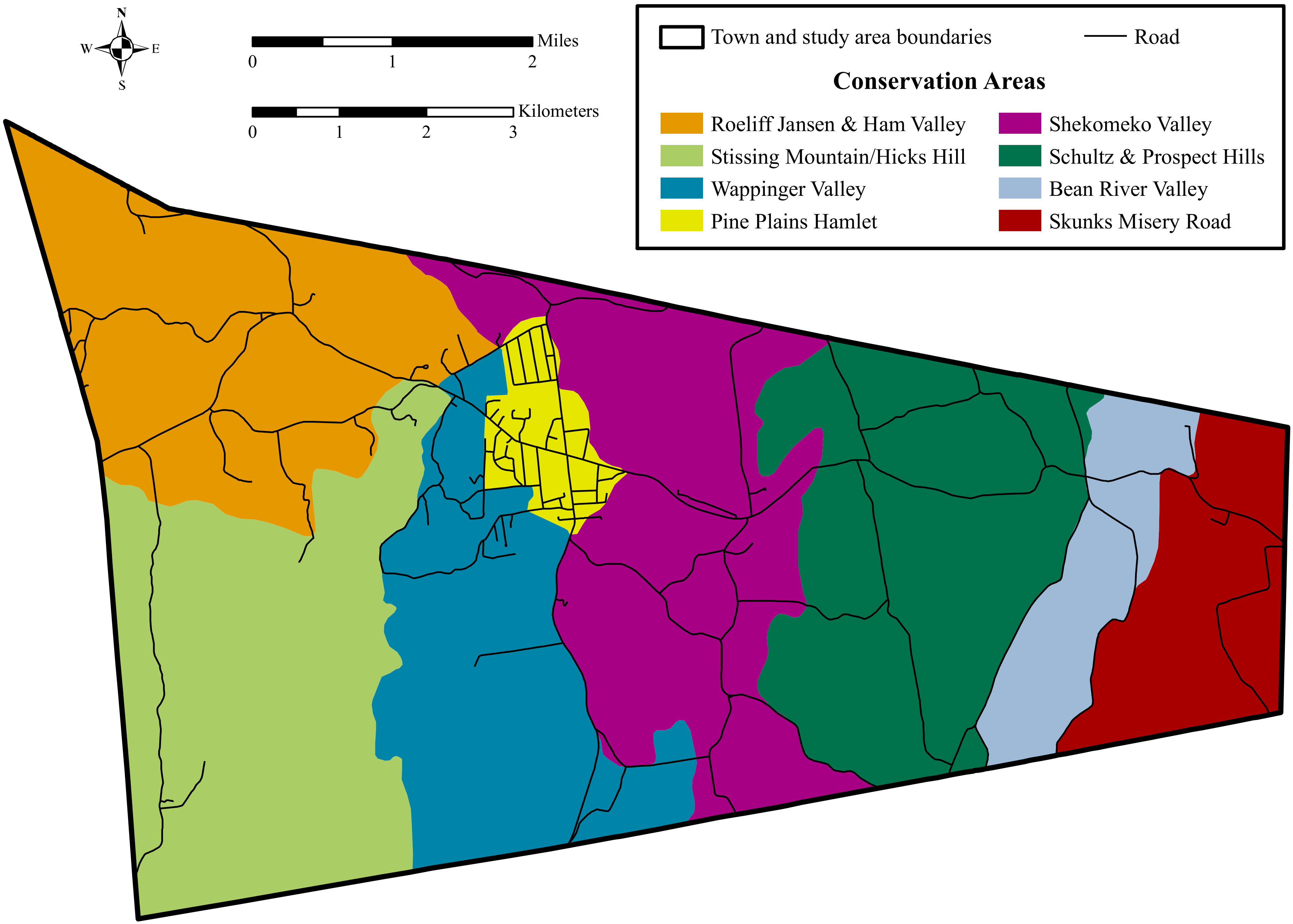
- Bean River, a medium-sized perennial tributary to the Shekomeko Creek
- Punch Brook, a small, perennial stream that flows north into the Roeliff Jansen Kill
- Extensive meadow areas
- Nine fens and large areas of calcareous wet meadow
- Multiple large, wetland complexes, including the largest contiguous swamp in the study area (48 ac [20 ha])

Skunks Misery Road

This easternmost part of the town includes the hills and valleys flanking Skunks Misery Road and Route 199. The southern portion of this area is exceptionally scenic. A variety of priority habitats are found in this part of the town, including:

- A nearly 1,000 ac (400 ha) patch of contiguous habitats between Tripp Road and Skunks Misery Road
- Extensive meadow areas
- Four fens and several calcareous wet meadows
- Two intermittent woodland pools

Figure 12. Conservation areas in the Town of Pine Plains, Dutchess County, New York. These divisions are based on the geophysical and biological attributes of the town, and are intended to aid townwide conservation planning. For a description of each area refer to the report. Hudsonia Ltd., 2009.



CONCLUSION

There are significant opportunities for biodiversity conservation in the rural landscape of the Town of Pine Plains. Development pressure is increasing, however, and 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 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 forest blocks, areas where fens or other 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 checked 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 additional 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 observed, and the site should be assessed for additional ecological values. 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 Pine Plains, Hudsonia hopes to have the opportunity 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 Pine Plains 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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REFERENCES CITED

Aerts, R. and F. Berendse. 1988. The effect of increased nutrient availability on vegetation dynamics in wet heathlands. Vegetatio 76:63-69.

Ambuel, G. and S.A. Temple. 1983. Songbird populations in southern Wisconsin forests: 1954 and 1979. Journal of Field Ornithology 53:149-158.

Askins, R.A. 1993. Population trends in grassland, shrubland, and forest birds in eastern North America. Current Ornithology 11:1-34.

Bailey, J.A. and M.M. Alexander. 1960. Use of closed conifer plantations by wildlife. New York Fish and Game Journal 7(2):130-148.

Beasley, V.R., S.A. Faeh, B. Wikoff, C. Staehle, J. Eisold, D. Nichols, R. Cole, A.M. Schotthoefer, M. Greenwell and L.E. Brown. 2005. Risk factors and declines in northern cricket frogs (*Acris crepitans*). P. 75-86 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Bednarz, J.C. and J.J. Dinsmore. 1982. Nest sites and habitat of red-shouldered and red-tailed hawks in Iowa. Wilson Bulletin 94(1):31-45.

Bell, K., C. Dickert, J. Tollefson, and G. Stevens. 2005. Significant habitats in the Town of Stanford, Dutchess County, New York. Report to the Millbrook Tribute Garden, the Dyson Foundation, the Town of Stanford, and the Dutchess Land Conservancy. Hudsonia Ltd., Annandale, NY. 123 p.

Billings, G. 1990. Birds of prey in Connecticut. Rainbow Press, Torrington, CT. 461 p.

Bormann, F.H., G.E. Likens, and J.S. Eaton. 1969. Biotic regulation of particulate and solution losses from a forest ecosystem. BioScience 19:600-610.

Bormann, F.H., G.E. Likens, T.G. Siccama, R.S. Pierce, and J.S. Eaton. 1974. The export of nutrients and recovery of stable conditions following deforestation at Hubbard Brook. Ecological Monographs 44(3):255-277.

Brennan, L.A. and W.P. Kuvlesky, Jr. 2005. North American grassland birds: An unfolding conservation crisis? Journal of Wildlife Management 69(1):1-13.

Brown, W.S. 1993. Biology, status, and management of the timber rattlesnake (*Crotalus horridus*): A guide for conservation. Society for the Study of Amphibians and Reptiles, Herpetological Circular No. 22.

Buech, R., L.G. Hanson, and M.D. Nelson. 1997. Identification of wood turtle nesting areas for protection and management. In J. Van Abbema, ed., Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference. New York Turtle and Tortoise Society and the WCS Turtle Recovery Program. New York.

Busch, P.S. ed. 1976. The ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy, Boston.

Cadwell, D.H, G.G. Connally, R.J. Dineen, P.J. Fleisher, M.L. Fuller, L. Sirkin, and G.C. Wiles. 1989. Surficial geologic map of New York (Lower Hudson sheet). Map and Chart Series 40, 1:250,000, 100 ft. contour. New York State Museum, Albany.

Calhoun, A.J.K. and M.W. Klemens. 2002. Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, NY. 57 p.

Carroll, T.E. and D.H. Ehrenfeld. 1978. Intermediate-range homing in the wood turtle, *Clemmys insculpta*. Copeia 978:117-126.

Crocoll, S.T. 1994. Red-shouldered hawk (*Buteo lineatus*). In A. Poole and F. Gill, eds. The Birds of North America, No. 107. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC.

Davies, K.F., C. Gascon, and C. Margules. 2001. Habitat fragmentation: Consequences, management, and future research priorities. P. 81-98 in M.E. Soule and G.H. Orians, eds., Conservation Biology: Research Priorities for the Next Decade. Island Press, Washington, DC.

DeOrsey, S. and B.A. Butler. 2006. The birds of Dutchess County, New York. Grinnell and Lawton Publishing, Millbrook, NY. 273 p.

Dickinson, R.A. 1993. Northern cricket frog (*Acris crepitans*) survey in Ulster County, New York, 1992. M.S. thesis, Bard College, Annandale, NY.

Drexler, J.Z. and B.L. Bedford. 2002. Pathways of nutrient loading and impacts on plant diversity in a New York peatland. Wetlands 22:263-281.

Eckler, J.T. and A.R. Breisch. 1990. Radio telemetry techniques applied to the bog turtle (*Clemmys muhlenbergii* Schoepff 1801). P. 70 in R.S. Mitchell, C. J. Sheviak, and D. J. Leopold, eds., Ecosystem Management: Rare Species and Significant Habitats. New York State Museum Bulletin No. 471. Albany.

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (eds). 2002. Ecological communities of New York State. Second Edition. A revised and expanded edition of Reschke (1990) (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany.

Environmental Laboratory. 1987. Corps of Engineers wetland delineation manual. Waterways Experiment Station, Corps of Engineers, Vicksburg, MS. 100 p. + appendices.

Environmental Law Institute. 2003. Conservation thresholds for land use planners. Environmental Law Institute, Washington, DC. 55 p.

Environmental Systems Research Institute, Inc. 2006. ArcView 9.2 GIS software. Redlands, CA.

Faber, M. 2002. Soil survey of Dutchess County, New York. Natural Resources Conservation Service, US Department of Agriculture. 356 p. + maps.

Fahrig, L., J.H. Pedlar, S.E. Pope, P.D. Taylor, and J.F. Wegner. 1995. Effect of road traffic on amphibian density. Biological Conservation 73: 177-182.

Findlay, C.S. and J. Bourdages. 2000. Response time of wetland biodiversity to road construction on adjacent lands. Conservation Biology 14(1):86-94.

Fisher, D.W., Y.W. Isachsen, and L.V. Rickard. 1970. Geologic map of New York (Lower Hudson Sheet). Map and Chart Series 15. 1:250,000, 100 ft. contour. New York State Museum and Science Service, Albany.

Fitch, H.S. 1960. Autecology of the copperhead. University of Kansas publication. Museum of Natural History 13:85-288.

Forman, R.T.T. and R.D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (U.S.A.) suburban highway. Conservation Biology 14(1):36-46.

Foscarini, D.A. and R.J. Brooks. 1997. A proposal to standardize data collection and implications for management of the wood turtle, *Clemmys insculpta*, and other freshwater turtles in Ontario, Canada. In J. Van Abbema, ed., Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference. New York Turtle and Tortoise Society and the WCS Turtle Recovery Program. New York.

Fowle, S.C. 2001. Priority sites and proposed reserve boundaries for protection of rare herpetofauna in Massachusetts. Report to the Massachusetts Department of Environmental Protection. Westborough, MA. 107 p.

Gibbons, J.W. 2003. Terrestrial habitat: A vital component for herpetofauna of isolated wetlands. Wetlands 23(3):630-635.

Godin, A.J. 1977. Wild mammals of New England. Johns Hopkins University Press, Baltimore. 304 p.

Gray, R.H. 1983. Seasonal, annual, and geographic variation in color morph frequencies of the cricket frog, *Acris crepitans*, in Illinois. Copeia 1983(2):300-311.

Gremaud, P. 1977. The ecology of the invertebrates of three Hudson Valley brooklets. Senior project, Bard College, Annandale, NY. 61 p.

Harding, J.H. and T.J. Bloomer. 1979. The wood turtle (*Clemmys insculpta*): A natural history. Bulletin of the New York Herpetological Society 15(1):9-26.

Hartwig, T., G. Stevens, J. Sullivan, and E. Kiviat. 2009. Blanding's turtle habitats in southern Dutchess County. Report to the Marilyn Milton Simpson Charitable Trusts and NYS DEC Hudson River Estuary Program. Hudsonia Ltd., Annandale, NY. 80 p.

Heady, L.T. and E. Kiviat. 2000. Grass carp and aquatic weeds: Treating the symptom instead of the cause. News from Hudsonia 15(1):1-3.

Hill, N.P. and J.M. Hagan. 1991. Population trends of some northeastern North American landbirds: A half-century of data. Wilson Bulletin 103(2):165-182.

Holthuijzen, A.M.A. and T.L. Sharik. 1984. Seed longevity and mechanisms of regeneration of eastern red cedar (*Juniperus virginiana* L.). Bulletin of the Torrey Botanical Club 111(2):153-158.

Hubbard, J.P. 1977. Importance of riparian ecosystems: Biotic considerations. In R.R. Johnson and D.A. Jones, eds., Importance, Preservation and Management of Riparian Habitat: A Symposium. USDA Forest Service General Technical Report RM-43.

Irwin, J.T. 2005. Overwintering in northern cricket frogs (*Acris crepitans*). P. 55-58 in M. Lannoo, ed., Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley.

Johnson, V.S., J.A. Litvaitis, T.D. Lee, and S.D. Frey. 2006. The role of spatial and temporal scale in colonization and spread of invasive shrubs in early successional habitats. Forest Ecology and Management 228(1-3): 124–134.

Joyal, L.A., M. McCollough, and M.L. Hunter, Jr. 2000. Population structure and reproductive ecology of Blanding's turtle (*Emydoidea blandingii*) in Maine, near the northeastern edge of its range. Chelonian Conservation and Biology 3:580-588.

Joyal, L.A., M. McCollough, and M.L. Hunter, Jr. 2001. Landscape ecology approaches to wetland species conservation: A case study of two turtle species in southern Maine. Conservation Biology 15:1755-1762.

Kaufmann, J.H. 1992. Habitat use by wood turtles in central Pennsylvania. Journal of Herpetology. 26(3):315-321.

Kiviat, E. 1976. Birds and mammals of the Thompson Pond Preserve, New York. In P.S. Busch ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy, Boston.

Kiviat, E. 1977. Buttercup Sanctuary report. National Audubon Society, Miles Sanctuary, CT. 45 p.

Kiviat, E. 1990. Stissing Mountain Area Critical Environmental Area recommendations: Report to the Town of Stanford Conservation Advisory Council. Hudsonia Ltd., Annandale, NY. 24 p.

Kiviat, E. 1993. Tale of two turtles: Conservation of the Blanding's turtle and bog turtle. News from Hudsonia 9(3):1-6.

Kiviat, E. 1997. Blanding's turtle habitat requirements and implications for conservation in Dutchess County, New York. P. 377-382 in J. van Abbema, ed., Proceedings: Conservation, restoration, and management of tortoises and turtles—an international conference. New York Turtle and Tortoise Society.

Kiviat, E. and G. Stevens. 2001. Biodiversity assessment manual for the Hudson River estuary corridor. New York State Department of Environmental Conservation, Albany. 508 p.

Kiviat, E. and G. Stevens. 2003. Environmental deterioration of the outwash plains: Necropsy of a landscape. News from Hudsonia 18(1): 1, 3.

Kiviat, E. and N. Zeising, 1976. The wetland flora of Thompson Pond, New York. In P.S. Busch ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy, Boston.

Klemens, M.W. 1993. Amphibians and reptiles of Connecticut and adjacent regions. State Geological and Natural History Survey of Connecticut, Bulletin 112, Hartford.

Klemens, M.W. 2001. Bog turtle conservation zones. Appendix A in Bog Turtle (*Clemmys muhlenbergii*) Northern Population Recovery Plan. U.S. Fish and Wildlife Service. Hadley, MA. 103 p.

Knab-Vispo, C., K. Bell, and G. Stevens. 2008. Significant habitats in the Town of North East, Dutchess County, New York. Report to the Town of North East, the Millbrook Tribute Garden, the Dyson Foundation and the Dutchess Land Conservancy. Hudsonia Ltd., Red Hook, NY. 150 p.

Knopf, E.F.B. 1962. Stratigraphy and structure of the Stissing Mountain area, Dutchess County, New York. Stanford University Publications in Geological Sciences 7(1), 55 p. + map and chart in pocket.

Lampila, P., M. Monkkonen, and A. Desrochers. 2005. Demographic responses by birds to forest fragmentation. Conservation Biology 19(5):1537-1546.

Lehtinen, R.M., S.M. Galatowitsch, and J.R. Tester. 1999. Consequences of habitat loss and fragmentation for wetland amphibian assemblages. Wetlands 19:1-12.

Likens, G.E., F.H. Bormann, N.M. Johnson, D.W. Fisher, and R.S. Pierce. 1970. Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem. Ecological Monographs 40(1):23-47.

Lowe, W.H. and G.E. Likens. 2005. Moving headwater streams to the head of the class. BioScience 55(3):196-197.

Lundgren, M.R., Small, C.J., and Dreyer, G.D., 2004. Influence of land use and site characteristics on invasive plant abundance in the Quinebaug Highlands of southern New England. Northeastern Naturalist 11:313–332.

Madison, D.M. 1997. The emigration of radio-implanted spotted salamanders, *Ambystoma maculatum*. Journal of Herpetology 31:542-552.

Marchand, M.N. and J.A. Litvaitis. 2004. Effects of habitat features and landscape composition on the population structure of a common aquatic turtle in a region undergoing rapid development. Conservation Biology 18(3):758-767.

McCormick, J.F. 1978. An initiative for preservation and management of wetland habitat. Office of Biological Services, U.S. Fish and Wildlife Service, Washington, DC. 25 p.

McVaugh, Rogers. 1958. Flora of the Columbia County area, New York. New York State Museum and Science Service Bulletin No. 360. University of the State of New York, Albany. 400 p.

Merritt, J.F. 1987. Guide to mammals of Pennsylvania. University of Pittsburgh Press, Pittsburgh. 408 p.

Metropolitan Conservation Alliance. 2002. Conservation overlay district: A model local law. Technical Paper Series, No. 3. Wildlife Conservation Society, Bronx, NY. 46 p.

Milam, J.C. and S.M. Melvin. 2001. Density, habitat use, movements, and conservation of spotted turtles (*Clemmys guttata*) in Massachusetts. Journal of Herpetology 35(3):418-427.

Mitchell, R.S. and G.C. Tucker. 1997. Revised checklist of New York State plants. Bulletin No. 490. New York State Museum, Albany. 400 p.

Mitchell, R.S. and C.J. Sheviak. 1981. Rare plants of New York State. Bulletin No. 445. New York State Museum, Albany. 96 p.

Murcia, C. 1995. Edge effects in fragmented forests: Implications for conservation. Trends in Ecology and Evolution 10:58-62.

New York Natural Heritage Program. 2009. Online Conservation Guide for *Acris crepitans*. Available from: http://www.acris.nynhp.org/guide.php?id=6706. Accessed July 30th, 2009.

NYS DEC and NYS Department of State. 2004. Local open space planning guide. NYS DEC, NYS Department of State, Hudson Valley Greenway, NYS Department of Agriculture and Markets, and NYS Office of Parks, Recreation, and Historic Preservation. Albany. 64 p.

NYS DEC. 2005. New York State comprehensive wildlife conservation strategy: A strategy for conserving New York's fish and wildlife resources. New York State Department of Environmental Conservation, Albany. 573 p.

NYS Department of State. 1987. Significant coastal fish and wildlife habitats of the Hudson River. New York State Department of State, Office of Coastal, Local Government, and Community Sustainability, Albany.

Panno, S.V., V.A. Nuzzo, K. Cartwright, B.R. Hensel, and I.G. Krapac. 1999. Impact of urban development on the chemical composition of ground water in a fen-wetland complex. Wetlands 19:236-245.

Parsons, T. and G. Lovett. 1993. Effects of land use on the chemistry of Hudson River tributaries. In J.R. Waldman and E.A. Blair, eds., Final Reports of the Tibor T. Polgar Fellowship Program, 1991. Hudson River Foundation, New York.

Penhollow, M.E., P.G. Jensen, and L.A. Zucker. 2006. Wildlife and habitat conservation framework: An approach for conserving biodiversity in the Hudson River Estuary Corridor. New York Cooperative Fish and Wildlife Research Unit, Cornell University and New York State Department of Environmental Conservation, Hudson River Estuary Program, Ithaca, NY. 139 p.

Petokas, Peter J. 1988. Preliminary ecological survey of the Culver Farm proposed development site, Shekomeko, Dutchess County, NY. Report to the Shekomeko Valley Association. Hudsonia Ltd., Annandale, NY. 8 p.

Reinmann, A. and G. Stevens. 2007 Significant habitats in the Town of Rhinebeck, Dutchess County, New York. Report to the Town of Rhinebeck, the Dyson Foundation, and the Dutchess Land Conservancy. Hudsonia Ltd., Annandale, NY. 132 p.

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Inigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, and T.C. Will. 2004. Partners in Flight North American landbird conservation plan. Cornell Lab of Ornithology, Ithaca, NY.

Richburg, J.A., W.A. Patterson III, and F. Lowenstein. 2001. Effects of road salt and *Phragmites australis* invasion on the vegetation of a western Massachusetts calcareous lake-basin fen. Wetlands 21:247-255.

Robbins, C.S. 1979. Effect of forest fragmentation on bird populations. P. 198-212 in R.M. DeGraaf and K.E. Evans, eds., Management of North-Central and Northeastern Forests for Nongame Birds, General Technical Report NC-51, USDA Forest Service, North Central Forest Experimental Station, St. Paul, MN.

Robbins, C.S. 1980. Effect of forest fragmentation on breeding bird populations in the Piedmont of the Mid-Atlantic region. Atlantic Naturalist 33:31-36.

Rosenberg, K.V., R.W. Rohrbaugh, Jr., S.E. Barker, R.S. Hames, J.D. Lowe, and A.A. Dhondt. 1999. A land manager's guide to improving habitat for scarlet tanagers and other forest-interior birds. Cornell Lab of Ornithology, Ithaca, NY. 24 p.

Rosenberg, K.V., R.S. Hames, R.W. Rohrbaugh, Jr., S.B. Swarthout, J.D. Lowe, and A.A. Dhondt. 2003. A land manager's guide to improving habitat for forest thrushes. Cornell Lab of Ornithology, Ithaca, NY. 32 p.

Rothermel, B.B. and R.D. Semlitsch. 2002. An experimental investigation of landscape resistance of forest versus old-field habitats to emigrating juvenile amphibians. Conservation Biology 16(5):1324-1332.

Saunders, D.L., J.J. Meeuwig, and A.C.J. Vincent. 2002. Freshwater protected areas: Strategies for conservation. Conservation Biology 16(1):30-41.

Semlitsch, R.D. 1998. Biological delineation of terrestrial buffer zones for pond-breeding salamanders. Conservation Biology 12:1112-1119.

Semlitsch, R.D. 2000. Size does matter: The value of small isolated wetlands. National Wetlands Newsletter 22(1):5-6,13.

Semlitsch, R.D. and J.R. Bodie. 1998. Are small, isolated wetlands expendable? Conservation Biology 12(5):1129-1133.

Singler, A. and B. Graber, eds. 2005. Massachusetts stream crossings handbook. Massachusetts Riverways Program, Massachusetts Department of Fish and Game, Boston. 11 p.

Smith, D.G. 1988. Keys to the freshwater macroinvertebrates of Massachusetts (No. 3): Crustacea Malacostraca (crayfish, isopods, amphipods). Report to Massachusetts Division of Water Pollution Control, Executive Office of Environmental Affairs, Department of Environmental Quality Engineering, and Division of Water Pollution Control. Boston. 53 p.

Sparling, D.W., T.P. Lowe, D. Day, and K. Dolan. 1995. Responses of amphibian populations to water and soil factors in experimentally treated aquatic macrocosms. Archives of Environmental Contamination and Toxicology 29:455-461.

Stevens, G. and E. Broadbent. 2002. Significant habitats of the Town of East Fishkill, Dutchess County, New York. Report to the Marilyn Milton Simpson Charitable Trusts and the Town of East Fishkill. Hudsonia Ltd., Annandale, NY. 56 p.

Strong, K. 2008. Conserving natural areas and wildlife in your community: Smart growth strategies for protecting the biological diversity of New York's Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit, Cornell University, and New York State Department of Environmental Conservation, Hudson River Estuary Program, Ithaca, NY. 101 p.

Sullivan, J. and G. Stevens. 2005. Significant habitats in the Fishkill and Sprout creek corridors, towns of Beekman, LaGrange, and Fishkill, Dutchess County, New York. Report to the New York State Department of Environmental Conservation, the Town of Beekman, the Town of LaGrange, the Town of Fishkill, and the City of Beacon. Hudsonia Ltd., Annandale, NY. 164 p.

Tabak, N., K. Bell, and G. Stevens. 2006. Significant habitats in the Town of Amenia, Dutchess County, New York. Report to the Town of Amenia, the Dyson Foundation, and the Dutchess Land Conservancy. Hudsonia Ltd., Annandale, NY. 133 p.

Tabak, N. and G. Stevens. 2008. Significant habitats in the Town of Poughkeepsie, Dutchess County, New York. Report to the Town of Poughkeepsie. Hudsonia Ltd., Red Hook, NY. 135 p.

Talmage, E. and E. Kiviat. 2004. Japanese knotweed and water quality on the Batavia Kill in Greene County, New York: Background information and literature review. Report to the Greene County Soil and Water Conservation District and the New York City Department of Environmental Protection. Hudsonia Ltd., Annandale, NY. 27 p.

Tesauro, J. 2009. Northern cricket frog (*Acris c. crepitans*) spring emergence and habitat use study, Glenmere Preserve, Village of Florida, New York. Unpublished report submitted to Rosenberg Development, LLC, Florida, New York. 12 p.

Tollefson, J. and G. Stevens. 2004. Significant habitats in the Town of Washington, Dutchess County, New York. Report to the Millbrook Tribute Garden, the Dyson Foundation, the Town of Washington, and the Dutchess Land Conservancy. Hudsonia Ltd., Annandale, NY. 89 p.

Trombulak, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(1):18-30.

Vickery, P.D, M.L. Hunter, Jr., and S.M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8(4):1087-1097.

Warthin, Jr., A.S. 1976. Geologic history of the Thompson Pond Preserve. In P.S. Busch ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy, Boston.

Wiens, J.A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs 8. 93 p.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. Ecology 66(4):1211-1214.

Williams, D.B. 1976. Ecological studies of Thompson Pond, New York: Physical-chemical data, coliforms, plankton, aquatic invertebrates and fish. In P.S. Busch ed. The Ecology of Thompson Pond in Dutchess County, New York. The Nature Conservancy, Boston, MA.

Zedler, P.H. 2003. Vernal pools and the concept of “isolated wetlands.” Wetlands 23(3): 597-607.

APPENDICES

Appendix A. Mapping conventions used to draw boundaries between certain habitat types, and additional information on defining habitat types.

Buttonbush pools and kettle shrub pools. Both of these wetlands are fairly deep-flooding, isolated from perennial streams, and have a shrub-dominated flora with buttonbush normally the dominant plant. We define kettle shrub pool as a specific type of buttonbush pool that is located in a glacial kettle—a depression formed by the melting of a stranded block of glacial ice. Since kettles can be difficult to identify definitively, in the absence of information on a buttonbush pool's origin we classify those that have deep, mucky substrates and are found within 490 ft (150 m) of mapped glacial outwash soils as kettle shrub pools.

Crest, ledge, and talus. Because crest, ledge, and talus habitats are usually embedded within other habitat types (most commonly upland forest), they were depicted as an overlay on the base habitat map. Except for the most exposed ledges, these habitats do not have distinct signatures on aerial photographs and were therefore mapped based on a combination of field observations and locations of potential bedrock exposures inferred from the mapped locations of shallow soils (<20 inches [50 cm]) on steep slopes (>15%) in Faber (2002). 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. All other rocky areas (both non-calcareous and unknown bedrock) were mapped simply as "crest, ledge and talus." While some wetlands can include rock outcrops, we did not show the crest, ledge, and talus overlay over wetlands because such wetlands are likely to support species other than those described in the crest, ledge, and talus section of the report.

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, small orchards, and large lawns. 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 areas. 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 not adjacent to buildings, and adjacent to significant habitats, were mapped as "cultural" habitats.

Intermittent woodland pools. Intermittent woodland pools are best identified in the spring when the pools are full of water and occupied by invertebrates and breeding amphibians. The presence of fairy shrimp is often a good indicator that the standing water is intermittent. 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 those wetlands with an open basin as intermittent woodland pools and those dominated by trees or shrubs as swamps, but they often serve similar ecological functions. 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 if the photographs are 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 ponds. We distinguish between the habitat categories “open water” and “constructed pond” based mostly on the degree to which the waterbody and its shorelines are managed. Most small to medium bodies of open water in Pine Plains were probably created by damming or excavation, and were mapped as constructed ponds. 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 the very few we happened to see in the field and those that were either identified on soils maps or have an identifiable signature on topographic maps. We expect there were many more springs and seeps in the Town of Pine Plains that we did not map. The presence of most seeps and springs must be determined in the field on a site-by-site basis.

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 as well as when they flowed underground for relatively short distances (e.g., under roads or small developments). 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 forests. 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 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 (where identifiable) were mapped as boundaries of adjacent forested habitat areas, since they can be significant fragmenting features.

Upland meadows and upland shrubland. We mapped upland meadows divided by fences and hedgerows as separate polygons, to the extent that these features were visible on the aerial photographs or observed in the field. Because upland meadows 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.

Wetlands. 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. 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 onsite soil data. On the ground, these areas were characterized by moist, fine-textured soils with common upland trees in the canopy, often dense thickets of vines and shrubs (e.g., Japanese barberry, Eurasian honeysuckle) in the understory, and facultative wetland and upland species of shrubs, forbs, and graminoids. In most cases, we mapped these areas of floodplain forest as upland forest. Because we did not examine soil profiles in the field, 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 study area, including those that were isolated from other habitats by development.

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 2008 (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 following categories 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 3000 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 Specie**s. 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

S1 Critically imperiled in New York State. 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 Imperiled in New York State. Typically 6-20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in New York State.

S3 Rare in New York State. 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 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 (NYS DEC 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 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 Pine Plains. 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), **NYS DEC 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 C.

UPLAND HARDWOOD FOREST

Plants
silvery spleenwort (RG)
Back's sedge (T)
American ginseng (RG)
red baneberry (RG)
blue cohosh (RG)
poke milkweed (RG)
lopseed (RG)
leatherwood (RG)
hackberry (RG)

Vertebrates
wood frog (RG)
spotted salamander (RG)
Jefferson salamander (SC, SGCN)
blue-spotted salamander (SC, SGCN)
marbled salamander (SC, S3, SGCN)
eastern box turtle (SC, S3, SGCN)

Vertebrates (cont.)
Blanding's turtle (T, S2S3, SGCN)
eastern racer (SGCN)
eastern ratsnake (SGCN)
northern goshawk (SC, S3N, SGCN)
red-shouldered hawk (SC, SGCN)
Cooper's hawk (SC, SGCN)
sharp-shinned hawk (SC, SGCN)
broad-winged hawk (RG)
ruffed grouse (SGCN)
American woodcock (PIF1, SGCN)
barred owl (RG)
whip-poor-will (SC, PIF2, SGCN)
eastern wood-pewee (PIF2)
Acadian flycatcher (S3)
wood thrush (PIF1, SGCN)
cerulean warbler (SC, PIF1, SGCN)

Vertebrates (cont.)
Canada warbler (PIF1, SGCN)
Kentucky warbler (S2, PIF1, SGCN)
black-and-white warbler (PIF2)
black-throated blue warbler (SGCN)
black-throated green warbler (RG)
worm-eating warbler (SGCN)
hooded warbler (RG)
ovenbird (RG)
scarlet tanager (PIF2, SGCN)
southern bog lemming (RG)
Indiana bat (E, S1, SGCN)
black bear (RG)
bobcat (RG)
New England cottontail (SC, S1S2, SGCN)
fisher (RG)

UPLAND CONIFER FOREST

Plants
pinesap (RG)

Vertebrates
blue-spotted salamander (SC, SGCN)
Cooper's hawk (SC, SGCN)
sharp-shinned hawk (SC, SGCN)

Vertebrates (cont.)
American woodcock (PIF1, SGCN)
long-eared owl (S3, SGCN)
short-eared owl (E, S2, PIF1, SGCN)
barred owl (RG)
red-breasted nuthatch (RG)

Vertebrates (cont.)
black-throated green warbler (RG)
Blackburnian warbler (PIF2)
pine siskin (RG)
evening grosbeak (RG)
purple finch (PIF2)

RED CEDAR WOODLAND

Plants
Carolina whitlow-grass (T, S2)
yellow wild flax (T, S2)
Bicknell's sedge (T, S3)
Indian grass (RG)

Invertebrates
olive hairstreak (butterfly) (RG)

Vertebrates
spotted turtle (SC, S3, SGCN)

Vertebrates (cont.)
wood turtle (SC, S3, SGCN)
Blanding's turtle (T, S2S3, SGCN)
eastern box turtle (SC, S3, SGCN)
eastern hognose snake (SC, S3, SGCN)
ruffed grouse (SGCN)
black-billed cuckoo (SGCN)
northern saw-whet owl (S3)
long-eared owl (S3, SGCN)

Vertebrates (cont.)
short-eared owl (E, S2, PIF1, SGCN)
whip-poor-will (SC, PIF2, SGCN)
eastern bluebird (RG)
brown thrasher (PIF2, SGCN)
golden-winged warbler (SC, PIF1, SGCN)
blue-winged warbler (PIF1, SGCN)
eastern towhee (PIF2)

NON-CALCAREOUS CREST/LEDGE/TALUS

Plants
mountain spleenwort (T, S2S3)
Bicknell's sedge (T, S3)
bronze sedge (RG)
clustered sedge (T, S2S3)
reflexed sedge (E, S2S3)
whorled milkweed (RG)
blunt-leaf milkweed (RG)
rock sandwort (RG)
goat's-rue (RG)
slender knotweed (R, S3)
dittany (RG)
Torrey's mountain-mint (E, S1)
Allegheny-vine (RG)
bearberry (RG)
three-toothed cinquefoil (RG)
stiff-leaf aster (RG)

Invertebrates
Edward's hairstreak (butterfly) (S3S4)

Invertebrates (cont.)
striped hairstreak (butterfly) (RG)
brown elfin (butterfly) (RG)
olive hairstreak (butterfly) (RG)
northern hairstreak (butterfly) (S1S3, SGCN)
gray hairstreak (butterfly) (RG)
Horace's duskywing (butterfly) (RG)
swarthy skipper (butterfly) (RG)
Leonard's skipper (butterfly) (RG)
cobweb skipper (butterfly) (RG)
dusted skipper (butterfly) (S3)

Vertebrates
Fowler's toad (SGCN)
northern slimy salamander (RG)
marbled salamander (SC, S3, SGCN)
eastern box turtle (SC, S3, SGCN)
eastern ratsnake (SGCN)
eastern racer (SGCN)
eastern hognose snake (SC, S3, SGCN)

Vertebrates (cont.)
eastern wormsnake (SC, S2, SGCN)
copperhead (S3, SGCN)
timber rattlesnake (T, S3, SGCN)
turkey vulture (RG)
golden eagle (E, SHB, S1N, SGCN)
whip-poor-will (SC, PIF2, SGCN)
common raven (RG)
winter wren (RG)
eastern bluebird (RG)
hermit thrush (RG)
Blackburnian warbler (PIF2)
cerulean warbler (SC, PIF1, SGCN)
worm-eating warbler (PIF1, SGCN)
small-footed bat (SC, S2, SGCN)
boreal redback vole (RG)
porcupine (RG)
fisher (RG)
bobcat (RG)

CALCAREOUS CREST/LEDGE/TALUS

Plants
purple cliffbrake (RG)
walking fern (RG)
smooth cliffbrake (T, S2)
wall-rue (RG)
side-oats grama (E, S1)
Emmons' sedge (S3)
Bicknell's sedge (T, S3)
yellow wild flax (T, S2)

Plants (cont.)
Carolina whitlow-grass (T, S2)
hairy rock-cress (RG)
yellow harlequin (S3)
Dutchman's breeches (RG)
pellitory (RG)
northern blazing-star (T, S2)
small-flowered crowfoot (T, S3)
roundleaf dogwood (RG)

Invertebrates
anise millipede (RG)
olive hairstreak (butterfly) (RG)

Vertebrates
eastern hognose snake (SC, S3, SGCN)
eastern racer (SGCN)
eastern ratsnake (SGCN)
copperhead (S3, SGCN)

OAK-HEATH BARREN

Plants
bronze sedge (RG)
clustered sedge (T, S2S3)
bearberry (RG)
three-toothed cinquefoil (RG)
dwarf shadbush (RG)
rusty woodsia (RG)

Invertebrates
brown elfin (butterfly) (RG)

Invertebrates (cont.)
cobweb skipper (butterfly) (RG)
Leonard's skipper (butterfly) (RG)
Edward's hairstreak (butterfly) (S3S4)

Vertebrates
copperhead (S3, SGCN)
timber rattlesnake (T, S3, SGCN)
turkey vulture (RG)
golden eagle (E, SHB, S1N, SGCN)

Vertebrates (cont.)
whip-poor-will (SC, PIF2, SGCN)
common raven (RG)
hermit thrush (RG)
Nashville warbler (RG)
prairie warbler (PIF1, SGCN)
field sparrow (PIF2)
vesper sparrow (SC, SGCN)
eastern towhee (PIF2)

UPLAND SHRUBLAND

Plants
stiff-leaf goldenrod (RG)
shrubby St. Johnswort (T, S2)
butterflyweed (RG)

Invertebrates
Aphrodite fritillary (butterfly) (RG)
cobweb skipper (butterfly) (RG)
dusted skipper (butterfly) (S3)
Leonard's skipper (butterfly) (RG)

Vertebrates
wood frog (RG)
spotted turtle (SC, S3, SGCN)
eastern box turtle (SC, S3, SGCN)

Vertebrates (cont.)
wood turtle (SC, S3, SGCN)
Blanding's turtle (T, S2S3, SGCN)
northern harrier (T, S3B, S3N, SGCN)
ruffed grouse (SGCN)
black-billed cuckoo (SGCN)
short-eared owl (E, S2, PIF1, SGCN)
northern saw-whet owl (S3)
whip-poor-will (SC, PIF2, SGCN)
willow flycatcher (SGCN)
brown thrasher (PIF2, SGCN)
loggerhead shrike (E, S1B, SGCN)
white-eyed vireo (RG)

Vertebrates (cont.)
blue-winged warbler (PIF1, SGCN)
golden-winged warbler (SC, PIF1, SGCN)
prairie warbler (PIF1, SGCN)
yellow-breasted chat (SC, S3, SGCN)
clay-colored sparrow (S2)
vesper sparrow (SC, SGCN)
field sparrow (PIF2)
grasshopper sparrow (SC, PIF2, SGCN)
Henslow's sparrow (T, S3B, PIF1, SGCN)
eastern towhee (PIF2)
New England cottontail (SC, S1S2, SGCN)

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 (RG)	wood turtle (SC, S3, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
Aphrodite fritillary (butterfly) (RG)	Blanding's turtle (T, S2S3, SGCN)	Henslow's sparrow (T, S3B, PIF1, SGCN)
dusted skipper (butterfly) (S3)	northern harrier (T, S3B, S3N, SGCN)	bobolink (SGCN)
Leonard's skipper (butterfly) (RG)	upland sandpiper (T, S3B, PIF1, SGCN)	eastern meadowlark (SGCN)

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)	common nighthawk (SC, SGCN)
field-dodder (S1)	spotted turtle (SC, S3, SGCN)	common raven (RG)
slender pinweed (T, S2)	wood turtle (SC, S3, SGCN)	bank swallow (RG)
rattlebox (E, S1)	Blanding's turtle (T, S2S3, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
blunt mountain-mint (T, S2S3)	eastern hognose snake (SC, S3, 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)

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)
spiny coontail (T, S3)	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)
spiny coontail (T, S3)	spotted turtle (SC, S3, SGCN)	northern harrier (T, S3B, S3N, SGCN)
Invertebrates	Blanding's turtle (T, S2S3, SGCN)	king rail (T, S1B, PIF1, SGCN)
black dash (butterfly) (RG)	American bittern (SC, SGCN)	Virginia rail (RG)
bronze copper (butterfly) (RG)	least bittern (T, S3B, S1N, SGCN)	sora (RG)
mulberry wing (butterfly) (RG)	great blue heron (RG)	common moorhen (RG)
	wood duck (PIF2)	marsh wren (RG)

WET MEADOW

Invertebrates
Baltimore (butterfly) (RG)
mulberry wing (butterfly) (RG)
black dash (butterfly) (RG)
two-spotted skipper (butterfly) (RG)
meadow fritillary (butterfly) (RG)
bronze copper (butterfly) (RG)
eyed brown (butterfly) (RG)

Invertebrates (cont.)
Milbert's tortoiseshell (butterfly) (RG)
phantom cranefly (RG)

Vertebrates
eastern ribbonsnake (RG, SGCN)
spotted turtle (SC, S3, SGCN)
American bittern (SC, SGCN)

Vertebrates (cont.)
northern harrier (T, S3B, S3N, SGCN)
Virginia rail (RG)
American woodcock (PIF1, SGCN)
sedge wren (T, S3B, PIF2, SGCN)
Henslow's sparrow (T, S3B, PIF1, SGCN)
southern bog lemming (RG)

FEN/CALCAREOUS WET MEADOW

Plants
wood horsetail (RG)
twig-rush (RG)
Schweinitz's sedge (T, S2S3)
handsome sedge (T, S1)
Bush's sedge (S3)
ovate spikerush (E, S1S2)
slender lady's tresses (RG)
rose pogonia (RG)
showy ladyslipper (RG)
spreading globeflower (R, S3)
scarlet Indian paintbrush (E, S1)
grass-of-Parnassus (RG)
Kalm's lobelia (RG)
bush aster (T, S2)

Plants (cont.)
fringed gentian (RG)
swamp lousewort (T, S2)
roundleaf sundew (RG)
small-flowered agrimony (S3)
bog valerian (E, S1S2)
buckbean (RG)
swamp birch (T, S2)
alder-leaf buckthorn (RG)

Invertebrates
Gammarus pseudolimnaeus (amphipod) (RG)
Pomatiopsis lapidaria (snail) (RG)
forcipate emerald (dragonfly) (S1, SGCN)
Kennedy's emerald (dragonfly) (SNA)
phantom cranefly (RG)

Invertebrates (cont.)
eyed brown (butterfly) (RG)
silver-bordered fritillary (butterfly) (RG)
two-spotted skipper (butterfly) (RG)
Dion skipper (butterfly) (S3)
Baltimore (butterfly) (RG)
mulberry wing (butterfly) (RG)
black dash (butterfly) (RG)

Vertebrates
bog turtle (E, S2, SGCN)
spotted turtle (SC, S3, SGCN)
eastern ribbonsnake (SGCN)
northern harrier (T, S3B, S3N, SGCN)
sedge wren (T, S3B, PIF2, SGCN)

INTERMITTENT WOODLAND POOL

Plants
Virginia chain fern (RG)
false hop sedge (R, S2)
featherfoil (T, S2)

Invertebrates
black dash (butterfly) (RG)
mulberry wing (butterfly) (RG)

Invertebrates (cont.)
springtime physa (snail) (RG)

Vertebrates
wood frog (RG)
four-toed salamander (SGCN)
Jefferson salamander (SC, SGCN)
marbled salamander (SC, S3, SGCN)

Vertebrates (cont.)
spotted salamander (RG)
spotted turtle (SC, S3, SGCN)
wood turtle (SC, S3, SGCN)
Blanding's turtle (T, S2S3, SGCN)
wood duck (PIF2)
American black duck (PIF1, SGCN)
northern waterthrush (RG)

CIRCUMNEUTRAL BOG LAKE

Plants
ovate spikerush (E, S1S2)
knotted spikerush (T, S2)
olivaceous spikerush (RG)
prairie sedge (RG)
twig-rush (RG)
floating bladderwort (T, S2)
hidden-fruit bladderwort (S3)
swollen bladderwort (E, S2)
horned bladderwort (RG)
spotted pondweed (T, S2)
water-thread pondweed (E, S1)
Hill's pondweed (T, S2)
spiny coontail (T, S3)
Beck's water-marigold (T, S3)

Plants (cont.)
rose pogonia (RG)
pipewort (RG)
roundleaf sundew (RG)
pitcher-plant (RG)
globe-fruited ludwigia (S2, T)
southern dodder (E, S1)

Vertebrates
wood frog (RG)
blue-spotted salamander (SC, SGCN)
four-toed salamander (SGCN)
northern cricket frog (E, S1, SGCN)
bog turtle (E, S2, SGCN)
spotted turtle (SC, S3, SGCN)
Blanding's turtle (T, S2S3, SGCN)
eastern ribbonsnake (SGCN)

Vertebrates (cont.)
pied-billed grebe (T, S3B, S1N, SGCN)
American bittern (SC, SGCN)
least bittern (T, S3B, S1N, SGCN)
great blue heron (RG)
wood duck (PIF2)
American black duck (PIF1, SGCN)
osprey (SC, SGCN)
red-shouldered hawk (SC, SGCN)
sharp-shinned hawk (SC, SGCN)
king rail (T, S1B, PIF1, SGCN)
sora (RG)
common moorhen (RG)
marsh wren (RG)
river otter (SGCN)

OPEN WATER/CONSTRUCTED POND		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
spiny coontail (T, S3)	Blanding's turtle (T, S2S3, SGCN)	pied-billed grebe (T, S3B, S1N, SGCN)
Vertebrates	American bittern (SC, SGCN)	osprey (SC, SGCN)
northern cricket frog (E, S1, SGCN)	great blue heron (RG)	bald eagle (T, S2S3B, SGCN)
spotted turtle (SC, S3, SGCN)	wood duck (PIF2)	river otter (SGCN)
wood turtle (SC, S3, SGCN)	American black duck (PIF1, 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)	spring salamander (RG)
	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)
spiny coontail (T, S3)	arrowhead spiketail (dragonfly) (S2S3, SGCN)	American black duck (PIF1, SGCN)
goldenseal (T, S2)	mocha emerald (dragonfly) (S2S3, SGCN)	wood duck (PIF2)
cattail sedge (T, S1)	sable clubtail (dragonfly) (S1, SGCN)	red-shouldered hawk (SC, SGCN)
Davis' sedge (T, S2)	ostrich fern borer (moth) (SGCN)	American woodcock (PIF1, SGCN)
small-flowered agrimony (S3)	***Vertebrates***	bank swallow (RG)
false-mermaid (RG)	creek chubsucker (fish) (RG)	winter wren (RG)
swamp rose-mallow (RG)	bridle shiner (fish) (RG)	cerulean warbler (SC, PIF1, SGCN)
may-apple (RG)	brook trout (fish) (SGCN)	Louisiana waterthrush (SGCN)
Invertebrates	slimy sculpin (fish) (RG)	river otter (SGCN)
Marstonia decepta (snail) (RG)	northern dusky salamander (RG)	Indiana bat (E, S1, SGCN)
brook floater (mussel) (T, S1, SGCN)		

Appendix D. Common and scientific names of plants mentioned in this report. Most scientific names follow the nomenclature of Mitchell and Tucker (1997).

Common Name	Scientific Name
agrimony, small-flowered	*Agrimonia parviflora*
alder	*Alnus*
alkali-grass, pale	*Puccinellia distans*
Allegheny-vine	*Adlumia fungosa*
arrowhead, broad-leaved	*Sagittaria latifolia*
arrowwood, northern	*Viburnum dentatum* v. *lucidum*
arum, arrow	*Peltandra virginica*
ash, green	*Fraxinus pensylvanica*
ash, white	*Fraxinus americana*
aspen, quaking	*Populus tremuloides*
aster, bush	*Aster borealis*
aster, stiff-leaf	*Aster linariifolius*
azalea, swamp	*Rhododendron viscosum*
baneberry, red	*Actaea spicata* ssp. *rubra*
barberry, Japanese	*Berberis thunbergii*
basswood	*Tilia americana*
bearberry	*Arctostaphylos uva-ursi*
bergamot, wild	*Monarda fistulosa*
birch, black	*Betula lenta*
birch, gray	*Betula populifolia*
birch, swamp	*Betula pumila*
blackberry, northern	*Rubus allegheniensis*
blackgum	*Nyssa sylvatica*
bladdernut	*Staphylea trifolia*
bladderwort, cone-spur	*Utricularia gibba*
bladderwort, floating	*Utricularia radiata*
bladderwort, hidden-fruit	*Utricularia geminiscapa*
bladderwort, horned	*Utricularia cornuta*
bladderwort, swollen	*Utricularia inflata*
blueberry, highbush	*Vaccinium corymbosum*
blueberry, late lowbush	*Vaccinium angustifolium*
blueberry, early lowbush	*Vaccinium pallidum*
bluegrass, Kentucky	*Poa pratensis*
bluejoint	*Calamagrostis canadensis*
bluestem, little	*Schizachyrium scoparium*
bracken	*Pteridium aquilinum*
breeches, Dutchman's	*Dicentra cucullaria*
buckbean	*Menyanthes trifoliata*
buckthorn, alder-leaf	*Rhamnus alnifolia*
butterflyweed	*Asclepias tuberosa*
butternut	*Juglans cinerea*
buttonbush	*Cephalanthus occidentalis*
cattail	*Typha*
cedar, eastern red	*Juniperus virginiana*
cinquefoil, shrubby	*Potentilla fruticosa*
cinquefoil, three-toothed	*Potentilla tridentata*
cliffbrake, purple	*Pellaea atropurpurea*
cliffbrake, smooth	*Pellaea glabella*
cohosh, blue	*Caulophyllum thalictroides*
columbine, wild	*Aquilegia canadensis*
coontail, spiny	*Ceratophyllum echinatum*
cottonwood, swamp	*Populus heterophylla*
crowfoot, small-flowered	*Ranunculus micranthus*
deerberry	*Vaccinium stamineum*
devil's-bit	*Chamaelirium luteum*
dittany	*Cunila origanoides*
dodder, buttonbush	*Cuscuta cephalanthi*
dodder, field	*Cuscuta campestris*
dodder, southern	*Cuscuta obtusiflora* v. *glandulosa*
dogwood, gray	*Cornus foemina* ssp. *racemosa*
dogwood, red-osier	*Cornus sericea*
dogwood, roundleaf	*Cornus rugosa*
dogwood, silky	*Cornus amomum*
elm, American	*Ulmus americana*
elm, slippery	*Ulmus rubra*
false-mermaid	*Floerkea proserpinacoides*
featherfoil	*Hottonia inflata*
fern, fragile	*Cystopteris fragilis*
fern, maidenhair	*Adiantum pedatum*
fern, marsh	*Thelypteris palustris*
fern, ostrich	*Matteuccia struthiopteris*
fern, sensitive	*Onoclea sensibilis*
fern, Virginia chain	*Woodwardia virginica*
fern, walking	*Asplenium rhizophyllum*
flag, blue	*Iris versicolor*
flax, yellow wild	*Linum sulcatum*
foxtail, short-awn	*Alopecurus aequalis*
gentian, closed	*Gentiana clausa*
gentian, fringed	*Gentianopsis crinita*
ginseng, American	*Panax quinquefolius*
globeflower, spreading	*Trollius laxus*
goat's-rue	*Tephrosia virginiana*
goldenrod, bog	*Solidago uliginosa*
goldenrod, rough-leaf	*Solidago patula*
goldenrod, stiff-leaf	*Solidago rigida*
goldenseal	*Hydrastis canadensis*
grama, side-oats	*Bouteloua curtipendula*
grass-of-Parnassus	*Parnassia glauca*
grass, reed canary	*Phalaris arundinacea*
grass, Indian	*Sorghastrum nutans*
hackberry	*Celtis occidentalis*
hairgrass	*Deschampsia flexuosa*
hair-rush	*Bulbostylis capillaris*
harlequin, yellow	*Corydalis flavula*
hawthorn	*Crataegus*
hemlock, eastern	*Tsuga canadensis*
hickory, pignut	*Carya glabra*
hickory, shagbark	*Carya ovata*
holly, winterberry	*Ilex verticillata*
honeysuckle, Eurasian	*Lonicera* x *bella*
horsetail, wood	*Equisetum sylvaticum*
huckleberry, black	*Gaylussacia baccata*
ironweed, New York	*Vernonia noveboracensis*
knotweed, Japanese	*Fallopia japonica*
knotweed, slender	*Polygonum tenue*
lady's-tresses	*Spiranthes lacera*
ladyslipper, showy	*Cypripedium reginae*
leatherleaf	*Chamaedaphne calyculata*
leatherwood	*Dirca palustris*
lobelia, Kalm's	*Lobelia kalmii*

(CONTINUED)

Common Name	Scientific Name	Common Name	Scientific Name
locust, black	*Robinia pseudoacacia*	saxifrage, golden	*Chrysosplenium americanum*
lopseed	*Phryma leptostachya*	sedge, Back's	*Carex backii*
loosestrife, purple	*Lythrum salicaria*	sedge, Bicknell's	*Carex bicknellii*
lousewort, swamp	*Pedicularis lanceolata*	sedge, bronze	*Carex aenea*
ludwigia, globe-fruited	*Ludwigia sphaerocarpa*	sedge, Bush's	*Carex bushii*
mannagrass	*Glyceria*	sedge, cattail	*Carex typhina*
maple, Norway	*Acer platanoides*	sedge, clustered	*Carex cumulata*
maple, red	*Acer rubrum*	sedge, Davis'	*Carex davisii*
maple, sugar	*Acer saccharum*	sedge, Emmons'	*Carex albicans* v. *emmonsii*
marjoram	*Origanum vulgare*	sedge, false hop	*Carex lupuliformis*
may-apple	*Podophyllum peltatum*	sedge, handsome	*Carex formosa*
meadowsweet	*Spiraea alba* v. *latifolia*	sedge, lakeside	*Carex lacustris*
milkweed, blunt-leaf	*Asclepias amplexicaulis*	sedge, Pennsylvania	*Carex pennsylvanica*
milkweed, poke	*Asclepias exaltata*	sedge, porcupine	*Carex hystericina*
milkwort, field	*Polygala sanguinea*	sedge, prairie	*Carex prairea*
milkwort, whorled	*Polygala verticillata*	sedge, reflexed	*Carex retroflexa*
monkey-flower, winged	*Mimulus alatus*	sedge, Schweinitz's	*Carex schweinitzii*
(a moss)	*Helodium paludosum*	sedge, sterile	*Carex sterilis*
moss, peat	*Sphagnum*	sedge, tussock	*Carex stricta*
mountain-mint, blunt	*Pycnanthemum muticum*	sedge, woolly-fruit	*Carex lasiocarpa*
mountain-mint, Torrey's	*Pycnanthemum torrei*	sedge, yellow	*Carex flava*
oak, black	*Quercus velutina*	serviceberry	*Amelanchier*
oak, chestnut	*Quercus montana*	shadbush, dwarf	*Amelanchier stolonifera*
oak, red	*Quercus rubra*	skunk-cabbage	*Symplocarpus foetidus*
oak, scarlet	*Quercus coccinea*	spike-muhly	*Muhlenbergia glomerata*
oak, scrub	*Quercus ilicifolia*	spikerush, knotted	*Eleocharis equisetoides*
oak, swamp white	*Quercus bicolor*	spikerush, olivaceous	*Eleocharis flavescens*
oak, white	*Quercus alba*	spikerush, ovate	*Eleocharis obtusa* v. *ovata*
orangeweed	*Hypericum gentianoides*	spleenwort, ebony	*Asplenium platyneuron*
paintbrush, scarlet Indian	*Castilleja coccinea*	spleenwort, maidenhair	*Asplenium trichomanes*
pellitory	*Parietaria pennsylvanica*	spleenwort, mountain	*Asplenium montanum*
pine, pitch	*Pinus rigida*	spleenwort, silvery	*Deparia acrostichoides*
pine, white	*Pinus strobus*	St. Johnswort, shrubby	*Hypericum prolificum*
pinesap	*Monotropa hypopithys*	sweetfern	*Comptonia peregrina*
pinweed, slender	*Lechea tenuifolia*	sweetflag	*Acorus*
pipewort	*Eriocaulon septangulare*	sweet-gale	*Myrica gale*
pogonia, rose	*Pogonia ophioglossoides*	sycamore	*Platanus occidentalis*
polypody, rock	*Polypodium vulgare*	thyme, wild	*Thymus pulegioides*
pond-lily, yellow	*Nuphar advena*	twig-rush	*Cladium mariscoides*
pond-lily, white	*Nymphaea odorata*	valerian, bog	*Valeriana uliginosa*
pondweed, Hill's	*Potamogeton hillii*	vervain, blue	*Verbena hastata*
pondweed, spotted	*Potamogeton pulcher*	viburnum, maple-leaf	*Viburnum acerifolium*
pondweed, water-thread	*Potamogeton diversifolius*	violet	*Viola*
poverty-grass	*Danthonia spicata*	wall-rue	*Asplenium ruta-muraria*
prickly-ash, American	*Zanthoxylum americana*	water hemlock	*Cicuta bulbifera*
raspberry	*Rubus*	water-marigold, Beck's	*Bidens beckii*
rattlebox	*Crotalaria sagittalis*	water-plantain	*Alisma triviale*
reed, common	*Phragmites australis*	water-shield	*Brasenia schreberi*
riverweed	*Podostemum ceratophyllum*	water-willow	*Decodon verticillatus*
rock-cress, hairy	*Arabis hirsuta* v. *pycnocarpa*	whitlow-grass, Carolina	*Draba reptans*
rose, multiflora	*Rosa multiflora*	willow	*Salix*
rose-mallow, swamp	*Hibiscus moscheutos*	willow, autumn	*Salix serissima*
rush, toad	*Juncus bufonius*	willow, sage-leaved	*Salix candida*
rush, soft	*Juncus effusus*	witch-hazel	*Hamamelis virginiana*
sandwort, rock	*Minuartia michauxii*	woodsia, rusty	*Woodsia ilvensis*
sarsaparilla, bristly	*Aralia hispida*	woolgrass	*Scirpus cyperinus*