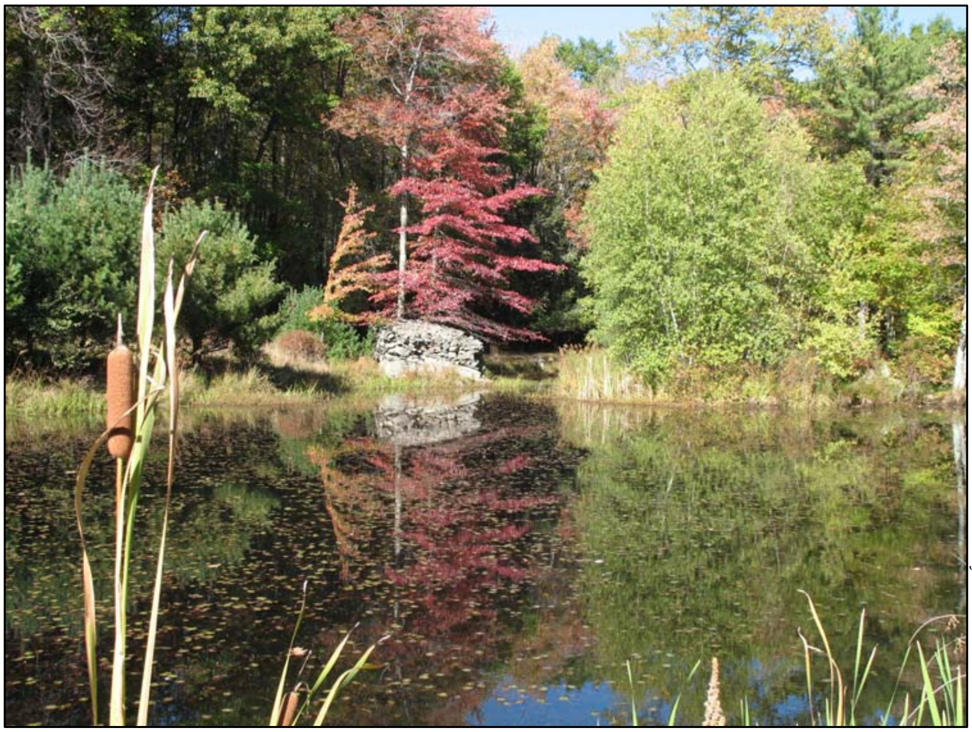
SIGNIFICANT HABITATS

IN SELECTED AREAS IN THE TOWN OF MARBLETOWN, ULSTER COUNTY, NEW YORK



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Report to the Town of Marbletown

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December 2007

Environmental Research and Education
Science for Conservation

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EXECUTIVE SUMMARY

Hudsonia biologists identified and mapped ecologically significant habitats in two selected tracts totaling approximately 6000 acres in the Catskill foothills and along the Rondout Creek in the Town of Marbletown. The study area was adjacent to an approximately 7500 acre (3000 ha) study area mapped by a Marbletown community group in 2006. Through map analysis, aerial photograph interpretation, and field observations we created a large-format map showing the locations and configurations of significant habitats throughout the study area. Some of these habitats are rare or declining in the region or support rare species of plants or animals, while others are high quality examples of common habitats or habitat complexes. Among our more interesting finds were 26 intermittent woodland pools; extensive crest, ledge, and talus habitats; 22 conifer and mixed forest swamps (including a tamarack/red maple swamp); and large forested areas exceeding 1,000 acres (300 ha).

In this report we describe each of the mapped habitat types, including their ecological attributes, some species of conservation concern they may support, and their sensitivities to human disturbance. We address conservation issues associated with these habitats and provide specific conservation recommendations. We also provide instructions on how to use this report and the map, both to review site-specific proposals and as a guide for landscape-level conservation planning and decision-making. Conservation priorities include protecting sensitive or rare habitats and high-quality or large examples of common habitats, and maintaining corridors between these areas.

The habitat map and report, together with the documents prepared for the adjacent study area (Cairo et al., in prep), can help the town identify 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 and surrounding areas are undergoing rapid change as farms, forests, and other undeveloped lands are converted to residential and commercial uses. The consequences of rapid land development include widespread habitat degradation, habitat fragmentation, 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, Dutchess County, 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 five Dutchess County towns—Amenia, East Fishkill, Rhinebeck, Stanford, and Washington, and has nearly completed maps of Northeast and Poughkeepsie. In 2006 the Town of Marbletown (Ulster County) was awarded a grant from the Hudson River Estuary Program of the New York State Department of Environmental Conservation to enable Hudsonia to undertake this project.

Tanessa Hartwig (Biologist), Amie Worley (Research Assistant), Nava Tabak (Biologist), and Gretchen Stevens (Director of Hudsonia's Biodiversity Resources Center) conducted the work on this project from August 2006 through October 2007. Through map analysis, aerial photograph interpretation, and field observations we created a map of ecologically significant habitats in the study area. Some of these habitats are rare or declining in the region, some may support rare species of plants or animals, while others are high quality examples of common habitats or habitat complexes. The emphasis of this project was on identifying and mapping general habitat types, rather than on conducting species-level surveys or mapping the known locations of rare species.

To facilitate intermunicipal planning, we strive for consistency in the ways that we define and identify habitats and present the information for town use, but we also expect that our methods and products will improve as the program evolves. Many passages in this report relating to general habitat descriptions, general conservation and planning concepts, and other information applicable to the region as a whole are taken directly from our other habitat mapping reports (Stevens and Broadbent 2002, Tollefson and Stevens 2004, Bell et al. 2005, Sullivan and Stevens 2005, Tabak et al. 2006, Reinmann and Stevens 2007) without specific attribution. This report, however, addresses our findings and specific recommendations for the Town of Marbletown. 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 property fits into the larger ecological landscape, and will inspire them to implement habitat protection measures voluntarily. We also hope that the town will engage in proactive land use and conservation planning to ensure that future development is planned with a view to long-term protection of the considerable biological resources of the Town of Marbletown.

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 non-biological components of their environment, such as soil, water, air, and sunlight. Protecting 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 gasses 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 unique role in the maintenance of biological communities. Maintaining the full complement of native species in a region allows an ecosystem to withstand stresses and adapt to changing environmental conditions.

What are Ecologically Significant Habitats?

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

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

Because most wildlife species need to travel among different habitats to satisfy their basic survival needs, landscape patterns can have a profound influence on wildlife populations. The size, connectivity, and juxtaposition of both common and uncommon habitats in the landscape all have important implications for biodiversity. In addition to their importance from a biological standpoint, habitats are also manageable units for planning and conservation at fairly large scales such as towns. By illustrating the location and configuration of ecologically significant habitats throughout the Town of Marbletown study area, 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 Marbletown is located in central Ulster County in southeastern New York. It encompasses approximately 55 mi^2 (143 km^2) and has a population of roughly 5,854 residents (2000 Census). Marbletown has a varied topography, stretching from the foothills of the Catskills in the western parts, to the Shawangunk Ridge in the south, to the Rondout Valley in the east. The town is drained by the Esopus and Rondout creeks, major tributaries to the Hudson River. Surficial material in Marbletown is primarily glacial till and lacustrine silt and clay, with recent alluvium along the large creeks (Cadwell et al. 1989). Elevations in Marbletown range from around 120 ft (39 m) above mean sea level along Rondout Creek in the southern part of town to 1,500 ft (492 m) along the Shawangunk ridge (USGS Mohonk Lake 7.5 minute quadrangle). The town contains several large ponds (including Lyonsville Pond, Roosa Lake, and a portion of the Ashokan Reservoir) and wetlands (including Vly Swamp), significant areas of farmland along the Esopus and Rondout creeks, many abandoned bluestone quarries, and a portion of the Delaware and Hudson Canal. Our habitat study focused on two parts of Marbletown: 5,314 ac (2,150 ha) in the west (hereafter called the “Catskill foothills”) and 751 ac (304 ha) in the southeast along Rondout Creek (called the “Rondout corridor”) (Figure 1). The boundaries of the study area were chosen in consultation with members of the Marbletown Environmental Conservation Commission. Another portion of Marbletown was mapped in 2006 by a group of Marbletown residents that took part in Hudsonia’s Biodiversity Assessment Training, an educational program that instructs participants in techniques for identifying important habitats and provides an introduction to the principles of biodiversity conservation planning.

Marbletown's landscape reflects the strong influences of bedrock geology and glacier activity. The bedrock of the Catskill foothills is dominated by sandstone and shale. Thinly laminated sandstones, also known as "bluestone," have been quarried from small mines throughout the town, and these old quarries are a common feature of the local landscape. The Rondout corridor is underlain variously by dolostone, limestone, sandstone, shale, quartzite, and conglomerate (Fisher et al. 1970). Soils in the Catskill foothills are predominantly derived from glacial till, and mostly consist of bouldery silt loam with 15-20% rock outcrops. Soils in the Rondout corridor are primarily alluvial with a glacial lacustrine or riverine origin, and are well-drained gravelly silt loam, sandy loam, or sand (Tornes 1979).

Land uses in the Town of Marbletown include farming (row crops, hay, and livestock), forestry, hunting preserves, a campground, horse stables and pastures, and residential, commercial, and industrial uses. Residences and their immediate surroundings are the most common type of developed uses in Marbletown. These are mainly concentrated in the small hamlets of Stone Ridge and High Falls and along the roads throughout the town. Most privately owned parcels in the study area are of 10 acres (4 ha) or less. However, 7 private landowners own parcels totaling over 100 ac (41 ha). The study area contains large areas of undeveloped open space (see Figure 5).

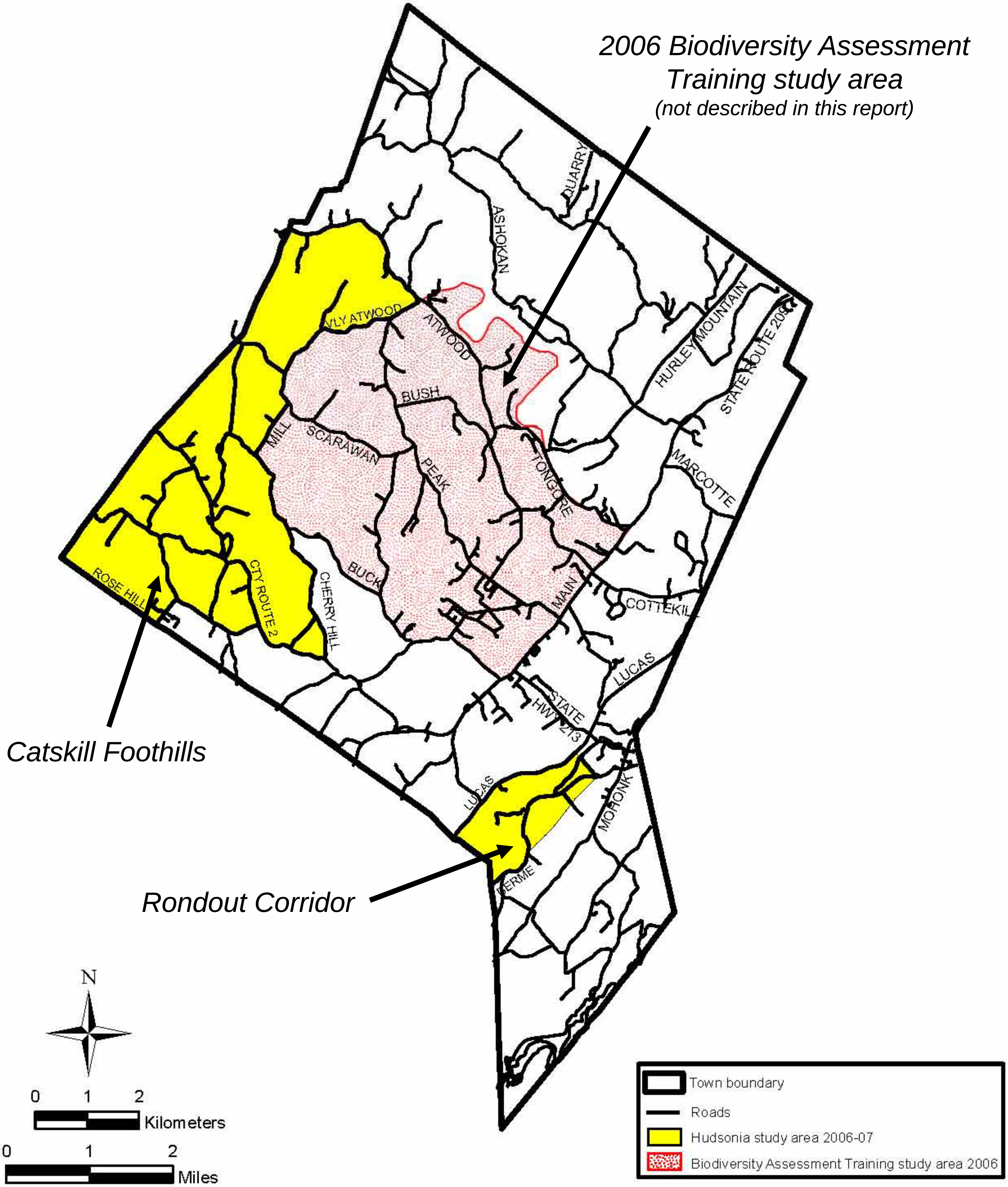


Figure 1. Study areas within the Town of Marbletown, Ulster County, New York. Hudsonia Ltd., 2007.

METHODS

Hudsonia identified habitats using map analysis, aerial photo interpretation, and field observations. Below we describe each phase in the Town of Marbletown 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. Our first step in the habitat mapping process is to assemble all of the necessary and relevant maps, Geographic Information System (GIS) data, and existing published and unpublished information from biologists who have worked in the area. We then 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 the region and biological data provided by the New York Natural Heritage Program, we also used the following resources for this project:

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

- *High-resolution infrared digital orthophotos (1 pixel = 12 in [30 cm])* taken in spring 2001 and *panchromatic digital orthophotos (1 pixel = 24 inches [61 cm])* taken in spring 2004, obtained from the New York State GIS Clearinghouse website (http://www.nysgis.state.ny.us; accessed August 2006). These digital aerial photos were used for on-screen digitizing of habitat boundaries.

- *U.S. Geological Survey topographic maps* (Ashokan, Kerhonkson, and Mohonk Lake 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 such habitats as cliffs, intermittent woodland pools, 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 biotic communities that become established on any site.

- *Soil Survey of Ulster County, New York* (Tornes 1979). 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 often 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 the 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 New York State GIS Clearinghouse website (http://www.nysgis.state.ny.us; accessed August 2006), including roads, streams, floodplains, and federal wetlands (National Wetlands Inventory data prepared by the U.S. Fish and Wildlife Service). We also obtained 33-ft (10-m) contour data, state wetlands, and tax parcel data from the Town of Marbletown.

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 3.2 (Environmental Systems Research Institute 1999) 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 going to the field sites we contacted property owners 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 questions regarding habitat identification or extent that could not be answered remotely. For example, distinctions between habitats such as wet meadow and calcareous wet meadow and calcareous crest and acidic crest can only be made in the field. In addition to conducting fieldwork on private land, we also viewed habitats from adjacent properties, public roads, and other public access areas. Because the schedule of this project (and non-participating landowners) prevented us from conducting intensive field verification on every parcel, this strategy increased our efficiency while maintaining a high standard of accuracy.

Ultimately we field checked approximately 42% of the undeveloped land area in the study area (2280 ac [920 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 have conducted fieldwork in one area, however, we are able to extrapolate our findings to adjacent parcels and similar settings.

Defining Habitat Types

Habitats are useful for categorizing places according to apparent ecological function, and are manageable units for scientific inquiry and land use planning. But habitats exist as part of a continuum of intergrading resources and conditions, and it is often difficult to draw a line to separate two habitats. Also, some distinct habitats are intermediates between two defined habitat types, and some habitat categories can be considered complexes of several habitat types. At least one of our habitats (crest/ledge/talus) occurs within other habitat types. In order to maintain consistency within and among habitat mapping projects, we have defined certain mapping conventions (or rules) that we use to delineate habitat boundaries. Some of these conventions are described in Appendix A. Because many parts of the study area were not visited in the field, and all of the mapping was conducted remotely, all of our mapped habitat boundaries should be considered approximations.

Each habitat profile in the Results section describes the ecological attributes of places that are included in that habitat. Developed areas and other areas that we consider non-significant habitats (e.g., structures; paved roads and driveways; other impervious surfaces; and small lawns, woodlots, and other habitat areas surrounded by development) are shown as white (no symbol or color) on the habitat map. Areas that have been developed since 2001 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 study area.

Final Mapping and Presentation of Data

We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map. We produced the final large-format habitat map on one 42 x 49 inch sheet at a scale of 1:10,000, using a Hewlett Packard DesignJet 800PS plotter. 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 Marbletown 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 map was carefully prepared and extensively field checked, there are inevitable inaccuracies in the final map. Because of this, we request that the following caveat be printed prominently on all maps:

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

RESULTS

Overview

The mapped areas illustrate some of the diversity of habitats that occur in the town and the complexity of their configuration in the landscape. A reduction of the completed habitat map is shown in Figure 2. Of the total 6064 ac (2454 ha) comprising the study area, approximately 90% is undeveloped (i.e., without structures, roads, etc.). In addition, approximately 71% of the study area is forested upland, 7% is meadow (agricultural areas and other managed and unmanaged grassland habitats), and 8% is wetland. Some of the smaller, more unusual habitats we documented include conifer and mixed forest swamps, intermittent woodland pools, and upland meadows dominated by little bluestem. In total, we identified 22 different kinds of habitats that we consider to be of potential ecological importance (Table 1).

Although the mapped areas represent ecologically significant habitats, all have been altered to various degrees by past and present human activities. Most or all areas of upland forest, for example, have been logged or quarried repeatedly in the past 300 years. Many of the wetlands have been extensively altered by human activities such as damming, filling, draining, and railroad and road construction. Although we have documented the location and extent of important habitats within the study area, in only a few cases have we provided information on the quality and condition of these habitats.

Table 1. Ecologically significant habitats documented by Hudsonia in selected areas in the Town of Marbletown, Ulster County, New York, 2007.

Upland Habitats	Wetland Habitats
Upland hardwood forest	Hardwood & shrub swamp
Upland conifer forest	Conifer swamp
Upland mixed forest	Mixed forest swamp
Crest/ledge/talus	Intermittent woodland pool
Calcareous crest/ledge/talus	Marsh
Quarry	Wet meadow
Upland shrubland	Calcareous wet meadow
Upland meadow	Open water
Orchard/plantation	Constructed pond
Cultural	Spring/seep
Waste ground	Stream

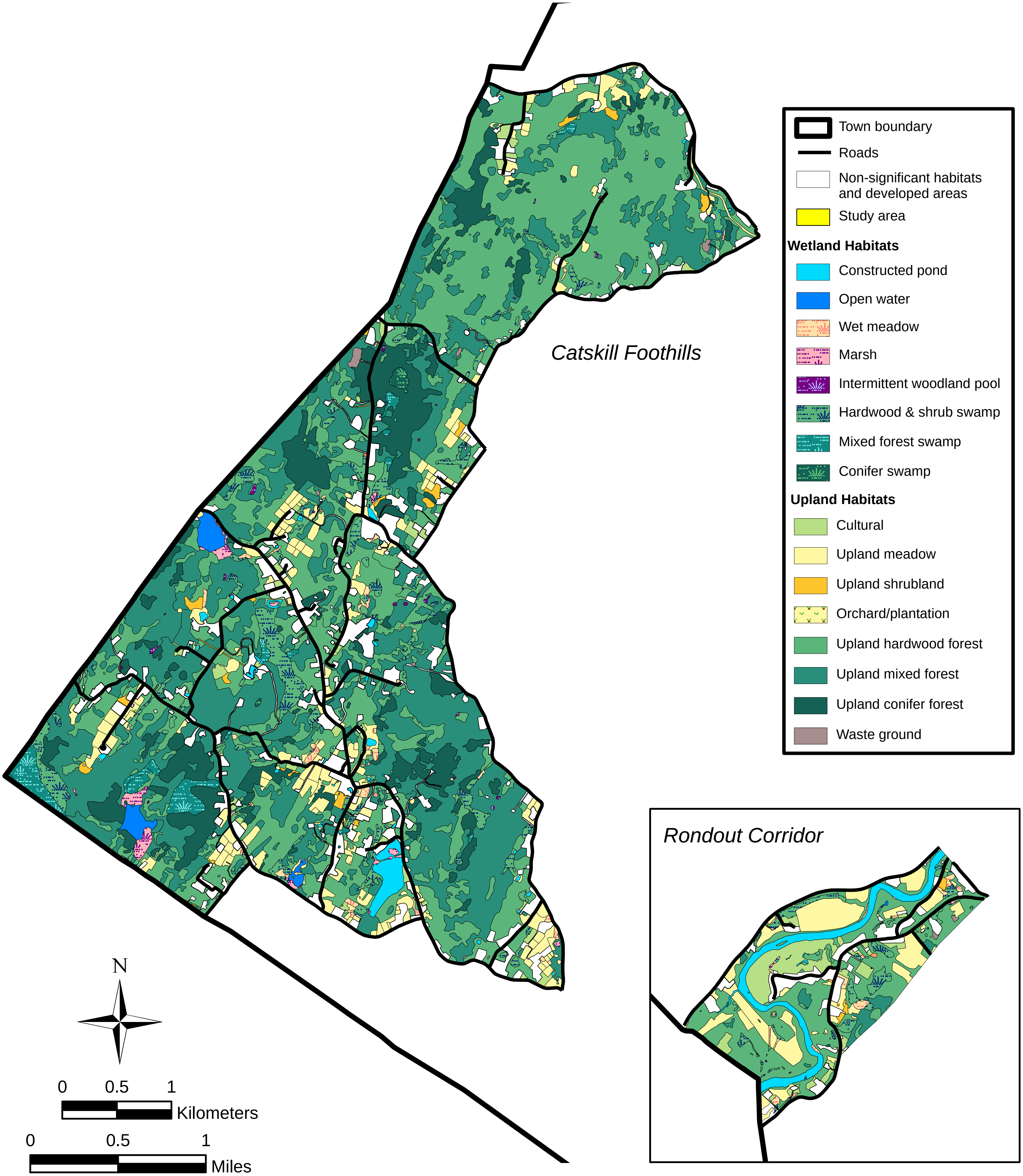


Figure 2. A reduction of the map illustrating the ecologically significant habitats in the Town of Marbletown study area, Ulster County, New York. Developed and other non-significant habitats are shown in white. The large-format map is printed at a scale of 1:10,000. Hudsonia Ltd., 2007.

HABITAT DESCRIPTIONS

In the following pages we describe some of the ecological attributes of the habitats identified in our study area, and discuss some conservation measures that can help to protect these habitats and the species of conservation concern they may support. We have assigned a code to each habitat type (e.g., upland conifer forest = ucf; marsh = ma) that corresponds with the codes appearing on the large-format (1:10,000 scale) habitat map sheet. We have indicated species of conservation concern (those listed by state agencies or considered rare by non-government organizations) by placing an asterisk (*) after the species name. Appendix B provides a more detailed list of rare species associated with each habitat, including their statewide and regional conservation status. The two-letter codes used in Appendix B to describe the conservation status of rare species are explained in Appendix C. Appendix D gives the common and scientific names of all plants mentioned in the report.

UPLAND HABITATS

UPLAND FORESTS

Ecological Attributes

We classified upland forests into just 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. Our broad forest types are useful for general planning purposes, however, and are also the most practical for our remote mapping methods.

Upland Hardwood Forest (uhf)

Upland hardwood forest is the most common habitat type in the Hudson Valley, and includes many different types of deciduous forest communities. Upland hardwood forests are used by a wide range of common and rare species of plants and animals. Common trees of upland hardwood forests include maples (sugar, red, striped), oaks (black, red, chestnut, white), hickories (shagbark, pignut, bitternut, sweet pignut), birches (black, yellow, paper), big-toothed aspen, and white ash. Chestnut oak can be common on rocky, exposed ridgetops. More northern species, including paper birch and yellow birch, join more typically southern trees such as sassafras and black gum on the slopes of the Catskills. Common understory species include lowbush blueberry, black huckleberry, witch-hazel, serviceberry (or shadbush), mountain laurel, striped maple, American hornbeam, white pine, and a wide variety of lichens, mosses, ferns, sedges (especially Pennsylvania sedge), and wildflowers.

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 important nesting habitat for a number of raptors, including red-shouldered hawk,* Cooper's hawk,* sharp-shinned hawk,* broad-winged hawk,* and barred owl,* and many species of songbirds including warblers, vireos, thrushes, and flycatchers. American woodcock* forages and nests in young hardwood forests. Acadian flycatcher,* wood thrush,* cerulean warbler,* Kentucky warbler,* and scarlet tanager* are some of the birds that require large forest-interior areas to nest successfully. Common raven,* worm-eating warbler,* and hooded warbler* are found in mountainous forests. 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 and black locust) can be used by Indiana bat,* eastern small-footed myotis,* 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 (ucf)

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 both abundant in the Catskill foothill region. Pitch pine also occurs in some areas. Conifer forests have a very shaded and protected understory with herb and shrub layers sparse or absent. 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*) 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 forests also provide important habitat for a variety of mammals, including eastern cottontail, red squirrel, porcupine, and eastern chipmunk (Bailey and Alexander 1960). Some conifer stands provide winter shelter for white-tailed deer and can be especially important for them during periods of deep snow cover.

Upland Mixed Forest (umf)

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 the Catskill foothills study section, mixed forests consisted of eastern hemlock, white pine, and occasionally pitch pine mixed with various northern hardwood species. On our map, in most cases the distinction between conifer and mixed forest was made by aerial photograph interpretation. Mixed forests are less densely shaded at ground level and support higher diversity and greater abundance of understory species than pure conifer stands.

Occurrence in the Town of Marbletown study area

In the Catskill foothills study section, upland mixed forest was the most widespread habitat type, with large areas of upland hardwood and upland conifer forest. Upland forest accounted for approximately 71% of the total land area in the study area. The largest areas of forest were the area north of Scarawan Road but south of Atwood Road and the Vly Swamp/Roosa Lake area. Most forests in the Catskill foothills contained rocky crest, ledge, or talus habitat (see section below). Areas of "rich forest" supporting calcium-associated plant species occurred in a few places. We presume that virtually all forests in the study area have been cleared or logged in the past and that no "virgin" stands remain. Most of the forests we observed, however, were relatively mature with few invasive plants. There may also be old forest stands that were not observed during our fieldwork. On certain crests, hardwood forests provided an open woodland habitat in which oaks were the dominant canopy species and the floor was covered with patches of lowbush blueberry, black huckleberry, and Pennsylvania sedge. Most of the natural conifer forests were dominated by white pine and eastern hemlock, and most were embedded within more extensive areas of mixed forest. Eastern hemlock stands were found most commonly on acidic ridges, in ravines, and along perennial streams. White pine was widespread and occurred in a variety of ecological settings. White pine stands were characteristic of early succession forests growing on abandoned agricultural land. Planted conifer stands often consisted of Norway spruce or white pine. Small numbers of pitch pine were found in certain mixed and conifer forests on shallow soils.

In the Rondout corridor, upland hardwood forest was the most widespread habitat type, accounting for approximately 40% of the total land area. Eastern red cedar was common in the understory of some hardwood forest areas that were progressing beyond early successional stages of growth. Several small areas of upland mixed forest were found within upland hardwood forest tracts. The largest area of upland mixed forest was found along the southeastern boundary of the Rondout corridor study area section, covering approximately 14 ac (6 ha) within the study area. White pine and eastern red cedar were the most common conifer species in these mixed forest stands. A small planted stand of Colorado blue spruce was the only upland conifer forest area we identified in the Rondout corridor. ***Floodplain forest*** was common along Rondout Creek, and we have depicted floodplain forests as an overlay in the Rondout corridor. Dominant trees in the floodplain forest included white or green ash, sugar maple, silver maple, eastern cottonwood, hackberry, basswood, pignut hickory, sycamore, and sometimes red oak and black locust. The soils had an obvious sandy component and were predominantly well-drained, although they experienced periodic flooding from the creek. In the understory, ostrich fern often dominated, with sensitive fern, white snakeroot, and wood nettle also present. River birch* and silver maple were commonly found along the creek banks.

Sensitivities/Impacts

Forests of all kinds are important habitats for wildlife. Extensive forested areas that are not fragmented by roads, trails, utility corridors, or developed lots are especially important for certain organisms, but are increasingly rare in the region. Primary sources of forest fragmentation include roads and driveways, residential lots, and agricultural areas. New development located along roads may block important wildlife movement corridors between forested blocks. New houses set back from roads by long driveways further add to the fragmentation of core 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. If done poorly, logging can also damage the understory and the forest soils, and cause soil erosion and sedimentation of streams. Soil compaction and removal of dead and downed wood and debris has several negative impacts, including the elimination of habitat for mosses, lichens, fungi, cavity-users, amphibians, reptiles, small mammals, and insects and the reduction of carbon sequestration. Where dirt roads or trails cut through the forest vehicle, horse, and pedestrian traffic can harm tree roots, cause soil erosion, spread non-native plants, and disturb birds; roads can also provide avenues for incursion of nest predators and nest parasites. 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 and human-subsidized deer populations. Gaps created by logging can provide habitat for fast-growing, shade-intolerant species such as tree-of-heaven. Once established, many of these non-native species are difficult to eliminate. Human habitation has also led to the suppression of naturally occurring wildfires which can be important for some forest species.

Introduced forest pests are also threatening forest health in the Hudson Valley. Of note is the hemlock woolly adelgid which has infested many eastern hemlock stands from Georgia to New England. This insect typically kills trees within 10-15 years and has the potential to make naturally occurring hemlock and mixed hemlock forests regionally rare. In the Catskill foothills, while hemlock forests appear to be in decline, there are still areas exhibiting few if any signs of infestation. See the Conservation Priorities section for recommendations on preserving the habitat values of large forests.

CREST/LEDGE/TALUS

Ecological Attributes

Rocky crest, ledge, and talus habitats often (but not always) occur together, so they are described and mapped together for this project. Crest and ledge habitats occur where soils are very shallow and bedrock is partially exposed at the ground surface, either at the summit of a hill or knoll (crest) or elsewhere (ledge). These habitats are usually embedded within other habitat types, most commonly upland forest. They can occur at any elevation, but may be most familiar on hillsides and hilltops in the region. Talus is the term for the fields of rock fragments of various sizes that often accumulate at the bases of steep ledges and cliffs. We also included large glacial erratics (glacially-deposited boulders) and ‘bouldery’ forests in this habitat type. Some crest, ledge, and talus habitats support well-developed forests, while others have only sparse, patchy, and stunted vegetation. Crest, ledge, and talus habitats often appear to be harsh and inhospitable, but they can support an extraordinary diversity of plants and animals. Some species, such as wall-rue,* smooth cliffbrake,* purple cliffbrake,* and 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 mapped 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 rock polypody, Pennsylvania sedge, little bluestem, hairgrass, and bristly sarsaparilla. Rare plants of non-calcareous crests include mountain wood fern, rusty woodsia,* Appalachian shoestring fern,* Braun's holly fern,* mountain spleenwort,* clustered sedge,* and slender knotweed.*

Northern hairstreak* (butterfly) occurs with oak species which are host plants for its larvae, and falcate orange-tip* can be found on dry, rocky slopes with rock-cresses or bittercresses. Rocky habitats with larger fissures, cavities, and exposed ledges may provide shelter, den, and basking habitat for eastern hognose snake,* eastern ratsnake,* eastern racer,* and northern copperhead.* Ledge areas with southeastern, southern, or southwestern exposure may provide winter den and spring "basking rocks" for timber rattlesnake.* Slimy salamander* occurs in non-calcareous wooded talus areas and rock piles. Breeding birds of crest habitats include prairie warbler,* golden-winged warbler,* Blackburnian warbler,* worm-eating warbler,* and cerulean warbler.* Bobcat* and fisher* use high-elevation crests and ledges for travel, hunting, and cover. Porcupine* and bobcat use ledge and talus habitats for denning. Boreal redback vole* is found in some rocky areas, and eastern small-footed myotis* roosts in talus habitat.

Occurrence in the Town of Marbletown study area

In the Catskill foothills, crest, ledge, and talus habitats were widespread (Figure 3). These habitats were found in almost all areas where fieldwork was conducted. Extensive ledges north of Scarawan Road were often at least 10 ft (3 m) tall and alternated with steep forested slopes, forming a 'stair-step' pattern. Glacial erratics were common throughout the foothills, as were bouldery forests. These forested areas were gently sloped, but covered with boulders ranging from 0.7 ft (0.2 m) to > 9 feet (> 3 m) in diameter. We included these in the crest, ledge, and talus layer of the habitat map because we felt they have similar ecological attributes to the more typical crest, ledge, and talus habitats. Calcareous rock outcrops were only found in a few areas – two in the northeast part of the study area section and one as a gravelly bank in the southeast part of the foothills.

In the Rondout corridor, crest, ledge, and talus habitat was much less common, but a handful of ledges were found on the banks of the Rondout Creek.

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 a part. Rare plants of crests are vulnerable to trampling and collecting; rare snakes are susceptible to road mortality, intentional killing, and collecting; and rare breeding birds of crests are easily disturbed by human activities nearby. The shallow soils of these habitats are susceptible to erosion from construction and logging activities, and from foot and ATV traffic. See the Conservation Priorities section for recommendations on preserving the habitat values of crest, ledge, and talus habitats.

BLUESTONE QUARRIES


Tanessa Hartwig © 2007

Bluestone quarry

Ecological Attributes

Bluestone is an even-textured sandstone derived from deposits in the Catskill Delta during the Devonian Period, approximately 345 million years ago. An attractive and durable paving stone, bluestone was first found in Ulster County, and was quarried heavily during the 1800's (Evers 1972).

Most of the quarries in the study area are long-abandoned. Workers cut off slabs of rock, leaving behind quarried ledges 5-20 ft (1.5-6 m) or higher and large piles of discarded bluestone. Some quarries are now completely shaded by a forest canopy, while others have remained treeless. These abandoned quarries now provide habitats similar to crest, ledge, and talus areas (see above) and, in some cases, intermittent woodland pools (see below).

Occurrence in the Town of Marbletown study area

Because of their small size and because they are often embedded within forested areas, quarries were difficult to identify remotely. We were only able to map those quarries that we saw in the field or that were indicated on soil or topographic maps, and we expect there are many more that we missed. Quarries (less than 5 ac [2 ha]) were most common in the rugged terrain north of Scarawan Road and in the Vly Swamp/Roosa Lake area (Figure 3). No quarries were found in the Rondout corridor study area.

Sensitivities/Impacts

Sensitivities are similar to those for crest, ledge, and talus habitats and intermittent woodland pools, if present.

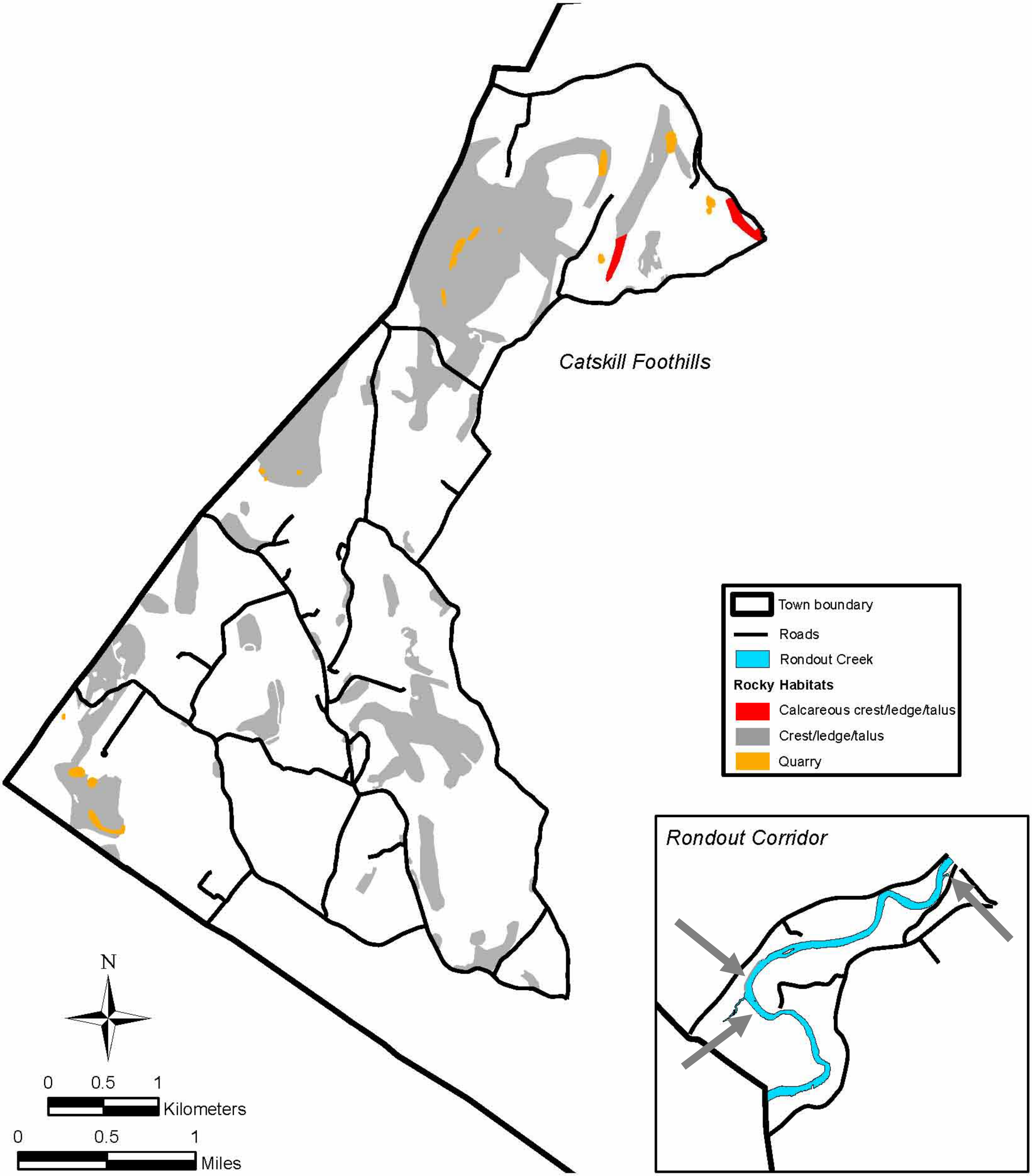


Figure 3. Generalized distribution of calcareous and non-calcareous crest, ledge, and talus habitats in the Town of Marbletown study area, Ulster County, New York. Arrows in the Rondout Corridor point to small areas of crest/ledge/talus habitat. Hudsonia Ltd., 2007.

UPLAND SHRUBLAND (us)

Ecological Attributes

We use the term “upland shrubland” to describe shrub-dominated uplands. In most cases, these are lands in transition between meadow and young forest, but they also occur along utility corridors maintained by cutting or herbicides, and in recently cleared areas. Recently cleared or disturbed sites often contain dense thickets of shrubs and vines, including a variety of brambles and young white pine. Abandoned agricultural fields and pastures often support more diverse plant communities, including scattered seedlings and sapling-size eastern red cedar, white pine, and oaks; shrubs such as meadowsweet, gray dogwood, northern blackberry, raspberries, and multiflora rose; and a variety of meadow grasses and forbs. Occasional large, open-grown trees (e.g., sugar maple, red oak) left as shade for livestock may be present.

Rare butterflies such as Aphrodite fritillary,* dusted skipper,* Leonard’s skipper,* and cobweb skipper* may occur in shrublands where their host plants are present. 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 insects, small mammals, and birds.

Occurrence in the Town of Marbletown study area

In the Catskill foothills, upland shrublands were distributed throughout the study area section, and ranged in size from 0.2 to 9 ac (0.1-3.5 ha), for a total of 76 ac (30 ha). Shrublands consisted of abandoned fields, logged areas, and utility corridors. Fields and logged areas were often colonized by white pine, while utility corridors were colonized by white pine, sweet-fern, or huckleberry.

In the Rondout corridor, upland shrubland covered a very small fraction of the study area (<0.1%). Upland shrubland areas mainly consisted of abandoned sections of fields colonized by weedy species such as autumn olive and multiflora rose.

Sensitivities/Impacts

Shrublands and meadows (see below) are closely related plant communities. Retarding development of tall trees in these habitats may promote overall biological diversity, and can be achieved by rotational mowing 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. As in upland meadows, soil compaction and erosion caused by ATVs, other vehicles, and equipment can reduce the habitat value for invertebrates, small mammals, nesting birds, and nesting turtles. If shrublands are left undisturbed, most will eventually become forests, which are also valuable habitats.

UPLAND MEADOW (um)

Tanessa Hartwig © 2007

Bluestem 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, with less than 20% shrub cover. The ecological values of these habitats can differ widely according to the types of vegetation present and variable 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, including Aphrodite fritillary,* use upland meadows that support their particular host plants. 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.

Upland meadows that are dominated by little bluestem can support rare plants, including rattlebox* and several wild flaxes (S. Barbour pers. comm.). Little bluestem is the host plant for several rare butterflies, including dusted skipper,* Leonard’s skipper,* cobweb skipper,* and swarthy skipper.*

Occurrence in the Town of Marbletown study area

Upland meadows accounted for about 6% of the total land area in the Catskill foothills study area section, and were located mostly in the south half of the foothills. Common upland meadows in the Catskill foothills were hayfields, goldenrod fields, little bluestem fields, and infrequently mowed lawns. Most were small (0.1 to 7.4 ac [0.04 to 3 ha]) and not intensively managed.

Upland meadow was the second most common habitat type in the Rondout corridor, accounting for nearly 20% of the total land area. The largest upland meadows in this area were hayfields and row crops, while some of the smaller meadows were less intensively managed. Meadows ranged from 0.08 to 35 ac (0.03 to 14 ha) in size.

Sensitivities/Impacts

Principle causes of meadow habitat loss or degradation are the intensification of agriculture, regrowth of shrubland and forest after abandonment, and residential and commercial development. The dramatic decline of grassland-breeding birds in the Northeast has been attributed to the loss of large patches of suitable meadow habitat; many of these birds need large meadows that are not divided by fences or hedgerows, which can harbor predators (Wiens 1969). Another threat to upland meadow habitats is the soil compaction and erosion caused by ATVs 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 plants and reduce viable habitat for butterflies, and mowing of upland meadows during the bird nesting season can cause extensive mortality of eggs, nestlings, and fledglings. Farmlands where pesticides and artificial fertilizers are used may have a reduced capacity to support biodiversity.

ORCHARD/PLANTATION (or/pl)

This habitat type includes actively maintained or recently abandoned fruit orchards, Christmas tree farms and plant nurseries. Conifer plantations with larger, older trees were mapped as "upland conifer forest." 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 future ecological values after abandonment than its current values. These habitats have some of the vegetation structure and ecological values of upland meadows and upland shrublands, and will ordinarily develop into young forests if they remain undisturbed after abandonment. In the Catskill foothills, we found 3 small conifer plantations totaling 3 ac (1.2 ha). Abandoned apple orchards that had lost their ordered structure were mapped either as upland hardwood forest or as upland shrubland depending on their characteristics. We found no orchard/plantation areas in the Rondout corridor.

CULTURAL (c)

We define "cultural" habitats as areas that are significantly altered and intensively managed (e.g., mowed), but are not otherwise developed with pavement or structures. In the Catskill foothills, cultural habitats included livestock enclosures, large gardens, large lawns, and an area with dumpsters, and accounted for 2% of the land cover. In the Rondout corridor, the largest cultural habitat was at the Stone Dock Golf Course, which covered approximately 50 ac (20 ha). Other cultural areas in the Rondout corridor included two cemeteries and large lawn and garden areas associated with residential buildings (including filled areas of the old canal; see below). Cultural habitats represented approximately 10% of the land area in the Rondout corridor.

As for orchards and plantations, we mapped cultural areas as an ecologically significant habitat type more for their potential future ecological values than their 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 there. Ornamental trees can provide microhabitats for cavity-nesting birds, bats (including Indiana bat*), and other animals. 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 habitat value is greatly diminished in comparison to relatively undisturbed habitats.

WASTE GROUND (wg)

Waste ground is a botanists' term for land that has been severely altered by previous or current human activity, but lacks pavement or structures. Unlike the "cultural" habitats described above, 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 mines, 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 may potentially occur in some waste ground habitats. Several snake and turtle species of conservation concern, including eastern hognose snake* and wood turtle,* may use the open, gravelly areas of waste grounds for burrowing, foraging, or nesting habitat. Bank swallow* and belted kingfisher often nest in the stable walls of inactive soil mines or piles of soil or sawdust. Bare, gravelly, or otherwise open areas provide nesting grounds for spotted sandpiper, killdeer, and possibly common nighthawk.* On sites where species of conservation concern are absent or unlikely, waste ground may have a low habitat value compared to relatively undisturbed habitats. The biodiversity value of waste ground, however, will often increase over time as it develops into a higher quality habitat. At the time of this report there were several apparently active mining operations in the study area, where the present-day value of waste ground habitat appeared negligible.

WETLAND HABITATS

SWAMPS

Ecological Attributes

A swamp is a wetland dominated by woody vegetation (trees or shrubs). We mapped three general types of swamp habitat in the study area: hardwood and shrub swamp, conifer swamp, and mixed swamp. Swamps are important to a wide variety of plants, birds, mammals, amphibians, reptiles, and invertebrates, especially when swamp habitats are contiguous with other wetland types or embedded within large areas of upland forest.

Hardwood and Shrub Swamp (hs)

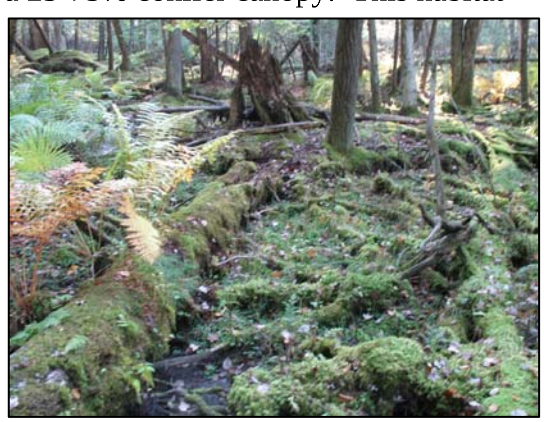
We combined deciduous forested and shrub swamps into a single habitat type because the two often occur together and can be difficult to separate using remote sensing techniques. Red maple, green ash, American elm, slippery elm, yellow birch, and swamp white oak are common trees of hardwood swamps in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

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 eastern 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 abundant moss-covered rocks, moss-covered downed wood, or woody hummocks. Red-shouldered hawk,* barred owl,* great blue heron,* wood duck,* prothonotary warbler,* Canada warbler,* and white-eyed vireo* potentially nest in hardwood swamps. Swamp cottonwood* is a very rare tree of deeply-flooding hardwood swamps, known from only five or six locations in the Hudson Valley.

Conifer and Mixed Forest Swamp (cs and ms)

Conifer swamps are a type of forested swamp where conifer species occupy 75% or more of the upper tree canopy. Mixed forest swamps have a 25-75% conifer canopy. This habitat has characteristics intermediate between those of hardwood and conifer swamps, and shares many of the ecological values of those habitats.

Conifer species at these latitudes and elevations that can tolerate wetland conditions include eastern hemlock, white pine, black spruce,



Mixed forest swamp

eastern tamarack, and northern white cedar. The dense canopy has a strong influence on the understory plant community and structure of these swamps. Shading creates a cooler microclimate, allowing snow and ice to persist longer into the early spring growing season. Conifers growing in wetlands frequently have very shallow root systems and are therefore prone to windthrow. The resulting tip-up mounds, root pits, and coarse woody debris all contribute to the habitat's complex structure and microtopography.

Mixed forest swamps with hemlock may support great laurel, swamp saxifrage, and early coralroot (Bierhorst 1995). Brown creeper and winter wren* breed in hemlock swamps (Thompson and Sorenson 2000).

Occurrence in the Town of Marbletown study area

Hardwood and shrub swamp was the most extensive wetland habitat type in the study area (Figure 4), with a total of 244 ac (99 ha). Swamps ranged in size from <0.5 to 38 ac (<0.2-15 ha). Most swamps were small, with an average extent of 2 ac (0.8 ha) in the Catskill foothills and 0.9 ac (0.3 ha) in the Rondout corridor. They were often contiguous with other wetland habitats such as marsh, wet meadow, and open water. We found black ash, a calcicole, in several swamps in the study area. The larger swamps in the Catskill foothills were in Lyonsville, and included Vly Swamp and a high-quality hardwood and shrub swamp with adjacent mixed forest swamp at Founder's Hollow (east of Upper Bone Hollow Road) among others. In the Catskill foothills, hardwood swamps often supported plant species with northern or high-elevation affinities, such as *Sphagnum* mosses and goldthread. In the Rondout corridor, most of the larger swamps were found east of Berme Road; one exception was a linear swamp along a tributary stream between the Rondout Creek and Lucas Turnpike. Some stretches of the old canal supported hardwood and shrub swamp (see below). Hardwood swamps in the Rondout corridor were dominated by red maple and/or green ash.

Conifer and mixed forest swamps in the Catskill foothills were typically embedded in upland conifer or mixed forests, and featured a hemlock canopy mixed with red maple, yellow birch, black gum, and white pine. The shrub layer included winterberry and highbush blueberry, and the herbaceous cover included a thick layer of *Sphagnum* as well as cinnamon fern, royal fern goldthread, and moneywort.

Vly Swamp, in the southwest corner of the foothills, was a red maple-tamarack mixed forest swamp, a rare community in New York (Edinger et al. 2002). Vly Swamp had a somewhat open canopy with tamarack, red maple, hemlock, yellow birch, white pine, and black spruce. Shrubs included winterberry, highbush blueberry, and swamp azalea. Herbs included cinnamon fern, Virginia chain fern,* royal fern, fowl mannagrass, bromelike sedge, goldthread, and pitcher-plant.* Substrates were saturated and mucky. Eastern sedge, silvery sedge, three-fruited sedge, and wild calla* have all been found in Vly Swamp (Bierhorst 1995), as well as Appalachian shoestring fern.* Arrowhead spiketail* and taper-tailed darner* (two rare dragonflies) also occur in Vly Swamp. Vly Swamp is one of the northernmost records for taper-tailed darner (Nikula 2001).

Swamps occurred in a variety of settings, such as on seepy slopes, along streams, and in depressions. Some were shrub-dominated (notably a buttonbush swamp west of So Hi Campground on Woodland Road), while others had a full canopy of hemlock, red maple, or green ash. Water depths 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 (see below), providing a seasonal source of water, breeding habitat for amphibians, and refuge for turtles.

Sensitivities/Impacts

Some swamps may be protected by federal or state wetland 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. Many of the larger swamps are located in low-elevation areas where human land uses are also concentrated. They can easily be damaged by alterations to the quality or quantity of surface water runoff, or by disruptions of 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 receive runoff high in nutrients, sediment, 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, and the quality of drinking water if the swamp is connected to a public water supply. 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 section for recommendations on preserving the habitat values of isolated pools and swamps within larger wetland complexes.

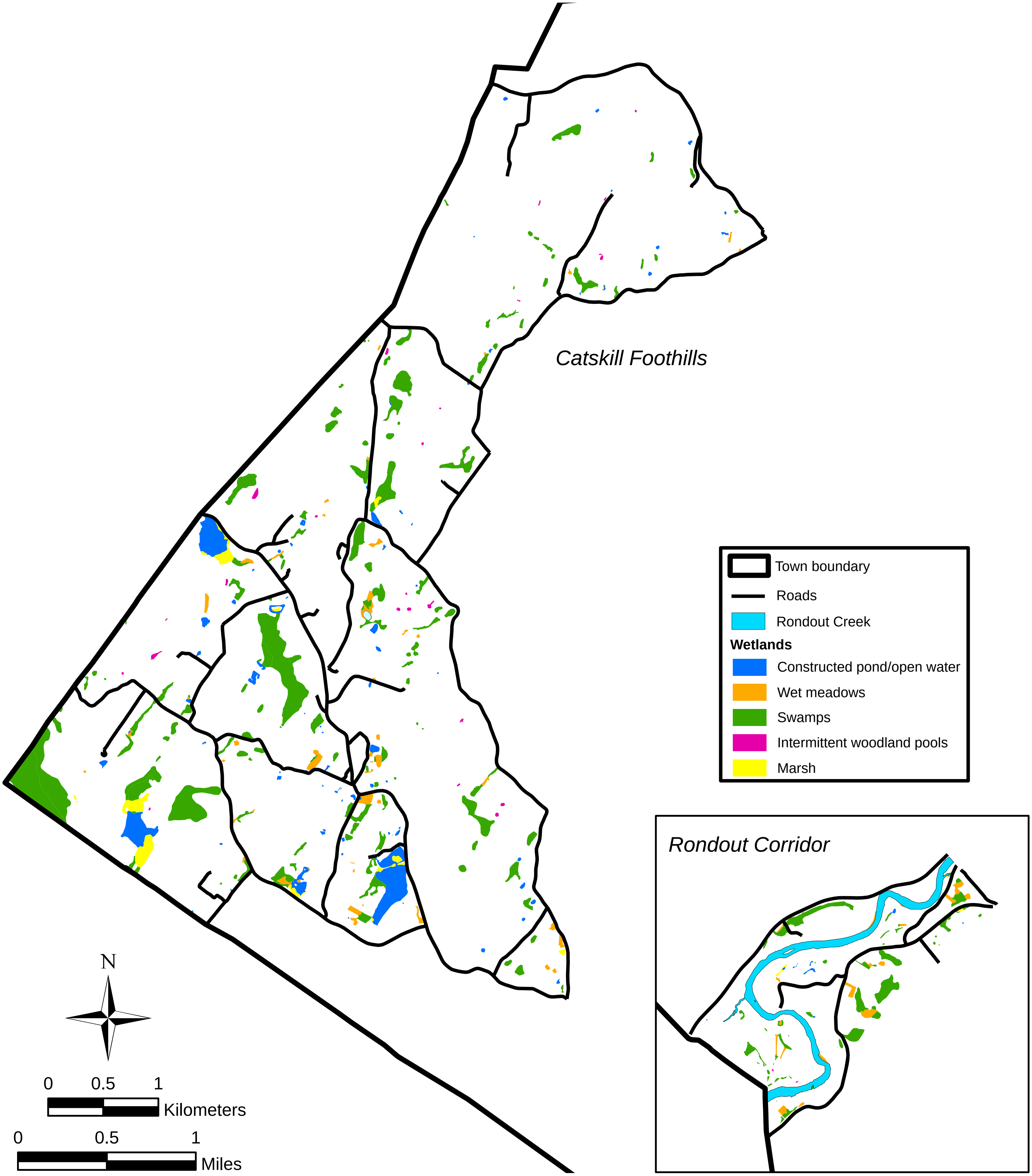


Figure 4. Wetland habitats in theTown of Marbletown study area, Ulster County, New York. Hudsonia Ltd., 2007.

INTERMITTENT WOODLAND POOL (iwp)

Ecological Attributes

An intermittent woodland pool is a small wetland partially or entirely surrounded by forest, typically with no surface water inlet or outlet (or an ephemeral one), and with standing water during winter and spring that dries up by mid- to late summer during a normal year. This habitat is a subset of the widely recognized "vernal pool" habitat, which may or may not be surrounded by forest. Despite the small size of intermittent woodland pools, those that hold water through early summer can support amphibian diversity equal to or higher than that of much larger wetlands (Semlitsch and Bodie 1998, Semlitsch 2000). Seasonal drying and lack of a stream connection ensure that these pools do not support fish, which are major predators on amphibian eggs and larvae. The surrounding forest supplies the pool with leaf litter, the base of the pool's food web, and 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* 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 Marbletown study area

We mapped 26 intermittent woodland pools in the study area. Pools were distributed throughout the Catskill foothills, but we found only three in the Rondout corridor. All were less than 0.8 ac (0.3 ha), with an average size of 0.2 ac (0.1 ha). Because these pools are small and often difficult to identify from aerial photographs, we expect there are others that we missed.

Sensitivities/Impacts

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

MARSH (ma)

Ecological Attributes

A marsh is a wetland that typically has standing water for most or all of the growing season, and is dominated by herbaceous (non-woody) vegetation that is emergent above the water surface. 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, common reed, tussock sedge, pickerel-weed, arrow-arum, broad-leaved arrowhead, water-plantain, and purple loosestrife are some typical emergent marsh plants in this region. Deeper water may have 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 spiny coontail* and buttonbush dodder.* Marshes are also important habitats for reptiles and amphibians, including eastern painted turtle, snapping turtle,* spotted turtle,* green frog, pickerel frog, and spring peeper. 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 and foraging or as nursery habitat. Many raptor, wading bird, and mammal species use marshes for foraging.

Occurrence in the Town of Marbletown study area

We mapped 15 marshes in the Catskill foothills, all south of Scarawan Road and totaling 24 ac (10 ha). Marshes were frequently found along the margins of or embedded in ponds or lakes. Because it was sometimes difficult to distinguish marsh from shrub swamp or wet meadow on aerial photographs, all mapped marsh boundaries should be considered approximate. Many of the marshes we observed in the field were dominated by purple loosestrife or cattail. In areas where beavers are active, the location and extent of open water and vegetated areas likely changes from year to year. Many of the mapped marshes within the town were small (<1 ac [0.4 ha]). The largest marsh areas (5-7 ac [2-3 ha]) were associated with Roosa Lake and a pond just south of County Route 2 at the west edge of the study area.

The six small marsh areas (> 0.3 ac [> 0.1 ha]) found in the Rondout Corridor were associated with constructed ponds, hardwood and shrub swamps, and Rondout Creek backwaters. The old canal also supported small areas of marsh habitat (see below).

Sensitivities/Impacts

In addition to human disturbances such as filling or draining, marshes are subject to stresses from offsite (upgradient) sources. Alteration of surface water runoff patterns or groundwater flows can lead to dramatic changes in the plant and animal communities of marshes. Polluted stormwater runoff from roads, parking lots, lawns, and other surfaces in developed landscapes carries sediments, nutrients, toxins, and other contaminants into the wetland. Nutrient and sediment inputs and human or beaver alteration of water levels can also alter the plant community, and facilitate invasion by non-native plants such as purple loosestrife and common reed. Purple loosestrife has displaced many native wetland graminoids in recent decades and is the dominant plant in several of the marshes in the study area. Noise and direct disturbance from human activities can discourage breeding activities of marsh birds. Because many animal species of marshes depend equally on surrounding upland habitats for their life history needs, protection of the ecological functions of marshes must go hand-in-hand with protection of surrounding habitats. See the Conservation Priorities section for recommendations on preserving the habitat values of marshes within larger wetland complexes.

WET MEADOW (wm)

Ecological Attributes

A wet meadow is a wetland dominated by herbaceous (non-woody) vegetation and lacking standing water for most of the year. Its period of inundation is longer than that of an upland meadow, but shorter than that of a marsh. Some wet meadows are dominated by common reed, reed canary-grass, tussock sedge, or purple loosestrife, while others have a diverse mixture of wetland grasses, sedges, forbs, and scattered shrubs. Sensitive fern, marsh fern, bluejoint, mannagrasses, woolgrass, soft rush, and blue flag 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 a variety of other meadow habitats for foraging.

Occurrence in the Town of Marbletown study area

In the Catskill foothills, wet meadows were more common south of Scarawan Road, and most often occurred along the margins of streams. We mapped over 52 wet meadows, for a total of

26 ac (12 ha) in the study section. Most wet meadows were smaller than 2 ac (0.8 ha). The largest concentration of wet meadows occurred along and within the drainage of the Peters Kill.

In the Rondout corridor, we mapped 11 ac (4.5 ha) of wet meadow; all occurrences were 2 ac (0.8 ha) or smaller. These meadows were most often in low-lying areas adjacent to upland meadows or mowed lawns. Additional small areas of wet meadow were associated with the old canal (see below). A distinct type of wet meadow was mapped in a few places along the shore of the Rondout Creek. These long, narrow meadows in the immediate floodplain of the creek were characterized by pebble or cobble substrates, and supported a mix of upland and wetland herbaceous vegetation, and sometimes saplings of floodplain tree species such as sycamore.

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 when soils are dry, e.g., in late summer. 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 section for recommendations on preserving the habitat values of wet meadows within larger wetland complexes.

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 and soils. These conditions favor the establishment of a calcicolous plant community, including such species as lakeside sedge, sweetflag, 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.* Ribbon snake* 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 wet meadows.

Occurrence in the Town of Marbletown study area

We documented two small (< 0.5 ac [0.2 ha]) calcareous wet meadows in the study area. 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 calcareous.

Sensitivities/Impacts

Calcareous wet meadows have similar sensitivities to disturbance as 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 (ow)

Tanessa Hartwig © 2007

Calcareous pond

Ecological Attributes

"Open water" habitats include naturally formed ponds and lakes, large pools lacking floating or emergent vegetation within marshes and swamps, and ponds that were originally constructed by humans but have since reverted to a more natural state (e.g., surrounded by unmanaged vegetation). Open water areas are important habitat for many common species, including invertebrates, fishes, frogs, turtles, waterfowl, muskrat, beaver, and bats. Open water areas sometimes support submerged aquatic vegetation that can provide important habitat for additional aquatic invertebrates and fish. Spiny coontail,* a state-listed plant, is often found in calcareous ponds. Spatterdock darner* uses ponds and pools with abundant vegetation, often spatterdock (Nikula 2003, Environmental Resource Mapper 2007). Spotted turtle* uses ponds and lakes during both drought and non-drought periods, and wood turtle* may overwinter and mate in open water areas. American bittern,* great blue heron,* osprey,* bald eagle,* wood duck,* American black duck,* and pied-billed grebe* may use open water areas as foraging habitat. Bats and river otter* also forage in or above open water habitats.

Occurrence in the Town of Marbletown study area

Natural open water areas were far less common than constructed ponds (see below) in the study area. Of the six open water areas mapped, four were smaller than 1 ac (0.4 ha). In the Catskill foothills, we found three larger ponds; the largest was the pond south of County Route 2 and west of Upper Bone Hollow Road (16 ac [6.5 ha]), followed by Roosa Lake (14 ac [5.6 ha]). A 4 ac (1.6 ha) pond north of Lower Bone Hollow Road and west of Smith Road, and the pond south of County Route 2, both supported calcicolous plants, including spiny coontail,* and may support other rare plants.

Sensitivities/Impacts

The habitat value of natural open water areas can be greater than that of constructed ponds if they are less intensively managed, less disturbed by human activities, and surrounded by undeveloped land. Open water habitats are, however, vulnerable to human impacts, such as shoreline development, aquatic weed control, 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 they are often located within larger wetland and stream complexes, any disturbance to the open water habitat may also have far-reaching impacts in the watershed. 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 open for recreation, ornamental or other reasons, it is best to avoid dredging and to allow other parts of the pond to develop abundant vegetation. This can be accomplished by harvesting aquatic vegetation only where necessary to create open lanes or pools for boating, fishing, or swimming. See the Conservation Priorities section for recommendations on preserving the habitat values of open water within wetland complexes.

CONSTRUCTED POND (cp)

Ecological Attributes

Constructed ponds include those water bodies that have been excavated or dammed by humans, either in existing wetlands or stream beds, or in upland terrain. These ponds are deliberately created for such purposes as watering livestock, irrigation, recreation, 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 in the constructed pond category the water bodies created during mining operations. 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 (see above).

Occurrence in the Town of Marbletown study area

Most of the water bodies we mapped in the study area were constructed ponds. These ponds were most commonly maintained for ornamental or recreational purposes and located within landscaped areas in close proximity to residences. Because of the potential value of constructed ponds as drought refuge and forage areas for turtles and other wildlife, we mapped constructed ponds within developed areas as well as those surrounded by intact habitats. Overall, we mapped 81 constructed ponds. All were smaller than 2 ac (0.8 ha), with the exception of Lyonsville Pond in the Catskill foothills, which was almost 28 ac (11 ha). In the Rondout corridor most of the ponds were at the Stone Dock Golf Course, where they were surrounded by maintained turf.

Sensitivities/Impacts

The habitat value of constructed ponds varies depending on the landscape context, the kinds of management, and the extent of other human disturbance. In general, the habitat value is higher when the ponds have undeveloped shorelines, are relatively undisturbed by human activities, have more vascular vegetation, and are embedded within intact habitat areas. 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 private yards. 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 artificial 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). Although springs often discharge into ponds, streams, or wetlands, 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 help maintain the cool temperature of many streams, an important habitat characteristic for some rare and declining fish species and aquatic invertebrates. They also serve as water sources for animals during droughts and cold winters, when other water sources freeze over, and help keep some ponds and wetlands cool.

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

Occurrence in the Town of Marbletown study area

Because the occurrence of springs and seeps is difficult to predict by remote sensing, we mapped only the very few we happened to see in the field and those that had a signature on one of our map sources. We expect there are many more in the study area that we did not map. More detailed inventories of seeps and springs should be conducted as needed on a site-by-site basis. In the Catskill foothills, we found several concentrations of seeps and springs in the high-elevation area north of Scarawan Road and on the steep slopes northeast of Vly Swamp. In the Rondout corridor, springs and seeps were mostly found in the south part of the study area.

Sensitivities/Impacts

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

STREAMS & RIPARIAN CORRIDORS

Ecological Attributes

Perennial streams flow continuously throughout years with normal precipitation, but some may dry up during droughts. They provide essential water sources for wildlife throughout the year, and are critical habitat for many plant, vertebrate, and invertebrate species. We loosely define "riparian corridor" as the zone along a perennial stream that includes the stream banks, the floodplain, and adjacent steep slopes. We did not map riparian corridors as an independent habitat type, but instead defined them according to conservation zones of a set width on either side of streams. These zones represent a minimum area surrounding the stream that is needed for effective protection of stream water quality and wildlife (see streams & riparian corridors in the Priority Habitats section). These conservation 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. We recommend that riparian corridors be delineated and mapped for each perennial stream in Marbletown, and that protective measures be designed for each stream.

Riparian zones tend to have high species diversity and high biological productivity, and many species of fish and wildlife depend on riparian habitats in some way for their survival (Hubbard 1977, McCormick 1978). Riparian forests, in particular, are effective at removing dissolved nutrients from stream water, and produce high quality detritus (dead plant matter) important to the aquatic food web. We know of many rare plants found in riparian zones elsewhere in the region, such as cattail sedge,* Davis' sedge,* and goldenseal.* The fish and aquatic invertebrate communities of perennial streams may be diverse, especially in clean-water streams with unsilted bottoms. Brook trout* and slimy sculpin* are two native fish species that require clear, cool streams for successful spawning. Wild brook trout, however, are now confined largely to small headwater streams in the region, due to degraded water quality and competition from brown trout, a non-native species 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 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,* American black duck,* and green heron. Red-shouldered hawk* and cerulean warbler* nest in areas with extensive riparian forests, especially those with mature trees. Bats, including Indiana bat* and eastern small-footed myotis,* use perennial stream corridors for foraging. Muskrat, beaver, mink, and river otter* are some of the mammals that use riparian corridors regularly.

Intermittent streams flow only during certain times of the year or after rains. They are the headwaters of most perennial streams, and are significant water sources for larger streams, and for lakes, ponds, and wetlands of all kinds. The condition of these streams therefore influences the water quantity and quality of those larger water bodies and wetlands. Intermittent streams can be important local water sources for wildlife, and their loss or degradation in a portion of the landscape can affect the presence and behavior of wildlife populations over a large area (Lowe and Likens 2005). Plants such as winged monkey-flower,* may-apple,* and small-flowered agrimony* are often 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 small perennial and intermittent streams provide breeding, larval, and adult habitat for northern dusky salamander,* mountain dusky salamander,* northern red salamander,* spring 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 Marbletown study area

Most streams in the Catskill foothills were intermittent. The only perennial streams were the Peters Kill, which drained to the Rondout Creek, and the Glad Klipt Kill, which drained to the Esopus Creek. The Rondout Corridor portion of the study area included approximately 3 mi (4.8 km) of the perennial Rondout Creek. The creek's riparian corridor contained a variety of habitats that are seasonally flooded to varying degrees. All other streams in the study area drained into the Rondout Creek, and most were intermittent.

Sensitivities/Impacts

Removal of trees or other shade-producing vegetation along a stream can lead to elevated water temperatures that adversely affect aquatic invertebrate and fish communities. Similarly, the loss of eastern hemlock forest cover along stream corridors due to hemlock woolly adelgid infestation can result in elevated water temperatures and altered water chemistry. Clearing of floodplain vegetation can reduce the important exchange of nutrients and organic materials between the stream and the floodplain, and can diminish the floodplain's capacity for floodwater attenuation, leading to increased flooding downstream, scouring and bank erosion, and sedimentation of downstream reaches. Any alteration of flooding regimes, stream water volumes, timing of runoff, and water quality can profoundly affect these habitats and species of streams and riparian zones. Hardening of the streambanks with concrete, riprap, gabions, or other materials reduces the biological and physical interactions between the stream and floodplain, and tends to be harmful both to stream and floodplain habitats. Removal of snags from the streambed degrades habitat for fishes, turtles, snakes, birds, muskrats, and their food organisms. Stream corridors are prone to invasion by Japanese knotweed, an introduced plant that is spreading in the region (Talmage and Kiviat 2004).

The habitat quality of a stream is affected not only by direct disturbance to the stream or its floodplain, but also by land uses throughout the stream's watershed. (A watershed is the entire land area that drains into a given waterbody). Urbanization (including roads and residential and commercial development) has been linked to deterioration in water quality (Parsons and Lovett 1993). Activities in the watershed that cause soil erosion, changes in surface water runoff, reduced groundwater infiltration, or contamination of surface water or groundwater are likely to affect stream habitats adversely. For example, an increase in impervious surfaces (roads, parking lots, roofs) may elevate runoff volumes, leading to erosion of stream banks and siltation of stream bottoms, and degrading the habitat for invertebrates, fish, and other animals. Road runoff often carries contaminants such as petroleum hydrocarbons, heavy metals, road salt, sand, and silt into streams. Applications of fertilizers and pesticides to agricultural fields, golf courses, lawns, and gardens in or near the riparian zone can degrade the water quality and alter the biological communities of streams. Construction, logging, soil mining, clearing for vistas, creating lawns, and other disruptive activities in and near riparian zones can hamper riparian functions and adversely affect the species that depend on streams, riparian zones, and nearby upland habitats. See the Conservation Priorities section for recommendations on preserving the habitat values of streams and riparian corridors.

Delaware & Hudson Canal

The old Delaware & Hudson Canal along Berme Road is a wide ditch-like channel that no longer serves as a long-distance water conduit. It varies greatly in its habitat characteristics, while being a somewhat continuous feature of the landscape in the Rondout corridor. For much of its length the canal supports wetland habitats of hardwood & shrub swamp, marsh, and wet meadow. In some sections the canal is filled in and maintained as mowed lawn by homeowners. The current hydrology of the old canal is difficult to discern, but it likely functions as an intermittent stream in some stretches. A berm of dredged material parallels the old canal, and largely supports upland hardwood forest and developed uses.

CONSERVATION PRIORITIES IN MARBLETOWN

PLANNING FOR BIODIVERSITY

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

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 Marbletown habitat map facilitates this approach by illustrating the location and configuration of significant habitats throughout the study area. 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) using the map to identify priorities for landscape-scale conservation and land use planning; 2) using the map as a resource for reviewing site-specific land use proposals; and 3) developing general strategies for achieving conservation goals.

Using the Habitat Map for Landscape-scale Conservation Planning

The Marbletown habitat map is useful for understanding the sizes of habitat units, the degree of connectivity between habitats, and the juxtaposition of habitats in the landscape, all of which have important implications for regional biodiversity. Habitat fragmentation is among the primary threats to biodiversity on a global scale (Davies et al. 2001). While some species and habitats may be adequately protected at a relatively small scale, many wide-ranging species, such as black bear,* barred owl,* and red-shouldered hawk,* require large, unbroken blocks of habitat. Many species, such as wood turtle* and Jefferson salamander,* need to travel among different habitats to satisfy their basic needs for food, water, cover, nesting and nursery areas, and population dispersal. Landscapes that are fragmented by roads, railroads, utility corridors, and developed land limit animal movements and interactions, disrupting patterns of dispersal, reproduction, competition, and predation. Habitat patches surrounded by human development function as islands, and species unable to move safely between habitats are vulnerable to genetic isolation and possible extinction over the long term. Landscapes with interconnected networks of unfragmented habitat, on the other hand, are more likely to support a broad diversity of native species and the ecological processes and disturbance regimes that maintain those species. Figure 5 shows blocks of contiguous undeveloped habitat within the study area that are <500, 500-1,000, and >1,000 ac (<200, 200-400, and >400 ha, respectively). The Catskill foothills, in particular, still contains many large habitat patches (Figure 5), and careful siting of new development can protect these patches and maintain corridors between them.

The habitat map can also be used to locate Priority Habitats for conservation, including those that are rare or support rare species, or that otherwise are particularly important to regional biodiversity. Every mapped habitat has potential ecological value, but we have identified several habitat types that we believe deserve special conservation attention. For instance, mixed forest and conifer wetlands in the Catskill foothills may support rare plants such as early coralroot,* and clusters of intermittent woodland pools provide key habitat for amphibians and other animals. Calcareous ponds may have rare submerged aquatic plants and the Rondout Creek and its tributaries are known to support wood turtle. Figures 6-9 illustrate some of the areas we have identified as having Priority Habitats and the conservation zones associated with them. These habitats are especially valuable if they are located within larger areas of intact and connected habitat.

The 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 minimal. If habitat maps are completed in the rest of the town, and in adjacent towns, the map can also be used for region-wide conservation planning.

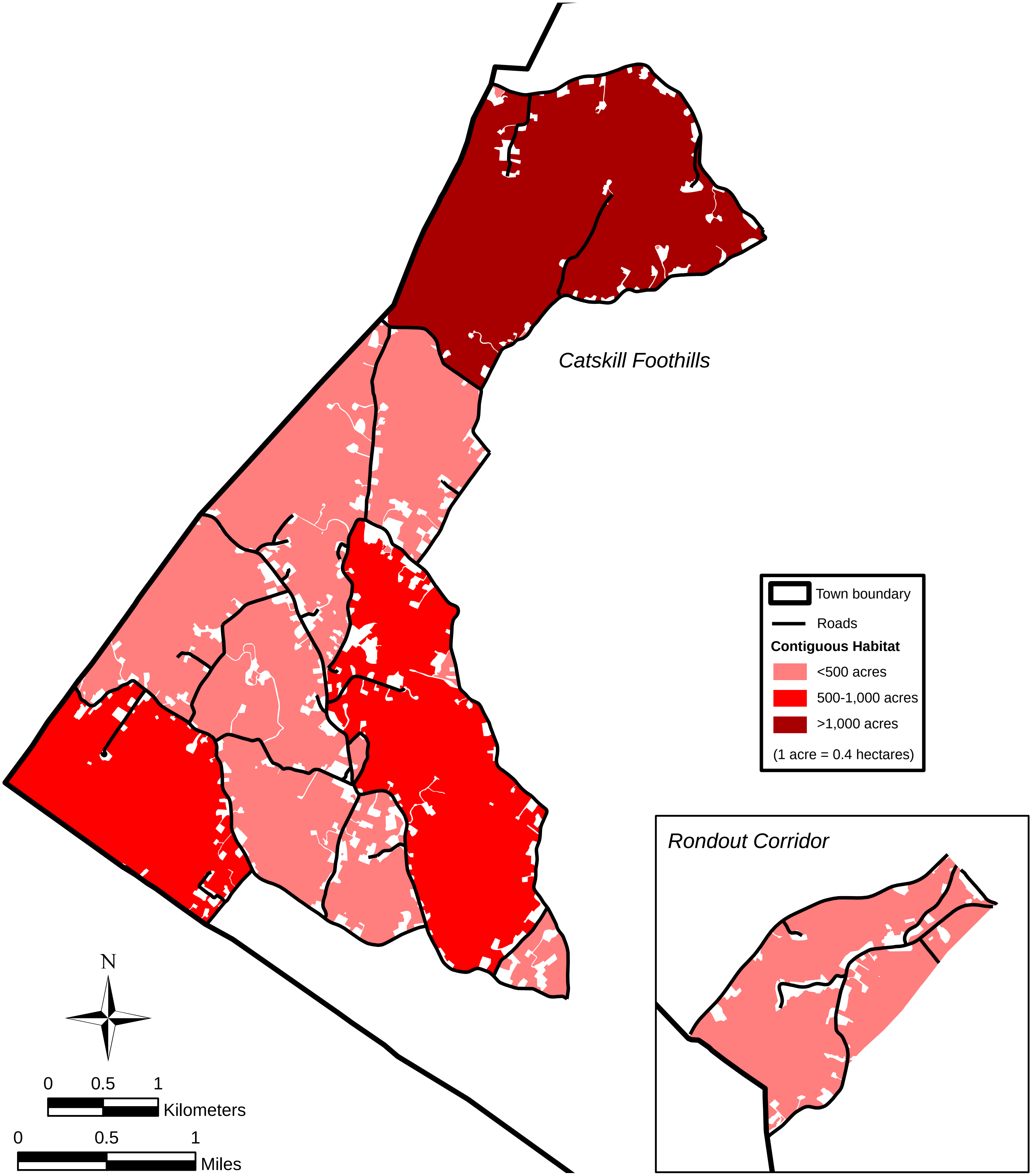


Figure 5. Contiguous habitat patches in theTown of Marbletown study area, Ulster County, New York. Developed areas and other non-significant habitats are shown in white. Hudsonia Ltd., 2007.

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

In addition to land use and conservation planning, the habitat map and report can be used for reviewing site-specific development proposals and other land use proposals. The habitat map can provide ecological information not only for the proposed development site, but also for 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 the impact of the proposed land use change on the habitats that may be present on and around the site:

1. Consult the habitat map to see which ecologically significant habitats, if any, are located on and near the site in question.
2. Read the descriptions of those habitats in this report.
3. Check 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 forested or meadow habitats.
   - Minimizing intrusions into forested areas that are within 650 ft (200 m) of an intermittent woodland pool.
   - Avoiding disturbances that would disrupt the quantity or quality of groundwater available to onsite or offsite springs, seeps, or streams.
   - Channeling stormwater runoff from paved areas or fertilized turf into detention basins or “rain gardens” instead of directly into streams, ponds, or wetlands. Oil-water separators can also be installed where runoff leaves paved areas.

- Locating developed features such that broad corridors of undeveloped land are maintained between those features and the habitats of concern.

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. Site visits by qualified professionals should be an integral part of the review process for any proposed land use change.

General Strategies for Achieving Conservation Goals

We hope that the habitat map and this report will help landowners understand how their land fits into the larger ecological landscape, and will inspire them to voluntarily adopt habitat protection measures. We also hope that the town will engage in proactive land use and conservation planning to ensure that future development is planned with a view to long-term protection of the tremendous biological resources that 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 four in 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 land use planners interested in establishing regulatory setbacks from sensitive habitats. A recent publication from the Metropolitan Conservation Alliance (2002) offers a model local ordinance to establish 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 landscape-scale basis to foster biodiversity conservation. The examples listed below are adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001).

- Protect large, contiguous, undeveloped tracts wherever possible.
- Plan landscapes with interconnected networks of undeveloped habitats (preserve links and create new links between natural habitats on adjacent properties). When considering protection for a particular species or group of species, design the networks according to the particular needs of the species of concern.
- Preserve natural disturbance processes such as fires, floods, seasonal drawdowns, landslides, and wind exposures wherever possible.
- Restore and maintain broad buffer zones of natural vegetation along streams, shores of water bodies and wetlands, and around the perimeter of other sensitive habitats.
- Direct human uses toward the least sensitive areas, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.
- Encourage development of altered land instead of unaltered land. Promote redevelopment of brownfields and previously altered sites, “infill” development, and re-use of existing structures wherever possible. 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 adjacent to

existing hamlets and villages wherever possible to maximize extent of unaltered land and minimize expanded vehicle use.

- Minimize the area of impervious surfaces (roads, parking lots, sidewalks, driveways, roof surfaces) and maximize onsite runoff retention and infiltration to help protect groundwater recharge and surface water quality and flows.
- Restore degraded habitats wherever possible, but do not use restoration projects as a license to destroy existing habitats. Habitat restoration should be based on scientific research so that it ultimately has the intended positive impacts on biodiversity.

PRIORITY HABITATS IN MARBLETOWN

Although land in the study area has been developed for residential uses, large areas of high-quality habitat still remain, particularly in the Catskill foothills. By employing a proactive approach to land use and conservation planning, the Town of Marbletown has the opportunity to protect the integrity of its biological resources for the long term. With limited financial resources to devote to conservation purposes, municipal agencies must decide how best to direct those resources and to employ other means to maximize conservation results. While it may be impossible to protect all significant habitats, there are reasonable ways to prioritize conservation efforts using the best available scientific information. Important considerations in prioritizing such efforts include preserving sensitive habitat types, high quality habitats, and a variety of habitats well distributed and well connected throughout the town. Below we highlight some habitat types that we consider “Priority Habitats” for conservation in the Town of Marbletown. While we hope this information will help the town think strategically about future land use planning, it must be understood that this is not an exhaustive list of important habitats, and every habitat unit appearing on the map is worthy of conservation.

We used the requirements of a selected group of species to help identify some of the areas where conservation efforts might yield the greatest return for biological diversity. We chose several species or groups of species that have large home ranges, specialized habitat needs, or acute sensitivity to disturbance (see Table 2). Many of these species are rare or declining in the region or statewide. Each of these species or groups requires a particular habitat type for a crucial stage in its life cycle (e.g., hibernation, breeding), and those "core habitats" typically form the hub of the animal's habitat complex. The various other habitats required during other life cycle stages are typically located within a certain distance of the core habitat. This distance defines the extent of the species' habitat complex and, therefore, the minimum area that needs to be protected or managed in order to conserve the species. We call this the "conservation zone" and discuss the size of this zone in the "Recommendations" subsection for each priority habitat. We used findings in scientific literature to estimate the Priority Conservation Zone for the species or group of concern (Table 2). If the habitats of the target species are protected, many other rare and common species that occur in the same habitats will also be protected.

Table 2. Priority Habitats, selected species of concern, and associated priority conservation zones identified by Hudsonia in the study area, Town of Marbletown, Ulster County, New York.

Priority Habitat	Associated Species or Group of Concern	Priority Conservation Zone	Rationale	References
Extensive forest	Forest interior-breeding birds	Unfragmented patches of 100+ ac (40+ ha).	Required for moderate to high probability of supporting breeding scarlet tanagers and forest thrushes in a 50-60% forested landscape.	Rosenberg et al. 1999, 2003
Crest/ledge/talus	Snakes of conservation concern	600 ft (190 m) from crest/ledge/talus borders.	A minimum radius of intact habitat needed to protect all but the farthest ranging snakes.	Harding 1997, ME Dept of Inland Fisheries & Wildlife 2003
Intermittent woodland pool	Pool-breeding amphibians	750 ft (230 m) from pool.	Encompasses non-breeding season foraging and refuge habitats and most dispersal routes between pools.	Madison 1997, Semlitsch 1998, Calhoun and Klemens 2002
Wetland complexes	Four-toed salamander	300 ft (90 m) beyond outermost wetlands in a complex.	Corresponds to maximum reported distance of movement from the nearest wetland.	Gibbs et al. 2007
Intermittent and perennial streams	Stream salamanders	At least 160 ft (50 m) on either side of stream.	Required to protect water quality in streams and most of the upland habitat used by stream salamanders.	Saunders et al. 2002, Crawford and Semlitsch 2007
Rondout Creek and tributaries	Wood turtle	650 ft (200 m) from outer edge of stream.	Encompasses most of the critical habitat including winter hibernacula, nesting areas, spring basking sites, foraging habitat, and overland travel corridors.	Carroll and Ehrenfeld 1978, Harding and Bloomer 1979, Buech et al. 1997, Foscarini and Brooks 1997

LARGE FORESTS

Target Areas

In general, forested areas with the highest conservation value are large forest tracts, mature and relatively undisturbed forests, and those with a lower proportion of edge to interior habitat. Smaller forests that provide connections between other forests, such as linear corridors or patches that could be used as "stepping stones," are also valuable in a landscape context. Figure 6 illustrates the location of forested areas (including both forested wetlands and uplands) in the study area, and the distribution of contiguous forest patches that were <100, 100-500, 500-1,000, and >1,000 ac (<40, 40-200, 200-400, and >400 ha, respectively). In the Catskill foothills, there were six patches larger than 100 ac (40 ha) and two patches larger than 500 ac (202 ha). The largest contiguous patch (over 1,000 ac [400 ha]) was on the ridges north of Scarawan Road. Extensive areas of forested crest, ledge, and talus occurred on these same ridges. Crest, ledge, and talus was prevalent throughout the foothills and is a distinctive feature of the area. In the Rondout corridor, all forest patches were less than 100 ac (40 ha). Figure 6 does not take into account the total size of forest patches that extend beyond the study area's boundaries, but this is an important consideration in understanding the habitat value of these patches. If study area boundaries are disregarded, the patch at the southwest corner of the Catskill foothills section extends into Rochester and Olive and should be considered an extensive forest (> 1000 ac) for the purpose of biodiversity conservation.

We hope that other such habitat mapping will be conducted in other towns in Ulster County. An expanding regional map would enable town officials and private landowners to plan strategically across town boundaries to ensure that large forested areas are conserved.

Conservation Issues

Loss of forest area and fragmentation of remaining forest are the two most serious threats facing forest-associated organisms. The decline of extensive forests has been implicated in the declines of numerous "area-sensitive" species which require many hundreds or thousands of acres of contiguous forest to survive and successfully reproduce in the long-term. These include large mammals such as black bear* and bobcat* (Godin 1977, Merritt 1987), some raptors (Bednarz and Dinsmore 1982, Billings 1990, Crocoll 1994), and many migratory songbirds (Robbins 1980, Ambuel and Temple 1983, Wilcove 1985, Hill and Hagan 1991). In addition to a loss of total area, fragmented forest has an increased proportion of edge habitat. Temper-ature, humidity, and light are altered near forest edges. Edge environments favor a set of disturbance-adapted species, including many predators and a nest parasite (brown-headed cowbird) of forest-breeding birds (Murcia 1995). The nesting success of many species of forest birds is diminished by forest fragmentation (Lampila et al. 2005). Large forests, particularly those that are more round and less linear, support forest species that are highly sensitive to disturbance and predation along forest edges. In landscapes with 50-60% forest cover, such as the Catskill foothills, scarlet tanager* requires patches of at least 100 ac (40 ha) for high quality breeding habitat (Rosenberg et al. 1999); forest thrushes need a minimum of about 200 ac (80 ha) (Rosenberg et al. 2003). Forested rocky crests provide habitat for several rare reptiles (see crest, ledge, and talus section below).

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

Recommendations

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

1. **Protect large, contiguous forested areas** wherever possible, and avoid development in forest interiors.
2. **Protect patches of forest types that are imperiled or less common in the town regardless of their size**. These include mature (and old-growth, if any is present) forests, rich (calcareous) forests, forests with an unusual tree species composition, hemlock forests (particularly healthy stands) or forests that have smaller, unusual habitats (such as calcareous crests or intermittent woodland pools) embedded in them.
3. **Maintain or restore broad corridors of intact habitat between large forested areas** (including connections across roads). This can sometimes be accomplished by protecting smaller forest patches that provide "stepping stone" connections between larger forest patches.
4. **Keep 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**.

Tree harvesting from privately owned woodlots is often important to sustain regional demand and to enable landowners to preserve open space. While human intervention is rarely required to preserve or improve forest health, there are some circumstances where silvicultural prescriptions can be used to give a degraded forest a jump start and facilitate the development of a forest with greater ecological value. Too often logging operations are done poorly and the consequences can include establishment of invasive species such as tree-of-heaven, an increase in pathogen infection and tree mortality rates, a decrease in microhabitat, structural, and species diversity, the loss of genetic diversity, and severe damage to soils. Some very general guidelines for forest management include:

1. **Avoid clearcutting, especially on steep slopes.**
2. **Minimize gap size and soil scarification**. These disturbances can create conditions that are ideal for the establishment of invasive plant species.
3. **Restrict harvesting to when there is snow cover, the ground is frozen, or the soil is dry.**
4. **Do not "high grade."** Often referred to as selective cutting, this method of harvesting removes the largest, highest quality trees and can result in a degraded gene pool.
5. **Avoid damaging advance regeneration in the understory.** This will ensure growing stock for the regenerating forest.
6. **Leave standing snags and "wolf trees" (open-grown trees with broad crowns) for wildlife.**
7. **Implement best management practices and leave substantial undisturbed buffers around streams, wetlands, and other bodies of water.**
8. **Leave logging slash and tops in the woods.**

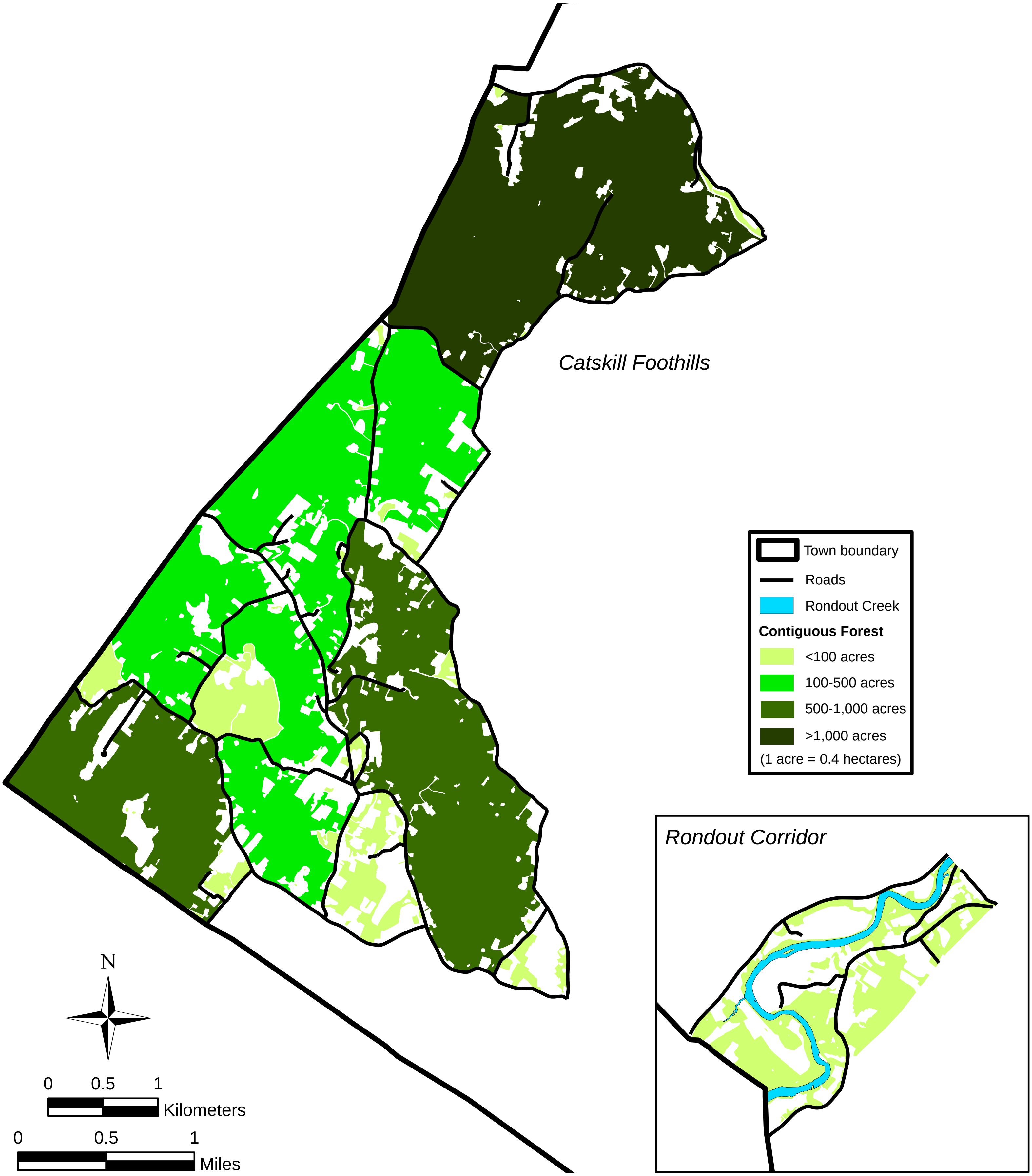


Figure 6. Contiguous forest patches (including hardwood, conifer, and mixed forests in uplands and swamps) in the Town of Marbletown study area, Ulster County, New York. Hudsonia Ltd., 2007.

CREST, LEDGE, AND TALUS

Target Areas

Extensive areas of crest, ledge, and talus occurred throughout the Catskill foothills area. We noted the location of crest oak woodlands on the ridges north of Scarawan Road. Much of the forested areas in the foothills were very bouldery; we included these in the crest, ledge, and talus overlay. We found three calcareous rock outcrops and talus areas in the Catskill foothills; the two larger outcrops were in the northeast part of the study area.

Conservation Issues

In the past, rocky crests were not often threatened by development because the steep rocky terrain made the construction of houses, roads, and other structures too expensive. Recently, however, increasing numbers of houses are being constructed on or near crests. The more open, dry woodlands occurring along hill summits and ridge tops are often viewed as prime sites for communication towers. These woodlands and crests are also frequented by people seeking scenic views, and thus are often subjected to ATV and foot traffic. All such disturbances can severely degrade these habitats and expose rare reptiles (see below) to fatal encounters with humans.

Crests, ledges, and talus in forested areas provide core habitat for several rare reptiles that require rocky outcrops and unshaded conditions at crucial stages in their life cycle. Snakes such as northern copperhead,* timber rattlesnake,* eastern racer,* and eastern ratsnake* may use open rocky habitats at key times of the year, including for spring basking and breeding and as winter hibernacula. Eastern racer and eastern ratsnake may travel 600 ft (190 m) or more to forage, bask, breed, nest, and hibernate (Harding 1997, ME Dept of Inland Fisheries and Wildlife 2003). Although much rarer in the Catskills region, snakes such as copperhead and timber rattlesnake have even larger home ranges (3300-7900 ft [1000-2400 meters]) (Fitch 1960, Brown 1993).

Perhaps one of the greatest threats to the long-term viability of the rare animals associated with crest, ledge, and talus is the isolation of these habitats from one another. The low-lying valley areas between ridge-top complexes are often seen as prime development sites. The construction of houses, roads, and other structures in these areas isolates habitats and the animal populations they support by preventing migration, dispersal, and genetic exchange. This, in turn, can limit the ability of these populations to adapt to changing climatic or other environmental conditions and make them more prone to local extinction.

Recommendations

The following guidelines will help protect fragile crest, ledge, and talus habitats and the sensitive species associated with them. If timber rattlesnakes or copperheads are known or expected to inhabit a particular area, the conservation zone should be extended to 7900 ft (2400 m).

1. **Minimize the building of new roads, houses, and other developments on or within 600 ft (190 m) of ledges and exposed rocky ridgetops**.
2. **Protect crest, ledge, and talus areas and upland and wetland habitats within 600 ft (190 m) from disturbances associated with high intensity human recreation**, including soil erosion, trampling of sensitive plants, and direct injury to or disturbance of animals.
3. **Maintain intact habitats in the areas between crests** to allow for dispersal of plant and animal populations.
4. **Avoid direct disturbance to dens of snakes of conservation concern**, and restrict logging to the winter months when the snakes are hibernating (Brown 1993).

INTERMITTENT WOODLAND POOLS

Target Areas

We identified and mapped 26 intermittent woodland pools in the study area (Figure 7), and we believe this to be an underestimate. Each intermittent pool is important to preserve, but groups or networks of pools are particularly valuable from a habitat perspective. Groups of pools can support metapopulations – groups of small populations that are able to exchange individuals and recolonize sites where the species has recently disappeared.

Conservation Issues

Because they lack fish and certain other predators and have high production of invertebrate food organisms, intermittent woodland pools provide crucial breeding and nursery habitat for several amphibian species that cannot successfully reproduce in other wetlands, including several of the mole salamanders (Jefferson salamander,* marbled salamander,* spotted salamander*) and wood frog.* During the non-breeding season, these amphibians are exclusively terrestrial and require the deep shade, deep leaf litter, uncompacted soil and fallen logs of the surrounding upland forest for foraging and shelter. The upland forested area within a 750 ft (230 m) radius of the intermittent woodland pool is considered necessary to support populations of amphibians that breed in intermittent woodland pools (Calhoun and Klemens 2002). Disturbance of vegetation or soils within this area—including the direct loss of pool and forest habitats, alteration of the duration of standing water, and degradation of pool water quality or forest floor habitat quality—can have significant adverse effects on the amphibians.

Pool-breeding amphibians are especially vulnerable to upland habitat fragmentation because of their annual movement patterns. Each year adults migrate to the intermittent woodland pools to breed, and then adults and (later) juveniles disperse from the pool to terrestrial habitats. 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 vulnerable to vehicle mortality where roads or driveways cross their travel routes, and roads, especially dense networks of roads or heavily-traveled roads, have been associated with reduced amphibian populations (Fahrig et al. 1995, Lehtinen et al. 1999, Findlay and Bourdages 2000). In addition, road salt entering the pools via runoff reduces larval survival in many species (Karraker and Gibbs 2006). Open fields and clearcuts are another barrier to forest-dwelling amphibians; juveniles have trouble crossing open fields due to a high risk of desiccation and predation in that exposed environment (Rothermel and Semlitsch 2002).

Populations of these amphibian species depend not only on a single woodland pool, but on a forested landscape dotted with such wetlands between 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 in the landscape, 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 meta-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 their key foraging and wintering habitats in the surrounding upland forests, and the forested migration corridors between individual pools and pool complexes.

Recommendations

To help protect pool-breeding amphibians and the habitat complex they require, we recommend that the following protective measures be taken (adapted from Calhoun and Klemens 2002):

1. **Protect the intermittent woodland pool depression**. Intermittent woodland pools are often overlooked during environmental reviews of proposed development projects and are frequently drained, filled, or dumped in. We advise that intermittent woodland pools be permanently protected from development and disturbance of any kind including the construction of houses, roads, lawns, and 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, stumps, and 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.
3. **Maintain critical terrestrial habitat within 750 ft (230 m) of the pool (see Figure 6)**. The upland forests within 750 ft (230 m) or more of a woodland pool are critical foraging and shelter habitats for pool-breeding amphibians during the non-breeding season. Roads, development, logging, ATV use, and other activities within this terrestrial habitat can crush many amphibians and destroy the forest floor

microhabitats that provide them with shelter and invertebrate food. Development within this zone can also prevent dispersal and genetic exchange between neighboring pools, thereby making local extinction more likely. A minimum of 75% of this zone should remain in contiguous (unfragmented) forest with an undisturbed forest floor. Wherever possible, forested connections between individual pools should be identified and maintained to provide overland dispersal corridors.

We also recommend the following for all development activities 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. De-icing compounds, petroleum hydrocarbons, silt, and other pollutants from roads degrade habitat quality in the pools. To minimize these potential adverse impacts:
   - Roads and driveways with projected traffic volumes in excess of 5-10 vehicles per hour should not be sited within 750 ft (230 m) of the pool.
   - Regardless of traffic volumes, the total length of roads 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.
   - Reduce road salt applications on existing roads within 550 ft (170 m) of woodland pools (Karraker and Gibbs 2006).
2. **Maintain woodland pool water quality and quantity at pre-disturbance levels**. Development within a woodland pool’s drainage basin can degrade pool water quality by increasing sediments, nutrients, and pollutants in 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. Activities such as 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 adversely affect the ability of amphibians to reproduce successfully in woodland pools. Protective measures include the following:

- Do not use intermittent woodland pools for storm water detention, either temporarily or permanently.
- Aggressively treat stormwater 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, herbicides, and fertilizers within the woodland pool's drainage basin. If mosquito control activities are a necessity they should be limited to the application of bacterial larvicides (Bti or Bs), which appears at this time to 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. Do not dredge or dam woodland pools to create ornamental or water supply ponds.
- Minimize impervious surfaces including roads, parking lots, and buildings to reduce runoff problems and resulting stormwater management needs.

3. **Avoid creating stormwater detention basins and other artificial depressions** that intermittently hold water (e.g., vehicle ruts) within 750 ft (230 m) of an intermittent woodland pool or in areas that might serve as overland migration routes between pools. These "decoy wetlands" can attract large numbers of pool-breeding amphibians, but the eggs laid in them rarely survive due to the high sediment and pollutant loads and short hydroperiod.
4. **Design or 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.
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 construction site (in consultation with the New York State Department of Environmental Conservation) to keep amphibians out of the active construction areas.

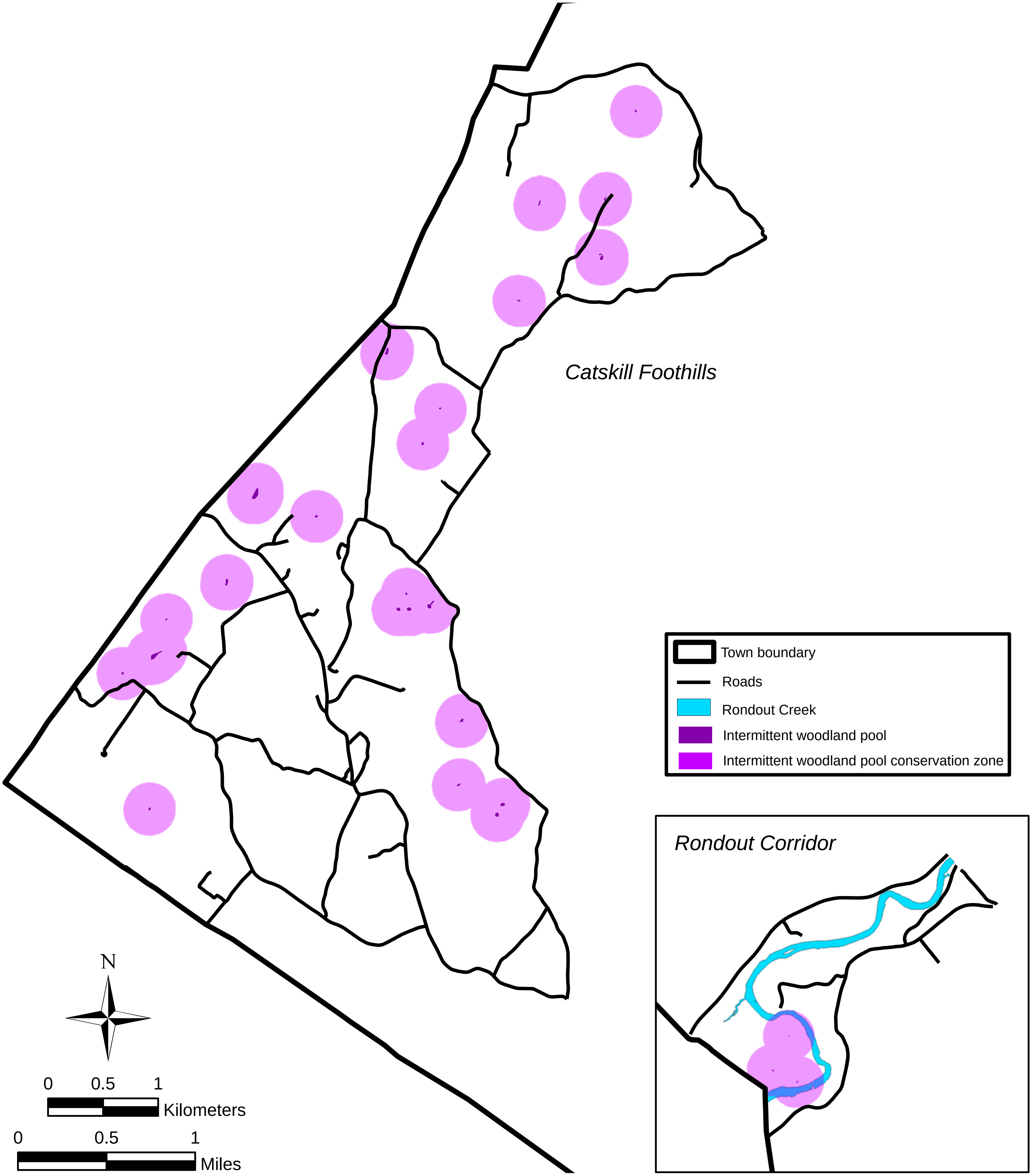


Figure 7. Intermittent woodland pools and associated conservation zones in theTown of Marbletown study area, Ulster County, New York. Conservation zones extend 750 ft (230 m) from intermittent woodland pool boundaries. Hudsonia Ltd., 2007.

WETLAND COMPLEXES

Target Areas

A wetland complex is any group of adjacent and nearby swamps, marshes, wet meadows or other wetland types and associated streams or ponds. 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. We have identified three wetland complexes of special conservation interest in the study area (Figure 8). The Vly Swamp complex includes Vly Swamp (the tamarack-red maple swamp), Roosa Lake, hardwood & shrub swamp, marsh, and mixed forest swamp. The Woodland North complex includes conifer and mixed forest swamp, hardwood and shrub swamp, and intermittent woodland pools. The Woodland South complex is composed of hardwood & shrub swamp (including a high quality buttonbush swamp), intermittent woodland pools, and wet meadow. These wetland complexes are particularly well-suited to provide for the habitat needs of four-toed salamander* (see below) as well as other wetland-dependent species of conservation concern.

Conservation Issues

Many animals use both wetlands and the surrounding upland habitats throughout the year. For instance, four-toed salamander* breeds in forested and other wetlands that contain deep mosses, especially *Sphagnum* mosses, but spends much of its adult life in deciduous or mixed forests surrounding the wetland (Blanchard 1923, Bishop 1941, Petranka 1998, Gibbs et al. 2007). Four-toed salamander prefers fishless wetlands and regularly shares breeding habitat with mole salamanders (see above for mole salamander habitat [Petranka 1998]). Four-toed salamander, however, requires areas of deep moss to lay its eggs (Chalmers and Loftin 2006). Like many salamanders, four-toed salamander spends much of its time terrestrially under cover objects such as stones, logs, stumps, and leaf litter (Petranka 1998, Gibbs et al. 2007). Little is known about its movement patterns, but Gibbs et al. (2007) report that four-toed salamander may be found more than 300 ft (90 m) from its breeding wetland. Wetland-breeding amphibians must be able to travel between wetlands for population dispersal and genetic exchange, and to exploit different habitat characteristics under different conditions of precipitation and temperature. For these reasons, maintaining amphibian populations requires maintaining whole complexes of wetlands and keeping the intervening upland habitats intact (e.g. Gibbons 1993, Chalmers and Loftin 2006).

Recommendations

1. **Protect intermittent woodland pools and their conservation zones** as described elsewhere in this report. These are habitats used by many species of amphibians, turtles, and other wildlife.
2. **Identify and protect wetland complexes composed of wetlands within 800 ft (250 m) of each other and the intervening upland habitats**. These upland areas encompass travel corridors for wildlife and provide dispersal routes between wetlands for four-toed salamanders and other amphibians of conservation concern.
3. **Protect mature forests within 300 ft (90 m) of a wetland boundary**. Mature trees provide plentiful fallen logs and other organic debris and regulate forest floor moisture, important habitat characteristics for four-toed salamander and other amphibians (Petranka 1998).
4. **Leave woody debris, rocks, and other objects on forest floor within 300 ft of a wetland boundary.** These objects provide cover for four-toed salamander and other amphibians of conservation concern.

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 intersected by roads or development.

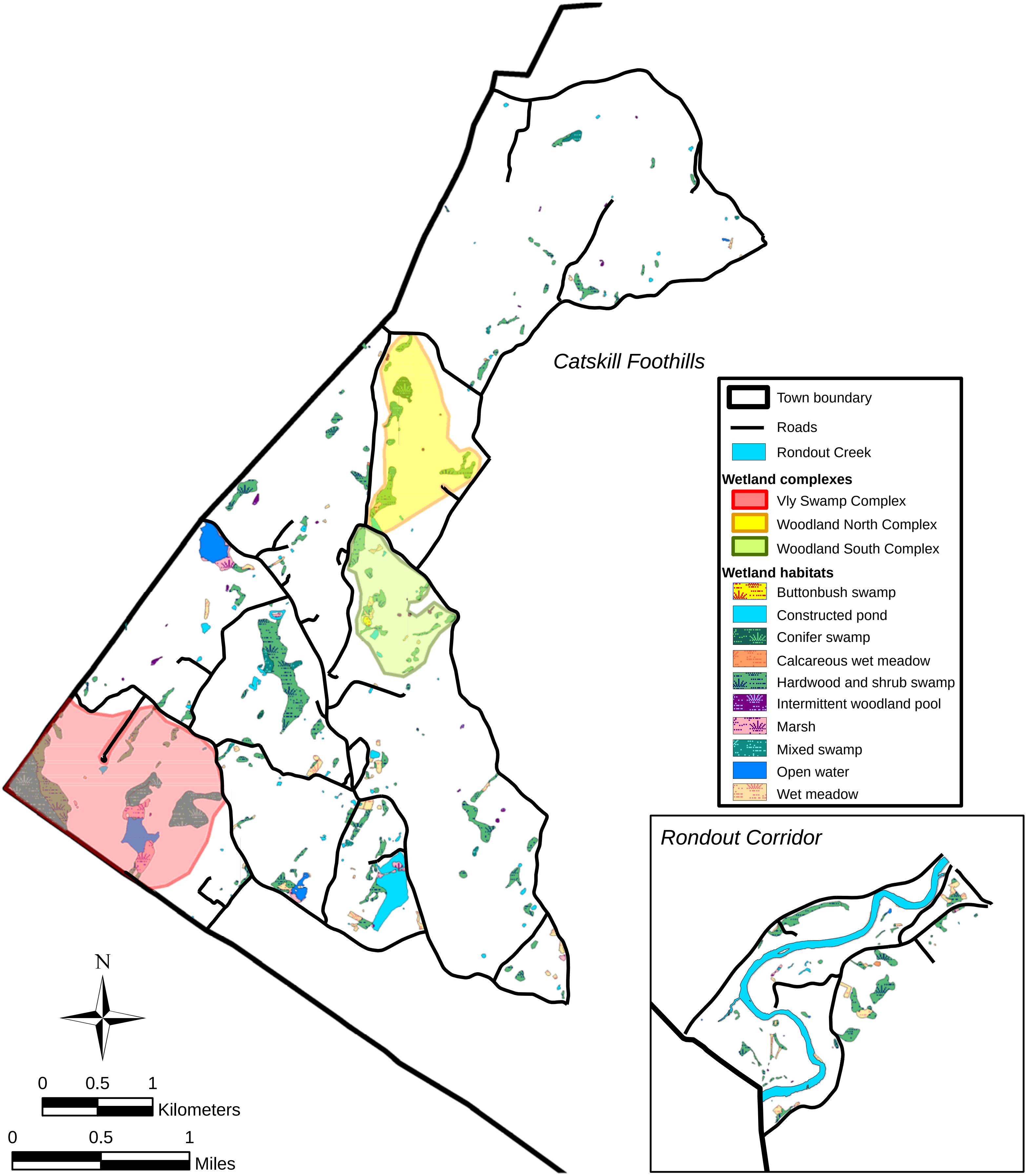


Figure 8. Wetland complexes and wetland habitats in the Town of Marbletown study area, Ulster County, New York. Hudsonia Ltd., 2007.

STREAMS AND RIPARIAN CORRIDORS

Target Areas

The Rondout Creek and Peters Kill were the major perennial waterways in the study area. The area's widespread network of smaller perennial and intermittent streams is also important, both to the organisms that depend on the streams and to the health of their entire watersheds. Figure 9 shows streams and their associated conservation zones (see below) in the study area.

Conservation Issues

Low-gradient perennial streams can be essential core habitat for the wood turtle,* a Species of Special Concern in New York State. Wood turtles use streams with overhanging banks, muskrat burrows, deep pools, 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 (especially females) move into and beyond the riparian zone to bask and forage in a variety of wetland and upland habitats, and females may travel long distances from their core stream habitat to find open, sparsely vegetated upland nesting sites. Wood turtles are known to occur in the Rondout Creek and several of its larger tributaries (B. Koffler pers. comm.).

Conserving wood turtles requires protecting not only their core habitat of perennial streams, 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 affects on wood turtles and their habitats. These effects include habitat degradation from stream alteration, habitat fragmentation from culverts, bridges, roads, and other structures, the direct loss of wetland habitat, degraded water quality from siltation, pesticides, fertilizers, sewage, and toxic compounds, increased nest predation by human-subsidized predators, disturbance from human recreational activities, pitfall hazards such as window wells and unfenced swimming pools, and road mortality of nesting females and other individuals migrating between habitats.

High gradient, rocky perennial or intermittent streams, springs and seeps, and the surrounding forest can be key habitat for stream salamanders, including northern red salamander,* northern dusky salamander,* mountain dusky salamander,* and spring salamander.* Stream salamanders are usually found under moss, rocks, dead leaves and other detritus, or logs in perennial and intermittent streams, springs, and seeps, along stream banks, or in nearby moist forests, and require clear, cool water. Forested areas, and sometimes meadows, provide foraging habitat and shelter for stream salamanders. Northern red salamander may wander as far as 930 ft (300 m) from the nearest stream (Hulse et al. 2001, T. Hartwig pers. obs.). Mountain dusky salamanders often forage in trees and shrubs in the surrounding forest (Conant and Collins 1998).

In addition, water quality in large streams depends in large part on the water quality and quantity of the small, intermittent streams that feed them (Lowe and Likens 2005). In order to protect water quality and salamander habitat in intermittent streams, the adjoining lands should be protected to at least 160 ft (50 m) on each side of the stream (Saunders et al. 2002, Crawford and Semlitsch 2007). This protective buffer 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 wildlife habitat in and near streams, we recommend the following measures:

1. **Protect the integrity of stream habitats**.
    - Prohibit engineering practices that alter the physical structure of the stream channel such as stream channelization, artificial stream bank stabilization (e.g., rock rip-rap, concrete), construction of dams or artificial weirs, vehicle crossing (e.g., construction or logging equipment, ATVs), and the clearing of natural stream bank vegetation. These activities can destroy key hibernation and basking habitat for wood turtles and disturb cover objects used by salamanders.
    - Avoid direct discharge of stormwater runoff, chlorine-treated wastewater, agricultural by-products, and other potential pollutants.
    - Establish a protective buffer zone extending at least 160 ft (50 m) on either side of all streams in the watershed, including perennial and intermittent tributary streams. Buffer zones should remain naturally vegetated and undisturbed by construction, conversion to impervious surfaces,

agriculture and livestock use, pesticide and fertilizer application, and installation of septic leachfields or other waste disposal facilities.

2. **Protect riparian wetland and upland habitats.** All riparian wetlands adjacent to streams should be protected from filling, dumping, drainage, impoundment, incursion of construction equipment, siltation, polluted runoff, and hydrological alterations. In addition, large, contiguous blocks of upland habitats (e.g., forests, meadows, shrublands) within 650 ft (200 m) of a core wood turtle stream or 160 ft (50 m) of other streams should be preserved to the greatest extent possible to provide basking, foraging, and nesting habitat for wood turtles and foraging habitat and shelter for stream salamanders. Special efforts may be needed to protect particular components of the habitat complex such as wet meadows and alder stands; wood turtle has been found to favor stands of alder, and wet meadows are often sought by wood turtles, especially females, for spring basking and foraging (Kaufmann 1992). These wetlands, however, are often omitted from state, federal, and site-specific wetland maps and are frequently overlooked in the environmental reviews of development proposals.

3. **Minimize impacts from new and existing stream crossings**. Stream crossings, particularly undersized bridges and narrow culverts, may be significant barriers to wood turtle movement along their core stream habitats. Wood turtles may shy away from entering such structures and choose a hazardous overland route to reach their destination. 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 specifications, 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, salamanders, and other animals.

- Construct the substrate within the structure of natural materials and match the texture and composition of upstream and downstream substrates. If possible, crossings should be installed in a manner that does not disturb the natural substrate of the stream bed.
- If the stream bed must be disturbed during construction, design the final elevation and gradient of the structure bottom so as to maintain water depth and velocities at low flow that are comparable to those found in natural stream segments just upstream and downstream of the structure. Sharp drops in elevation at the inlet or outlet of the structure can be a physical barrier to turtles, salamanders, and other small animals.

4. **Minimize impacts from new and existing roads**. Road mortality of nesting wood turtles and individual wood turtles and salamanders dispersing to new habitats is one of the greatest threats to wood turtle and salamander populations.

   To minimize the adverse effects of roads on wood turtles, we recommend the following actions be undertaken within the 650 ft (200 m) wide priority 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.

   To minimize the effects of roads on stream salamanders:
   - Prohibit the building of new roads within the 160 ft (50 m) riparian zone. 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.
   - Reduce road salt applications on existing roads within 550 ft (170 m) of salamander streams (Karraker and Gibbs 2006). Road salt is known to adversely affect woodland pool salamanders, and probably has similar affects on stream salamanders.

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

6. **Protect wood turtle 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 (e.g., upland meadows, upland shrublands, waste ground with exposed gravelly soils) within the 650 ft (200 m) corridor be protected from development and other disturbance.

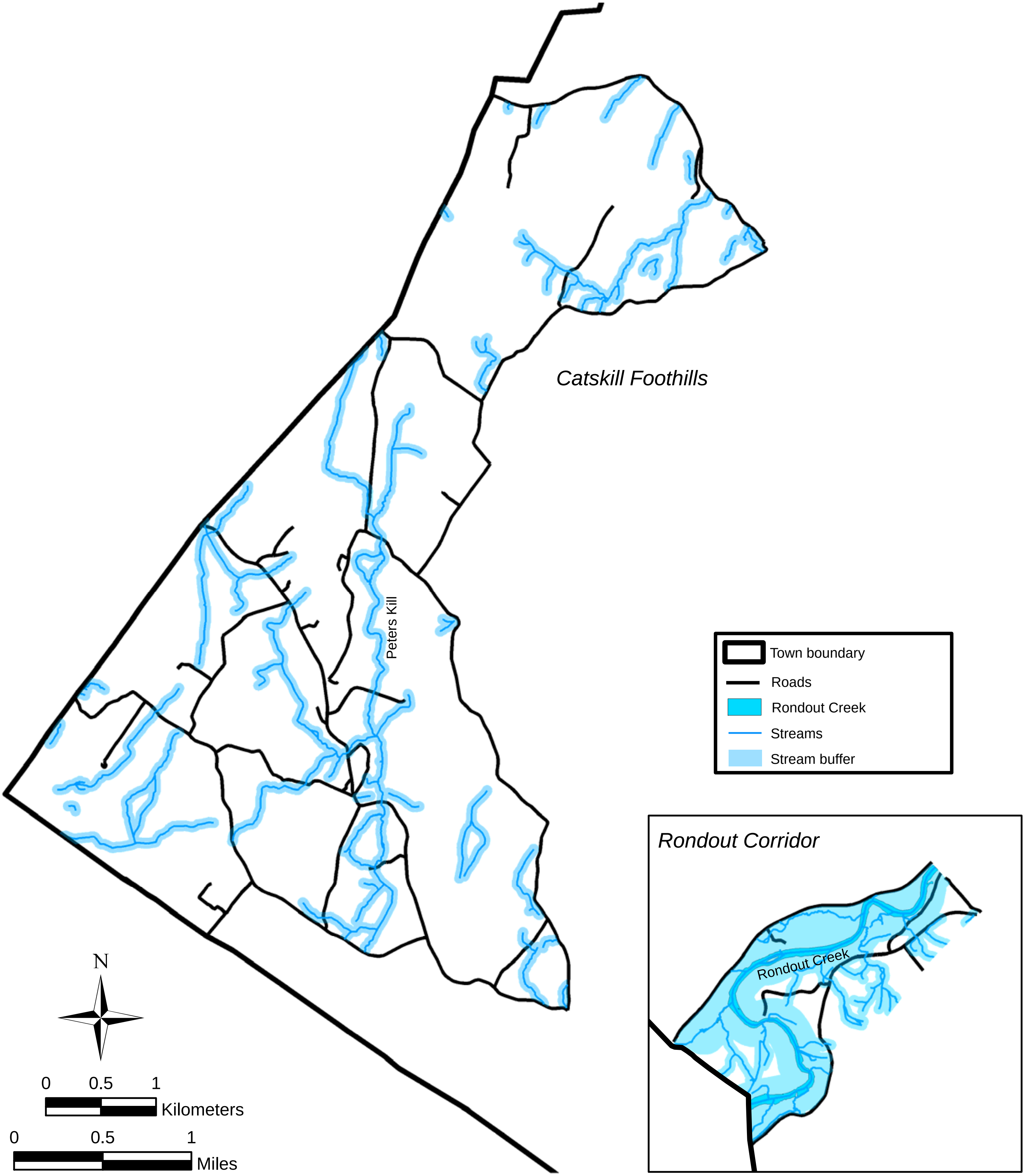


Figure 9. Streams and associated conservation zones in the Town of Marbletown study area, Ulster County, New York. Streams have minimum conservation zones of 160 ft (50 m) on each side; possible wood turtle streams have conservation zones of 660 ft (200 m). Hudsonia Ltd., 2007.

CONCLUSION

There are significant opportunities for biodiversity conservation in the rural landscape of the Town of Marbletown. Development pressure is on the rise, however, and strategic land use and conservation planning is needed to ensure that species, communities, and ecosystems are protected for the long term. Through our habitat mapping work, Hudsonia hopes to equip town agencies, landowners, and others with information about local habitats of ecological significance, so they can take steps to protect the resources of greatest importance to them.

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. After conveying the completed habitat map, database, and report to the Town of Marbletown, Hudsonia hopes to have the opportunity to assist town officials, landowners, and other interested individuals and groups in interpreting the map, understanding the ecological resources of the town, and devising ways to integrate this new information into land use planning and decision making.

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, the areas where intermittent woodland pools or other uncommon habitats are concentrated, and the patterns of habitat fragmentation caused by roads and residential development. This kind of general information can help the town consider where future development should be concentrated and where future conservation efforts should be targeted. An understanding of the significant ecological resources in the town will enable local decision makers to focus limited conservation resources where they will have the greatest impact.

At the site-specific scale, we hope the map will be used as a resource for routine deliberations over development proposals and other proposed land use changes. The map and report provide an independent body of information for environmental reviews, and will help raise questions about important biological resources that might otherwise be overlooked. We strongly emphasize, however, that the map has not been exhaustively field checked and should therefore be used only as a source of general information. In an area proposed for development, for example, the habitat map can provide basic ecological information about the site and the surrounding lands, but the map should not be considered a substitute for site visits by qualified professionals. During site visits, the presence and boundaries of important habitats should be verified, changes that have occurred since our mapping should be observed, and the site should be assessed for additional ecological values. 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, it is important for the town to 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 Marbletown 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, to integrate the needs of the human community with those of the natural communities, and to protect the ecological patterns and processes that support us and the rest of the living world.

ACKNOWLEDGMENTS

We are extremely grateful to the Hudson River Estuary Program of the New York State Department of Environmental Conservation who provided funding for this project, and to the Town of Marbletown for their partnership and support. In particular, Mary Collins and Maggie Colan provided us with contact information for landowners. The Marbletown Town Board, Planning Board, and Environmental Conservation Commission welcomed the project, and members of these agencies provided assistance. We thank the Town of Marbletown and the New York State GIS Clearinghouse for providing GIS data. The New York State GIS Clearinghouse provided the high resolution orthophoto images that greatly improved the accuracy of our mapping. Nick Conrad of the New York Natural Heritage Program provided data on rare species occurrences. We also thank the following Hudsonia biologists: Andy Reinmann assisted with field work and created the figures; Nava Tabak assisted with mapping and field work and wrote much of the text regarding Rondout corridor habitats; Amie Worley did the preliminary mapping of the Rondout Corridor; and Kristen Bell assisted with preparation of the report and created the large format map. Finally, we would like to thank the following landowners and residents of the Town of Marbletown, who graciously allowed us access to their land for field work, or provided other valuable information:

Theresa Anderson
Philippe Bader
Madeleine Bleecker
Thomas Bodkin
Patricia and Roy Carlin
Cathy Durso and the New York City Department of Environmental Protection
Teresa and William Eggers
Joan Ewing, Epworth Retreat Center
Steven Fein
Jesse and James Feth
Michelle Fox
Janet Fryer and Brian Lynn
Phillip Goldstein and Rita Prusinski
Kenneth Green
Harry and Sarah Hansen
Mark Houghtaling
John Ingram
Ernest Iverson
Mary Johnston
Linda Karpell
Allen and Norma Mastandrea
Michael McCracken
Michael McDonough
Thomas McNulty
Kathleen and Brian Miller
Robert Miller
Jill Moscowitz
Marie and Jonas Nachsin
Rita and John Neidhardt
John North and the Stone Dock Golf Course
John Parete
Brother Donald, Founder's Hollow
Steven and Carol Pressman
Martin Puryear
Paul Rubin
Robert Sacca
Marcia Schaef
Terry and Karen Siencey, Epworth Retreat Center
Theodore and Debby Shemella
Janet Siskind
Pamlyn Smith
Kurt Sutherland
Kiki Tan
Michael and Mary Tannen
Magnus Thompson
Milford Vandemark

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APPENDICES

Appendix A. Mapping conventions used to identify and map 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 on the base habitat map. Except for the most exposed ledges, these habitats do not have distinct signatures on aerial photographs and were therefore mapped based on a combination of field observations and locations of potential bedrock exposures inferred from the mapped locations of shallow soils (<20 inches [50 cm]) on steep (>15%) slopes in Tornes (1979). 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. All other areas of exposed bedrock (both non-calcareous and unknown bedrock) were mapped simply as crest, ledge, and talus.

Cultural. Very large lawns were among the areas typically mapped as “cultural” habitats. It was sometimes difficult to distinguish extensive lawns from upland meadows using aerial photos, so in the absence of field verification some lawns may have been mapped as upland meadow.

Developed areas. Habitats surrounded by or intruding into developed land were mapped only if their dimensions exceeded 50 m (165 ft) in all directions, or if they seemed to provide important connections to other large habitat areas. Exceptions to this protocol were wetlands within developed areas, which we mapped 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 adjacent to significant habitats, were mapped as “cultural” habitats.

Intermittent woodland pools. Intermittent woodland pools are best identified in the spring when the pools are full of water and occupied by invertebrates and breeding amphibians. The presence of fairy shrimp is often a good indicator that the standing water is intermittent. For those intermittent woodland pools we visited in late summer and fall, we relied on general physical features of the site to distinguish them from isolated swamps. We classified those wetlands with an open basin as intermittent woodland pools and those dominated by trees or shrubs as swamps, but they often serve similar ecological functions. Many intermittent woodland pools can also be mapped remotely since they have a distinct signature on aerial photographs, and are readily visible within areas of deciduous forest if the photographs are taken in a leaf-off season. Intermittent woodland pools located within areas of conifer forest, however, are not easily identified on aerial photographs, and we may have missed some of these in areas we were unable to visit.

Open water and constructed ponds. Most bodies of open water in Marbletown were probably created by damning or excavation, so most were mapped as constructed ponds. Those that we mapped as "open water" habitats included natural ponds, substantially unvegetated pools within marshes and swamps, and ponds that were probably constructed but are now substantially unmanaged and surrounded by unmanaged vegetation.

Orchard/Plantation. Christmas tree plantations with young trees were included in this category (rather than in upland 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 study area 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 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 used the "stream" habitat for ditches because they function as such from a hydrological perspective.

Upland forests. We mapped just three types of upland forests: hardwood, mixed, and conifer forest. Although these forests are extremely variable in 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 includes non-wetland forests of all ages, at all elevations, and of all species mixtures. Gravel and dirt roads (where identifiable) were used to delineate boundaries of adjacent forested habitat areas, since they can be significant fragmenting features.

Upland meadows and upland shrubland. We mapped upland meadows divided by fences and hedgerows as separate polygons, to the extent that these features were visible on the aerial photographs. 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 hydrophytic vegetation and easily visible indicators of surface hydrology (Environmental Laboratory 1987). We did not examine soil profiles. Along stream corridors and in other low-lying areas with somewhat poorly-drained soils, it was often difficult to distinguish between upland forest and hardwood swamp without the benefit of onsite soil data. On the ground, these areas were characterized by moist, fine-textured soils with common upland trees in the canopy, often dense thickets of vines and shrubs (e.g., Japanese barberry, Eurasian honeysuckle) in the understory, and facultative wetland and upland species of shrubs, forbs, and graminoids. In most cases, we mapped these areas 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.

Appendix B. Species of conservation concern potentially associated with habitats in the Town of Marbletown study areaas. 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), **Hudsonia's regional ranks** (RG), and New York State's **Species of Greatest Conservation Need** (SGCN). 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 C.

UPLAND HARDWOOD FOREST		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
silvery spleenwort (RG)	marbled salamander (SC, S3, SGCN)	Acadian flycatcher (S3)
American ginseng (RG)	red salamander (RG, SGCN)	wood thrush (RG, PIF1, SGCN)
red baneberry (RG)	mountain dusky salamander (RG)	scarlet tanager (PIF2, SGCN)
blue cohosh (RG)	eastern box turtle (SC)	cerulean warbler (SC, PIF1, SGCN)
leatherwood (RG)	eastern racer (RG, SGCN)	Kentucky warbler (S2, RG, PIF1, SGCN)
hackberry (RG)	northern goshawk (SC, S3N, SGCN)	black-and-white warbler (PIF2)
spring avens (E, S2S3)	red-shouldered hawk (SC, SGCN)	black-throated blue warbler (RG, SGCN)
rough avens (E, S2)	Cooper's hawk (SC, SGCN)	black-throated green warbler (RG)
small whorled pogonia (T, SH)	sharp-shinned hawk (SC, SGCN)	hooded warbler (RG)
northern monk's-hood (T, S1)	broad-winged hawk (RG)	ovenbird (RG)
Invertebrates	ruffed grouse (SGCN)	Indiana bat (E, S1, SGCN)
tawny emperor (butterfly) (S3)	American woodcock (RG, PIF1, SGCN)	eastern small-footed myotis (SC, S2, SGCN)
Vertebrates	barn owl (S3, SGCN)	eastern pipistrelle (RG)
wood frog (RG)	barred owl (RG)	black bear (RG)
spotted salamander (RG)	red-headed woodpecker (SC, PIF1, SGCN)	bobcat (RG)
Jefferson salamander (SC, S3, SGCN)	eastern wood-pewee (RG, PIF2)	southern bog lemming (RG)
blue-spotted salamander (SC, S3, SGCN)		
UPLAND CONIFER FOREST		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
pinesap (RG)	American woodcock (RG, PIF1, SGCN)	Blackburnian warbler (RG, PIF2)
Vertebrates	long-eared owl (RG, SGCN)	pine siskin (RG)
blue-spotted salamander (SC, S3, SGCN)	ruffed grouse (SGCN)	red-breasted nuthatch (RG)
red salamander (RG, SGCN)	barred owl (RG)	evening grosbeak (RG)
Cooper's hawk (SC, SGCN)	black-throated green warbler (RG)	purple finch (PIF2)
sharp-shinned hawk (SC, SGCN)		
CALCAREOUS CREST/LEDGE/TALUS		
Plants	***Plants (cont.)***	***Vertebrates***
purple cliffbrake (RG)	yellow harlequin (S3)	eastern hognose snake (SC, S3S4, SGCN)
smooth cliffbrake (T, S2)	Dutchman's breeches (RG)	eastern racer (RG, SGCN)
alpine cliff fern (E, S1)	butterfly-weed (RG)	eastern ratsnake (RG, SGCN)
walking fern (RG)	pellitory (RG)	northern copperhead (RG, SGCN)
Emmons' sedge (S3)	roundleaf dogwood (RG)	eastern small-footed myotis (SC, S2, SGCN)
hairy rock-cress (RG)	***Invertebrates***	whip-poor-will (SC, PIF2, SGCN)
northern monk's-hood (T, S1)	anise millipedes (RG)	
small-flowered crowfoot (T, S3)		

NON-CALCAREOUS CREST/LEDGE/TALUS		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
mountain spleenwort (T, S2S3)	northern monk's-hood (T, S1)	eastern box turtle (SC)
Bradley's spleenwort (E, SH)	bearberry (RG)	eastern racer (RG, SGCN)
rusty woodsia (RG)	Appalachian sandwort (T, S2)	eastern ratsnake (RG, SGCN)
Braun's holly fern (RG)	three-toothed cinquefoil (RG)	northern copperhead (RG, SGCN)
alpine cliff fern (E, S1)	stiff-leaf aster (RG)	eastern hognose snake (SC, S3S4, SGCN)
Bicknell's sedge (T, S3)	***Invertebrates***	timber rattlesnake (T, S3, SGCN)
bronze sedge (RG)	Edward's hairstreak (butterfly) (S3S4)	turkey vulture (RG)
clustered sedge (T, S2S3)	striped hairstreak (butterfly) (RG)	whip-poor-will (SC, PIF2, SGCN)
reflexed sedge (E, S2S3)	brown elfin (butterfly) (RG)	common raven (RG)
highland rush (T, S2)	falcate orange-tip (butterfly) (S3S4[W])	winter wren (RG)
whorled milkweed (RG)	northern hairstreak (butterfly) (S1S3, SGCN)	eastern bluebird (RG)
blunt-leaf milkweed (RG)	gray hairstreak (butterfly) (RG)	hermit thrush (RG)
eastern prickly-pear (RG)	Horace's duskywing (butterfly) (RG)	Blackburnian warbler (RG, PIF2)
whorled milkwort (RG)	swarthy skipper (butterfly) (RG)	cerulean warbler (SC, PIF1, SGCN)
rock sandwort (RG)	Leonard's skipper (butterfly) (RG)	worm-eating warbler (RG, PIF1)
downy arrowwood (RG)	cobweb skipper (butterfly) (RG)	prairie warbler (PIF1, SGCN)
goat's-rue (RG)	dusted skipper (butterfly) (S3)	eastern small-footed myotis (SC, S2, SGCN)
slender knotweed (R, S3)	***Vertebrates***	boreal redback vole (RG)
dittany (RG)	slimy salamander (RG)	porcupine (RG)
Torrey's mountain-mint (E, S1)	marbled salamander (SC, SGCN)	fisher (RG)
Allegheny-vine (RG)	Fowler's toad (RG, SGCN)	bobcat (RG)
UPLAND SHRUBLAND		
Plants	***Vertebrates***	***Vertebrates (cont.)***
stiff-leaf goldenrod (RG)	wood frog (RG)	white-eyed vireo (RG)
shrubby St. Johnswort (T, S2)	spotted turtle (SC, SGCN)	blue-winged warbler (PIF1, SGCN)
hyssop skullcap (E, S1)	eastern box turtle (SC, S3, SGCN)	golden-winged warbler (SC, PIF1, SGCN)
butterflyweed (RG)	wood turtle (SC, SGCN)	prairie warbler (PIF1, SGCN)
Invertebrates	eastern racer (RG, SGCN)	yellow-breasted chat (SC, SGCN)
Aphrodite fritillary (butterfly) (RG)	northern harrier (T, S3B, S3N, SGCN)	clay-colored sparrow (S2)
dusted skipper (butterfly) (S3)	northern saw-whet owl (RG)	vesper sparrow (SC, SGCN)
Leonard's skipper (butterfly) (RG)	common nighthawk (SC, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
cobweb skipper (butterfly) (RG)	brown thrasher (PIF2, SGCN)	eastern towhee (PIF2)
	loggerhead shrike (E, S1B)	field sparrow (PIF2)
UPLAND MEADOW		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
hyssop skullcap (E, S1)	spotted turtle (SC, SGCN)	common nighthawk (SC, SGCN)
rattlebox (E, S1)	snapping turtle (SGCN)	sedge wren (T, S3B, PIF2, SGCN)
yellow wild flax (T, S2)	eastern box turtle (SC, S3, SGCN)	eastern bluebird (RG)
Invertebrates	wood turtle (SC, SGCN)	bobolink (RG, SGCN)
Aphrodite fritillary (butterfly) (RG)	eastern racer (RG, SGCN)	eastern meadowlark (RG, SGCN)
dusted skipper (butterfly) (S3)	northern harrier (T, S3B, S3N, SGCN)	savannah sparrow (RG)
Leonard's skipper (butterfly) (RG)	upland sandpiper (T, S3B, PIF1)	vesper sparrow (SC, SGCN)
swarthy skipper (butterfly) (RG)	barn owl (SC3, SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
cobweb skipper (butterfly) (RG)		
WASTE GROUND		
Plants	***Plants (cont.)***	***Vertebrates (cont.)***
hair-rush (RG)	slender knotweed (R, S3)	northern copperhead (RG)
toad rush (RG)	***Vertebrates***	American black duck (RG, PIF1, SGCN)
orangeweed (RG)	Fowler's toad (RG, SGCN)	common nighthawk (SC, SGCN)
field dodder (S3)	wood turtle (SC, SGCN)	bank swallow (RG)
slender pinweed (T, S2)	spotted turtle (SC, SGCN)	common raven (RG)
rattlebox (E, S1)	snapping turtle (SGCN)	grasshopper sparrow (SC, PIF2, SGCN)
blunt mountain-mint (T, S2S3)	eastern hognose snake (SC, S3S4, SGCN)	

SWAMP		
Plants	***Invertebrates***	***Vertebrates (cont.)***
wood horsetail (RG)	phantom cranefly (RG)	wood duck (RG, PIF2)
moss (*Entodon brevisetus*) (S2S3)	***Vertebrates***	red-shouldered hawk (SC, SGCN)
Appalachain shoestring fern (E, S1)	blue-spotted salamander (SC, SGCN)	Virginia rail (RG)
Virginia chain fern (RG)	four-toed salamander (RG, SGCN)	American woodcock (RG, PIF1, SGCN)
ostrich fern (RG)	spotted turtle (SC, SGCN)	barred owl (RG)
rhodora (T, S2)	snapping turtle (SGCN)	white-eyed vireo (RG)
Jacob's-ladder (S3)	wood turtle (SC, SGCN)	eastern bluebird (RG)
wild calla (RG)	eastern box turtle (SC, S3, SGCN)	prothonotary warbler (S2, PIF1, SGCN)
early coralroot (RG)	great blue heron (RG)	Canada warbler (RG, PIF1)
swamp cottonwood (T, S2)		
MARSH		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
spiny coontail (T, S3)	eastern racer (RG, SGCN)	northern harrier (T, S3B, S3N, SGCN)
buttonbush dodder (E, S1)	pied-billed grebe (T, S3B, S1N, SGCN)	king rail (T, S1B, PIF1, SGCN)
winged monkey-flower (R, S3)	American bittern (SC, SGCN)	Virginia rail (RG)
Vertebrates	least bittern (T, S3B, S1N, SGCN)	sora (RG)
northern leopard frog (RG)	great blue heron (RG)	common moorhen (RG)
snapping turtle (SGCN)	wood duck (RG, PIF2)	marsh wren (RG)
spotted turtle (SC, SGCN)	American black duck (RG, PIF1, SGCN)	
WET MEADOW		
Invertebrates	***Invertebrates (cont.)***	***Vertebrates (cont.)***
mulberry wing (butterfly) (RG)	Milbert's tortoiseshell (butterfly) (RG)	American bittern (SC, SGCN)
black dash (butterfly) (RG)	phantom cranefly (RG)	northern harrier (T, S3B, S3N, SGCN)
two-spotted skipper (butterfly) (RG)	***Vertebrates***	Virginia rail (RG)
meadow fritillary (butterfly) (RG)	spotted turtle (SC, SGCN)	American woodcock (RG, PIF1, SGCN)
Baltimore (butterfly) (RG)	wood turtle (SC, SGCN)	sedge wren (T, S3B, PIF2, SGCN)
bronze copper (butterfly) (RG)	ribbon snake (RG, SGCN)	southern bog lemming (RG)
eyed brown (butterfly) (RG)	smooth green snake (RG)	
INTERMITTENT WOODLAND POOL		
Plants	***Vertebrates***	***Vertebrates (cont.)***
featherfoil (T, S2)	four-toed salamander (RG, SGCN)	spotted turtle (SC, SGCN)
false hop sedge (R, S2)	Jefferson salamander (SC, SGCN)	wood turtle (SC, SGCN)
Invertebrates	marbled salamander (SC, SGCN)	wood duck (RG, PIF2)
black dash (butterfly) (RG)	spotted salamander (RG)	American black duck (RG, PIF1, SGCN)
mulberry wing (butterfly) (RG)	wood frog (RG)	northern waterthrush (RG)
springtime physa (snail) (RG)		
OPEN WATER/CONSTRUCTED POND		
Plants	***Vertebrates (cont.)***	***Vertebrates (cont.)***
spiny coontail (T, S3)	spotted turtle (SC, SGCN)	great blue heron (RG)
Invertebrates	wood turtle (SC, SGCN)	American bittern (SC, SGCN)
spatterdock darner (dragonfly) (S2, SGCN)	snapping turtle (SGCN)	bald eagle (T, S2S3B, SGCN)
Vertebrates	pied-billed grebe (T, S3B, S1N, SGCN)	osprey (SC, SGCN)
red salamander (RG, SGCN)		
SPRING/SEEP		
Plants	***Invertebrates (cont.)***	***Vertebrates (cont.)***
Bush's sedge (S3)	gray petaltail (dragonfly) (SC, S2, SGCN)	mountain dusky salamander (RG)
spiked wood-rush (E, S1)	tiger spiketail (dragonfly) (S1, SGCN)	spring salamander (RG)
Jacob's-ladder (S3)	arrowhead spiketail (dragonfly) (S2S3, SGCN)	red salamander (RG, SGCN)
northern monk's-hood (T, S1)	***Vertebrates***	longtail salamander (SC, S2S3, SGCN)
Invertebrates	northern dusky salamander (RG)	
Piedmont groundwater amphipod (RG, SGCN)		

STREAM & RIPARIAN CORRIDOR		
Plants	***Invertebrates***	***Vertebrates (cont.)***
winged monkey-flower (RG, S3)	arrowhead spiketail (dragonfly) (S2S3, SGCN)	red salamander (RG, SGCN)
riverweed (T, S2)	mocha emerald (dragonfly) (S2S3, SGCN)	spring salamander (RG)
spiny coontail (T, S3)	sable clubtail (dragonfly) (S1, SGCN)	wood turtle (SC, SGCN)
ostrich fern (RG)	*Marstonia decepta* (snail) (RG)	great blue heron (RG)
cattail sedge (T, S1)	brook floater (mussel) (T, S1, SGCN)	American black duck (RG, PIF1, SGCN)
Davis' sedge (T, S2)	*Pisidium adamsi* (fingernail clam) (RG)	wood duck (RG, PIF2)
Jacob's-ladder (S3)	*Sphaerium fabale* (fingernail clam) (RG)	red-shouldered hawk (SC, SGCN)
small-flowered agrimony (S3)	***Vertebrates***	American woodcock (RG, PIF1, SGCN)
false-mermaid (RG)	creek chubsucker (fish) (RG)	bank swallow (RG)
swamp rose-mallow (RG)	bridle shiner (fish) (RG, SGCN)	Louisiana waterthrush (SGCN)
may-apple (RG)	brook trout (fish) (RG, SGCN)	cerulean warbler (SC, PIF1, SGCN)
goldenseal (T, S2)	slimy sculpin (fish) (RG)	river otter (RG, SGCN)
wingstem (T, S2)	American eel (fish) (SGCN)	Indiana bat (E, S1, SGCN)
northern monk's-hood (T, S1)	mountain dusky salamander (RG)	eastern small-footed myotis (SC, S2, SGCN)
river birch (S3)	northern dusky salamander (RG)	eastern pipistrelle (RG)

Appendix C. Explanation of ranks of species of conservation concern listed in Appendix B. Explanations of New York State Ranks and New York Natural Heritage Program Ranks are from the New York Natural Heritage Program website, accessed December 2006 (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.

SR Reported in New York but without persuasive documentation.

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.

W Watchlist

REGIONAL STATUS (HUDSON VALLEY) – ANIMALS AND PLANTS

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

BIRDS - PARTNERS IN FLIGHT PRIORITY SPECIES LISTS

Based on August 2003 lists for physiographic areas # 17 (Northern Ridge and Valley) and # 9 (Southern New England).

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

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

SPECIES OF GREATEST CONSERVATION NEED (SGCN) IN NEW YORK

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.

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	Common Name	Scientific Name
agrimony, small-flowered	*Agrimonia parviflora*	dittany	*Cunila origanoides*
alder	*Alnus*	dodder, buttonbush	*Cuscuta cephalanthi*
Allegheny-vine	*Adlumia fungosa*	dodder, field	*Cuscuta pentagona*
arrow-arum	*Peltandra virginica*	dogwood, gray	*Cornus foemina* ssp. *racemosa*
arrowhead, broad-leaved	*Sagittaria latifolia*	dogwood, roundleaf	*Cornus rugosa*
arrowwood, downy	*Viburnum rafinesquianum*	dogwood, silky	*Cornus amomum*
arrowwood, northern	*Viburnum dentatum* v. *lucidum*	elm, American	*Ulmus americana*
ash, black	*Fraxinus nigra*	elm, slippery	*Ulmus rubra*
ash, green	*Fraxinus pensylvanica*	false-mermaid	*Floerkea proserpinacoides*
ash, white	*Fraxinus americana*	featherfoil	*Hottonia inflata*
aspen, big-toothed	*Populus grandidentata*	fern, alpine cliff	*Woodsia alpina*
aster, stiff-leaf	*Aster linariifolius*	fern, Appalachian shoestring	*Vittaria appalachiana*
avens, rough	*Geum virginianum*	fern, Braun's holly	*Polystichum braunii*
avens, spring	*Geum vernum*	fern, cinnamon	*Osmunda cinnamomea*
azalea, swamp	*Rhododendron viscosum*	fern, marsh	*Thelypteris palustris*
baneberry, red	*Actaea spicata* ssp. *rubra*	fern, mountain wood	*Dryopteris campyloptera*
barberry, Japanese	*Berberis vulgaris*	fern, ostrich	*Matteuccia struthiopteris*
basswood	*Tilia americana*	fern, royal	*Osmunda regalis*
bearberry	*Arctostaphylos uva-ursi*	fern, sensitive	*Onoclea sensibilis*
birch, black	*Betula lenta*	fern, Virginia chain	*Woodwardia virginica*
birch, paper	*Betula papyrifera*	fern, walking	*Asplenium rhizophyllum*
birch, river	*Betula nigra*	flag, blue	*Iris versicolor*
birch, yellow	*Betula alleghaniensis*	flax, yellow wild	*Linum sulcatum*
bittercress	*Cardamine*	ginseng, American	*Panax quinquefolius*
bitternut	*Carya cordiformis*	goat's-rue	*Tephrosia virginiana*
blackberry, northern	*Rubus allegheniensis*	goldenrod, rough-leaf	*Solidago patula*
bladdernut	*Staphylea trifolia*	goldenrod, stiff-leaf	*Solidago rigida*
bladderwort	*Utricularia*	goldenseal	*Hydrastis canadensis*
blazing-star, northern	*Liatris scariosa* v. *novae-angliae*	goldthread	*Coptis trifolia*
blueberry, highbush	*Vaccinium corymbosum*	gum, black	*Nyssa sylvatica*
blueberry, lowbush	*Vaccinium angustifolium*	hackberry	*Celtis occidentalis*
blueberry, lowbush	*Vaccinium pallidum*	hairgrass	*Deschampsia flexuosa*
bluejoint	*Calamagrostis canadensis*	hair-rush	*Bulbostylis capillaris*
bluestem, little	*Schizachyrium scoparium*	harlequin, yellow	*Corydalis flavula*
breeches, Dutchman's	*Dicentra cucullaria*	hemlock, eastern	*Tsuga canadensis*
butterfly-weed	*Asclepias tuberosa*	hickory, pignut	*Carya glabra*
butternut	*Juglans cinerea*	hickory, shagbark	*Carya ovata*
buttonbush	*Cephalanthus occidentalis*	hickory, sweet pignut	*Carya ovalis*
cabbage, skunk	*Symplocarpus foetidus*	holly, winterberry	*Ilex verticillata*
calla, wild	*Calla palustris*	honeysuckle, Eurasian	*Lonicera* x *bella*
canary-grass, reed	*Phalaris arundinacea*	hornbeam	*Carpinus caroliniana*
cattail	*Typha*	horsetail, wood	*Equisetum sylvaticum*
cedar, eastern red	*Juniperus virginiana*	huckleberry	*Gaylussacia baccata*
cedar, northern white	*Thuja occidentalis*	ironweed, New York	*Vernonia noveboracensis*
chokeberry	*Aronia*	Jacob's-ladder	*Palemonium vanbruntiae*
cinquefoil, three-toothed	*Potentilla tridentata*	knotweed, Japanese	*Fallopia japonica*
cliffbrake, purple	*Pellaea atropurpurea*	knotweed, slender	*Polygonum tenue*
cliffbrake, smooth	*Pellaea glabella*	laurel, great	*Rhododendron maximum*
cohosh, blue	*Caulophyllum thalictroides*	laurel, mountain	*Kalmia latifolia*
columbine, wild	*Aquilegia canadensis*	leatherwood	*Dirca palustris*
coontail, spiny	*Ceratophyllum echinatum*	locust, black	*Robinia pseudoacacia*
coralroot, early	*Coralorrhiza trifida*	loosestrife, purple	*Lythrum salicaria*
cottonwood, eastern	*Populus deltoides*	mannagrass	*Glyceria*
cottonwood, swamp	*Populus heterophylla*	mannagrass, fowl	*Glyceria striata*
crowfoot, small-flowered	*Ranunculus micranthus*	mallow, swamp-rose	*Hibiscus moscheutos*
devil's-bit	*Chamaelirium luteum*		*(CONTINUED)*

Common Name	Scientific Name	Common Name	Scientific Name
maple, mountain	*Acer spicatum*	rush, highland	*Juncus trifidus*
maple, red	*Acer rubrum*	rush, toad	*Juncus bufonius*
maple, silver	*Acer saccharinum*	rush, soft	*Juncus effusus*
maple, striped	*Acer pensylvanicum*	sandwort, Appalachian	*Minuartia glabra*
maple, sugar	*Acer saccharum*	sandwort, rock	*Minuartia michauxii*
may-apple	*Podophyllum peltatum*	sarsaparilla, bristly	*Aralia hispida*
meadowsweet	*Spiraea latifolia*	sassafras	*Sassafras albidum*
milkweed, blunt-leaf	*Asclepias amplexicaulis*	saxifrage, golden	*Chrysosplenium americanum*
milkweed, whorled	*Asclepias verticillata*	saxifrage, swamp	*Saxifraga pensylvanica*
milkwort, whorled	*Polygala verticillata*	sedge	Cyperaceae
moneywort	*Lysimachia nummularia*	sedge, Bicknell’s	*Carex bicknellii*
monkey-flower, winged	*Mimulus alatus*	sedge, bromelike	*Carex bromoides*
monk’s-hood, northern	*Aconitum noveboracense*	sedge, bronze	*Carex aenea*
moss	*Entodon brevisetus*	sedge, Bush’s	*Carex bushii*
moss	*Helodium paludosum*	sedge, cattail	*Carex typhina*
moss, peat	*Sphagnum*	sedge, clustered	*Carex cumulata*
mountain-mint, blunt	*Pycnanthemum muticum*	sedge, Davis’	*Carex davisii*
mountain-mint, Torrey’s	*Pycnanthemum torrei*	sedge, eastern	*Carex atlantica*
nannyberry	*Viburnum lentago*	sedge, Emmons’	*Carex albicans* v. *emmonsii*
nettle, wood	*Laportea canadensis*	sedge, false hop	*Carex lupuliformis*
oak, black	*Quercus velutina*	sedge, lakeside	*Carex lacustris*
oak, chestnut	*Quercus montana*	sedge, Pennsylvania	*Carex pensylvanica*
oak, red	*Quercus rubra*	sedge, reflexed	*Carex retroflexa*
oak, scrub	*Quercus ilicifolia*	sedge, silvery	*Carex canescens*
oak, swamp white	*Quercus bicolor*	sedge, three-fruited	*Carex trisperma*
oak, white	*Quercus alba*	sedge, tussock	*Carex stricta*
olive, autumn	*Elaeagnus umbellata*	serviceberry	*Amelanchier*
orangeweed	*Hypericum gentianoides*	skullcap, hyssop	*Scutellaria integrifolia*
pellitory	*Parietaria pensylvanica*	snakeroot, white	*Eupatorium rugosum*
pickerel-weed	*Pontederia cordata*	spatterdock	*Nuphar variegatum*
pine, pitch	*Pinus rigida*	spleenwort, Bradley’s	*Asplenium bradleyi*
pine, white	*Pinus strobus*	spleenwort, ebony	*Asplenium platyneuron*
pinesap	*Monotropa hypopithys*	spleenwort, maidenhair	*Asplenium trichomanes*
pinweed, slender	*Lechea tenuifolia*	spleenwort, mountain	*Asplenium montanum*
pitcher-plant	*Sarracenia purpurea*	spleenwort, silvery	*Deparia acrostichoides*
pogonia, small whorled	*Isotria medeoloides*	spruce, black	*Picea mariana*
polypody, rock	*Polypodium vulgare*	spruce, Colorado blue	*Picea pungens*
pond-lily, yellow	*Nuphar advena*	spruce, Norway	*Picea abies*
pond-lily, white	*Nymphaea odorata*	St. Johnswort, shrubby	*Hypericum prolificum*
pondweed	*Potamogeton*	sweet-fern	*Comptonia peregrina*
prickly-ash, American	*Zanthoxylum americana*	sweetflag	*Acorus*
prickly-pear, eastern	*Opuntia humifusa*	sycamore	*Platanus occidentalis*
quillwort, riverbank	*Isoetes riparia*	tamarack, eastern	*Larix laricina*
raspberry	*Rubus*	tree-of-heaven	*Ailanthus altissima*
rattlebox	*Crotalaria sagittalis*	watermilfoil	*Myriophyllum*
reed, common	*Phragmites australis*	water-plantain	*Alisma triviale*
rhodora	*Rhododendron canadense*	willow	*Salix*
riverweed	*Podostemum ceratophyllum*	wingstem	*Verbesina alternifolia*
rock-cress	*Arabis*	witch-hazel	*Hamamelis virginiana*
rock-cress, hairy	*Arabis hirsuta* v. *pycnocarpa*	wood-rush, spiked	*Luzula spicata*
rose, multiflora	*Rosa multiflora*	woodsia, rusty	*Woodsia ilvensis*
rose-mallow, swamp	*Hibiscus moscheutos*	woolgrass	*Scirpus cyperinus*