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

Report to the Town of Poughkeepsie

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EXECUTIVE SUMMARY

Hudsonia biologists identified and mapped ecologically significant habitats in the Town of Poughkeepsie during the period January through November 2007. Through map analysis, aerial photograph interpretation, and field observations we created a large-format map showing the location and configuration of these habitats throughout the town. Some of the habitats are rare or declining in the region or support rare species of plants or animals, while others are high quality examples of common habitats or habitat complexes. Among our interesting finds were calcareous ledges, 13 buttonbush and kettle shrub pools, 48 intermittent woodland pools, extensive wetlands and wetland complexes, forested areas with mature trees, tidal habitats (e.g., swamps, marshes, and mudflats), and several contiguous habitat patches greater than 500 acres (200 hectares).

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 discuss the places in Poughkeepsie that we believe should receive priority in conservation and planning efforts. We also provide instructions on how to use this report and the map, both to review site-specific proposals and as a guide for town-wide conservation planning and decision making.

The habitat map, which contains ecological information unavailable from other sources, can help the Town of Poughkeepsie 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 the mid-Hudson Valley 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, and the loss of native biodiversity. 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 allow 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 based in Red Hook, New York, initiated a series of extensive habitat mapping projects in Dutchess County in 2001. These projects demonstrate how Hudsonia's *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001) can be used to identify important biological resources over large geographic areas and inform local communities about biodiversity conservation.

Hudsonia has now completed town-wide habitat maps for seven Dutchess County towns—Amenia, East Fishkill, North East, Poughkeepsie, Rhinebeck, Stanford, and Washington. These projects have been funded by a variety of private and public sources. The Hudson River Estuary Program of the New York State Department of Environmental Conservation provided funding to the town for the Poughkeepsie mapping project. We received support for the project from the Town of Poughkeepsie Conservation Advisory Council and Planning Department, as well as from many local landowners.

Nava Tabak (Biologist) conducted most of the work on this project from January 2007 through November 2007, with assistance from other Hudsonia biologists. Through map analysis, aerial photograph interpretation, and field observations we created a map of ecologically significant habitats in the Town of Poughkeepsie. Some of these habitats are rare or declining in the region, some may support rare species of plants or animals, some are high quality examples of common habitats or habitat complexes, and others may provide other important services to the ecological landscape. The emphasis of this project was on identifying and mapping general habitat types; we did not conduct species-level surveys or map the locations of rare species.

Hudsonia will soon be undertaking habitat mapping projects for additional towns in Dutchess County, and we hope to extend the 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 work to improve our methods and products as the program evolves. Many passages in this report relating to general habitat descriptions, general conservation and planning concepts, and other information applicable to the region as a whole are taken directly from previous Hudsonia reports accompanying habitat maps in Dutchess County (Stevens and Broadbent 2002, Tollefson and Stevens 2004, Bell et al. 2005, Sullivan and Stevens 2005, Tabak et al. 2006, Reinmann and Stevens 2007, Knab-Vispo et al. 2008) without specific attribution. This report, however, addresses our findings and specific recommendations for the Town of Poughkeepsie. We intend for each of these projects to build on the previous ones, and believe that the expanding body of biodiversity information will be a valuable resource for site-specific, town-wide, and region-wide planning and conservation efforts.

We hope that this map and report will help landowners understand how their properties fit into the larger ecological landscape, and will inspire them to implement habitat protection and enhancement measures voluntarily. We also hope that the Town of Poughkeepsie will engage in proactive land use and conservation planning to ensure that future development is implemented with a view to long-term protection of its remaining biological resources.

What is Biodiversity?

The concept of biodiversity, or biological diversity, encompasses all of life and its processes. It includes ecosystems, biological communities, species and their genes, as well as their interactions with each other and with the abiotic 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, 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 organisms such as fungi and insects, plays a specific role in the maintenance of biological communities. Maintaining the full complement of native species in a region better enables an ecosystem to withstand stresses and adapt to changing environmental conditions.

What are Ecologically Significant Habitats?

For 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 wildlife and biodiversity as a whole. In addition to their importance from a biological standpoint, habitats are also manageable units for planning and conservation at fairly large scales such as towns. By illustrating the location and configuration of significant habitats throughout the Town of Poughkeepsie, the habitat map can serve as a valuable source of ecological information that can be incorporated into local land use planning and decision making.

Study Area

The Town of Poughkeepsie is located in western Dutchess County in southeastern New York. It is approximately 28.6 mi^2 (74 km^2) in area (excluding 2.3 mi^2 [6 km^2] of Hudson River) and has a population of roughly 41,800 residents (2000 Census). The town's landscape is composed of small hills and stream valleys. All of the land in Poughkeepsie ultimately drains into the Hudson River. The main Hudson River tributary is Wappinger Creek, which forms most of the eastern and southern border of the town. Large portions of the town are drained by the Casperkill (or Casper Creek, Casperkill Creek) and Fallkill Creek, which flow in a generally southwesterly direction; two smaller, unnamed streams drain the northwestern- and northeastern-most parts of the town. Elevations in Poughkeepsie range from mean sea level along the Hudson River and the mouth of the Wappinger Creek to 480 ft (146 m) at the top of Peach Hill near the northern town boundary. The northeastern part of the town contains several large wetlands and wetland complexes, and several tidal wetlands occur along the Hudson River in the southern part of the town and in the lowest reach of Wappinger Creek.

As reflected by the topography of the town, the bedrock geology of Poughkeepsie is largely composed of elongate formations of sedimentary rock (graywacke, shale, argillite, and siltstone) running in a generally northeast-southwest direction. Smaller formations in the center and eastern parts of the town are composed of limestone and dolostone (Fisher et al. 1970) (Figure 1). Poughkeepsie Mélange (a formation of various rock fragments cemented together) is distributed through the town, often as an inclusion to shale formations. In some cases the bedrock formations in the town are separated by faults (Fisher and Warthin 1976). The surficial material in the town is primarily glacial till. Recent alluvium and glacial outwash predominate on the Wappinger Creek floodplain. A sizeable area of outwash also occurs in the north-central part of the town, and there are several kame deposits in the town. Near the Hudson River are lacustrine deposits (sand, silt, and clay), and large areas of bedrock at or near the surface (Cadwell et al. 1989).

Land uses in the Town of Poughkeepsie are heavily dominated by residential and commercial development. Other uses include recreational facilities, small scale agriculture, a large mine, and preserved open space. The great majority of parcels in the town are small (one acre or less) and privately owned. Most of the 16 parcels larger than 100 acres are privately owned; Bowdoin Park (county owned) and Peach Hill Park (town owned) are the notable exceptions.

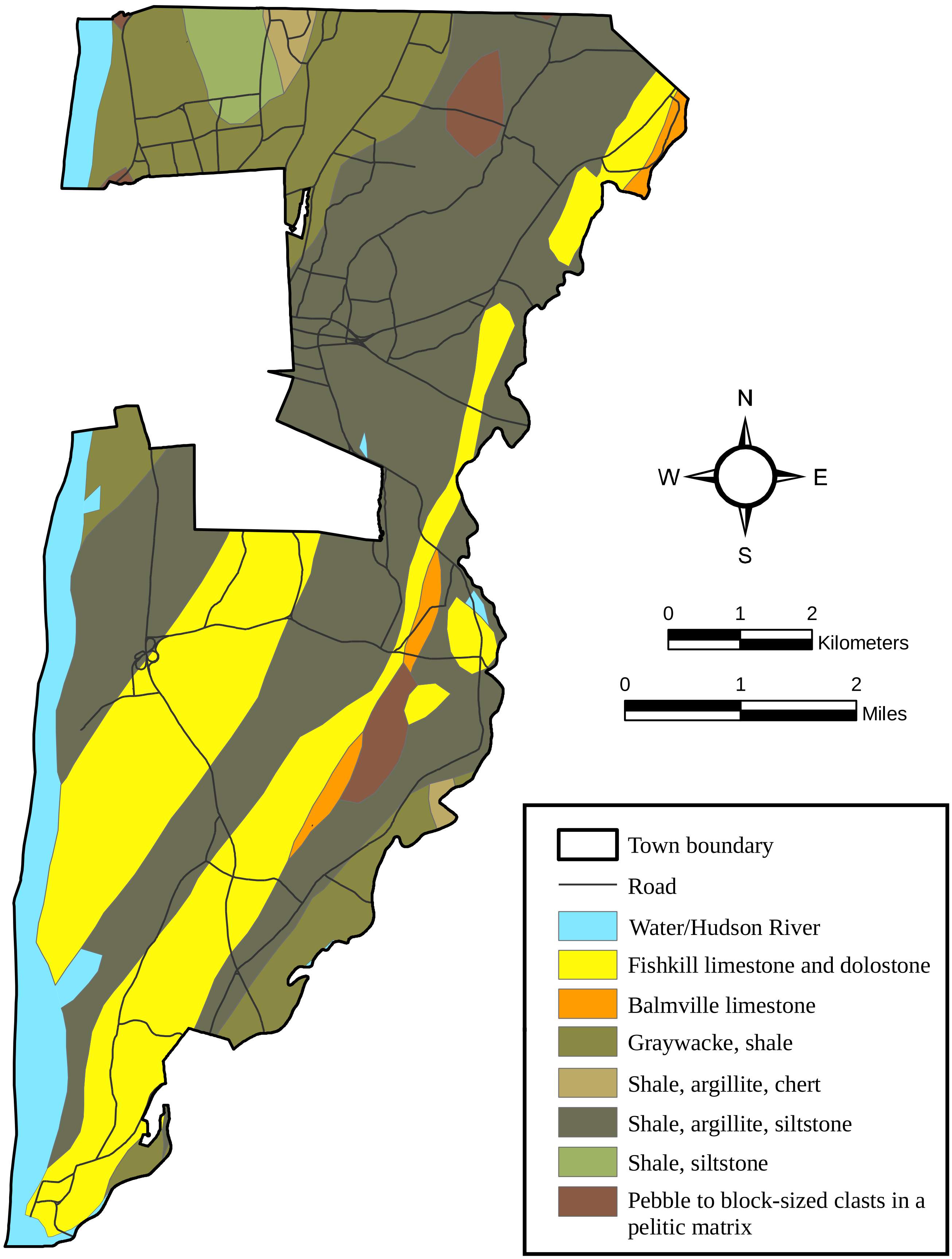


Figure 1. Generalized bedrock geology of the Town of Poughkeepsie, Dutchess County, New York. Geology data from Fisher et al. 1970. Hudsonia Ltd., 2008.

METHODS

Hudsonia employs a combination of laboratory and field methods in the habitat identification and mapping process. Below we describe each phase in the Poughkeepsie 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 previous studies conducted by Hudsonia biologists in Poughkeepsie 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 1995, 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.

- *High-resolution (1 pixel = 7.5 in [19 cm]) color infrared digital orthophotos* taken in spring 2004, obtained from the New York State GIS Clearinghouse website (http://www.nysgis.state.ny.us; accessed January 2007). These digital aerial photos were used for on-screen digitizing of habitat boundaries.

- *U.S. Geological Survey topographic maps* (Poughkeepsie, Pleasant Valley, and Wappingers Falls 7.5 minute quadrangles). Topographic maps contain extensive information about landscape features, such as elevation contours, surface water features, and significant cultural features. Contour lines on topographic maps can be used to predict the occurrence of habitats such as cliffs, intermittent woodland pools and other 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). Along with topography, surficial and bedrock geology strongly influence the development of particular soil properties and aspects of groundwater and surface water chemistry, and thus have important implications for the biological communities that become established at 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 usually indicate the location of wetland habitats such as swamps, marshes, and wet meadows. The location of alkaline soils can be used to predict the occurrence of fens and calcareous wet meadows.

- *GIS data*. A Geographic Information System enables us to overlay multiple data layers on a computer screen, greatly enhancing the efficiency and accuracy with which we can predict the diverse habitats that are closely linked to local topography, geology, hydrology, and soil conditions. GIS also enables us to create detailed, spatially accurate maps. We obtained most of our GIS data layers from the Dutchess County Environmental Management Council (EMC), including roads, soils, bedrock geology, surficial geology, and wetlands. National Wetlands Inventory data prepared by the U.S. Fish and Wildlife Service was obtained from their 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.

Preliminary Habitat Mapping and Field Verification

We prepared a preliminary map of predicted habitats based on map analysis and stereo interpretation of aerial photographs. We digitized the predicted habitats onscreen over the orthophoto images using ArcView 9.2 (Environmental Systems Research Institute 2006) computer 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, and to assess their quality.

We identified landowners using tax parcel data, and before visiting field sites we contacted landowners for permission to go on their land. We prioritized sites for field visits based both on opportunity (i.e., willing landowners) and our need to answer habitat questions that could not be answered remotely. For example, differentiating wet meadow from calcareous wet meadow and calcareous crest from acidic crest can only be done in the field. In addition to conducting field work on private land, we viewed habitats from adjacent properties, public roads, and other public access areas. Because the schedule of this project (and non-participating landowners) prevented us from conducting field visits to every parcel in the town, this strategy increased our efficiency while maintaining a high standard of accuracy.

Ultimately we field checked part or all of 68% of the total number of habitat units in the town. This figure translates to approximately 55% of the undeveloped area in Poughkeepsie (5783 acres [2325 ha]). Areas that could not be field checked show our remotely-mapped habitats. We assume that areas of the habitat map that were field checked are generally more accurate than areas we did not visit. Once we had conducted field work in some areas, however, we were able to extrapolate our findings to adjacent parcels and similar settings throughout the town.

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. We have classified broad habitat types that are identifiable largely by their vegetation and visible physical properties. Habitats exist, however, as part of a continuum of intergrading resources and conditions, and it is often difficult to draw a line to separate two habitats. Additionally, some distinct habitats are intermediates between two defined habitat types, and some habitat categories can be considered complexes of several habitats. In order to maintain consistency within and among habitat mapping projects, we have developed certain mapping conventions (or rules) that we use to delineate habitat boundaries. Some of these are described in Appendix A. Because much of the area in Poughkeepsie was only mapped remotely, and all mapped habitat boundaries are drawn without survey or GPS equipment, all of the mapped features should be considered approximations.

Each habitat profile in the Results section describes the general ecological attributes of places that are included in that habitat type. Developed areas and other areas that we consider to be non-significant habitats (e.g., structures, paved roads and driveways, other impervious surfaces, and small lawns, meadows, and woodlots) are shown as white (no symbol or color) on the habitat map. Areas that have been developed 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 underestimated the extent of developed land in the town.

Final Mapping and Presentation of Data

We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map. We printed the final large-format habitat map at a scale of 1:10,000 using a Hewlett Packard DesignJet 800PS plotter (on three sheets measuring 36 x 45, 36 x 42, and 36 x 41 inches). We also printed the entire town map on a single sheet at a scale of 1:17,500. The GIS database that accompanies the 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 Poughkeepsie 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 not suitable for detailed planning and site design, or for jurisdictional determinations (e.g., for wetlands). Boundaries of wetlands and other habitats depicted here are only approximate."*

May-apple flower

RESULTS

OVERVIEW

The large-format Town of Poughkeepsie habitat map illustrates the diversity of habitats that occur in the town and their configuration in the landscape. Figure 2 is a reduction of the completed habitat map. Of the total 30.9 mi^2 (80 km^2) area encompassed in the Town of Poughkeepsie, approximately 53% of the town was mapped as significant habitat, with the Hudson River comprising nearly 14% of this habitat area (or 7.3% of the total area of the town). The existing development is dispersed through the town so that undeveloped land has been largely fragmented into discontinuous patches. Figure 6 shows blocks of contiguous undeveloped habitat areas within the town, color-coded by size. Several types of common habitats cover extensive areas within these blocks. For example, upland forests cover approximately 24% of the land in the town (i.e., excluding the Hudson River), and open meadows (managed and unmanaged grassland habitats) and swamps each occupy nearly 4% of the land in the town. "Cultural" areas, which are defined as highly managed habitats without pavement or structures (e.g., golf courses, cemeteries), account for over 5% of the land in the town. Some of the smaller, more unusual habitats we documented include kettle shrub pool, buttonbush pool, and habitats associated with the Hudson River, such as estuarine rocky shore, tidal mudflat, and tidal swamp. In total, we identified 27 general habitat types in the Town of Poughkeepsie that we consider to be of potential ecological importance (Table 1).

Although the mapped areas represent ecologically significant habitats, all have been altered by past and present human activities. Most or all areas of the upland forests, for example, have been logged repeatedly in the past 300 years, and many forested areas lack the structural complexity of mature forests. Many of the wetlands in the town have been extensively altered by human activities such as damming, filling, draining, and railroad and road construction. Several introduced plants species (e.g., purple loosestrife, common reed, Eurasian honeysuckles, multiflora rose, garlic mustard, water chestnut) are widespread in upland and wetland habitats in the town, and have likely had various impacts on these habitats, including the displacement of some native species. We have documented the location and extent of important habitats in Poughkeepsie, but only in some cases have we provided information on the quality and condition of these habitats. Notes in the GIS database provide some of these assessments. Locations of a few habitat types are depicted on map figures in this report, but most habitats are shown only on the large-format map sheets, separate from this report.

Table 1. Ecologically significant habitats documented by Hudsonia in the Town of Poughkeepsie, Dutchess County, New York, 2007.

Upland Habitats	Wetland Habitats	Hudson River Habitats
Upland hardwood forest Upland conifer forest Upland mixed forest Red cedar woodland Crest/ledge/talus Upland shrubland Upland meadow Orchard/plantation Cultural Waste ground	Hardwood & shrub swamp Intermittent woodland pool Buttonbush pool Kettle shrub pool Marsh Wet meadow Calcareous wet meadow Spring/seep Constructed pond Open water Stream	Estuarine rocky shore Supratidal railroad causeway Freshwater tidal swamp Freshwater tidal marsh Tidal mudflat Tidal tributary mouth

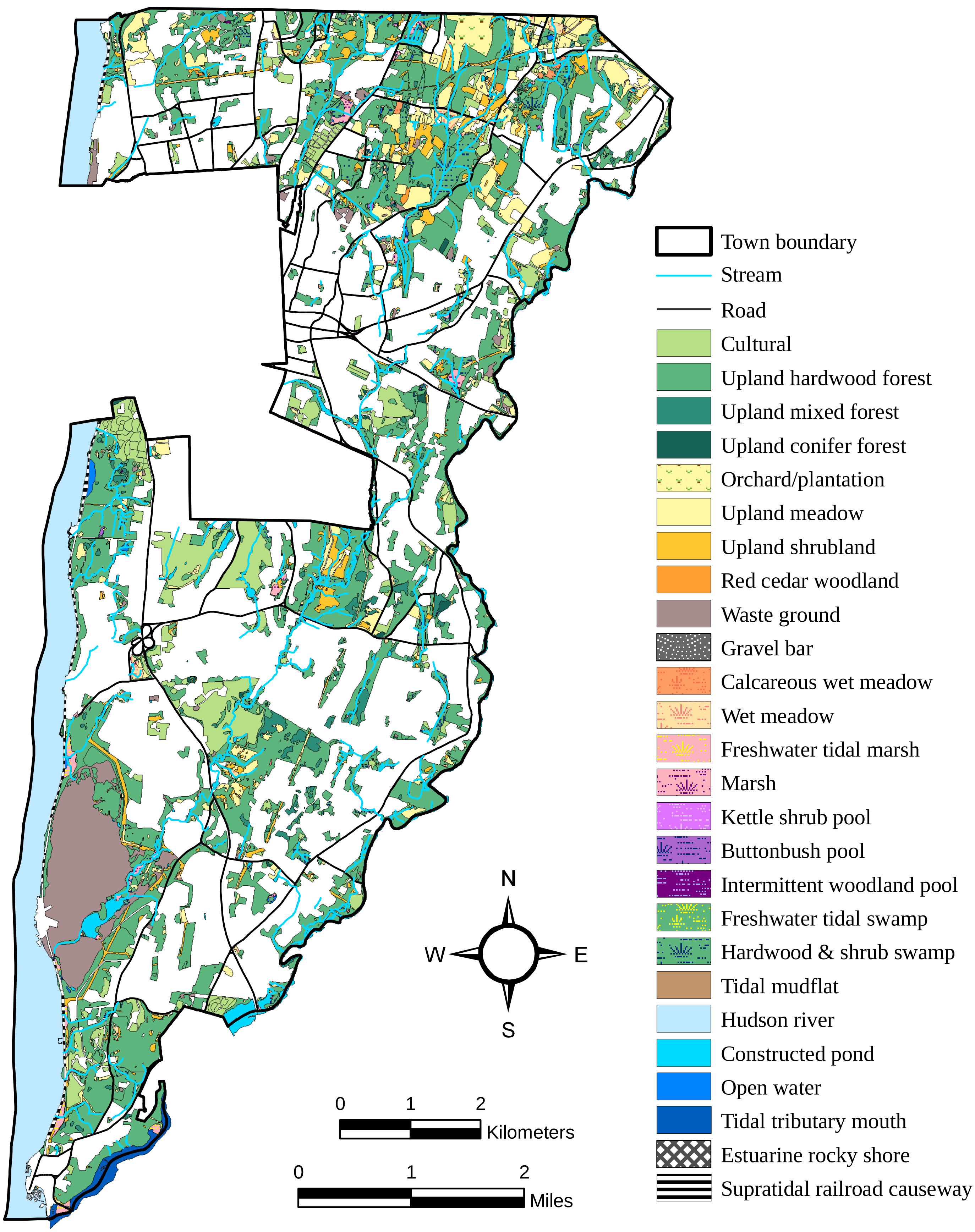


Figure 2. A reduction of the map illustrating the ecologically significant habitats in the Town of Poughkeepsie, Dutchess County, New York. Developed areas and other non-significant habitats are shown in white. The large-format map is printed in three sections at a scale of 1:10,000. Hudsonia Ltd., 2008.

HABITAT DESCRIPTIONS

In the following pages we describe some of the ecological attributes of the habitats identified in the Town of Poughkeepsie, and discuss some conservation measures that can help to protect these habitats and the species of conservation concern they may support. We have indicated species of conservation concern (those that are listed by state or federal agencies or considered rare or vulnerable by non-government organizations) that are associated with these habitats by placing an asterisk (*) after the species name. Appendix C provides a more detailed list of rare species that may occur in the town, organized by habitat type and including the statewide and regional conservation status of each species. 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 that upland forests are in fact much more 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</u>

Upland hardwood forest is the most common habitat type in the region, and includes many different types of deciduous forest communities at all elevations. Upland hardwood forests are used by a wide range of common and rare species of plants and animals. Common trees of upland hardwood forests in Poughkeepsie include maples (sugar, red, Norway), oaks (black, red, white), hickories (shagbark, pignut), white ash, and black locust. Common understory species include introduced honeysuckle shrubs, spicebush, hop hornbeam, and a variety of wildflowers, sedges, ferns, lichens, and mosses.

Eastern box turtle* spends most of its time in upland forests and meadows, finding shelter under logs and organic litter. Many snake species forage widely in upland forests and other habitats. Upland hardwood forests provide nesting habitat for raptors, including red-shouldered hawk,* Cooper's hawk,* sharp-shinned hawk,* broad-winged hawk,* and barred owl,* and many species of songbirds including warblers, vireos, thrushes, woodpeckers, and flycatchers. American woodcock* forages and nests in young hardwood forests. Pileated woodpecker uses large trees (live or standing dead) for foraging, roosting, and nesting (Bull and Jackson 1995). Acadian flycatcher,* wood thrush,* cerulean warbler,* Kentucky warbler,* and scarlet tanager* are some of the birds that may require large forest-interior areas to maintain viable populations. Large mammals such as black bear,* bobcat*, and fisher* also require large expanses of forest. Many small mammals are associated with upland hardwood forests, including eastern chipmunk, southern flying squirrel, and white-footed mouse. Hardwood trees greater than 5 inches (12.5 cm) in diameter (especially those with loose platy bark such as shagbark hickory or deeply furrowed bark such as black locust) can be used by Indiana bat* and other bat species 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. Many smaller habitats, such as intermittent woodland pools and crest, ledge, and talus, are frequently embedded within areas of upland hardwood forest.

Upland Conifer Forest

This habitat includes pole-sized (approximately 5-10 in [12-25 cm] diameter at breast height) to mature conifer plantations and naturally occurring upland forests with more than 75% cover of conifer trees. Eastern hemlock and white pine are typical species of spontaneous conifer stands in the area. Various native and non-native species are used in conifer plantations. In general, plantations are more uniform in size and age of trees, structure, and overall species composition than natural conifer stands. 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,* black-throated green warbler,* evening grosbeak,* purple finch,* 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

The term "upland mixed forest" refers to non-wetland forested areas with both hardwood and conifer species, 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 Poughkeepsie

Forested areas in the Town of Poughkeepsie, including both forested wetlands and uplands, are shown in Figure 3. The largest contiguous forest in the Town of Poughkeepsie occupies an approximately 275 ac (111 ha) area south of Bedell Road and extending to approximately the old Maybrook rail line. Other large forested areas 200 ac (80 ha) and larger include an area north of Bedell Road, a portion of the Vassar Farms property, an area east and south of the Casperkill Country Club, a large portion of Locust Grove continuing north to the Poughkeepsie Rural Cemetery, an area between Creek Road and Salt Point Turnpike, and an area south of Bower Road. Six additional forest areas were greater than 100 ac (40 ha). The forested areas in the town are probably not large enough to support all of the forest dwelling animals listed in the habitat descriptions above, but are still likely to host many species adapted to smaller forest areas (including some forest interior species) and forest edge habitats.

Upland hardwood forest was the most widespread habitat type in the town, accounting for approximately 24% of the total land area. In some places we found "rich forest" which supported calcium-associated plant species. We presume that virtually all forests in the Town of Poughkeepsie have been cleared or logged in the past and that no "virgin" stands remain. However, many large forest-grown trees were found in the town, most commonly in some proximity to the Hudson River or Wappinger Creek, and were noted in the "natural history notes" GIS layer. We observed pileated woodpeckers, which depend on the presence of large trees, on several occasions in Poughkeepsie forests. Upland hardwood forests that can be characterized as floodplain forest were common in level areas adjacent to the Wappinger Creek. Species such as sycamore and eastern cottonwood were common in these places; we also found rich forest herbaceous species in several of these forests and black maple* in one locality. The understory of hardwood forests in the Town of Poughkeepsie was often dominated by non-native shrubs such as shrub honeysuckles and multiflora rose (which is a common condition in post-logging and post-agricultural forests in the Hudson Valley).

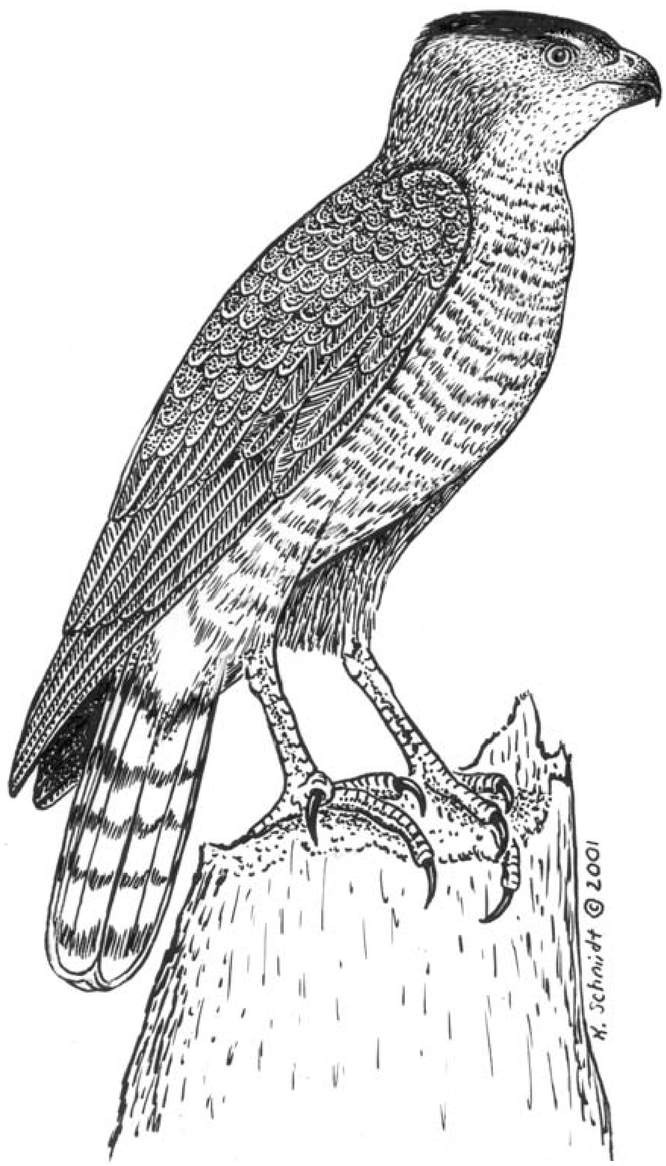
Upland mixed and conifer forests covered relatively small total areas (179 ac [72 ha] and 31 ac [12.5 ha], respectively). The largest areas of mixed or conifer forest were found in the east central part of the town. Most of the natural forests with conifers had eastern hemlock, white pine, and/or eastern red cedar. Eastern hemlock stands were found most commonly on somewhat steep, shallow, and/or rocky soils. As in other parts of Dutchess County, many hemlock stands in the town were infested with hemlock woolly adelgid, especially those close to the Hudson River. 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 succession forests on abandoned farmland. Planted conifer stands often consisted of Norway spruce, Scotch pine, or white pine. It is important to note that different kinds of conifer forests occupy different ecological niches 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.

Sensitivities/Impacts

Forests of all kinds are important habitats for wildlife. Extensive forested areas that are unfragmented by roads, meadows, trails, utility corridors, or developed lots are especially important for certain organisms, but are increasingly rare in the region. New development located along roads may prevent wildlife from traveling between forested blocks. New houses set back from roads by long driveways further add to the fragmentation of interior forest areas. 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. Poor logging practices can also damage the understory and cause soil erosion and siltation of streams. Soil compaction and removal of dead and downed wood and debris have many 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. The roadway itself can provide nest predators (such as raccoon and opossum) and the brown-headed cowbird (a nest parasite) access to interior forest areas. 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. Gaps created by logging can provide habitat for fast-growing, shade-intolerant, non-native species such as tree-of-heaven. Once established, many of these non-native species are difficult to eliminate. Due to the fragmented nature of forested areas in the Town of Poughkeepsie, most have some non-native species, and they reach high densities in many places. Human habitation has also led to the suppression of naturally occurring wildfires which can be important for the persistence of some forest species.

Introduced forest pests are also threatening forest health in the Hudson Valley. Of note is the hemlock woolly adelgid, an insect which has infested many eastern hemlock stands from Georgia to New England. The adelgid typically kills trees within 10-15 years and has the potential to cause naturally occurring upland mixed and conifer forests to become regionally rare. In Poughkeepsie many hemlock stands are in some stage of decline, but there are still several areas with hemlocks exhibiting few if any signs of infestation. The hemlock stands are generally healthier in the western part of town than the east. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of large forests in large contiguous habitat complexes.)



Cooper's hawk

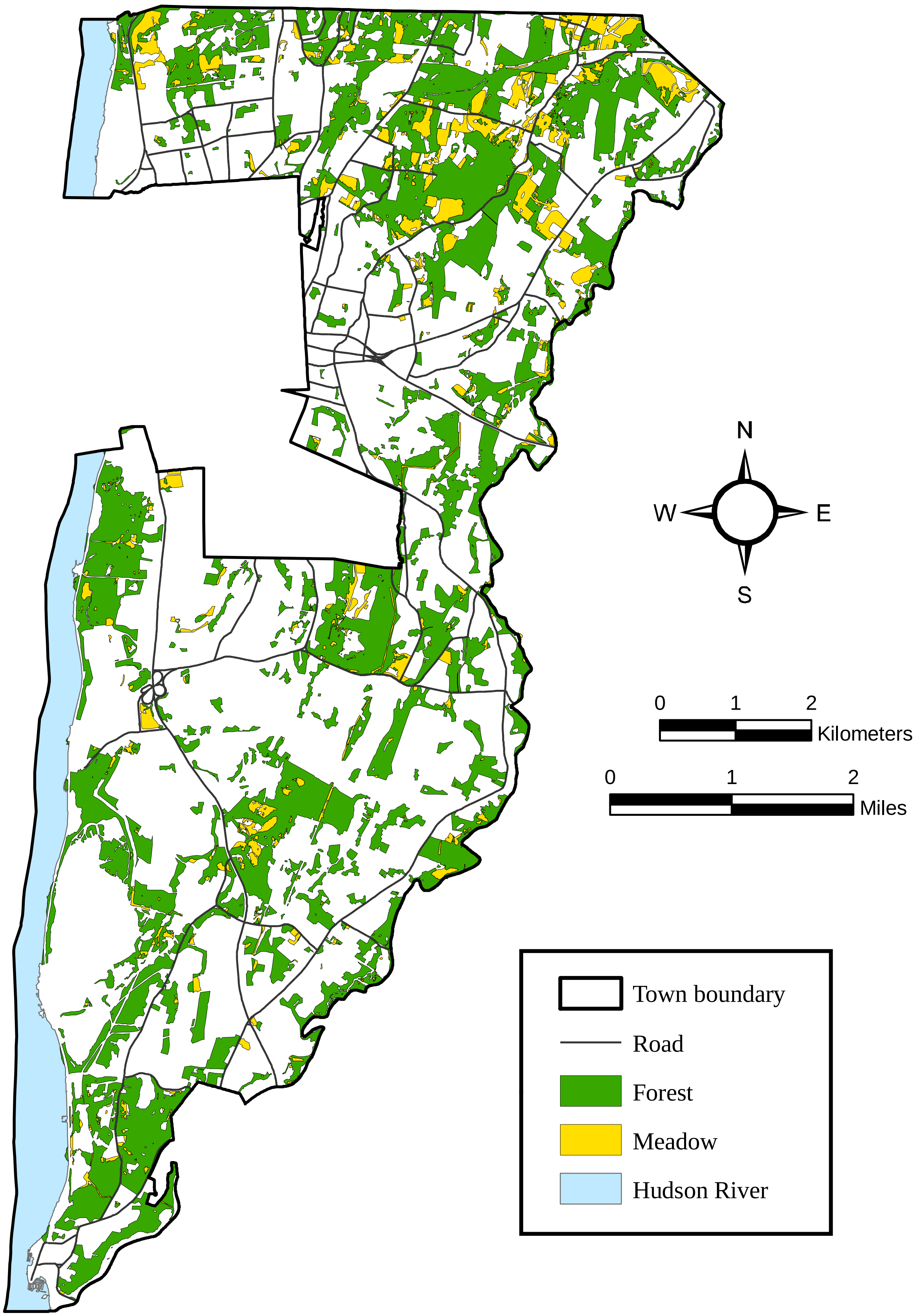


Figure 3. Contiguous forest patches (including upland forests and swamps) and contiguous meadow patches (including upland meadows, wet meadows, and calcareous wet meadows) in the Town of Poughkeepsie, Dutchess County, New York. Hudsonia Ltd., 2008.

RED CEDAR WOODLAND

Ecological Attributes

Red cedar woodlands feature an overstory dominated by widely spaced eastern red cedar trees with 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). Red cedar stands tend to become more dense (leaving smaller grassy areas) as the trees mature. They tend to develop particularly dense stands in areas with calcareous soils. Other less common saplings and small trees in this habitat include gray birch, white ash, red maple, quaking aspen, and red oak. The understory vegetation is typical of upland meadow (see below). 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 but begin to decline once overtopped by hardwoods. We mapped areas where abundant red cedar occurs under a canopy of hardwoods as “upland mixed forest.”

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 or forest habitats to reach the nesting grounds. Eastern hognose snake* may also use red cedar woodlands 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 fruit-like seeds of red cedar are a food source for eastern bluebird,* cedar waxwing, and other birds. Many songbirds also use red cedar for nesting and roosting, including field sparrow,* eastern towhee,* and brown thrasher.* Insectivorous birds such as black-capped chickadee and golden-crowned kinglet forage in red cedar.

Occurrence in the Town of Poughkeepsie

Red cedar woodlands were small and relatively uncommon in the Town of Poughkeepsie, where recently-abandoned agricultural areas are few. The areas of red cedar woodland that were still present were often associated with a rocky substrate, which may be a cause for a slower transition into young forests.

Sensitivities/Impacts

Extensive occurrences of red cedar woodlands are limited in Dutchess County. 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. Human disturbances may also facilitate the invasion of non-native forbs and shrubs that tend to diminish habitat quality by forming dense stands that 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.

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 low-elevation 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 that often accumulate at the bases of steep ledges and cliffs. We also included large glacial erratics (glacially-deposited boulders) in the “crest/ledge/talus” 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 array of uncommon or rare plants and animals. Some species, such as wall-rue,* smooth cliffbrake,* purple cliffbrake,* and northern slimy salamander* are found only in and near such habitats 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 differentiated calcareous bedrock exposures wherever possible. In the region, calcareous crests support 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, and maidenhair spleenwort. They can support numerous rare plant species, such as walking fern,* and yellow harlequin.* 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, and common polypody. Rare plants of non-calcareous crests include clustered sedge,* and slender knotweed.*

Northern oak 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 racer,* eastern ratsnake, and northern copperhead.* 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 crests and ledges for travel, hunting, and cover. Bobcat also uses ledge and talus habitats for denning. Southern redback vole is found in some rocky areas, and small-footed bat* roosts in talus habitat.

Occurrence in the Town of Poughkeepsie

Crest, ledge, and talus habitats were scattered throughout the town (Figure 4). The largest areas with exposed rock were found along the Hudson River shoreline and its vicinity. Calcareous crest, ledge, and talus areas were also identified throughout the town. We found walking fern,* a regionally scarce plant, on two calcareous ledges in the east central part of the town. While ledge and talus were most commonly found in forested areas, there were several areas of shale gravel that supported only patchy herbaceous vegetation. We mapped ledge habitats that were exposed by the construction of roads and the railroad only when they were contiguous with other significant habitat types.

Sensitivities/Impacts

Crest, ledge, and talus habitats often occur in locations that are valued by humans for recreational uses, scenic vistas, and house sites. Construction of trails, roads, and houses destroys crest, ledge, and talus habitats directly, and causes fragmentation of these habitats and the forested areas of which they are often a part. Rare plants of rocky habitats are vulnerable to trampling and collecting; rare snakes are susceptible to road mortality, intentional killing, and collecting; and rare breeding birds 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.

Walking fern on a calcareous ledge

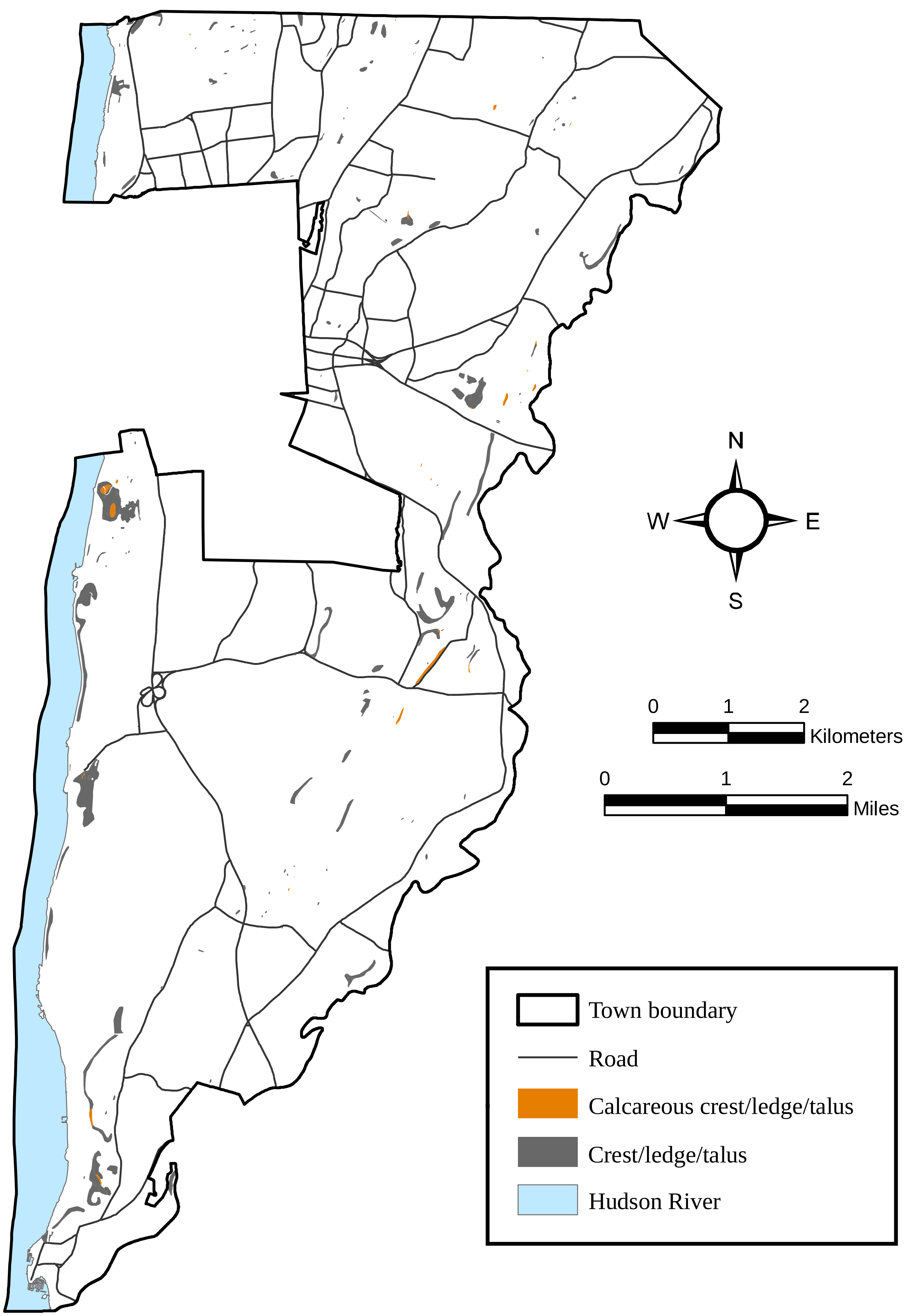


Figure 4. Generalized distribution of crest, ledge, and talus and identified calcareous crest, ledge, and talus in the Town of Poughkeepsie, Dutchess County, New York. Locations identified from field observations and inferred from areas of shallow soils on steep slopes as mapped in Faber (2002). Hudsonia Ltd., 2008.

UPLAND SHRUBLAND

Ecological Attributes

We use the term "upland shrubland" to describe non-forested uplands with significant (>20 %) shrub cover. In most cases these are lands in transition between meadow and young forest, but they also occur in recently cleared areas, and are sometimes maintained as shrubland along utility corridors by cutting or herbicides. Recently cleared or disturbed sites often contain dense thickets of shrubs and vines, including the non-native Japanese barberry, Bell's honeysuckle, oriental bittersweet, and multiflora rose. Abandoned agricultural fields and pastures often support more diverse plant communities, including a variety of meadow grasses and forbs, shrubs such as meadowsweet, gray dogwood, northern blackberry, raspberries, and multiflora rose, and scattered seedling- and sapling-size eastern red cedar, hawthorns, white pine, gray birch, red maple, white ash, black cherry, quaking aspen, and oaks. Occasional large, open-grown trees (e.g., sugar maple, white oak, sycamore) left as shade for livestock may be present.

A few species of rare plants are known from calcareous shrublands in the region, such as stiff-leaf goldenrod,* butterflyweed,* and shrubby St. Johnswort.* Rare butterflies such as Aphrodite fritillary,* dusted skipper,* and Leonard's skipper* may occur in shrublands where their host plants are present (violets for the fritillary and native grasses, such as little bluestem, for the skippers). 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. 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, white-footed mouse, and eastern cottontail.

Occurrence in the Town of Poughkeepsie

Upland shrublands were commonly found in abandoned agricultural areas and utility corridors, and ranged in size from 0.02 to 18.8 ac (>0.01-7.6 ha), for a total of 382 ac (155 ha). The largest shrublands were generally those that occupied abandoned agricultural fields.

Sensitivities/Impacts

Shrublands and meadows (see below) are closely related plant communities and share many of the same ecological values. 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 and other vehicles and equipment can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. If shrublands are left undisturbed, most will eventually become forests, which are also valuable habitats.

UPLAND MEADOW

Ecological Attributes

This broad category includes active cropland, hayfields, pastures, equestrian fields, abandoned fields, and other upland areas dominated by herbaceous vegetation. Upland meadows are typically dominated by grasses and forbs, and have less than 20% shrub cover. The ecological values of these habitats can differ widely according to the types of vegetation present and varied 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 other 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 future ecological values that we consider all types of meadow habitat to be ecologically significant.

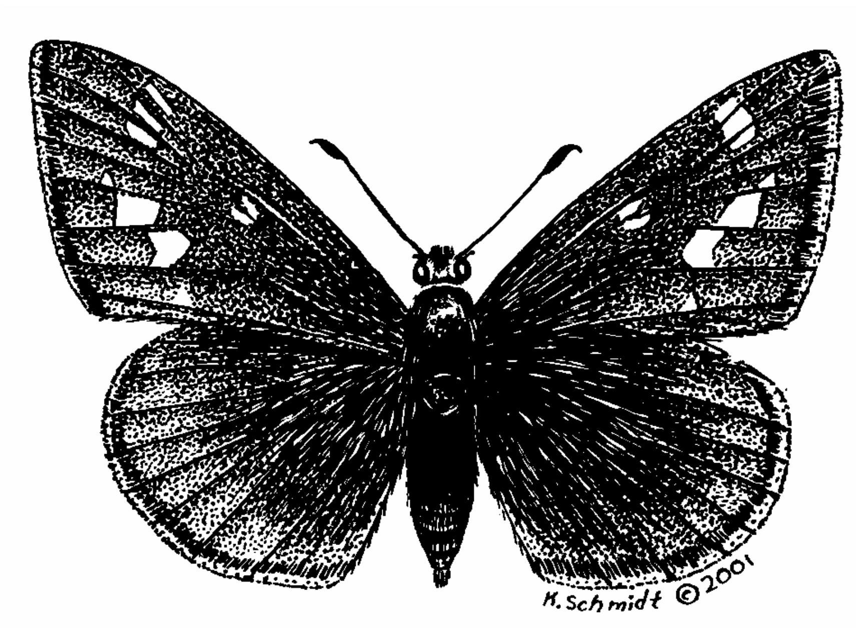
Several species of rare butterflies such as Aphrodite fritillary,* dusted skipper,* Leonard's skipper,* and swarthy skipper* use upland meadows that support their particular host plants (violets for the fritillary and native grasses, such as little bluestem, for the skippers). Upland meadows can be used for nesting by wood turtle,* spotted turtle,* eastern box turtle,* painted turtle, and snapping turtle. Grassland-breeding birds such as northern harrier,* upland sandpiper,* grasshopper sparrow,* vesper sparrow,* savannah sparrow,* eastern meadowlark,* and bobolink* use extensive meadow habitats for nesting and foraging. 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 Poughkeepsie

Upland meadow was a common habitat type in the Town of Poughkeepsie, but accounted for only 4% of the total land area. Figure 3 illustrates the location and distribution of contiguous meadow habitat in the town (including both upland and wet meadows). This figure does not include areas of upland shrubland that in some cases had considerable patches of herbaceous cover. Upland meadows were relatively small in the Town of Poughkeepsie, ranging from smaller than 0.1 ac (0.04 ha) to nearly 31 ac (12.5 ha). The largest upland meadows were concentrated in the north part of the town, and consisted mostly of mowed fields rather than crop fields or pasture; two capped landfills were also among these larger meadows. Some small areas of upland meadow in the town had a relatively sparse herbaceous layer growing on shale gravel (depicted on the map as upland meadow with crest/ledge/talus).

Sensitivities/Impacts

Principle causes of meadow habitat loss in the region are the regrowth of shrubland and forest after abandonment, and residential and commercial development; the latter is the most common cause in suburban areas such as the Town of Poughkeepsie. The dramatic decline of grassland-breeding birds in the Northeast has been attributed to the loss of large areas 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 and 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 plant populations 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 and Planning section for recommendations for maintaining large meadow habitats.)



Dusted skipper

ORCHARD/PLANTATION

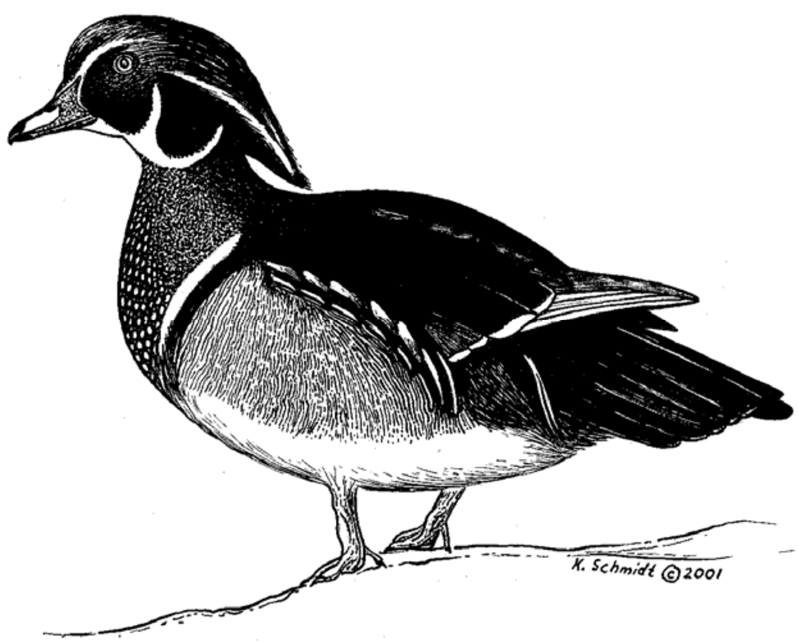
This habitat type includes actively maintained or recently abandoned fruit orchards, Christmas tree farms, and plant nurseries. Conifer plantations with larger, older trees are mapped as "upland conifer forest." Orchards and plantations are used by many common bird species for foraging and nesting. Christmas tree farms are potential northern harrier* breeding habitat. Fruit orchards with old trees are potential breeding habitat for eastern bluebird* and may be valuable to other cavity-using birds, bats, and other animals. The habitat value of active orchards or plantations is often compromised by frequent mowing, application of pesticides, and other human activities; we considered this an ecologically significant habitat type more for its ecological values after abandonment than for its value while actively maintained as an orchard or plantation. These habitats have some of the vegetation structure and ecological values of upland meadows and upland shrublands, and will ordinarily develop into young forests if they remain undisturbed after abandonment. Orchards/plantations were uncommon in the Town of Poughkeepsie. The largest of these is the abandoned orchard on Peach Hill at the northern border of the town, which covers an area of 93 ac (38 ha). Several tree plantations were concentrated in the northeast part of the town.

CULTURAL

We define "cultural" habitats as areas that are significantly altered and intensively managed (e.g., mowed), but are not otherwise developed with pavement or structures. We mapped this as an ecologically significant habitat type more for its potential future 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 and roost in cultural areas. American kestrel, spring migrating songbirds, and bats may forage in these habitats, and wood duck* may nest here. Individual ornamental trees can provide habitat for cavity-nesting birds, roosting bats (including Indiana bat* and small footed myotis*), and other animals. 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 ecological services such as buffering less disturbed habitats from human activities, and linking patches of undeveloped habitat together. Because cultural habitats are already significantly altered, however, their current habitat value is greatly diminished compared to relatively undisturbed habitats.

Occurrence in the Town of Poughkeepsie

Cultural areas were the second most common habitat type in the Town of Poughkeepsie, and included golf courses, playing fields, cemeteries, and large lawns. The golf courses and some cemeteries covered extensive areas, with the four largest of these nearing or exceeding 100 ac (40 ha). Two of these largest cultural areas (the Casperkill Country Club and the Poughkeepsie Rural Cemetery) were part of larger, contiguous patches of habitat (Figure 6).



Wood duck

WASTE GROUND

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 substantially unvegetated. This category encompasses a variety of highly impacted areas such as active and abandoned gravel mines, rock quarries, mine tailings, dumps, unvegetated wetland fill, unvegetated 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 and mosses may potentially occur in some waste ground habitats. Several snake and turtle species of conservation concern, including eastern hognose snake* Blanding's turtle,* and wood turtle,* may use the open, gravelly areas of waste grounds for burrowing, foraging, or nesting habitat. Bank swallow* and belted kingfisher sometimes nest in the stable walls of inactive soil mines or piles of soil or sawdust. Bare, gravelly, or otherwise open areas provide nesting grounds for spotted sandpiper, killdeer, and possibly common nighthawk.* The biodiversity value of waste ground will often increase over time as it develops into a higher quality habitat. However, on sites where species of conservation concern are absent or unlikely, waste ground probably has a low habitat value compared to other relatively undisturbed habitats. We mapped one large active mining operation (the Tilson mine, where the current habitat value appeared negligible) and many small disturbed areas as waste ground in the Town of Poughkeepsie.

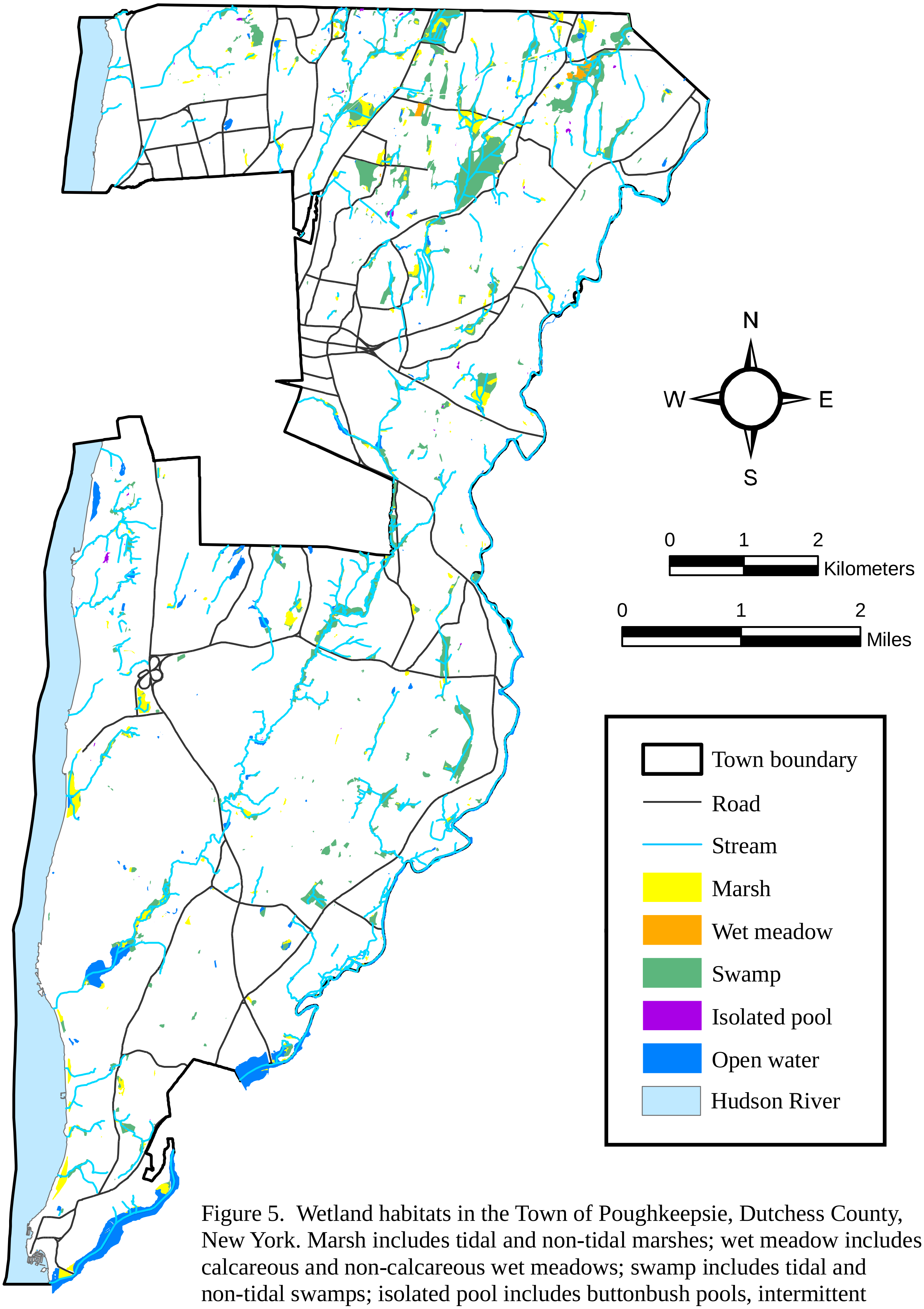


Figure 5. Wetland habitats in the Town of Poughkeepsie, Dutchess County, New York. Marsh includes tidal and non-tidal marshes; wet meadow includes calcareous and non-calcareous wet meadows; swamp includes tidal and non-tidal swamps; isolated pool includes buttonbush pools, intermittent woodland pools, and kettle shrub pools; and open water includes constructed ponds, open water, tidal and non-tidal streams. Hudsonia Ltd., 2008.

WETLAND HABITATS

HARDWOOD & SHRUB SWAMP

Ecological Attributes

A swamp is a wetland dominated by woody vegetation (trees and/or shrubs). We combined 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, pin oak, and swamp white oak are common trees of hardwood swamps in the region. Typical shrubs include silky dogwood, swamp azalea, spicebush, winterberry holly, and highbush blueberry, and common herbaceous species are tussock sedge, sensitive fern, and skunk cabbage.

Swamps are important to a wide variety of birds, mammals, amphibians, reptiles, and invertebrates, especially when swamp habitats are contiguous with other wetland habitats or embedded within large areas of upland forest. Swamp cottonwood,* a NYS Threatened species known from only a handful of locations in the Hudson Valley, is a tree of deep-flooding hardwood swamps. 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, uses swamps with rocks or abundant moss-covered downed wood or woody hummocks. Red-shouldered hawk,* barred owl,* great blue heron,* wood duck,* prothonotary warbler,* Canada warbler,* Virginia rail,* and white-eyed vireo* may nest in hardwood swamps.

Occurrence in the Town of Poughkeepsie

Hardwood and shrub swamp was by far the most extensive wetland habitat type in the Town of Poughkeepsie, covering a total of 700 ac (283 ha) (Figure 5). Swamps ranged in size from <0.1 to 91 ac (<0.04-37 ha), with an average extent of 1.7 ac (0.7 ha). They were often contiguous with other wetland habitats such as marsh, wet meadow, and sometimes deep water areas mapped as open water (Figure 5). The largest contiguous swamp was located northwest of Van Wagner Road, and had both forested and shrub-dominated portions. Other large swamps in the northeastern section of town included an area east of Van Wagner Road and south of Bower Road and an area between Salt Point Turnpike and Edgewood Drive. Another large, contiguous swamp was associated with the Casperkill at Vassar Farms. Smaller swamps were widely scattered through the town. Hardwood and shrub swamps were typically dominated by red maple, green ash, swamp white oak, or silky dogwood.

Swamps occurred in a variety of settings, such as along streams, in depressions, or on seepy slopes. Some were shrub-dominated (native or exotic), while others had a full canopy of trees. Water depth varied greatly, with some swamps drying completely in the summer months while others retained relatively deep pools. Swamps that were isolated from streams and other wetlands may have ecological roles similar to those of intermittent woodland pools, providing a seasonal source of water with few aquatic predators, breeding habitat for pool-breeding amphibians, and refuge for turtles (see below). Although we did not designate them as a separate habitat, some swamps in Poughkeepsie were calcareous and supported plant species of calcareous wetlands such as black ash and small-flowered agrimony.

Sensitivities/Impacts

Some swamps are protected by federal or state laws, but 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 value, similar to intermittent woodland pools (see below). Many of the larger swamps in the region are located in low-elevation areas where human land uses are also concentrated. They can easily be damaged by alterations to the quality, quantity, or timing of surface water runoff, or by disruptions of the groundwater sources feeding them. Swamps that are surrounded by agricultural land are subjected to runoff contaminated with agricultural chemicals, and those near roads and other developed areas often receive runoff high in nutrients, sediment, de-icing salts, and toxins. Polluted runoff and groundwater degrade the 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 of swamps. Direct disturbance, such as logging, can damage soil structure, plant communities, and microhabitats, and provide access for invasive plants. Ponds for ornamental or other purposes are sometimes excavated in swamps, but the loss of habitat values of the pre-existing swamp usually far outweighs any habitat value gained in the new, artificial pond environment. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of swamps within larger wetland complexes.)

Tussock sedge in swamp

INTERMITTENT WOODLAND POOL

Ecological Attributes

An intermittent woodland pool is a small wetland partially or entirely surrounded by forest, typically with no surface water inlet or outlet (or an ephemeral one), and with standing water during 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 leaf litter, the base of the pool’s food web; the forest is also essential habitat for adult amphibians during the non-breeding seasons.

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

Occurrence in the Town of Poughkeepsie

We mapped 48 small intermittent woodland pools in the Town of Poughkeepsie (Figure 8). Pools were scattered in undeveloped parts of the town within upland forests and occasionally adjacent to swamps. Most of the pools were smaller than 0.1 ac (0.04 ha), with an average size of 0.07 ac (0.03 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 function of the pools is frequently destroyed. Intermittent woodland pools are often excluded from federal and state wetland protection due to their small size and their isolation from other wetland and stream 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 and Planning section for recommendations on protecting the habitat values of intermittent woodland pools.)

Marbled salamander

BUTTONBUSH POOL/KETTLE SHRUB POOL

Ecological Attributes

Buttonbush pools are seasonally or permanently flooded, shrub-dominated pools, 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, a shrub thicket in the middle of the pool is entirely or partly surrounded by an open water moat. Small trees such as red maple or green ash may occur in the pool interior. These pools are typically isolated from streams, though some may have a small, intermittent inlet and/or outlet. Standing water is normally present in winter and spring but often disappears by late summer, or remains only in isolated puddles.

The kettle shrub pool, a specific type of buttonbush pool, has all the previous characteristics but is located in a glacial kettle—a depression formed by the melting of a stranded block of glacial ice. Glacial outwash soils (e.g., Hoosic gravelly loam) are found adjacent to these pools. 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 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 other buttonbush pools also have many of the habitat attributes of intermittent woodland pools, and are used by many intermittent woodland pool species (see above).

Occurrence in the Town of Poughkeepsie

We documented nine buttonbush pools and four kettle shrub pools in the Town of Poughkeepsie (Figure 8). Most were less than 1 ac (0.4 ha). The kettle shrub pools were all found in the northeastern section of the town.

Sensitivities/Impacts

Buttonbush pools and kettle shrub pools may be particularly sensitive to changes in hydrology. Groundwater extraction in the vicinity could alter the pool's hydroperiod and water depth, and alteration of surface water entering or leaving the pool could drastically change its character. These pools are also sensitive to changes in water chemistry; runoff from roads, agricultural fields, lawns, and construction sites all negatively affect water quality. Development and habitat fragmentation in the surrounding landscape threaten the habitat connections between 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. The presence of glacial outwash soils make the areas around kettle shrub pools attractive places for gravel mining operations, which may alter the water chemistry or hydroperiod, or even extend into the pools. More information about this habitat is found in Kiviat (1993), Kiviat and Stevens (2001; under "Kettle Shrub Pool" and "Blanding's Turtle"), and Kiviat and Stevens (2003). (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of buttonbush pools and kettle shrub pools.)

Tiger swallowtail on buttonbush flowers

MARSH

Ecological Attributes

A marsh is a wetland that has standing water for most or all of the growing season, and is dominated by herbaceous (non-woody) vegetation. Marshes often occur at the fringes of deeper water bodies (e.g., lakes and ponds), or in close association with other wetland habitats such as wet meadows or swamps. The edges of marshes, where standing water is less permanent, often grade into wet meadows. Cattail, tussock sedge, arrow arum, broad-leaved arrowhead, water-plantain, and purple loosestrife are some typical emergent marsh plants in this region. Deeper water may support rooted, floating-leaved plants such as pond-lilies, or submergent aquatic plants such as pondweeds, bladderworts, and watermilfoils.

Several rare plant species are known from marshes in the region, including buttonbush dodder.* Marshes are 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,* American black duck,* and wood duck* use marshes for nesting, nursery, or foraging habitat. Many raptor, wading bird, and mammal species use marshes for foraging.

Occurrence in the Town of Poughkeepsie

We mapped 75 marsh areas in the Town of Poughkeepsie, covering a total of 67 ac (27 ha) (Figure 5). Marshes were frequently found along the margins of or embedded in hardwood and shrub swamps, wet meadows, or constructed ponds. 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. Common reed, purple loosestrife, cattail, and common duckweed were dominant in many of the marshes we observed in the field. Most of the mapped marshes within the town were small (<1 ac [0.4 ha]). Some of these were constructed ponds that had filled with sediment and vegetation over time. We also mapped as marshes those ponds that were relatively shallow and had a dense cover of floating vegetation. The largest marsh area in the town (approximately 12.4 ac [5 ha]) was part of the wetland northeast of St. Peter's Cemetery adjacent to Salt Point Turnpike. Another large marsh (approximately 9.7 ac [3.9 ha]) was contiguous with a large swamp north of Manchester Road (Route 55) near the eastern town boundary.

Sensitivities/Impacts

In addition to direct disturbances such as filling or draining, marshes are subject to stresses from offsite (upgradient) sources. Alteration of surface water runoff patterns or groundwater flows can lead to dramatic changes in the plant and animal communities of marshes. Polluted stormwater runoff from roads, parking lots, lawns, and other surfaces in developed landscapes carries sediments, nutrients, de-icing salts, toxins, and other contaminants into the wetland. Alteration of water levels by humans or beaver can also alter the plant community, and as with elevated nutrient and sediment inputs can facilitate invasion by non-native plants such as purple loosestrife and common reed. Purple loosestrife and common reed have displaced many of the native wetland graminoids in recent decades and are now common plants in many of the marshes in the Town of Poughkeepsie. 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 to meet various needs throughout the year, protection of the ecological functions of marshes must go hand-in-hand with protection of surrounding habitats. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of marshes within larger wetland complexes.)

WET MEADOW

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 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 several 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 other meadow habitats for foraging. (See below for a description of calcareous wet meadow, a specific type of wet meadow habitat).

Occurrence in the Town of Poughkeepsie

Wet meadows were scattered through the Town of Poughkeepsie, and were often associated with swamps and streams. We mapped 293 wet meadows, covering 150 ac (61 ha) in the town. Most wet meadows were smaller than 1 ac (0.4 ha). The largest wet meadow occurred south of Bedell Road in the north central part of the town, and covered approximately 13.9 ac (5.6 ha). Many wet meadows were dominated by non-native species such as purple loosestrife, and probably non-native genotypes of common reed and reed canary grass. In several localities we noted the poor regeneration of this year’s purple loosestrife stalks, but were unable to identify the cause (one possibility is the use of a biological control in the area). Wet meadows mapped along Wappinger Creek often occurred on a gravelly substrate and supported a mixture of wetland and upland herbaceous species, in a manner typical of meadows in a floodplain area.

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 has similar negative consequences. It is less damaging to the plant community to mow in late summer, when the soils are dry, than when soils are moist or wet (see the information on large meadows in the Priority Habitats section for general recommendations about mowing practices). Wet meadows that are part of larger complexes of meadow and shrubland habitats are prime sites for development or agricultural use, and are often drained or excavated. Because many wet meadows are omitted from state, federal, and site-specific wetland maps, they are frequently overlooked in environmental reviews of development proposals. (See the Conservation Priorities and Planning section for recommendations on preserving the habitat values of wet meadows within larger wetland complexes.)

Calcareous wet meadow

CALCAREOUS WET MEADOW

Ecological Attributes

A calcareous wet meadow is a 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 lakeside sedge, sweetflag, blue vervain, New York ironweed, rough-leaf goldenrod, and small-flowered agrimony.* The vegetation is often lush and tall.

High quality calcareous wet meadows with diverse native plant communities may support species-rich invertebrate communities, including phantom cranefly* and rare butterflies such as Dion skipper,* two-spotted skipper,* and Baltimore.* Eastern ribbonsnake* and spotted turtle* use calcareous wet meadows for basking and foraging. Many common wetland animals, such as green frog, pickerel frog, red-winged blackbird, meadow jumping mouse, and swamp sparrow use calcareous and other wet meadows.

Occurrence in the Town of Poughkeepsie

We documented 19 calcareous wet meadows in the Town of Poughkeepsie, most of which were smaller than 1 ac (0.4 ha). The largest calcareous wet meadow covered 7.3 ac (2.9 ha) south of Bower Road in the northeast section of the town. Most of the calcareous wet meadows in Poughkeepsie were contiguous with swamps and upland meadows. 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.

Sensitivities/Impacts

Calcareous wet meadows have sensitivities to disturbance similar to those of other wet meadows (see above). They are particularly vulnerable to soil disturbances, nutrient enrichment, and siltation, which often facilitate the spread of invasive species. Like other small wetland habitats without permanent surface water, they are often omitted from wetland maps and consequently overlooked in the environmental review of development proposals.

OPEN WATER

Ecological Attributes

"Open water" habitats include naturally formed ponds and lakes, large pools within tidal and non-tidal marshes and swamps that lack floating or emergent vegetation, and ponds that were apparently constructed by humans but have since reverted to a more natural state (i.e., surrounded by minimally managed habitats). 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. Open water areas can be important habitat for many common species of invertebrates, fishes, frogs, turtles, waterfowl, muskrat, beaver, and bats. These waterbodies sometimes support submerged aquatic vegetation that can provide important habitat for additional aquatic invertebrates and fish. Spiny coontail* (NYS Threatened) 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 occur in circumneutral ponds. American bittern,* osprey,* bald eagle,* wood duck,* American black duck,* pied-billed grebe,* and great blue heron* use open water areas as foraging habitat. Bats and river otter* also forage in open water habitats.

Occurrence in the Town of Poughkeepsie

We mapped far fewer open water habitats than constructed ponds (see below) in the Town of Poughkeepsie (and most or all of these "open water" areas were likely to be constructed in origin). Of the 51 open water habitats we mapped, the great majority were smaller than 0.5 ac (0.2 ha). The largest area mapped as open water was Sunfish Cove, a waterbody artificially created by the railroad causeway, which separates the cove from the Hudson River; this cove may be slightly subject to tidal influence, but lacks an obvious opening in the causeway. Bodies of open water where we observed abundant rooted, floating-leaved vegetation (e.g., pond-lilies, water chestnut) were mapped as marshes.

Sensitivities/Impacts

The habitat value of natural open water areas is maximized when they are not intensively managed or disturbed by human activities, and when they are surrounded by other intact habitats. Open water habitats are vulnerable to human impacts from 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 habitats 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 undeveloped ponds and lakes. If part of a pond or lake must be kept weed-free 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.

CONSTRUCTED POND

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. Most of these ponds are deliberately created for such purposes as fishing, watering livestock, irrigation, swimming, boating, and aesthetics. Some ponds are constructed near houses or other structures to serve as a source of water in the event of a fire. We also included 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 natural open water habitats. Undisturbed, shallower ponds can develop into marshes or swamps over time (see the open water and other wetland habitat descriptions).

Occurrence in the Town of Poughkeepsie

We classified the majority of the open water bodies in the Town of Poughkeepsie as constructed ponds. Most were maintained for ornamental or water retention purposes (and located in industrial, commercial, or landscaped areas). Because of the potential value of constructed ponds as drought refuge and foraging areas for turtles and other wildlife, we mapped constructed ponds within developed areas along with those surrounded by intact habitats.

All but 19 of the 165 constructed ponds we mapped were smaller than 1.0 ac (0.4 ha). Wappinger Lake, a dammed portion of Wappinger Creek, was the largest constructed pond, although only a portion of it (measuring 25.5 ac [10.3 ha]) is within the boundary of the Town of Poughkeepsie. Shallow constructed ponds with substantial cover of rooted floating-leaved or emergent vegetation (e.g., pondweeds, cattail, purple loosestrife, common reed) were mapped as marsh. Ponds entirely surrounded by forest and other minimally managed habitats were mapped as open water, even if they were constructed in origin.

Sensitivities/Impacts

The habitat value of constructed ponds varies depending on factors such as the landscape context, extent of human disturbance, and degree of invasion by non-native species. In general, the habitat value is higher when the ponds have undeveloped shorelines, are relatively undisturbed by human activities, have more native vascular plant vegetation, and are embedded within an area of intact habitat. Because many constructed ponds are not buffered by sufficient natural vegetation and soil, 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 those maintained as ornamental ponds 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, care should be taken to minimize these impacts.

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 natural habitats far outweighs any habitat value gained in the new artificially created environments.

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). Springs often discharge into ponds, streams, or wetlands, but 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 significant water sources for many of our streams, and they help maintain the cool temperature of many streams, which is an important habitat characteristic for some rare and declining fish species and other stream organisms. 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 springs and 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* uses springs and cold streams.

Occurrence in the Town of Poughkeepsie

Because the occurrence of springs and seeps is difficult to predict by remote sensing, we mapped only the very few we saw in the field and those that had a recognizable signature on (or could be inferred from) one of our map sources. We expect there are many more springs and seeps in the town that we did not map. More detailed inventories of seeps and springs should be conducted as needed on a site-by-site basis.

Sensitivities/Impacts

Springs are easily disrupted by disturbance to upgradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltrating waters. 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 an essential water source 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 riparian corridors. Instead we have delineated buffer 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 in the Priority Habitats section, and Figure 9). These buffer zones do not necessarily cover the whole riparian corridor for any stream, however, which varies in width depending on local topography, the size of the stream's catchment area, and other factors.

Riparian areas tend to have high species diversity and high biological productivity, and many species of animals 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 those more restricted to floodplains, such as sycamore and eastern cottonwood.

We know of many rare plants of streams and floodplains in the region, such as 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 stocked in many streams by the New York State Department of Environmental Conservation and by private groups. Wood turtle* uses perennial streams with pools and recumbent logs, undercut banks, or muskrat or beaver burrows. Perennial streams and their riparian zones, including 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 riparian forests, especially those with extensive stands of mature trees. Bats, including Indiana bat,* use perennial stream corridors for foraging (U.S. Fish and Wildlife Service 2007). Muskrat, beaver, mink, and river otter* are some of the mammals that use riparian corridors regularly. Riparian forests are particularly effective at removing dissolved nutrients from stream water, and produce high quality detritus (dead plant matter) important to the aquatic food web.

Intermittent streams flow only during certain times of the year or after rains, but some may flow throughout the growing season in wet years. They are the headwaters of most perennial streams, and are significant water sources for lakes, ponds, and many kinds of wetlands. The condition of these streams therefore directly influences the water quantity and quality of those 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,* may-apple,* and small-flowered agrimony* are 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 Poughkeepsie

Though altered by the surrounding development, perennial streams were prominent features in the Town of Poughkeepsie. Wappinger Creek, the largest perennial stream in the study area, forms most of the eastern boundary of the town, its currents sometimes depositing gravel on its shore or in small islands (shown as “gravel bar” on the map). The Casperkill flowed for approximately 10 miles (16 km) through the center of the town. Fallkill Creek and its perennial tributaries formed the major drainages in the north central portion of the town, and several smaller, unnamed perennial streams (or sections of streams) were also identified throughout the town. Intermittent streams were common (Figure 9).

The riparian zone of the Wappinger Creek included areas of distinctive floodplain vegetation. Trees such as sycamore, eastern cottonwood, and box elder were common in floodplain forests (mapped as upland hardwood forest), and their understory often supported ostrich fern or Japanese stiltgrass. Meadows in floodplain areas commonly had a mixture of wetland species such as purple loosestrife and sensitive fern, and facultative wetland species of graminoids, ferns, and herbs (these were mapped as wet meadows only where wetland species predominated). In one floodplain forest we identified black maple,* and several riparian forests supported rich forest indicators such as basswood, bladdernut, wild ginger, and wild leek.

Sensitivities/Impacts

Removal of trees or other shade-providing vegetation along a stream can lead to elevated water temperatures that adversely affect aquatic invertebrate and fish communities. This effect on water temperature may be magnified when riparian conifer cover is lost (e.g., as when eastern hemlocks along stream corridors decline due to a hemlock woolly adelgid infestation), and such losses may also cause an alteration in water chemistry. Clearing of floodplain vegetation can reduce the important exchange of nutrients and organic materials between the stream and the floodplain. It can also diminish the floodplain's capacity for flood attenuation, leading to increased flooding downstream, scouring and bank erosion, and siltation of downstream reaches. Any alteration of flooding regimes, stream water volumes, timing of runoff, and water quality can profoundly affect the habitat characteristics and species of streams and riparian zones. 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 to both stream and floodplain habitats. Channelized streams have higher velocities which can be destructive during snow melt and rain events. 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 a number of riparian weeds, including 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 water body.) Urbanization (including roads and residential, commercial, and industrial development) has been linked to deterioration in stream water quality in the region (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, driveways, parking lots, and roofs) may increase runoff, leading to erosion of stream banks and siltation of stream bottoms, and a consequent degradation of 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 and Planning section for recommendations on protecting the habitat values of streams and riparian corridors.)

Wappinger Creek

HUDSON RIVER HABITATS

ESTUARINE ROCKY SHORE

Ecological Attributes

This habitat type includes beaches of gravel, cobble, and natural rock rubble, as well as rock outcrops, ledges, and cliffs in and above the intertidal zone of the Hudson River. Estuarine rocky shores are subject to regular tidal inundation or wetting by wave splash and wind spray. These habitats also experience rapid heating and cooling, ice scouring in winter, and intermittent wind and wave disturbance. The plant community is usually sparse in the intertidal zone, but may be moderately dense in the splash zone above the high water mark. Many of the plants of rocky crest habitats (see above) occur in the drier portions of rocky shores while *Carex* sedges and other plants (e.g., sneezeweed) adapted to frequent wetting and drying occur near the high water mark and in the splash zone just above. Northern white cedar* and eastern red cedar can be found growing in rock crevices and on shallow soil while small crests with more developed soils can support hardwood trees. Rare plants of the upper intertidal zone of freshwater reaches of the Hudson River include estuary beggar-ticks,* heartleaf plantain,* and terrestrial starwort.* Eastern prickly-pear* has been found on a rocky shore in Rockland County, and river birch* on a rocky peninsula in Dutchess County. The faunal diversity supported by this habitat is poorly understood. Ledge- and rock-nesting birds such as eastern phoebe, mallard, and American black duck* may nest above mean high water. Map turtle* may bask and nest on rocky shores and harbor seal* may haul-out on isolated segments (Kiviat and Hartwig 1994). Mollusks may be prominent inhabitants, including the introduced zebra mussel.

Occurrence in the Town of Poughkeepsie

Small areas of estuarine rocky shore (mostly ledges) were relatively common along the Hudson River shore of the town. While many were colonized by non-native plants, some supported native and calcicolous plants. Since this habitat type is best mapped by looking at the shore from the Hudson River, there were likely to be additional estuarine rocky shores that we did not identify in those areas where we did not field check by boat.

Sensitivities/Impacts

Human uses such as mining, railroad construction, and hiking have historically affected estuarine rocky shores throughout the Hudson Valley. These activities can result in erosion and compaction of the thin soils, loss of flora through trampling, and disturbance of sensitive wildlife. Colonization by aggressive, non-native plants likely displaces native species from the already limited soils of these rocky habitats. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of estuarine rocky shores and tidal wetlands.)

Supratidal railroad causeway and estuarine rocky shore (far left)

SUPRATIDAL RAILROAD CAUSEWAY

"Supratidal railroad causeway" refers to the elevated railroad tracks that run parallel to the shores of the Hudson River, at some locations separating coves and bays from the river. These railroads rest on a foundation of fill material composed of coal cinder and crushed stone over larger blocks of rock. The railroad beds are contaminated with toxic elements and organic compounds from coal and petroleum use and wood preservatives used in the railroad ties, and are repeatedly sprayed with herbicides to prevent vegetation from overgrowing the tracks. Discarded railroad ties and a variety of other railroad-generated refuse litter large areas of the habitat. The vegetation is often dominated by non-native species and can range from nearly bare to a moderate cover of herbs and grasses. A narrow band of shrubs and young trees often occurs along the base of the railroad bed.

Despite its highly disturbed nature, this habitat has some potential biodiversity value worth noting. Several rare plants, including Drummond's rock-cress,* slender knotweed,* and kidneyleaf mud-plantain,* are known from supratidal railroads in the Hudson Valley. These railroads are also used intensively for nesting by snapping and eastern painted turtles. Wood turtle,* map turtle,* and spotted turtle* may also use the cinders and exposed gravel found along the railroad for nesting, and this habitat is sometimes used by snakes for basking.

Supratidal railroad causeway occupied much of the length of the Hudson River shore in the Town of Poughkeepsie. There were five lengths of causeway that separated coves of various sizes from the Hudson River.

FRESHWATER TIDAL SWAMP

Ecological Attributes

Freshwater tidal swamp is a forested or shrub-dominated wetland that occurs in the upper tidal zone of the freshwater reach of the Hudson River and its tidal tributaries, and can be found along the mainland or on islands. Tidal swamps may grade into non-tidal hardwood and shrub swamps as elevation increases (see above) or freshwater tidal marshes at lower elevations (see below). The substrate is continuously wet and is subjected to twice daily flooding by tidal water. In times of drought this tidal water may be slightly brackish as far north as Poughkeepsie.

Hudson River freshwater tidal swamps are biologically rich, but their ecology has been little studied. The plant community is similar to that of non-tidal swamps in the region. Areas that are more strongly influenced by the tide may have many dead or damaged trees. Common trees include red maple, green ash, black ash, slippery elm, sycamore, eastern cottonwood, and swamp white oak. Other trees and shrubs include willows, black gum, pin oak, Bell's honeysuckle, silky dogwood, red-osier dogwood, alder, northern arrowwood, nannyberry, and spicebush.

Nine species of rare mosses and two rare liverworts have been found in Dutchess County tidal swamps. Swamp lousewort,* Fernald's sedge,* and winged monkey-flower* occur in several tidal swamps in the region, and spongy arrowhead,* goldenclub* and heartleaf plantain* have been found at swamp edges. Wood turtle,* beaver, and mink are known to use Hudson River tidal swamps, and osprey* and bald eagle* sometimes perch in large trees near swamp edges. Faunal diversity is generally similar to that of non-tidal hardwood and shrub swamps (see above), but tidal swamps are also used by river otter,* banded killfish, mummichog, and common carp.

Occurrence in the Town of Poughkeepsie

We mapped seven small tidal swamps in the southern portion of the town. The largest of these areas covered 4.3 ac (1.7 ha) adjacent to the southernmost Hudson River cove in the town. We found estuary beggar-ticks* at the edge of one tidal swamp in the town. Tidal swamp habitat was generally found adjacent to tidal marsh, tidal tributary mouth, and upland forest habitats (see above and below).

Sensitivities/Impacts

Tidal swamp sensitivities are similar to those of non-tidal swamps; additionally, alterations to wave stresses, tidal inundation patterns, or sediment deposition regimes could alter the extent or quality of the tidal swamp habitats. Tidal swamps should be protected from logging, ATV use, and other activities that could destroy important wildlife habitat or damage the swamp floor. Any applications of pesticides for mosquito management should be undertaken with caution. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of tidal wetlands.)

TIDAL MUDFLAT

Ecological Attributes

A tidal mudflat is a sparsely vegetated wetland that occurs in the shallow bays, tributary mouths, and other shallow zones in the tidal portion of the Hudson River. These habitats are restricted to the lowest portion of the intertidal zone, usually between tidal marsh and permanent open water. Tidal mudflats experience deep flooding at high tide and are exposed for short periods at low tide. The sparse plant community is typically of low-growing, rosette-leaved aquatics, such as strap-leaf arrowhead,* that are completely submerged at high tide. Some rare plants of Hudson River tidal mudflats include spongy arrowhead,* mudwort,* and false pimpernel.* Tidal mudflats can host rare species of mussels including alewife floater,* yellow lampmussel,* and tidewater mucket.* A variety of wading birds, waterfowl, and raptors forage on mudflats during low tide.

Occurrence in the Town of Poughkeepsie

We found the largest tidal mudflat in the southernmost Hudson River cove in Poughkeepsie, and several smaller mudflats in the tidal portion of the Wappinger Creek. These ribbon-like areas totaled less than 1.5 ac (0.6 ha) in size, and were recognizable by the presence of strap-leaf arrowhead. However, because tidal mudflats are difficult to identify remotely and can only be observed during the lowest tides, there may be some additional mudflats in areas we did not see at low tide.

Sensitivities/Impacts

These habitats are sensitive to the same kinds of mechanical, pollution, and noise disturbances described for tidal marshes (see above). Any alteration of wave stresses or sediment deposition regimes could alter the extent or quality of mudflat habitats. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of tidal wetlands.)

TIDAL TRIBUTARY MOUTH

Ecological Attributes

In this report the term “tidal tributary mouth” refers to the tidal reaches of Hudson River tributary streams. This habitat occurs no higher (farther upstream) than the first topographic contour line (10 ft [3 m] elevation) or the first dam, whichever is lower. This portion of the stream is strongly influenced by the mixing of non-tidal and tidal waters. The substrate and water chemistry of these habitats are often very different from those found in the non-tidal reaches of the tributary or in the Hudson River. In winter there is often intense ice scouring of the stream bed and shore line. The plant and animal communities are composed of freshwater species able to tolerate tidal fluctuations as well as stream flooding.

Tidal tributary mouths tend to be sites of concentrated biological activity. Several rare or uncommon plants such as lizard’s tail,* estuary beggar-ticks,* smooth bur-marigold,* and goldenclub,* and at least one rare snail (*Pomatiopsis lapidaria*) have been found in tidal tributary mouths of the Hudson. Macroinvertebrates may be abundant and diverse in these habitats, which also serve as spawning sites for fishes such as rainbow smelt,* and foraging sites for birds including osprey* and American bittern.*

Occurrence in the Town of Poughkeepsie

The mouth of the Wappinger Creek was tidal for approximately 7.7 miles (12.4 km) in the Town of Poughkeepsie. This considerable tidal reach was associated with tidal marsh, tidal swamp, and tidal mudflat habitats. Much of this tributary mouth was colonized by water chestnut, a non-native, aggressive, floating-leaved aquatic plant. A very small length of the mouth of the Casperkill (approximately 118 yards [108 meters]) was also mapped as tidal; its habitat value may be greatly diminished by the surrounding industrial area.

Sensitivities/Impacts

Noise, pollution, and mechanical disturbance from boat traffic can cause extreme disturbance to the plant and animal communities of tidal tributary mouths. Foot traffic on tributary banks can damage vegetation and increase susceptibility to bank erosion. Poor water quality in the tributary streams will reduce the habitat quality of the tidal stream mouths. Dams impede fish spawning runs, and the installation of fish ladders or dam by-passes would do much to support the populations of river herring (alewife and blueback herring), American eel, and many other fish species that spawn in non-tidal portions of Hudson River tributaries. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of tidal wetlands.)

Mouth of the Wappinger Creek, a tidal tributary of the Hudson River

FRESHWATER TIDAL MARSH

Ecological Attributes

A freshwater tidal marsh is a non-forested wetland that occurs in the shallow bays and tributary mouths along the freshwater tidal portion of the Hudson River, in the zone between mean high and mean low water elevations. The substrate is regularly exposed at low tide and flooded twice daily by high tide. Tidal marshes at tributary mouths also receive water and sediment from the associated freshwater stream. The plant community is composed primarily of emergent herbaceous species, including common freshwater marsh plants and other species tolerant of tidal fluctuations.

Tidal marshes in this reach of the Hudson can be divided into three general zones, each with a distinctive plant community. The lower tidal zone is typically dominated by spatterdock, common three-square, strap-leaf arrowhead, pickerelweed, or softstem bulrush. The substrate in this zone is generally exposed only around low tide. The middle tidal zone is inundated by water for less time than the lower tidal zone and tends to have a more diverse plant community that includes pickerelweed, arrow arum, broad-leaved arrowhead, common three-square, wild rice, rice cutgrass, spotted jewelweed, and narrow-leaf cattail. The upper tidal zone is inundated only around mean high water level and tends to be dominated by narrow-leaf cattail, common reed, purple loosestrife, and arrow arum, and may include several of the species found in the middle tidal zone.

Many rare plants have been reported from freshwater tidal marshes, including Fernald's sedge,* Long's bittercress,* spongy arrowhead,* goldenclub,* American waterwort,* and heartleaf plantain.* The fishes and birds of freshwater and brackish tidal marshes can be diverse and abundant. Least bittern,* American bittern,* sora, Virginia rail, and common moorhen* are known to breed in Hudson River tidal marshes, and osprey,* northern harrier,* bald eagle,* and great blue heron* forage in these habitats.

Occurrence in the Town of Poughkeepsie

Freshwater tidal marsh habitat was found in all but one of the coves along the Hudson River in Poughkeepsie. Tidal marshes were also found in the tidal portion of the Wappinger Creek, and occasionally at the mouths of smaller streams. We mapped a total of 14 tidal marshes covering nearly 38 ac (15.4 ha). Tidal marshes ranged in size from smaller than 0.1 ac (0.04 ha) to a 14.3 ac (5.8 ha) marsh found in the cove north of the Tilcon mine. This habitat was often part of larger wetland complexes with tidal tributary mouth, tidal swamp, and open water habitats (see above).

Sensitivities/Impacts

Soil compaction and trampling or clearing of vegetation in tidal marshes can damage microhabitats and can promote the spread of invasive plants such as common reed and purple loosestrife. Motorized boat traffic can cause water pollution and mechanical destruction of plants, and can disturb breeding and foraging birds and other animals in these habitats. Any alteration of wave stresses or deposition regimes could alter the extent or quality of the tidal marsh habitats. Dumping of refuse in upstream areas or directly in the marshes can pollute the habitat with toxins and sediments. (See the Conservation Priorities and Planning section for recommendations on protecting the habitat values of tidal wetlands.)

Tidal marsh in a Hudson River cove

CONSERVATION PRIORITIES AND PLANNING

Most local land use decisions in the Hudson Valley are made on a site-by-site basis, without the benefit of good ecological information about the site or the surrounding lands. The loss of biological resources from any single development site may seem trivial, but the cumulative effects of decision-making solely on a site-by-site basis have been far-reaching. Regional impacts have included the disappearance of certain habitats from whole segments of the landscape, the fragmentation and degradation of many other habitats, the local and regional extinction of species, and the depletion of overall biodiversity.

Because biological communities, habitats, and ecosystems do not respect property boundaries, the best approach to biodiversity conservation is from the perspective of whole landscapes. The Town of Poughkeepsie habitat map facilitates this approach by illustrating the location and configuration of significant habitats throughout the town. The map, together with the information included in this report, can be applied directly to land use and conservation planning and decision making at multiple scales. In the following pages, we outline recommendations for: 1) developing general strategies for biodiversity conservation; 2) using the map to identify priorities for town-wide conservation, land use planning, and habitat enhancement; and 3) using the map as a resource for reviewing site-specific land use proposals.

GENERAL GUIDELINES FOR BIODIVERSITY CONSERVATION

We hope that the Poughkeepsie 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 important 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 of the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001) provides additional information about these and other conservation tools. Several recent 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 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 Department of Environmental Conservation 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.

In addition to regulations and incentives designed to protect specific types of habitat, the town can also apply some general practices on a town-wide basis to foster biodiversity conservation. The examples listed below are adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001).

- **Protect large, contiguous, undeveloped tracts** wherever possible.
- **Protect high quality isolated habitat patches.** Relatively small, isolated habitats areas may function as refuges for uncommon plants and for animals that have small ranges or are well adapted to edge habitats and travel through developed areas. Such "islands" of habitat may provide certain plants or animals protection from predators, diseases, and other community processes that limit their ability to survive. Isolated habitat patches are particularly valuable if they include high quality significant habitat types that meet the needs of species of conservation concern.
- **Plan landscapes with interconnected networks of undeveloped habitats** (preserve links and create new links between natural habitats on adjacent properties). When possible, enhance the connective value of existing features such as streams, abandoned rail lines, and utility rights-of-way. 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 floods, seasonal drawdowns, 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.
- **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 along existing roads**; discourage construction of new roads in undeveloped areas. **Promote clustered and pedestrian-centered development**

wherever possible (in areas where no sensitive habitats are present) to maximize extent of unaltered land and minimize expanded vehicle use.

- **Minimize areas of lawn and impervious surfaces** (roads, parking lots, sidewalks, paved driveways, roof surfaces), and maximize onsite runoff retention and infiltration to help groundwater recharge, protect surface water quality, and moderate flood flows.
- **Restore degraded habitats wherever possible**, but do not use restoration projects as a license to destroy intact habitats. Base any habitat restoration on sound scientific principles and research in order to maximize the likelihood of having the intended positive outcomes on biodiversity, and monitor restored habitat to assess these outcomes.
- **Modify the urban matrix to provide more habitat elements** (for example, tree-lined streets). Use public education and incentives to encourage private landowners to provide additional habitat in their yards.
- **Promote the establishment of conservation agreements** on parcels of greatest apparent ecological value.

TOWN-WIDE BIODIVERSITY PLANNING

The Town of Poughkeepsie habitat map illustrates the locations and 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. Although intact habitats were the focus of this study, biodiversity conservation efforts in an urban/suburban landscape such as the Town of Poughkeepsie must also consider the potential for enhancement of developed areas for the purpose of supporting native biodiversity.

Our recommendations for conservation of existing habitats focus on the identification of high priority habitats and habitat complexes, and the undeveloped connections (or “corridors”) between them. These priority habitats include those that are rare or support rare species, or that are otherwise particularly important to local or regional biodiversity. For instance, there are documented occurrences of Blanding’s turtles, a NYS Threatened species, in Poughkeepsie. Buttonbush pools and kettle shrub pools may be the only places in the town suitable as core habitat for yet undocumented and future populations. Figures 6-9 illustrate some of the areas we have identified as having “priority habitats” for conservation and the “conservation zones” associated with those habitats. These areas are especially valuable if they are located within larger areas of intact and connected habitat extending beyond the boundaries of the town.

While most of our conservation recommendations focus on intact habitats, we also provide some general recommendations for the developed areas, which aim to improve habitat characteristics for native species of conservation concern. We discuss some measures that can be taken to protect and add elements of habitats which alone are too small to map at the town-wide scale (e.g., individual trees), but can be important for some species. We also address habitat corridors, with a focus on opportunities for creating new connections and enhancing the tenuous existing connections of natural corridors in intensively developed landscapes.

The town-wide habitat map and this report provide a landscape perspective that can help the town establish conservation goals, priorities, and strategies. Taking a landscape approach to land use planning is much more likely to yield sound conservation decisions than the typical parcel-by-parcel approach. 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. As habitat maps are completed in adjacent towns, the maps can also be used for conservation planning across town boundaries.

PRIORITY HABITATS IN POUGHKEEPSIE

Although much land in Poughkeepsie has been developed for residential, commercial, and industrial uses, large areas of habitat and high-quality habitats still remain. By employing a proactive approach to land use and conservation planning, the Town of Poughkeepsie has the opportunity to protect the integrity of its remaining biological resources for the long term. Below we highlight some habitat types and complexes (i.e., particular combinations of habitats) that we consider "priority habitats" for conservation in the region. With limited resources to devote to conservation purposes, municipal agencies must decide how best to direct those resources to maximize conservation results. Important considerations in prioritizing such efforts include preserving high quality habitats, a variety of habitats, and the most sensitive habitat types. While we hope this information will help the town think strategically about future land uses, it must be understood that these "priority habitats" are just some of the important habitats in the town.

We used the requirements of a selected group of species to illustrate how the protection of the remaining habitat resources would contribute to the conservation of biological diversity in the town. We chose several species or groups of species that have large home ranges, specialized habitat needs, or acute sensitivity to disturbance (see Table 2). Many are rare or declining in the region or statewide. Each of these species or groups requires a particular habitat type for a crucial stage of their life cycle (e.g., hibernation, breeding), and those "core habitats" typically form the hub of the animal's habitat complex. The various other habitats required during other life cycle stages are typically located within a certain distance of the core habitat. This distance roughly defines the extent of the species' habitat complex and, therefore, the minimum area that needs to be protected or managed in order to maintain a local population. 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 the scientific literature to estimate the priority conservation zone for the species or group of concern (Table 2). If the habitats of the sensitive species of concern are protected, many other rare and common species that occur in the same habitats will also be protected.

Due to the highly fragmented nature of habitats in the Town of Poughkeepsie, the conservation zones we recommend around priority habitats often overlap with already developed areas. While this will make it impossible to follow some of the recommendations for these zones (for example, protecting forest areas around a wetland when there is no remaining forest area around it), we show and discuss the full extent of these conservation zones for two reasons: 1) some conservation recommendations can still be followed in developed areas, and 2) in some cases these zones can be considered for habitat restoration.

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

Priority Habitat	Associated Species or Group of Concern	Priority Conservation Zone	Rationale	References
Large contiguous habitat complex	Forest interior-breeding birds, spotted turtle	Unfragmented areas with a high percent of forest cover and/or wetland complexes	Maximizes the occurrence and breeding success of species.	Robbins et al. 1989, Kluza et al. 2000, Joyal et al. 2001
Large meadow	grassland-breeding birds	Unfragmented patches greater than 25 ac (10 ha)	Required for successful breeding and maintenance of viable populations.	Vickery et al. 1994
Intermittent woodland pool	pool-breeding amphibians	750 ft (230 m) from pool	Encompasses non-breeding season foraging and refuge habitats and dispersal routes between pools.	Madison 1997, Semlitsch 1998, Calhoun and Klemens 2002
Buttonbush pool/kettle shrub pool	Blanding's turtle	3300 ft (1000 m) from pool	Encompasses most of the critical habitat including nesting areas, summer foraging wetlands, drought refuge pools, and overland travel corridors.	Kiviat 1997, Hartwig et al. in prep.
Freshwater tidal wetlands	breeding marsh birds	650 ft (200 m) from marsh	Minimizes human-induced flushing and habitat avoidance.	Values reviewed in Rodgers and Smith 1997
Perennial stream	wood turtle	650 ft (200 m) from stream	Encompasses most of the critical habitat including hibernacula, nesting areas, spring basking sites, foraging habitat, and overland travel corridors.	Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997

LARGE CONTIGUOUS HABITAT COMPLEXES

Target areas

Although the Town of Poughkeepsie has a long history of land development, it still contains several relatively large habitat patches that have high value for wildlife. Careful siting of new development can protect these patches from further fragmentation, and some landscape analysis will help identify places where measures could be taken to allow the safe movement of wildlife among them. Figure 6 illustrates the locations and relative sizes of contiguous habitat patches in the town, as well as areas that might be functioning as connective corridors. The habitat map does not take into account the actual size of habitat patches that extend beyond Poughkeepsie's boundary, but this is an important consideration in understanding the habitat value of these areas. Hudsonia has published habitat maps for several other Dutchess County towns, and will be mapping additional towns in the near future. This growing regional map will enable town officials and private landowners to plan strategically across town boundaries to ensure that large, contiguous habitat areas are conserved.

The large, contiguous habitat complexes in the town encompass the largest forested areas (both upland and wetland) and most of the wetland complexes in the town. 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. There were 13 forest patches of greater than 100 ac (40 ha) each. The largest contiguous patch of forest encompassed 275 ac (111 ha) south of Bedell Road, and included several forested swamps.

A wetland complex is any group of adjacent and nearby swamps, marshes, wet meadows, streams, or other wetland types. Wetland complexes with especially high habitat value include extensive complexes, those with a wide variety of wetland types, and those that have intact upland habitat between the wetlands. For example, a large and diverse wetland complex in the area south of Bower Road includes swamp, marsh, wet meadows, kettle shrub pool, open water, and intervening upland forest and shrubland. Another wetland complex between Salt Point Turnpike and Edgewood Drive includes swamp, marsh, wet meadow, and open water habitats in a relatively small contiguous area.

Conservation Issues

Habitat fragmentation is among the primary threats to biodiversity worldwide (Davies et al. 2001). While some species and habitats may be adequately protected at a relatively small scale, wide-ranging species, such as 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 developed land limit animal movements and interactions, disrupting patterns of dispersal, reproduction, competition, predation, and behavior (Adams et al. 2006). Habitat patches surrounded by human development function as islands, and species unable to move between habitats are vulnerable to genetic isolation and possible extirpation over the long term. Landscapes with interconnected networks of habitat patches, on the other hand, are more likely to support diverse native species and the ecological processes and disturbance regimes that maintain those species.

Loss of forest area and fragmentation of remaining forest are the two most serious threats facing forest-adapted organisms. Logging can also degrade habitat quality for some forest species. The abundance and nesting success of many species of forest interior-breeding birds is dependent on relatively large contiguous forest areas (Robbins et al. 1989, Lampila et al. 2005). For example, wood thrushes are much more likely to breed successfully in forest patches greater than 200 ac (80 ha) (Rosenberg et al. 2003). Residential development is a considerable cause of reduced abundances of forest birds in the Northeast (Kluza et al. 2000). In addition to a loss of total area, fragmented forests have an increased proportion of edge habitat. Temperature, humidity, and light are altered near forest edges, and edge environments favor a set of disturbance-adapted species, including many predators and brown-headed cowbird, a nest parasite of forest-breeding birds (Murcia 1995). Fragmentation and an increase in edge environments can make the forests more susceptible to colonization by invasive plants that can displace native vegetation. Large forests, particularly those in configurations that are more round and less linear, support forest species that are highly sensitive to disturbance and predation along forest edges.

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). 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).

Many animals move among several types of wetland and upland habitats throughout the year. For instance, spotted turtle* is known to use marsh, 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: 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).

Recommendations

We recommend that the remaining large blocks of habitat within the Town of Poughkeepsie that include large forested areas and wetland complexes be considered priority areas for conservation, and that efforts be taken to fully protect these habitats wherever possible. If new development in these areas cannot be avoided, it should be concentrated near the edges and near existing roads and other development so that as much area as possible is preserved without fragmentation. New roads or driveways should not extend into the interior of the contiguous habitat area and should not divide the habitat into smaller isolated patches.

Wetland complexes vary enormously, and can be difficult to define on a map. In general, look for areas with a moderate to high density of wetland habitats that are not fragmented by roads or development. Intact small wetland complexes can also occur outside of the large habitat areas, and the conservation recommendations particular to them (see below) should be followed in such cases.

Some general guidelines for forest and wetland complex conservation within large habitat areas include the following:

1. ***Protect large, contiguous habitat areas*** wherever possible, and avoid development in their 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 other habitats (such as calcareous crest/ledge/talus or woodland pools) embedded in them.
3. ***Maintain or restore connections between large habitat areas.*** This can sometimes be accomplished by protecting smaller forest patches that provide "stepping stone" connections between larger forest patches, or fitting roads with wildlife crossing structures (such as culverts or underpasses).
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***.
6. ***Protect intermittent woodland pools, shrub pools, and their conservation zones*** as described elsewhere in this report. These are habitats used by spotted turtle especially in the summer, as well as other turtles, pool-breeding amphibians, and many other animals.
7. ***Maintain intact upland habitat connections between wetlands within wetland complexes.*** For example, when intermittent woodland pools 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, nesting, aestivation, and basking sites, as well as corridors for many other species.
8. ***Minimize disturbance in spotted turtle nesting habitat within 390 ft (120 m) of all the wetlands***. Spotted turtle usually nests in open sites such as upland fields or lawns, but also in sedge tussocks in wetlands.
9. ***Avoid creating pitfall hazards*** in wetland complex areas (see buttonbush pool/kettle shrub pool recommendations below).

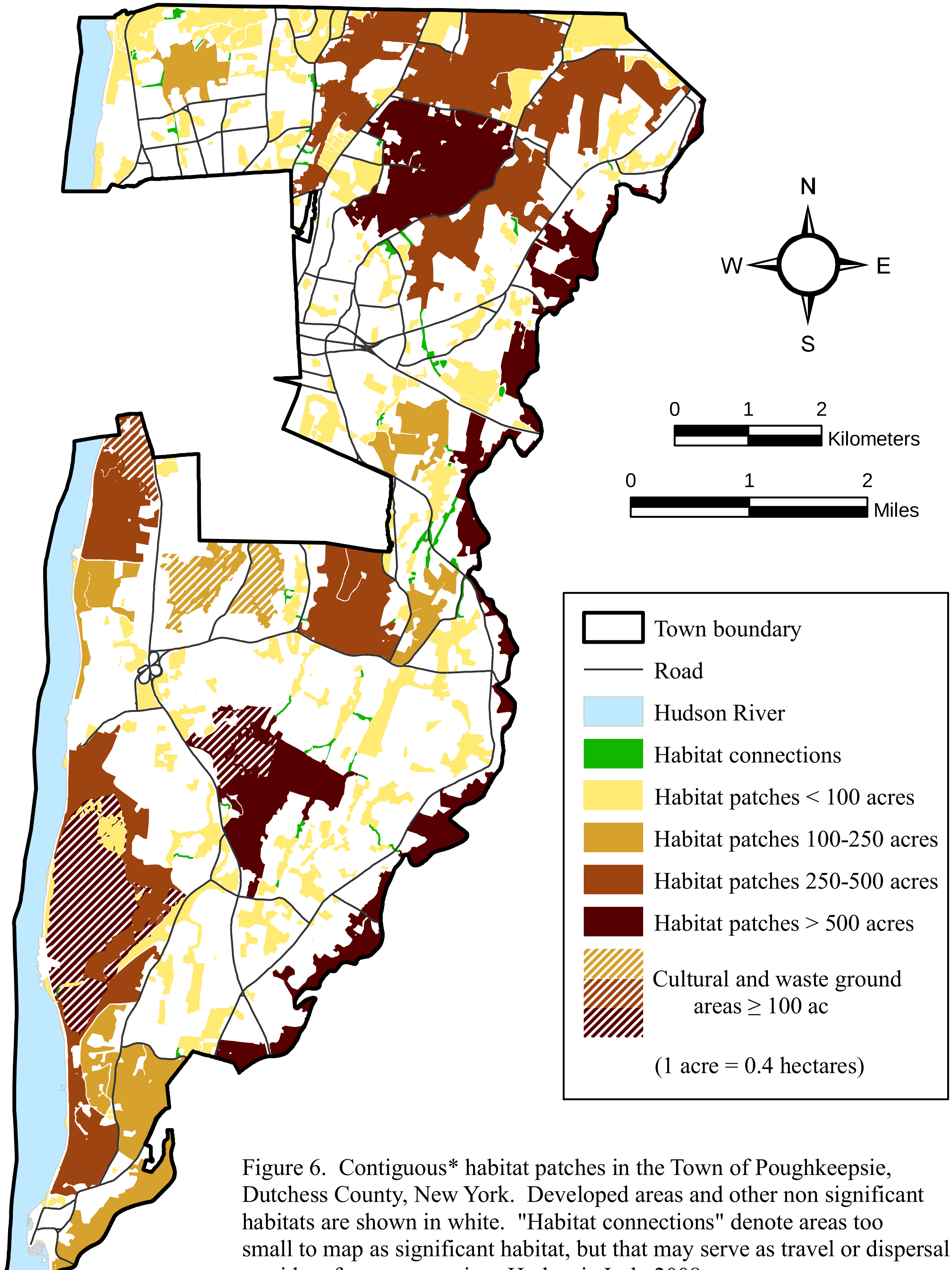


Figure 6. Contiguous* habitat patches in the Town of Poughkeepsie, Dutchess County, New York. Developed areas and other non significant habitats are shown in white. "Habitat connections" denote areas too small to map as significant habitat, but that may serve as travel or dispersal corridors for some species. Hudsonia Ltd., 2008.

*The > 500 ac habitat patch along the eastern boundary of the town is composed of many smaller habitat patches connected by Wappinger Creek, a stream habitat. The railroad causeway was considered a dividing feature in analyzing habitat contiguity. The Tilcon mine was treated as a developed area in the calculation of the size of the surrounding habitat, since the mine currently has little habitat value.

LARGE MEADOWS

Target Areas

Large and contiguous patches of meadow, particularly pasture, hayfields, and old fields, can be valuable wildlife habitats. In Poughkeepsie, the largest meadows and meadow complexes were in the northern part of the town; the largest complex (37 ac [15 ha]) was south of Bedell road (Figure 3). Smaller meadows and shrublands that could potentially serve as wildlife travel corridors or "stepping stones" between nearby habitats are also important.

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 as grassy meadows have been lost and fragmented by the intensification of agriculture, regrowth of forest, and residential and commercial development (Askins 1993, Brennan and Kuvlesky 2005). These birds require large, undivided meadows (25-500+ 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). Although upland meadow was one of the most common habitat types in Poughkeepsie, only four of those meadows were larger than 25 ac (10 ha), the minimum preferred area for savannah sparrow to nest (Vickery et al. 1994), for example, and one of these meadows is part of an ongoing residential development. 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. Even when development does not destroy the entire meadow habitat, the remaining fragments are usually small and have much lower biodiversity value. 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 harm from other human activities such as mowing, conversion to row crops, application of pesticides, and ATV traffic.

Recommendations

For cases where landowners have flexibility in their mowing and grazing practices, Massachusetts Audubon (http://www.massaudubon.org) provides the following management suggestions for improving meadow habitats for grassland birds in the Northeast:

1. ***Mowing after August 1*** helps to ensure fledging of nestling birds; if mowing must occur before then, leave some unmowed strips or patches.
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, provides good habitat for birds and butterflies.
3. ***On active farms, 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 breeding birds.
5. ***Raising mower blades to six inches or more, using flushing bars, and avoiding night mowing*** when birds are roosting all help reduce bird mortality.
6. ***Light grazing*** can be beneficial if livestock are rotated among fields throughout the season.

Capped landfills can be managed to attract grassland breeding birds and provide this important habitat type in suburban areas. A successful example of such management is the capped landfill at Croton Point Park in Westchester County, New York (Kiviat and Worley, pers. comm.). There are several capped landfills in the Town of Poughkeepsie and the largest of these would be the best candidates for such management.

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

Beyond the ecological values of large meadows, there are compelling reasons to conserve land with agricultural potential in the Town of Poughkeepsie. From a cultural and economic standpoint, maintaining our ability to produce food locally has obvious advantages in the face of climate change and unstable and unpredictable energy supplies.

INTERMITTENT WOODLAND POOLS

Target Areas

We identified and mapped 48 intermittent woodland pools in the Town of Poughkeepsie (Figure 7), and we expect there were others that we missed. Each intermittent pool is important to preserve, but groups or networks of pools are particularly valuable from a habitat perspective. Such aggregations of pools can support metapopulations–groups of small populations that are able to exchange individuals and recolonize sites where the species has recently disappeared. Most of the intermittent woodland pools that remain in the town were part of relatively large areas of intact habitat, making such protection of networks feasible.

Conservation Issues

Because they lack fish and certain other predators, intermittent woodland pools provide crucial breeding and nursery habitat for several amphibian species that reproduce less successfully in other wetlands, including several of the mole salamanders (Jefferson salamander,* marbled salamander,* spotted salamander*) and wood frog.* During the non-breeding season, these amphibians 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 can have significant adverse effects on the amphibians, 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.

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. The mole 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 susceptible to vehicle mortality where roads or driveways cross their travel routes, and roads, especially 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 also barriers to forest-dwelling amphibians. Juveniles have trouble crossing open fields due to a high risk of desiccation and predation in that exposed environment (Rothermel and Semlitsch 2002).

Populations of these amphibians 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, there are interannual fluctuations in the habitat quality of different pools 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 population 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 nearby accessible pools, key foraging and wintering habitats in the surrounding upland forests, and the forested matrix that includes the migration corridors between individual pools and pool complexes.

Recommendations

To help protect pool-breeding amphibians and the habitat complex they require, we recommend the following 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 used for dumping. We advise that intermittent woodland pools be permanently protected from development and disturbance of any kind including the construction of houses, roads, lawns, and 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***. This zone provides important shelter for high densities of adult and recently emerged salamanders and frogs during the spring and early summer. 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. To maintain the habitat quality of this zone, avoid any disturbance to the vegetation or soils.
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 harm 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. To protect pool-breeding amphibians, at least 75% of this zone should remain as 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. ***Do not channel runoff from roads and developed areas into intermittent woodland pools*****.**

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 impacts:
    - Roads and driveways with projected traffic volumes in excess of 5 vehicles per hour should not be sited within 750 ft (230 m) of the pool.
    - Regardless of traffic volumes, the total length of roads 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 watershed can degrade pool water quality by increasing sediment, nutrient, and pollutant loading to the pool. 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. The redirection of natural surface water flows can decrease 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 render the habitat unsuitable for breeding amphibians. Protective measures include the following:
    - Do not use intermittent woodland pools for stormwater detention, either temporarily or permanently.
    - Aggressively treat stormwater in the pool’s watershed 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.
    - Avoid or minimize the use of pesticides and fertilizers within the woodland pool’s watershed. If mosquito control activities are necessary, limit them to the application of bacterial or fungal larvicides, which may have lesser negative impacts on non-target pool biota than other methods.

- Maintain both surface water runoff and groundwater inputs to intermittent woodland pools at pre-construction levels. 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 or 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 and other animals.
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.

Intermittent woodland pool

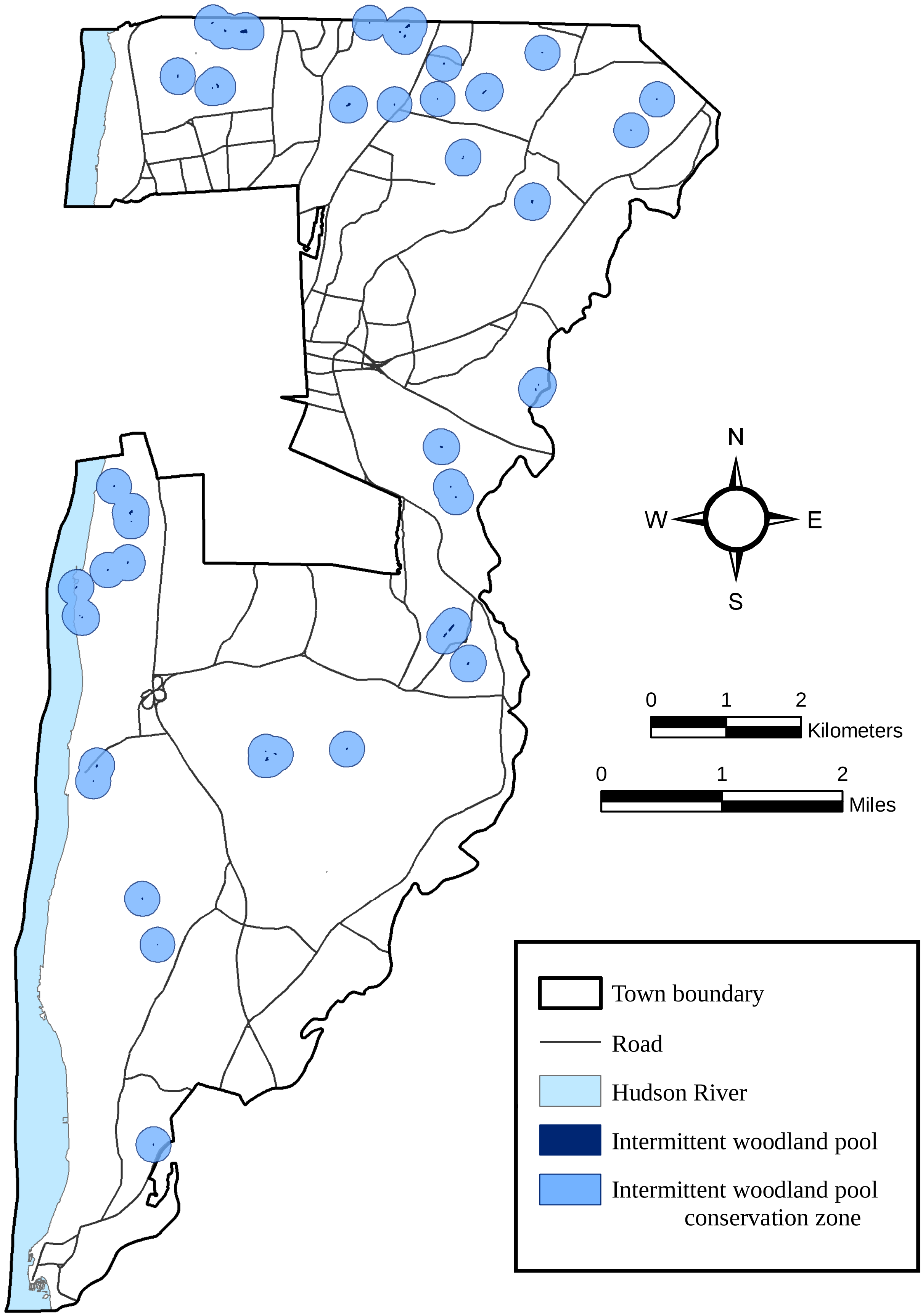


Figure 7. Intermittent woodland pools and their conservation zones in the Town of Poughkeepsie, Dutchess County, New York. Intermittent woodland pool conservation zones extend 750 ft (230 m) from edges of pools. Hudsonia Ltd., 2008.

BUTTONBUSH POOLS/KETTLE SHRUB POOLS

Target Areas

We identified nine buttonbush pools and four kettle shrub pools in the Town of Poughkeepsie. All of the kettle shrub pools and most of the buttonbush pools occurred in the northeastern part of town, and the remaining buttonbush pools were found west of Route 9 (South Road) south of the City of Poughkeepsie and north of the Tilcon mine (Figure 8).

Conservation Issues

Blanding's turtles* (NYS Threatened) occur in and near the Town of Poughkeepsie, and some of the habitat complexes used by these turtles have been identified (Hartwig et al., in prep.). Kettle shrub pools are the typical core wetlands used by the Blanding's turtle 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. The Blanding's turtle typically spends winter, and much of the spring, early summer, and fall seasons in its core wetland, which is used for hibernation, thermoregulation, and foraging. During the active season, Blanding's turtles also use other nearby wetlands, including emergent marshes, swamps, and intermittent woodland pools, for foraging, thermoregulating, 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 foraging areas, nesting sites, overwintering areas, and refuge habitats in an area up to 3,300 ft (1,000 m) from a core wetland habitat. In the Northeast and elsewhere in their range, movements of 6,500 feet (2,000 m) or more have been documented on numerous occasions (e.g., Joyal et al. 2001, Fowle 2001). Erik Kiviat (pers. comm.) has made similar observations in Dutchess County.

These long distance movements enable turtles to select alternative habitats as habitat quality or social dynamics change, and to breed with individuals from neighboring habitat complexes. 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 6,500 ft (2,000 m) zones around each pool (Figure 8) (Hartwig et al., in prep.). The 1,000 m "Conservation Zone" encompasses the wetlands that the turtles 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 within which the Blanding's turtle makes long distance movements to explore new wetlands or to 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.

Development activity within this habitat complex can have significant adverse effects on the turtles and their habitats. These effects include the direct loss of wetland habitat (especially small, unregulated wetlands), degraded water quality (from pesticides, fertilizers, de-icing salts, and other toxic substances), altered wetland hydroperiod and water depth from groundwater extraction, 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.

Recommendations

To help protect Blanding's turtles and the habitat complexes they require, we recommend the following measures (adapted from Hartwig et al., in prep.).

For the **2000-meter Areas of Concern**:

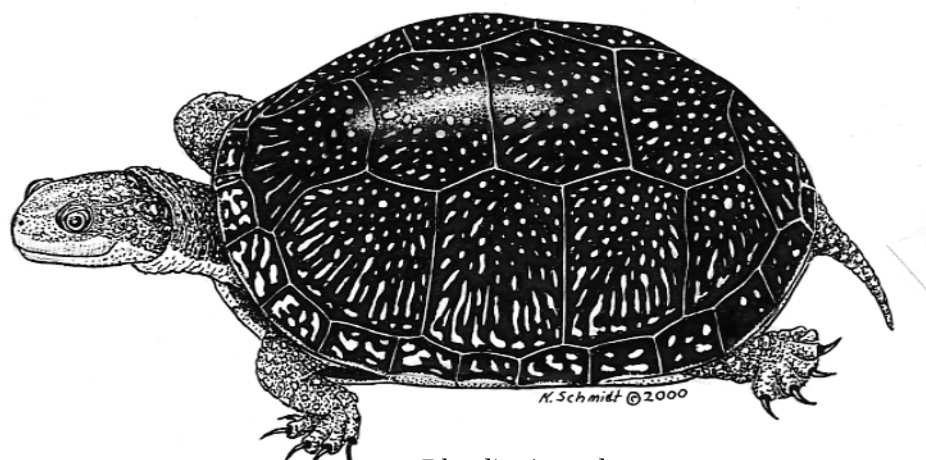
1. ***Minimize impacts from new and existing roads***. Prohibit the building of new roads crossing or adjoining Blanding's turtle habitat complexes. This applies to public and private roads of all kinds including driveways. Keep vehicle speeds low on existing roads by installing speed bumps, low speed limit signs, and wildlife crossing signs. Medium and heavy volume roads within the priority zone should be considered as candidates for installation of experimental turtle underpasses.
2. ***Maintain broad corridors between habitats*** and broad buffers (at least 100 ft [30 m] in width) of natural soil and vegetation around all wetlands. Broad, naturally vegetated travel corridors should be maintained between individual habitats within a complex (e.g., between kettle shrub pools, foraging wetlands, drought refuge ponds, and nesting areas) and between neighboring habitat complexes.
3. ***Minimize or eliminate pesticide use*** on lawns, gardens, and agricultural fields, and minimize movement of soil and nutrients into wetlands.
4. ***Educate landowners*** about the Blanding's turtle and its conservation.

Additional recommendations for the **1000-meter Conservation Zone** include:

1. ***Protect nesting areas***. Blanding's turtles typically nest in upland meadow or open shrublands, habitats that also tend to be prime targets for development. We recommend that large areas of potential nesting habitat within the Conservation Zone (e.g., upland meadows, upland shrublands, 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 permit applications (e.g., freshwater wetlands, stormwater management, and mined lands permits) and siting of water supply wells, septic systems, and other sewage treatment systems. Site soil mines to avoid impacts on Blanding's turtles and their habitats.
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.

4. ***Identify all potential pitfall hazards*** such as window wells, storm drains, catch basins, swimming pools, and silt fencing, and design or modify them to prevent the entrapment of turtles.
5. ***Identify all 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 greater than 82 ft (25 m) apart to allow turtles to move freely across the landscape.
6. ***Instruct the public*** (construction crews an/or residents) on how to look for and safely move turtles from under cars, construction equipment, or mowing machines before operating or driving.
7. ***Erect temporary exclusion fencing*** to keep Blanding's turtles out of work areas. The need for this measure can be determined on a case-by-case basis by the New York State Department of Environmental Conservation or a Blanding's turtle specialist

Finally, within 650 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 650 ft (200 m) of a core wetland pool. A buffer of natural vegetation and soil in this area will minimize direct impacts to the turtles, help maintain wetland hydrology and water temperature, and filter runoff containing silt and other pollutants.



Blanding's turtle

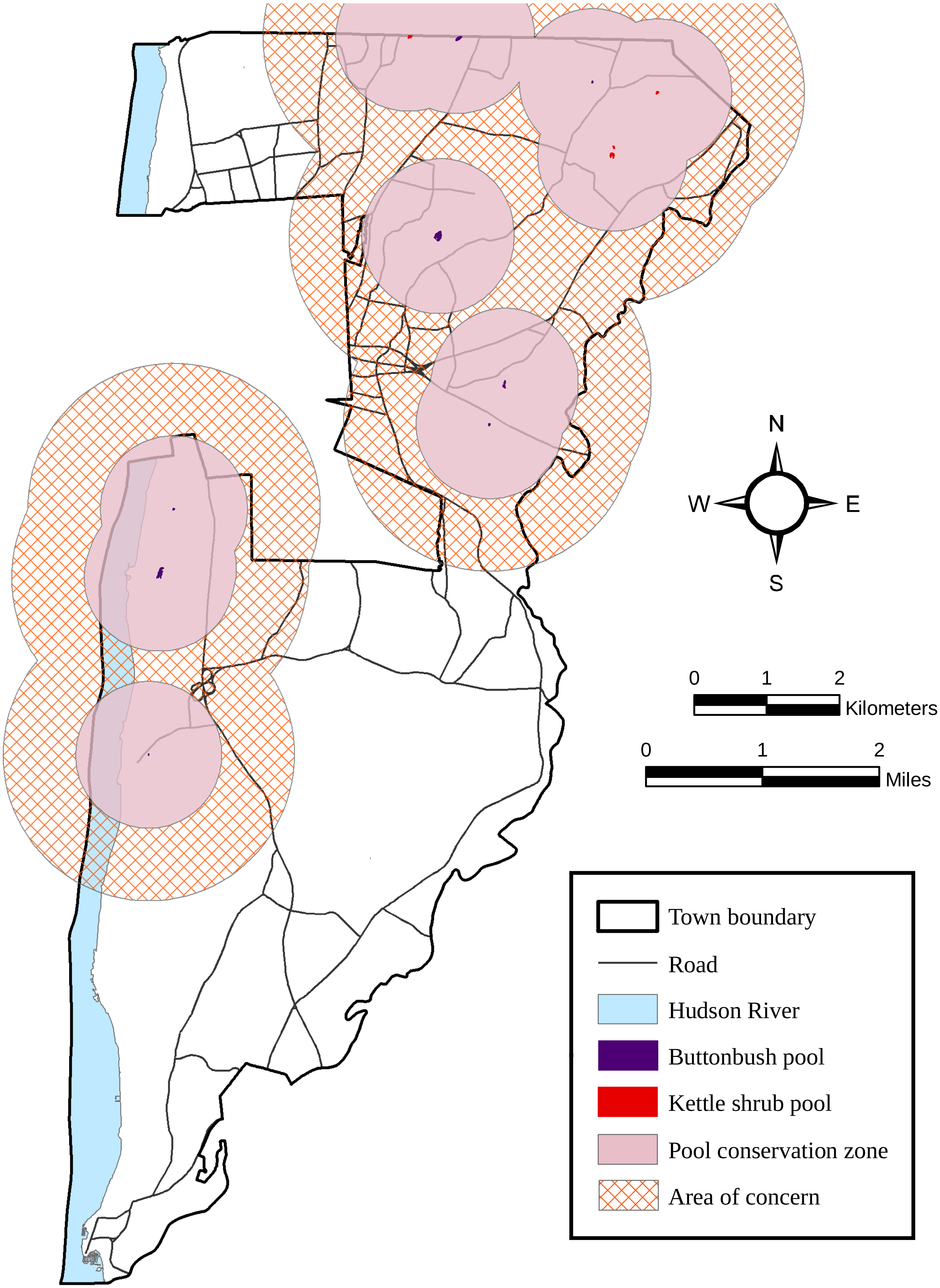


Figure 8. Buttonbush pools, kettle shrub pools, conservation zones, and areas of concern in the Town of Poughkeepsie, Dutchess County, New York. Conservation zones extend 3300 ft (1000 m) from edges of pools; areas of concern extend 6500 ft (2000 m) from edges of pools. Hudsonia Ltd., 2008.

FRESHWATER TIDAL WETLANDS

Target Areas

The conservation zone around freshwater tidal wetland habitats encompasses a 650 ft (200 m) area adjacent to all tidal marsh, tidal swamp, tidal mudflat, and tidal tributary mouth habitats as well as areas of open water adjacent to these habitats. These habitats occur adjacent to the Hudson River and sometimes across the railroad tracks, in the four tidal coves of the Hudson River that were mapped, and in the lower portion of the Wappinger Creek.

Conservation Issues

Some tidal habitats are uncommon on the Hudson and many provide important habitat for plants and animals of conservation concern (see Appendix C). Birds such as American bittern,* least bittern,* northern harrier,* king rail,* Virginia rail,* sora,* common moorhen,* and marsh wren* depend on marshes for nesting and foraging. These birds can be easily disturbed by human activity in or near the marsh, especially during the nesting season. We observed suitable nesting habitat for marsh breeding birds in some of the tidal marshes in the study area.

Human activity near tidal habitats, such as hiking (e.g., on a boardwalk), using motorized watercraft, and ATV riding in the surrounding uplands, can flush marsh birds from their nests and foraging areas or distract them from normal behavior. Such disturbances can diminish nesting success by making the eggs and fledglings more susceptible to predation. Chronic disturbance may also discourage these birds from even attempting to nest in the marsh habitat and may deter harbor seal* and map turtle* which use estuarine rocky shore habitat. Physical disturbance to the soils and the plant communities may encourage invasion by non-native plants such as common reed and purple loosestrife. Depending on the characteristics of the reedbeds or loosestrife stands, these species can render the marsh habitats unsuitable for many marsh breeding birds and other species of conservation concern (Kiviat 2006).

In addition to these freshwater tidal wetlands, we have included estuarine rocky shores in the protective measures recommended below. Harbor seals* use estuarine rocky shore for hauling out (Kiviat and Hartwig 1994), and map turtle* may use these habitats for nesting. These species are likely to be deterred from using the shores by disturbances similar to those that affect the birds that breed in freshwater tidal marshes.

Recommendations

1. ***Protect tidal habitats*** from disturbances of any kind including dredging, channelization of the tidal tributary mouth and associated tidal channels, removal of vegetation, alteration of tidal hydrology, mining of estuarine rocky shores, and intensive human recreational use. In areas that are (or may become) open for public use we recommend that special effort be taken to minimize or prevent the adverse effects associated with human recreation, including minimizing human activity during the nesting and fledgling season of marsh birds, and designing trails and platforms that discourage off-trail recreation.
2. ***Prevent disturbance to any habitats within 650 horizontal ft of tidal wetlands (and estuarine rocky shores).*** Broad areas of undisturbed habitats, especially forests, act as buffers from nearby land uses, helping to mitigate noise and other disturbances to marsh breeding birds and other wildlife. We recommend that all intact habitats within 650 horizontal ft (200 m) of the tidal wetland and rocky shores be protected to the greatest extent possible to serve as a noise and visual buffer. If development within this buffer cannot be avoided, it should be designed to minimize potential adverse impacts to the sensitive species that may occur. Measures that could help minimize impacts to these species include timing construction activities to occur after the end of the bird nesting and fledging season, using the greatest possible setback distance from the tidal habitats, and minimizing disturbance or clearing of densely vegetated areas between the tidal habitat and the development.
3. ***Prohibit the use of motorized watercraft, ATVs, and other intensive human recreation that could potentially disturb marsh birds and other wildlife within the above conservation zone.*** Any boardwalks or observation decks constructed near tidal habitats should be located at the most distant and discreet vantage points. Trails should not follow the wetland-upland boundary.

STREAMS AND RIPARIAN CORRIDORS

Target Areas

Wappinger Creek, the Casperkill, and Fallkill Creek are the major perennial streams in Poughkeepsie (Figure 9). The town's widespread network of smaller perennial and intermittent streams is also important, not only to the organisms that depend directly on the streams but also to the wider ecosystem.

Conservation Issues

Low gradient, perennial streams can be essential core habitat for the wood turtle,* a NYS Species of Special Concern. Wood turtles use streams with overhanging banks, muskrat burrows, or other underwater shelter for overwintering. In early spring, they use overhanging tree limbs and stream banks for basking. In late spring and summer, wood turtles move away from the stream 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 perennial steam habitat, 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 650 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. These effects include habitat degradation from stream alteration; removal of woody debris from stream beds; 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 part on the water quality and quantity of the small, intermittent streams that feed them (Lowe and Likens 2005). In order to 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 (and further on steep slopes). 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

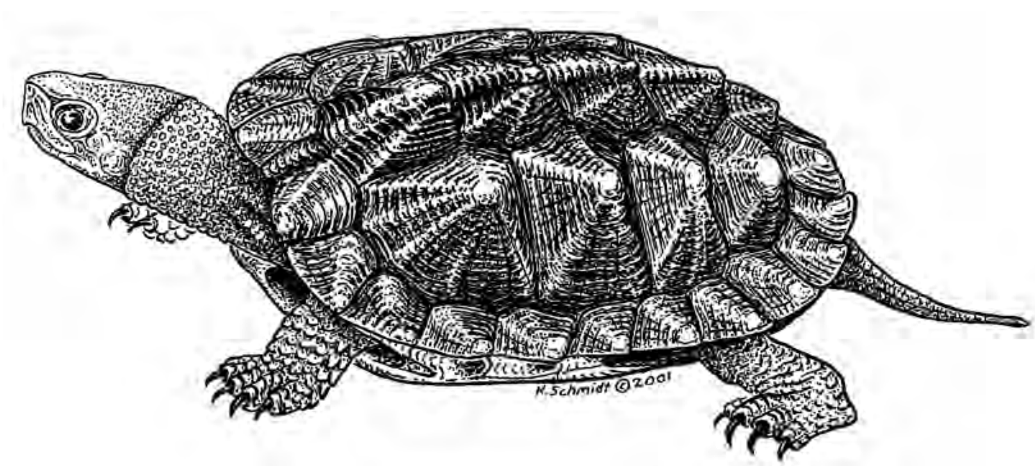
To help protect wood turtles and the habitat complexes they require, as well as many other stream-associated wildlife species, we recommend the following measures:

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 and woody debris. These activities can destroy key wood turtle hibernation and basking habitat.
    - Avoid direct discharge of stormwater runoff, chlorine-treated wastewater, agricultural by-products, and other potential pollutants into streams.
    - 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, 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 areas should be protected from filling, dumping, drainage, impoundment, incursion by construction equipment, siltation, polluted runoff, and hydrological alterations. Additional activities that create pitfall hazards for turtles and other small animals should be avoided (see above recommendations for buttonbush pools/kettle shrub pools). Establish a 650 ft (200 m) stream conservation zone in which large, contiguous blocks of upland habitats (e.g., forests, meadows, shrublands) are preserved to the greatest extent possible to provide basking, foraging, and nesting habitat for the wood turtle. Special efforts may need to

be taken 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 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***. Engineered elements of 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, putting them in the way of vehicles and other hazards. 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 these 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). 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.
    - Install the crossing in a manner that does not disturb the natural substrate of the stream. If the substrate must be disturbed, re-construct the substrate of natural materials and match the texture and composition of upstream and downstream substrates.
    - 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 650 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 upland 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 650 ft (200 m) stream conservation zone (e.g., upland meadows, upland shrublands, waste ground with exposed sandy or gravelly soils) be protected from development and other disturbance, and that broad travelways between those areas and the nearby wetlands and stream be maintained intact.



Wood turtle

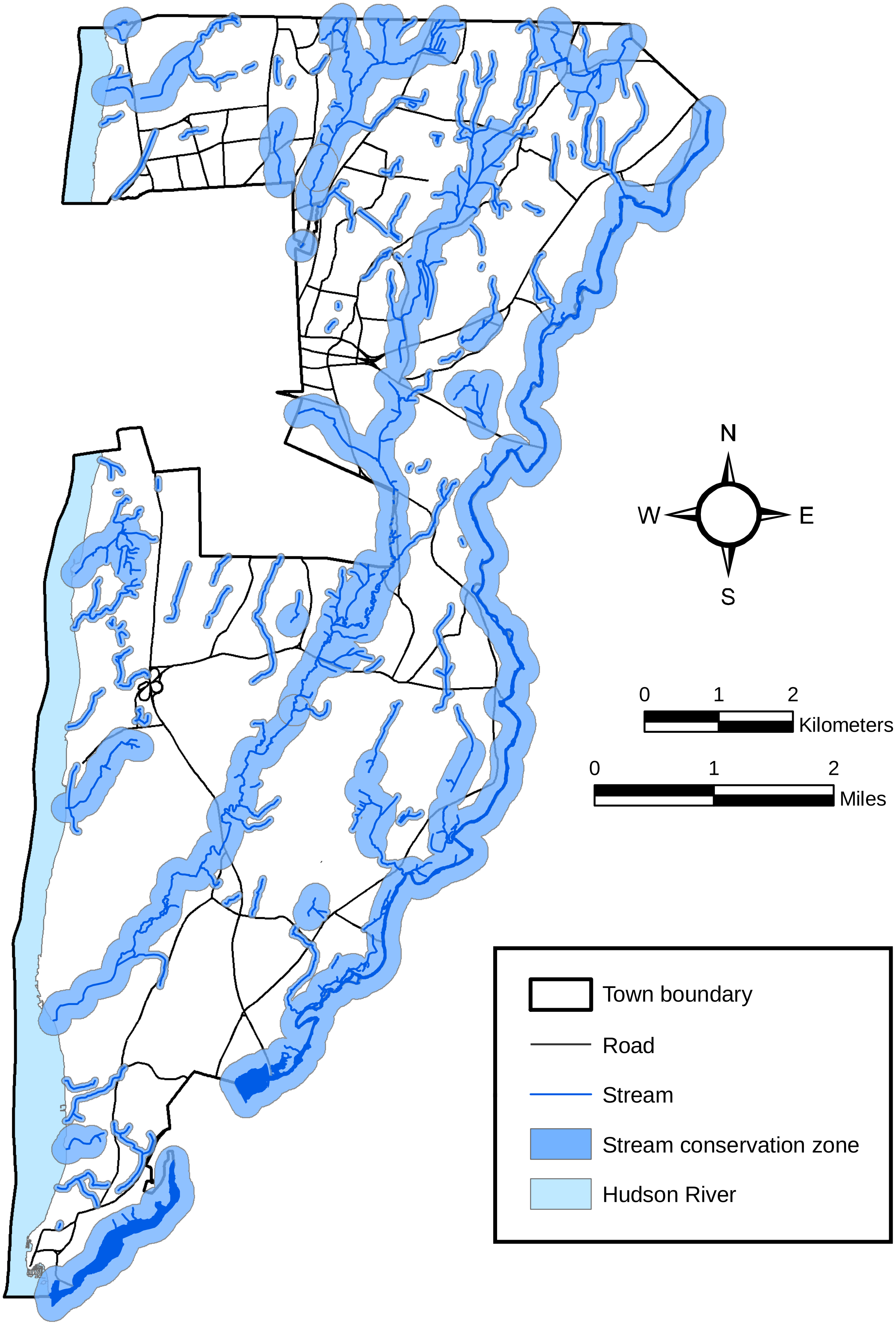


Figure 9. Streams and their conservation zones in the Town of Poughkeepsie, Dutchess County, New York. Stream conservation zones extend at least 160 ft (50 m) from edges of streams; conservation zones for large, perennial streams extend 660 ft (200 m). Hudsonia Ltd., 2008.

ENHANCEMENT OF DEVELOPED AREAS

A well rounded biodiversity conservation approach in urban and suburban landscapes must also consider areas that are already developed. Although developed areas are most heavily used by common wildlife species (e.g., pigeons, starlings, gray squirrels, raccoons, and various rodents) that are adapted to disturbance, uncommon species can also inhabit or travel through developed areas if nearby habitats are suitable. Bats and certain species of birds (including eastern screech owl, barn owl, and Cooper's hawk) will take advantage of individual trees, small groves, and structures in developed areas. Peregrine falcons (NYS Endangered) have been nesting on the Mid-Hudson Bridge and foraging in the City and Town since 1996 (DeOrsey and Butler 2006), and Indiana bat* (NYS Endangered) uses trees in Poughkeepsie as maternity colonies (Zangla 2007).

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

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

ENHANCING HABITAT CHARACTERISTICS

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

2. ***Replace lawn areas with multi-layered landscapes.*** Manicured lawns have a lower biodiversity value and their maintenance requires higher inputs of water and chemicals than other types of horticultural landscaping, such as wildflower meadows, perennial gardens, or ornamental woodlands. They are most commonly maintained with motorized lawn mowers, which contribute to air and noise pollution. While the choice to maintain lawns in residential areas is often one of personal taste or safety, public education and landowner incentives can promote landscaping that provides higher quality resources for wildlife while reducing pollution in developed areas.

3. ***Manage constructed ponds (such as stormwater control ponds and ornamental ponds) for wildlife.***
   - Avoid or minimize the use of pesticides and fertilizers in and near ponds.
   - Plant or maintain shoreline vegetation.

- Add small, gently sloping, vegetated islands to large ponds (>5 ac [2 ha]).
- Encourage a combination of emergent vegetation and open water (i.e., interspersed shallow and deep areas).
- Include irregular shorelines, gently sloped shores, and the capability for controlling water levels in the design of new ponds.

4. ***Restore natural stream buffers wherever possible.*** Vegetated stream shorelines and floodplains serve to control erosion, moderate flooding, and protect water quality. They enhance the habitat quality of the stream and in some cases its recreational value. They also allow for natural movements of the stream channel over time, which improves the stream's capacity to dissipate the energy of water flow. (See the Streams and Riparian Corridors priority habitat section above).
5. ***Maximize onsite infiltration of rainwater and snowmelt.*** Impervious surfaces such as pavement and roofs alter hydrological patterns by preventing precipitation from infiltrating through the soil to groundwater, instead promoting overland flow to ditches, streams, and ponds. This effect prevents the recharge of groundwater and the filtration of pollutants by soil and vegetation, while increasing the likelihood of flooding, stream bank erosion, and surface water pollution (including sedimentation).
    - Encourage the use of pervious driveway materials in residential and commercial construction and renovation.
    - Construct stormwater retention ponds, wetlands, and rain gardens that allow infiltration of surface water to groundwater.
    - Follow stormwater Best Management Practices (BMP's) in areas of new construction. Examples of BMP's include preserving natural vegetation and installing and maintaining soil retention structures, check dams, soil traps, and silt fences. A national menu of stormwater BMP's can be found on the U.S. Environmental Protection Agency website (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm).
    - Encourage the collection of rainwater for use in gardens and lawn areas.

MINIMIZING DISTURBANCE TO RESIDENT AND MIGRATORY BIOTA

1. ***Minimize the impacts of roads on wildlife.*** One of the greatest immediate threats to wildlife in suburban areas is road mortality. A study to identify the roadways with the highest incidence of such mortality and the species most commonly crossing roads in the town could be used to direct the following measures to the places where they will be most effective.
   - Reduce speed limits and post wildlife crossing signs along roads in areas where wildlife are known to cross.
   - Install structures for safe wildlife crossing, such as culverts, overpasses, underpasses, and modified roadside curbs. Design such passageways to accommodate the largest possible number of species. The USDA wildlife crossing toolkit is an online source of information on such structures (www.wildlifecrossings.info).
   - Modify the immediate roadside areas to promote safer wildlife crossings. Factors to be considered include the location of barriers such as guardrails, and roadside vegetation (type and distance to the road's edge) (Barnum 2003, Clevenger et al 2003).

2. ***Minimize noise and light pollution.*** High levels of noise and light in cities can be a deterrent to some wildlife species. While some noise and light are inevitable in urban environments, certain sources can be minimized. Below are examples of actions that can be implemented and/or enforced as local or town-wide light and noise ordinances.
   - Prohibit the use of fireworks in order to minimize disturbance to birds.
   - Require that outdoor lights be directed downward (rather than outward or upward) to minimize the light pollution to offsite and overhead areas.
   - Require that lights in tall business buildings be turned off or dimmed in the evenings to minimize the disorienting effect that these lights can have on migrating birds.
   - Encourage the use of light technologies (such as low-pressure sodium lights) that minimize the attraction of flying insects, and prohibit the use of "bug-zappers."

3. ***Discourage human-sponsored predators and wildlife feeding.*** Human-sponsored predators are species such as raccoon, opossum, and striped skunk, which thrive due to conditions created by humans. Human interference with the habits and diets of wild animals not only impacts population dynamics, but can lead to nuisance behavior.

- Do not intentionally feed wildlife.
- Properly secure trash receptacles.

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

- Plan for lower disturbance human activities/developments adjacent to intact habitats.
- Consider wildlife travel routes (including bird flight paths) in placement of developments and buildings.
- Encourage building designs that minimize harm to wildlife. For example, consult New York City Audubon's publication "Bird-Safe Building Guidelines" (Brown and Caputo 2007) when planning building construction and renovation.

REVIEWING SITE-SPECIFIC LAND USE PROPOSALS

In addition to town-wide land use and conservation planning, the habitat map and report can be used for reviewing site-specific development and other land use proposals. The habitat map can provide ecological information about both the proposed development site and the surrounding areas that might be affected. We recommend that landowners, developers, and reviewers considering a new land use proposal at a particular site take the following steps to evaluate and mitigate the impact of the proposed land use change on the habitats that may be present on and around the site:

1. Consult the large format habitat map and Figure 6 to see if the site in question is part of a large, contiguous block of habitat or a habitat connection, and which ecologically significant habitats, if any, are located on and near the site.
2. Read the descriptions of those habitats in this report.
3. Check to see if any of the habitats in the area of the proposal are described in the "Priority Habitats" section of this report, either individually or as part of a habitat complex, and 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, contiguous habitat mosaics.
   - Locating developed features such that broad corridors of undeveloped land are maintained between 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 kettle shrub pools or buttonbush pools.
   - Channeling stormwater runoff from paved areas or fertilized turf into detention basins or "rain gardens" instead of directly into ditches, streams, ponds, or

wetlands; installing and maintaining oil-water separators where runoff leaves paved areas.

- Minimizing the clearing of vegetation during construction, and restoring cleared areas with native plantings instead of lawn, wherever possible.

5. Follow the general biodiversity conservation practices outlined earlier in this section of the report.

Because the habitat map has not been 100% field checked we emphasize that, at the site-specific scale, it should be used strictly as a general guide for land use planning and decision making. Onsite observations by professional biologists should be an integral part of the review process for any significant land use change.

CONCLUSION

The Town of Poughkeepsie has a considerable diversity of ecologically significant habitats, including some known to support rare or vulnerable species in the town or in the region. For example, we found nine buttonbush pools and four kettle shrub pools which are the core habitat type for the Blanding's turtle, a NYS Threatened species known to occur in Poughkeepsie. Forty-eight intermittent woodland pools, which are critical breeding and nursery habitat for amphibians of conservation concern, were scattered throughout the town. We mapped calcareous ledges and several tidal habitats, any of which can support rare plant species. Some relatively large habitat patches supported forest and wetland complexes that are likely to be crucial to overall biodiversity protection. With development pressure on the rise, strategic land use and conservation measures are needed to ensure that species, communities, and ecosystems are protected for the long term. We hope that the habitat map and this report will help landowners, developers, and town agencies consider the biological landscape as a whole, and design effective measures 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. Hudsonia hopes to assist Poughkeepsie town agencies and others 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.

The map 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 special habitats are concentrated, and the patterns of habitat fragmentation caused by roads and other 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 biological 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 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 ascertained, and the site should be assessed for additional ecological values. 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.

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 Poughkeepsie 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 the natural communities, and protect the ecological patterns and processes that support us and the rest of the living world.

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APPENDICES

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

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 over other habitats. Places where this overlay appears without an underlying habitat signify bare rock exposures that were large enough to map as their own habitat. Except for the most exposed ledges, these habitats do not have distinct signatures on aerial photographs and were therefore mapped mostly 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 (>15%) slopes 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. The areas that appear on the map as calcareous crest, ledge and talus were extrapolated from the locations of calcareous outcrops observed in the field.

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 golf courses, playing fields, cemeteries, and large lawns. On aerial photos it was sometimes difficult to distinguish extensive lawns from less intensively managed upland meadows, so in the absence of field verification some lawns may have erroneously been mapped as "upland meadow," and vice versa.

Developed areas. Habitat areas surrounded by or intruding into developed land were mapped only if their dimensions exceeded 50 m (165 ft) in all directions, or when their total area was roughly two acres (0.8 ha) or larger. This area threshold was adjusted slightly to exclude the mapping of some areas slightly larger than two acres in heavily developed areas, and to include smaller areas when they were immediately adjacent to larger mapped habitats. Exceptions to this protocol were wetlands within developed areas, which we mapped (along with their immediately adjacent, non-cultural habitats) if they were identifiable on the aerial photographs or if we observed them in the field. 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 roads, 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 on photographs taken in a leaf-off season. Intermittent woodland pools located within areas of conifer forest, however, are not easily identified on aerial photographs, and we may have missed some of these in areas we were unable to visit.

Open water and constructed ponds. Most bodies of open water in Poughkeepsie were probably created by damming or excavation. Those that we mapped as "open water" habitats included natural ponds; large, substantially unvegetated pools within marshes and swamps; pools formed by flooding on perennial stream floodplains; and ponds that were constructed but are now unmanaged and surrounded by unmanaged vegetation. All other ponds were classified as "constructed pond".

Orchard/Plantation. This category included fruit orchards and Christmas tree plantations with young trees. Older conifer plantations were mapped as conifer forest.

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 Poughkeepsie that we did not map. The precise locations and boundaries of seeps and springs should 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. We mapped the likely location of streams that are diverted underground in developed areas only when they re-surfaced at a distance of less than 200 meters (650 ft). 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 included ditches as stream habitat because they function as such from a hydrological perspective. Some larger perennial streams deposit sand or gravel bars, which we mapped upon observation and subsequent extrapolation. Gravel bars are considered part of the stream habitat, and discussed briefly in the report in the streams section. The location and size of such deposits can be highly variable from year to year. Where the eastern and southern border of the Town of Poughkeepsie was apparently delineated by the course of the Wappinger Creek, we mapped its entire width, even where the creek has since shifted to be outside the boundary.

Upland forests. We mapped just three general types of upland forests: hardwood, mixed, and conifer forest. Although these forests are extremely variable in their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other factors, we used these broad categories for practical reasons. Deciduous and coniferous trees are generally distinguishable in aerial photos taken in the spring, although dead conifers can be mistaken for deciduous trees. 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 therefore include non-wetland forests of all ages, at all elevations, and of all species mixtures, including floodplain forests. Gravel and dirt roads (where identifiable) were mapped as boundaries between 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 field verified. 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 aerial photographs. In the field, we identified wetlands primarily by the predominance of hydrophytes 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, non-native honeysuckles) in the understory, and facultative wetland and upland species of shrubs, forbs, and graminoids. In most cases, we mapped these areas 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 town, 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 2007 (http://www.dec.state.ny.us/website/dfwmr/heritage/index.htm).

NEW YORK STATE RANKS

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.

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

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

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

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

SNA A visitor to the state but not a regular occupant (such as a bird or insect migrating through the state), or a species that is predicted to occur in NY but that has not been found.

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

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

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

- Species on the current federal list of endangered or threatened species that occur in New York.
- Species that 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.

PARTNERS IN FLIGHT PRIORITY SPECIES LISTS – BIRDS

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 7 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.

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

***** Prothonotary warbler was not included on the WatchLists for our region, but we have included it 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 Poughkeepsie. These are not comprehensive lists, but merely a sample of the species of conservation concern known to use these habitats in the region. The two-letter codes given with each species name denote its conservation status. Codes include **New York State ranks** (E, T, R, SC), **NY Natural Heritage Program ranks** (S1, S2, S3, SNA), **NYS 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 ranking systems are explained in Appendix B.

UPLAND HARDWOOD FOREST		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
silvery spleenwort (RG)	spotted salamander (RG)	wood thrush (SGCN, RG, PIF1)
blue cohosh (RG)	Jefferson salamander (SC)	scarlet tanager (SGCN, PIF2)
glaucous sedge (E, S2S3)	blue-spotted salamander (SC)	worm-eating warbler (SGCN, RG)
Reznicek's sedge (U, S1S2)	marbled salamander (SC, S3)	cerulean warbler (SC, SGCN, PIF1)
Wildenow's sedge (T, S2S3)	eastern box turtle (SC, S3, SGCN)	Kentucky warbler (S2, RG, PIF1)
hackberry (RG)	eastern hognose snake (SC, S3)	black-and-white warbler (PIF2)
leatherwood (RG)	northern goshawk (SC, S3N, SGCN)	black-throated blue warbler (SGCN, RG)
red baneberry (RG)	red-shouldered hawk (SC, SGCN)	black-throated green warbler (RG)
sweet-gum (RG)	Cooper's hawk (SC, SGCN)	ovenbird (RG)
Virginia snakeroot (E, S2)	sharp-shinned hawk (SC)	southern bog lemming (RG)
Invertebrates	broad-winged hawk (RG)	Indiana bat (E, S1, SGCN)
tawny emperor (S3)	American woodcock (SGCN, RG, PIF1)	black bear (RG)
Vertebrates	barred owl (RG)	bobcat (RG)
wood frog (RG)	eastern wood-pewee (RG, PIF2)	

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

RED CEDAR WOODLAND		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
Indian grass (RG)	wood turtle (SC, S3, SGCN)	short-eared owl (E, S2, PIF1)
Invertebrates	eastern box turtle (SC, S3)	eastern bluebird (RG)
olive hairstreak (butterfly) (RG)	eastern hognose snake (SC, S3)	eastern towhee (PIF2)
Vertebrates	northern harrier (T, S3B, S3N)	brown thrasher (PIF2)
spotted turtle (SC, S3, SGCN)	northern saw-whet owl (S3)	field sparrow (PIF2)
Blanding's turtle (T, S2S3, SGCN)	long-eared owl (S3)	

NON-CALCAREOUS CREST/LEDGE/TALUS

Plants
bronze sedge (RG)
clustered sedge (T, S2S3)
reflexed sedge (E, S2S3)
whorled milkweed (RG)
blunt-leaf milkweed (RG)
eastern prickly-pear (RG)
whorled milkwort (RG)
rock sandwort (RG)
goat's-rue (RG)
slender knotweed (R, S3)
Allegheny-vine (RG)
stiff-leaf aster (RG)

Invertebrates
Edward's hairstreak (butterfly) (S3S4)
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)

Vertebrates
Fowler's toad (SGCN, RG)
marbled salamander (SC, S3, SGCN)
northern slimy salamander (RG)
eastern box turtle (SC, S3)
worm snake (SC, S2, SGCN)
northern copperhead (S3, SGCN)
eastern hognose snake (SC, S3, SGCN)
eastern ratsnake (SGCN, RG)
turkey vulture (RG)
golden eagle (E, SHB, S1N, SGCN)
whip-poor-will (SC, SGCN, PIF2)
common raven (RG)
worm-eating warbler (SGCN, RG, PIF1)
cerulean warbler (SC, SGCN, PIF1)
winter wren (RG)
eastern bluebird (RG)
hermit thrush (RG)
small-footed myotis (bat) (SC, S2)
bobcat (RG)

CALCAREOUS CREST/LEDGE/TALUS

Plants
purple cliffbrake (RG)
walking fern (RG)
smooth cliffbrake (T, S2)
wall-rue (RG)
Emmons' sedge (S3)
hairy rock-cress (RG)
yellow harlequin (S3)
Dutchman's breeches (RG)
pellitory (RG)
small-flowered crowfoot (T, S3)
roundleaf dogwood (RG)
downy arrowwood (RG)
fragrant sumac (RG)

Invertebrates
anise millipede (RG)
falcate orangetio (butterfly) (S3S4)
olive hairstreak (butterfly) (RG)
red-bellied tiger beetle (RG)

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

UPLAND SHRUBLAND

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

Invertebrates
Aphrodite fritillary (butterfly) (RG)
Leonard's skipper (butterfly) (RG)

Vertebrates
wood frog (RG)
Blanding's turtle (T, S2S3, SGCN)
spotted turtle (SC, S3, SGCN)
eastern box turtle (SC, S3, SGCN)
wood turtle (SC, S3, SGCN)
northern harrier (T, S3B, S3N, SGCN)
short-eared owl (E, S2, PIF1)
northern saw-whet owl (S3)
loggerhead shrike (E, S1B)
blue-winged warbler (SGCN, PIF1)
golden-winged warbler (SC, SGCN, PIF1)
prairie warbler (SGCN, PIF1)
yellow-breasted chat (SC, S3)
clay-colored sparrow (S2)
vesper sparrow (SC, SGCN)
grasshopper sparrow (SC, SGCN, PIF2)
eastern towhee (PIF2)
brown thrasher (SGCN, PIF2)
field sparrow (PIF2)

UPLAND MEADOW

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

Vertebrates
Fowler's toad (SGCN, RG)
Blanding's turtle (T, S2S3, SGCN)
spotted turtle (SC, S3, SGCN)
eastern box turtle (SC, S3, SGCN)
wood turtle (SC, S3, SGCN)
northern harrier (T, S3B, S3N, SGCN)
sedge wren (T, S3B, PIF2)
eastern bluebird (RG)
savannah sparrow (RG)
vesper sparrow (SC, SGCN)
bobolink (SGCN, RG)
eastern meadowlark (SGCN, RG)

WASTE GROUND

Plants
hair-rush (RG)
toad rush (RG)
orangeweed (RG)
field-dodder (S3)
slender pinweed (T, S2)
rattlebox (E, S1)
blunt mountain-mint (T, S2S3)
slender knotweed (R, S3)

Invertebrates
dusted skipper (butterfly) (S3)
little yellow (butterfly) (RG)
swarthy skipper (butterfly) (RG)

Vertebrates
Fowler's toad (SGCN, RG)
Blanding's turtle (T, S2S3, SGCN)
wood turtle (SC, S3, SGCN)
eastern hognose snake (SC, S3, SGCN)
northern copperhead (S3, SGCN)
American black duck (SGCN, RG, PIF1)
common nighthawk (SC)
common raven (RG)
grasshopper sparrow (SC, SGCN, PIF2)
bank swallow (RG)

SWAMP

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

INTERMITTENT WOODLAND POOL

Plants
Virginia chain fern (RG)
cattail sedge (R, S2)
false hop sedge (R, S2)
featherfoil (T, S2)
Vertebrates
springtime physa (snail) (RG)
Vertebrates (cont.)
wood frog (RG)
Jefferson salamander (SC, SGCN)
marbled salamander (SC, S3, SGCN)
spotted salamander (RG)
Blanding's turtle (T, S2S3, SGCN)
Vertebrates (cont.)
spotted turtle (SC, S3, SGCN)
wood turtle (SC, S3, SGCN)
wood duck (RG, PIF2)
American black duck (SGCN, RG, PIF1)
northern waterthrush (RG)

BUTTONBUSH POOL/KETTLE SHRUB POOL

Plants
Helodium paludosum (moss) (RG)
pale alkali-grass (RG)
short-awn foxtail (RG)
spiny coontail (T, S3)
Plants (cont.)
buttonbush dodder (E, S1)
Vertebrates
wood frog (RG)
blue-spotted salamander (SC, SGCN)
Blanding's turtle (T, S2S3, SGCN)
Vertebrates (cont.)
spotted turtle (SC, S3, SGCN)
eastern ribbonsnake (SGCN, RG)
wood duck (RG, PIF2)
American black duck (SGCN, RG, PIF1)

MARSH

Plants
winged monkey-flower (R, S3)
swamp lousewort (T, S2)
buttonbush dodder (E, S1)
spiny coontail (T, S3)
Vertebrates
northern cricket frog (E, S1, SGCN)
northern leopard frog (RG)
Vertebrates (cont.)
Blanding's turtle (T, S2S3, SGCN)
spotted turtle (SC, S3, SGCN)
American bittern (SC, SGCN)
least bittern (T, S3B, S1N, SGCN)
great blue heron (RG)
wood duck (RG, PIF2)
American black duck (SGCN, RG, PIF1)
Vertebrates (cont.)
pied-billed grebe (T, S3B, S1N, SGCN)
northern harrier (T, S3B, S3N, SGCN)
king rail (T, S1B, SGCN, PIF1)
Virginia rail (RG)
sora (RG)
common moorhen (RG)
marsh wren (RG)

WET MEADOW

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

CALCAREOUS WET MEADOW

Plants
wood horsetail (RG)
Schweinitz's sedge (T, S2S3)
Bush's sedge (S3)
ovate spikerush (E, S1S2)
slender lady's-tresses (RG)
small-flowered agrimony (S3)
showy ladyslipper (RG)
Plants (cont.)
Kalm's lobelia (RG)
Invertebrates
phantom cranefly (RG)
eyed brown (butterfly) (RG)
black dash (butterfly) (RG)
two-spotted skipper (butterfly) (RG)
Dion skipper (butterfly) (S3)
Invertebrates (cont.)
Baltimore (butterfly) (RG)
mulberry wing (butterfly) (RG)
Vertebrates
spotted turtle (SC, S3, SGCN)
eastern ribbonsnake (SGCN, RG)
northern harrier (T, S3B, S3N)
sedge wren (T, S3B, PIF2)

OPEN WATER/CONSTRUCTED POND

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

SPRING/SEEP

Plants
devil's-bit (T, S1S2)
Invertebrates
Piedmont groundwater amphipod (RG)
Invertebrates (cont.)
gray petaltail (dragonfly) (SC, S2)
tiger spiketail (dragonfly) (S1, SGCN)
Vertebrates
northern dusky salamander (RG)
spring salamander (RG)

STREAM & RIPARIAN CORRIDOR

Plants
cattail sedge (T, S1)
Davis' sedge (T, S2)
winged monkey-flower (R, S3)
riverweed (T, S2)
spiny coontail (T, S3)
goldenseal (T, S2)
river birch (S3)
lizard's tail (RG)
small-flowered agrimony (S3)
false-mermaid (RG)
swamp rose-mallow (RG)
may-apple (RG)
black maple (RG)
Marstonia decepta (snail) (RG)
Invertebrates
brook floater (mussel) (T, S1)
Pisidium adamsi (fingernail clam) (RG)
Sphaerium fabale (fingernail clam) (RG)
ostrich fern borer (moth) (SGCN)
arrowhead spiketail (dragonfly) (S2S3, SGCN)
mocha emerald (dragonfly) (S2S3, SGCN)
sable clubtail (dragonfly) (S1)
American rubyspot (damselfly) (S3)
Vertebrates
creek chubsucker (fish) (RG)
bridle shiner (fish) (RG)
brook trout (SGCN, RG)
Fowler's toad (SGCN, RG)
slimy sculpin (fish) (RG)
northern dusky salamander (RG)
Vertebrates (cont.)
red salamander (RG)
spring salamander (RG)
wood turtle (SC, S3, SGCN)
great blue heron (RG)
American black duck (SGCN, RG, PIF1)
wood duck (RG, PIF2)
red-shouldered hawk (SC, SGCN)
American woodcock (SGCN, RG, PIF1)
cerulean warbler (SC, SGCN, PIF1)
bank swallow (RG)
winter wren (RG)
Louisiana waterthrush (RG)
river otter (SGCN, RG)
Indiana bat (E, S1, SGCN)
small-footed bat (S2, SC)

ESTUARINE ROCKY SHORE

Plants
estuary beggar-ticks (R, S3)
heartleaf plantain (T, S3)
terrestrial starwort (T, S2S3)
Plants (cont.)
eastern prickly-pear (RG)
river birch (S3)
northern white cedar (RG)
Vertebrates
map turtle (RG)
American black duck (SGCN, RG, PIF1)
harbor seal (S3)

SUPRATIDAL RAILROAD CAUSEWAY

Plants
Drummond's rock-cress (E)
slender knotweed (R, S3)
Vertebrates
kidneyleaf mud-plantain (S3)
wood turtle (SC, S3, SGCN)
Vertebrates (cont.)
spotted turtle (SC, S3, SGCN)
map turtle (RG)

FRESHWATER TIDAL SWAMP

Plants
Fernald's sedge (T, S2S3)
swamp lousewort (T, S2)
winged monkey-flower (R, S3)
goldenclub (T, S2)
Plants (cont.)
heartleaf plantain (T, S3)
spongy arrowhead (T, S2)
estuary beggar-ticks (R, S3)
Vertebrates
wood turtle (SC, S3, SGCN)
osprey (SC, SGCN)
bald eagle (T, S2S3B, SGCN)
river otter (SGCN, RG)

TIDAL MUDFLAT		
Plants	***Invertebrates***	***Vertebrates (cont.)***
river quillwort (E, S1)	alewife floater (mussel) (S1S2)	map turtle (RG)
spongy arrowhead (T, S2)	yellow lampmussel (mussel) (S3)	least bittern (T, S3B, S1N, SGCN)
mudwort (S3)	tidewater mucket (mussel) (S1)	American bittern (SC, SGCN)
false pimpernel (RG)	***Vertebrates***	ruddy duck (S1)
heartleaf plantain (T, S3)	shortnose sturgeon (E, S1)	red-breasted merganser (RG)
kidneyleaf mud-plantain (S3)	American brook lamprey (S3)	osprey (SC, SGCN)
Hudson River water-nymph (E, S1)	northern hog sucker (RG)	bald eagle (T, S2S3B, SGCN)
	diamondback terrapin (S3)	

TIDAL TRIBUTARY MOUTH		
Plants	***Plants (cont.)***	***Vertebrates***
lizard's tail (RG)	heartleaf plantain (T, S3)	rainbow smelt (RG)
spongy arrowhead (T, S2)	goldenclub (T, S2)	American brook lamprey (S3)
estuary beggar-ticks (R, S3)	***Invertebrates***	northern hog sucker (RG)
smooth bur-marigold (T, S2)	*Pomatiopsis lapidaria* (snail) (S3)	American bittern (SC, SGCN)
		osprey (SC, SGCN)

FRESHWATER TIDAL MARSH		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
Fernald's sedge (T, S2S3)	smooth bur-marigold (T, S2)	osprey (SC, SGCN)
Long's bittercress (T, S2)	goldenclub (T, S2)	northern harrier (T, S3B, S3N, SGCN)
spongy arrowhead (T, S2)	***Vertebrates***	bald eagle (T, S2S3B)
American waterwort (E, S1)	great blue heron (RG)	common moorhen (RG)
heartleaf plantain (T, S3)	least bittern (T, S3B, S1N, SGCN)	sora (RG)
estuary beggar-ticks (R, S3)	American bittern (SC, SGCN)	marsh wren (RG)

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

Common Name	Scientific Name
agrimony, small-flowered	*Agrimonia parviflora*
alder	*Alnus*
alkali-grass, pale	*Torreyochloa pallida* v. *pallida*
Allegheny-vine	*Adlumia fungosa*
arrow arum	*Peltandra virginica*
arrowhead, broad-leaved	*Sagittaria latifolia*
arrowhead, spongy	*Sagittaria calycina* v. *spongiosa*
arrowhead, strap-leaf	*Sagittaria subulata*
arrowwood, downy	*Viburnum rafinesquianum*
arrowwood, northern	*Viburnum dentatum* v. *lucidum*
ash, black	*Fraxinus nigra*
ash, green	*Fraxinus pensylvanica*
ash, white	*Fraxinus americana*
aspen, quaking	*Populus tremuloides*
aster, stiff-leaf	*Aster linariifolius*
azalea, swamp	*Rhododendron viscosum*
baneberry, red	*Actaea spicata* ssp. *rubra*
barberry, Japanese	*Berberis vulgaris*
basswood	*Tilia americana*
beggar-ticks, estuary	*Bidens bidentoides*
birch, black	*Betula lenta*
birch, gray	*Betula populifolia*
birch, river	*Betula nigra*
bittercress, Long's	*Cardamine longii*
bittersweet, oriental	*Celastrus orbiculatus*
blackberry, northern	*Rubus allegheniensis*
bladdernut	*Staphylea trifolia*
bladderwort	*Utricularia*
blueberry, highbush	*Vaccinium corymbosum*
blueberry, late lowbush	*Vaccinium angustifolium*
blueberry, southern lowbush	*Vaccinium pallidum*
bluegrass, Kentucky	*Poa pratensis*
bluejoint	*Calamagrostis canadensis*
bluestem, little	*Schizachyrium scoparium*
bulrush, softstem	*Schoenoplectus tabernaemontani*
bur-marigold, smooth	*Bidens laevis*
butterflyweed	*Asclepias tuberosa*
butternut	*Juglans cinerea*
buttonbush	*Cephalanthus occidentalis*
cabbage, skunk	*Symplocarpus foetidus*
canary-grass, reed	*Phalaris arundinacea*
cattail	*Typha*
cattail, narrow-leaf	*Typha angustifolia*
cedar, eastern red	*Juniperus virginiana*
cedar, northern white	*Thuja occidentalis*
cherry, black	*Prunus serotina*
chestnut, water	*Trapa natans*
chokeberry	*Aronia*
cliffbrake, purple	*Pellaea atropurpurea*
cliffbrake, smooth	*Pellaea glabella*
cohosh, blue	*Caulophyllum thalictroides*
columbine, wild	*Aquilegia canadensis*
coontail, spiny	*Ceratophyllum echinatum*
cottonwood, eastern	*Populus deltoides*
cottonwood, swamp	*Populus heterophylla*
crowfoot, small-flowered	*Ranunculus micranthus*
cutgrass, rice	*Leersia oryzoides*
devil's-bit	*Chamaelirium luteum*
dodder, buttonbush	*Cuscuta cephalanthi*
dodder, field	*Cuscuta pentagona*
dogwood, flowering	*Cornus florida*
dogwood, gray	*Cornus foemina* ssp. *racemosa*
dogwood, red-osier	*Cornus sericea*
dogwood, roundleaf	*Cornus rugosa*
dogwood, silky	*Cornus amomum*
duckweed, common	*Lemna minor*
Dutchman's breeches	*Dicentra cucullaria*
elder, box	*Acer negundo*
elm, American	*Ulmus americana*
elm, slippery	*Ulmus rubra*
false-mermaid	*Floerkea proserpinacoides*
featherfoil	*Hottonia inflata*
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*
foxtail, short-awn	*Alopecurus aequalis*
ginger, wild	*Asarum canadense*
goat's-rue	*Tephrosia virginiana*
goldenclub	*Orontium aquaticum*
goldenrod, rough-leaf	*Solidago patula*
goldenrod, stiff-leaf	*Solidago rigida*
goldenseal	*Hydrastis canadensis*
grass, Indian	*Sorghastrum nutans*
greenbrier	*Smilax*
gum, black	*Nyssa sylvatica*
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	*Lonicera*
honeysuckle, Bell's	*Lonicera* x *bella*
hornbeam, American	*Ostrya virginiana*
hornbeam, hop	*Carpinus caroliniana*
horsetail, wood	*Equisetum sylvaticum*
ironweed, New York	*Vernonia noveboracensis*
jewelweed, spotted	*Impatiens capensis*
knotweed, Japanese	*Fallopia japonica*
knotweed, slender	*Polygonum tenue*
lady's-tresses, slender	*Spiranthes lacera*
ladyslipper, showy	*Cypripedium reginae*

(continued)

Common Name	Scientific Name	Common Name	Scientific Name
leatherwood	*Dirca palustris*	rock-cress, Drummond's	*Arabis drummondii*
leek, wild	*Allium tricoccum*	rock-cress, hairy	*Arabis hirsuta* var. *pycnocarpa*
liverwort	Hepaticae	rose-mallow, swamp	*Hibiscus moscheutos*
lizard's tail	*Saururus cernuus*	rose, multiflora	*Rosa multiflora*
lobelia, Kalm's	*Lobelia kalmii*	rush, toad	*Juncus bufonius*
locust, black	*Robinia pseudoacacia*	rush, soft	*Juncus effusus*
loosestrife, purple	*Lythrum salicaria*	sandwort, rock	*Minuartia michauxii*
lousewort, swamp	*Pedicularis lanceolata*	saxifrage, golden	*Chrysosplenium americanum*
mannagrass	*Glyceria*	sedge, bronze	*Carex aenea*
maple, black	*Acer nigrum*	sedge, Bush's	*Carex bushii*
maple, Norway	*Acer platanoides*	sedge, cattail	*Carex typhina*
maple, red	*Acer rubrum*	sedge, clustered	*Carex cumulata*
maple, sugar	*Acer saccharum*	sedge, Davis'	*Carex davisii*
may-apple	*Podophyllum peltatum*	sedge, Emmons'	*Carex albicans* v. *emmonsii*
meadowsweet	*Spiraea alba* var. *latifolia*	sedge, false hop	*Carex lupuliformis*
milkweed, blunt-leaf	*Asclepias amplexicaulis*	sedge, Fernald's	*Carex merritt-fernaldii*
milkweed, whorled	*Asclepias verticillata*	sedge, glaucous	Carex glaucodea
milkwort, whorled	*Polygala verticillata*	sedge, lakeside	*Carex lacustris*
monkey-flower, winged	*Mimulus alatus*	sedge, Pennsylvania	*Carex pensylvanica*
(a moss)	*Helodium paludosum*	sedge, reflexed	*Carex retroflexa*
mountain-mint, blunt	*Pycnanthemum muticum*	sedge, Reznicek's	*Carex reznicekii*
mud-plantain, kidneyleaf	*Heteranthera reniformis*	sedge, Schweinitz's	*Carex schweinitzii*
mudwort	*Limosella australis*	sedge, tussock	*Carex stricta*
mustard, garlic	*Alliaria petiolata*	sedge, Wildenow's	*Carex willdenowii*
nannyberry	*Viburnum lentago*	serviceberry	*Amelanchier*
oak, black	*Quercus velutina*	snakeroot, Virginia	*Aristolochia serpentaria*
oak, chestnut	*Quercus montana*	sneezeweed	*Helenium autumnale*
oak, pin	*Quercus palustris*	spatterdock	*Nuphar lutea*
oak, red	*Quercus rubra*	spicebush	*Lindera benzoin*
oak, scrub	*Quercus ilicifolia*	spikerush, ovate	*Eleocharis obtusa* v. *ovata*
oak, swamp white	*Quercus bicolor*	spleenwort, ebony	*Asplenium platyneuron*
oak, white	*Quercus alba*	spleenwort, maidenhair	*Asplenium trichomanes*
orangeweed	*Hypericum gentianoides*	spleenwort, silvery	*Deparia acrostichoides*
pellitory	*Parietaria pensylvanica*	spruce, Norway	*Picea abies*
pickerelweed	*Pontederia cordata*	St. Johnswort, shrubby	*Hypericum prolificum*
pimpernel, false	*Lindernia dubia* var. *inundata*	starwort, terrestrial	*Callitriche terrestris*
pine, pitch	*Pinus rigida*	stiltgrass, Japanese	*Microstegium vimineum*
pine, Scotch	*Pinus sylvestris*	sumac, fragrant	*Rhus aromatica*
pine, white	*Pinus strobus*	sumac, poison	*Toxicodendron vernix*
pinesap	*Monotropa hypopithys*	sweet-gum	*Liquidambar styraciflua*
pinweed, slender	*Lechea tenuifolia*	sweetflag	*Acorus calamus*
plantain, heartleaf	*Plantago cordata*	sycamore	*Platanus occidentalis*
polypody, common	*Polypodium vulgare*	three-square, common	*Scirpus pungens*
pond-lily, yellow	*Nuphar advena*	tree-of-heaven	*Ailanthus altissima*
pond-lily, white	*Nymphaea odorata*	vervain, blue	*Verbena hastata*
pondweed	*Potamogeton*	water-nymph, Hudson River	Najas guadalupensis ssp. muenscheri
prickly-ash, American	*Xanthoxylum americana*	wall-rue	*Asplenium ruta-muraria*
prickly-pear, eastern	*Opuntia humifusa*	watermilfoil	*Myriophyllum*
quillwort, river	*Isoetes riparia*	water-plantain	*Alisma triviale*
raspberry	*Rubus*	waterwort, American	*Elatine americana*
rattlebox	*Crotalaria sagittalis*	willow	*Salix*
reed, common	*Phragmites australis*	witch-hazel	*Hamamelis virginiana*
rice, wild	*Zizania aquatica*	woolgrass	*Scirpus cyperinus*
riverweed	*Podostemum ceratophyllum*		