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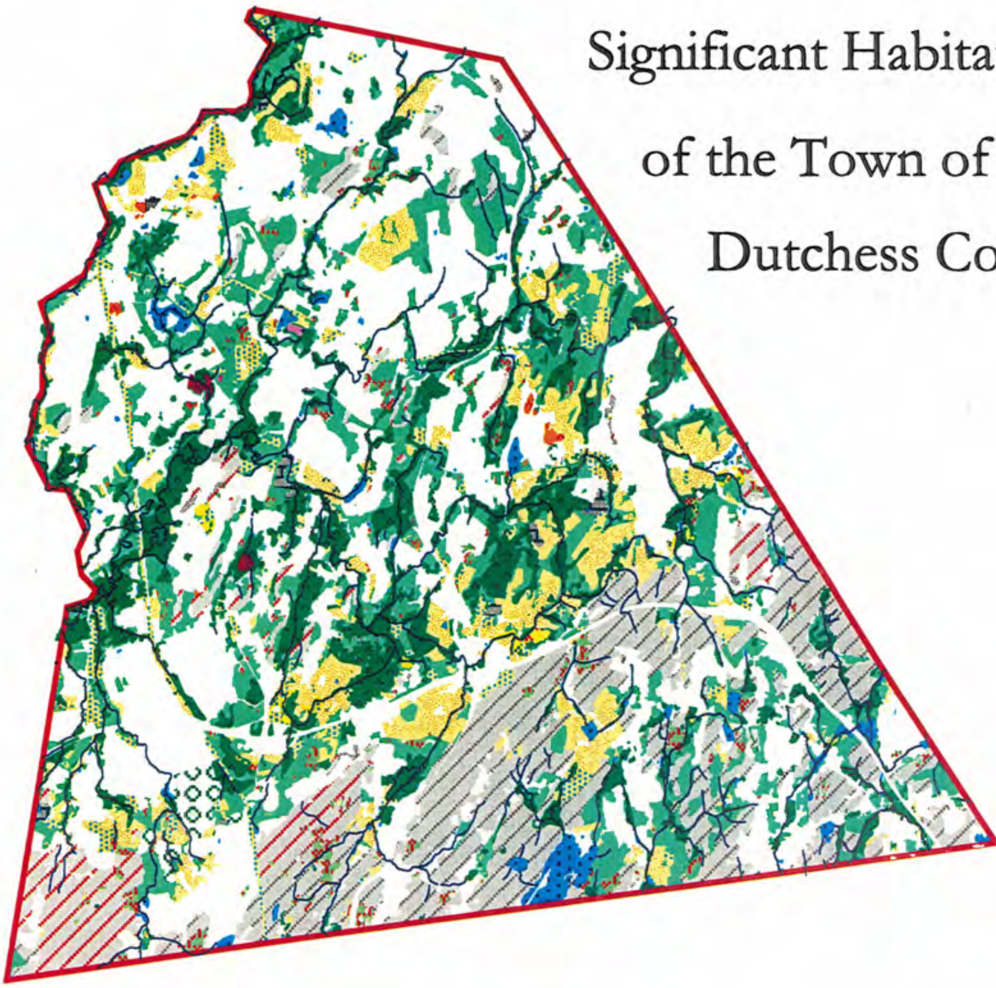

Significant Habitats of the Town of East Fishkill, Dutchess County, New York

Report to the Marilyn Milton Simpson Charitable Trusts, and the Town of East Fishkill

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Background

In January 2001, Hudsonia embarked on a project to identify and map ecologically significant habitats throughout the Town of East Fishkill, Dutchess County, New York. The project grew out of our observations of the loss of important habitats and species in the region due to rapid land development. The publication of Hudsonia's *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* in 2001 provided another important impetus for the project. We wanted to conduct a pilot assessment project that would demonstrate the ways the *Manual* could be used to identify important biological resources and inform local communities about biodiversity conservation. We believe that if landowners, developers, public planners, and local officials have good information about biological resources, they will be better able to locate and design new development such that impacts to important and sensitive habitats are minimized or avoided.

Hudsonia has been conducting small-scale, site-specific biological assessments in the Hudson Valley for many years, helping landowners, citizens' groups, conservation organizations, developers, and public officials recognize some of the important habitats and species of conservation concern that are most at risk from poorly planned land development. Although many land use decisions are necessarily made parcel-by-parcel, it is apparent to us that the longterm viability of biological communities, habitats, and ecosystems cannot be protected on a piecemeal basis, but requires consideration of whole landscapes. For this reason, we think that local land use planning and decision-making would be improved if general biodiversity information were available for large areas, such as whole towns, watersheds, or counties.

To this end, we designed a project to conduct a large-scale biodiversity assessment in southern Dutchess County, New York. Upon receiving a grant for the project from the Marilyn Milton Simpson Charitable Trusts, we sought a town with governing boards interested in having biodiversity information at their disposal to aid in town planning and land use decision-making. We found enthusiastic support for the project in the Conservation Advisory Council, the Town

Supervisor, and the Town Board of East Fishkill, and were pleased to make the town our study site.

Eben Broadbent (Research Assistant) and Gretchen Stevens (Project Manager) conducted the work on this project during the period January 2001 through March 2002. Through map analysis and field observations we created a map of the habitats we consider to be the most ecologically significant in the Town of East Fishkill. Some of these habitats are themselves rare in the region, or are in danger of becoming rare in the near future. Others are not rare, but may support some of our rarest and most vulnerable species of plants and animals. Some provide especially important ecological services to other parts of the ecosystem.

The habitat map was posted in the East Fishkill Town Hall in March 2002. This report briefly describes the habitats, discusses some aspects of their ecological importance, and discusses some conservation measures that can help to protect habitats and species of conservation concern. We conducted no rare species surveys in this study, and have neither identified nor mapped the known locations of rare species.

We hope that the map and report will help local residents and landowners appreciate the biological richness of the areas where they live and work, and help town planners and decision-makers identify the areas of greatest ecological significance, develop conservation goals, and establish conservation policies and practices that will help protect biodiversity resources while serving other social, cultural, and economic needs of the human community.

This report and map were prepared especially for use by the Conservation Advisory Council, the Planning Board, and the Town Board of East Fishkill. The Geographic Information System (GIS) database containing the habitat map data will be conveyed to the Town Assessor's office. We have also given a copy of the report and the GIS database to the Dutchess County Environmental Management Council (EMC), and the Dutchess County Department of Planning and Development.

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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 environments, such as soil, water, air, and sunlight. Many ecologists agree that maintenance of native biodiversity is fundamental to the effective functioning of the ecosystems that sustain the human community and the living world around us.

While biodiversity conservation efforts often focus on protection of certain rare or imperiled species, a species will be protected in the long term only if its <u>habitats</u> are maintained intact. The local or regional disappearance of a habitat can lead to the local or regional extinction of species that depend on the habitat. The focus of this project, therefore, is on habitats of special conservation concern.

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 described according to the biological and non-biological components of the environment. Habitats that we consider "ecologically significant" may be themselves rare or declining in the region, or they may support rare species and other species of conservation concern, or they may be unusual examples of otherwise common habitats, e.g., especially large, especially isolated from human activities, especially old, or lacking alien species, or they may provide connections between other important habitat units.

Why be concerned about biological diversity?

Native biological diversity is one of the essential components of intact ecosystems. The very survival of the human community depends on the basic ecosystem services that make the earth habitable, such as climate moderation, oxygen production, soil formation, water and air purification, and production and decomposition of organic matter. While the value of these services is immense and probably incalculable, ecosystems also help to produce the extractable and harvestable natural resources that provide the materials on which our human economies are based. Diverse biological communities and ecosystems are also responsible for the richness of the natural landscapes around us that are so important for visual pleasure, recreation, inspiration, and spiritual solace.

Although many of the common habitats of the Hudson Valley are extremely important to maintaining ecosystem functions, there are several reasons why our work often focuses on habitats and species that are rare or declining. Rare species, rare communities, and the habitats that support them are often in the greatest immediate danger of disappearing. The decline or disappearance of rare species often warns us of environmental deterioration, and may be related to collapses in other parts of the ecosystem. While we do not fully understand the role of most organisms in the ecosystem, and cannot fully predict the consequences of the extinction of any particular species, we do know that even some inconspicuous organisms, such as fungi or insect pollinators, have hugely important roles in the maintenance of certain biological communities. We also know that artificially simplified systems can be devastated by normal events such as diseases or floods. Maintaining the full natural complement of native species and communities in a region can allow an ecosystem to respond to stresses (such as artificial disturbance, pollution, or climate change), and adapt to changing environmental conditions.

The study area

The Town of East Fishkill encompasses approximately 135 km^2 (52 mi^2) at the southern edge of Dutchess County, New York. Most of the town is drained by Fishkill Creek, a major tributary to the Hudson River; the largest tributaries to Fishkill Creek in the town are Sprout Creek (the largest), Wiccopee Creek, Whortlekill Creek, and Black Pond Brook. The southeastern corner of East Fishkill lies in the Croton River watershed. Steep, rocky hills along the southern edge of town are part of the Hudson Highlands physiographic region, a range of hills running northeast-southwest from Connecticut into New Jersey. The rest of the town is characterized by rolling topography, with occasional steep hills. The bedrock geology is dominated by limestone, dolostone, and shale in the central part of the town, gneiss in the southern hills, and slate, phyllite, and schist in the northern part of town (Figure 1) (Fisher et al. 1970). The surficial geology is primarily glacial till and outwash, with several areas of kame and lacustrine deposits (Cadwell et al. 1986). Exposed and near-surface bedrock dominates much of the Hudson Highlands. Elevations range from approximately 67 m (220 ft) at Lomala to approximately 384 m (1260 ft) on Round Mountain, the highest of the southern hills. While East Fishkill has a rich agricultural history, only a few active dairy farms, horse farms, orchards, vegetable farms, nurseries, and Christmas tree farms remain. The major commercial center is Hopewell Junction. Fairly intensive residential development has spread into many of the formerly rural areas of the town over the last 2-3 decades.

METHODS

Over 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 physiography and geology. The first phase of the habitat mapping for this project entailed extensive map analysis of bedrock geology, topography, and soils, and interpretation of aerial photographs, to predict the locations of habitats and prepare a preliminary habitat map. We also drew on previous studies conducted by Hudsonia biologists on several sites in East Fishkill in the 1970s, 1980s and 1990s.

We used paper copies of the U.S. Geological Survey (USGS) topographic maps (Hopewell Junction, Poughquag, Pleasant Valley, and Oscawana Lake 7.5 minute quadrangles), the surficial and bedrock geology maps (Lower Hudson sheets) produced by the New York Geological Survey (Fisher et al. 1970, Cadwell et al. 1986), and the Dutchess County Soil Survey Users Guide and maps (Natural Resource Conservation Service, unpublished). We also used these data in digital format obtained through the New York State GIS Clearinghouse, the Dutchess County

Environmental Management Council (EMC), and the Town of East Fishkill Assessor's Office. From the Dutchess County EMC, we obtained data layers for streams and roads in East Fishkill. The stream data were automated by the EMC GIS laboratory from the New York State Department of Environmental Conservation 1991 Biological Survey data. The road data originated with the Dutchess County Department of Emergency Response.

For interpretation of aerial photographs, we used a F-71 mirror stereoscope (obtained from Forestry Suppliers, Inc.), and color infrared aerial photograph prints (1:40000 scale) from the National Aerial Photography Program (NAPP) series, taken in the springs of 1994 and 1995, obtained from the U.S. Geological Survey. For onscreen mapping, we used high resolution (1 m [3.25 ft] horizontal accuracy) true color digital orthophotos, taken spring 2000, and made available from the Dutchess County Office of Real Property Tax. We reprojected all GIS coverages to New York State Plane NAD1983 to make them compatible with the 2000 orthophotos.

We used combinations of map features (e.g., bedrock chemistry; soil depth, texture, chemistry, and drainage; slopes) and features visible on aerial photographs (e.g., exposed bedrock, vegetation cover types) to identify potential habitats (e.g., carbonate crest, hardwood swamp, fen, upland meadow). We prepared a preliminary habitat map based on map analysis and stereo photointerpretation of the NAPP series photos, and digitized the predicted habitats onscreen over the 2000 orthophoto images. We field-checked as many of the mapped habitat units as possible to ascertain their presence and extent. We corrected and refined the preliminary map on the basis of our field observations to produce the final habitat map.

We established certain mapping conventions to simplify our work and to improve the consistency of the final habitat map. In most cases, upland forest, shrubby oldfield, and upland meadow areas surrounded by or intruding into developed land were mapped only if their dimensions exceeded 50 m (165 ft) in all directions, or if they were connected to other large habitat areas. We mapped smaller areas of wooded swamp, wet meadow, and kettle shrub pool, and intermittent woodland pool if they were identifiable on the NAPP photographs. Most of the habitats were digitized onscreen at a scale of approximately 1:8000. The map data should not be presumed meaningful at larger scales.

We mapped wetlands remotely using topographic and soils map data, and aerial photo-interpretation. For those areas that we were able to see in the field, we identified wetlands primarily by the predominance of hydrophytic vegetation, the presence of local topographic indicators, and easily visible indicators of surface hydrology (Environmental Laboratory 1987). We did not examine profiles of surface soil layers. The locations of wetland boundaries (and all other habitat boundaries) on the habitat map should be treated as sketched 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 onsite by a wetland scientist and mapped by a land surveyor.

For the stream coverage, we used the digital data provided by the Dutchess County EMC, but amended it in various ways. 1) The original coverage showed gaps where streams flowed through large wetlands, ponds, or other impounded areas. We connected the stream segments that flowed through such areas. 2) We added a few intermittent streams that we identified on maps or photographs or in the field but which were missing from the coverage. At many locations the existing stream coverage did not register exactly with orthophoto image, but was offset by 10-30 m (30-100 ft); we did not correct the stream coverage in those instances.

We field-checked as many of the mapped habitat units as possible, but were unable to see all areas. We obtained verbal permission from many landowners to walk on their property. We avoided walking onto land where permission had been denied or onto land that was posted against trespassing. We viewed inaccessible land from roadways, utility corridors, railroad corridors, and adjacent properties wherever possible. We estimate that we field-checked portions of approximately 80% of the mapped habitat units. Inaccessible areas that could not be viewed by any of these means were mapped entirely by remote sensing (map and photo analysis).

We conducted the map analysis and prepared the habitat maps using ArcView v. 3.2 GIS software on an IBM ThinkPad A21E computer. The final large-format paper map was printed at a scale of 1:10000 on a Hewlett Packard 750C DesignJet plotter. The pre-existing GIS digital data used for this project, and the newly created habitat database will be conveyed to the Town of East Fishkill for use in public planning and decision-making. We request that any maps printed from this database for public viewing be printed at scales no larger than 1:10000, that the habitat map data be attributed to Hudsonia, and that all printed maps be accompanied by the caveat (titled "An Important Caution") appearing on the display map printed by Hudsonia. The text of that caveat is as follows:

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

RESULTS

We identified 23 different kinds of habitats in East Fishkill that we consider to be of special ecological importance. Below is a general description of each habitat type (its map code in parentheses), and a brief discussion of its ecological significance, including some of the plant and animal species of conservation concern that may use the habitat. The two-letter code given with certain species denotes their rarity or vulnerability status; these ranks are explained in Appendix 1:

<u>Statewide Rank</u>

E	NYS Endangered
SC	NYS Species of Special Concern
T	NYS Threatened
H	NY Natural Heritage Program rank S1, S2, or S3 on the active list

<u>Regional Rank</u>

RD	Regionally declining
RR	Regionally rare
RS	Regionally scarce
RV	Regionally vulnerable

The regional ranks are assigned by Hudsonia and have no regulatory status.

For each habitat described below, we mention only a few of the common and rare plants and animals associated with the habitat. We refer readers to the Habitat Profiles (Section 7) in the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001) for more extensive descriptions of these habitats in the Hudson Valley region. In this report, we refer to plants by common name. Appendix 2 gives the scientific names of all plants mentioned here.

We use several terms and references in the discussions below that may require explanation. We use the term "calcareous" to describe alkaline environments (e.g., soils, water, bedrock) that are rich in calcium carbonate. These environments are limited in extent in the Hudson Valley, and often support distinctive biological communities and rare species. The term "calcicolous" (noun = calcicole) describes organisms that inhabit calcium-rich environments. We refer to several wetlands by the names assigned to them on the New York State Freshwater Wetland maps; for example, HJ-18 and HJ-19.

Units of measure are given in both metric and English, using the following abbreviations:

m = meter
ha = hectare
km = kilometer
ft = feet
ac = acre
mi = mile

Figures 1-7 depict the locations of several kinds of habitats throughout the town. Refer to the map posted in the Town Hall for locations of all the ecologically significant habitats identified in this survey.

Upland Meadow (um)

This broad category includes active cropland, hayfields, pastures, and abandoned fields. We also mapped extensive lawns in this category if they were adjacent to relatively undisturbed habitats.

The ecological values of these habitats can differ widely according to the vegetation and the kinds of disturbance (tilling, mowing, grazing, pesticide applications) they are subjected to. We mapped all these kinds of meadows as a single habitat in part to simplify our work, but also because, after abandonment, these meadows tend to develop similar general habitat values. Undisturbed meadows develop diverse plant communities of grasses, forbs, and shrubs and support a large array of wildlife, including invertebrates, reptiles, mammals, and birds.

Several species of rare butterflies, such as aphrodite fritillary,[RR] dusted skipper,[H] Leonard's skipper,[RR] and swarthy skipper,[RR] use upland meadows that support their particular host plants. Upland meadows can also be used for nesting by Blanding's turtle[T,H], wood turtle[SC], spotted turtle[SC], box turtle,[SC] and common species such as painted and snapping turtles. Grassland breeding birds, such as grasshopper sparrow,[SC] vesper sparrow,[SC] Henslow's sparrow,[T,H] eastern meadowlark,[D] bobolink,[V] northern harrier,[T,H] and upland sandpiper[T,H] use extensive upland meadow habitats for nesting and foraging. The decline of grassland birds in the Northeast has been attributed to the loss of suitable habitat in recent decades (Askins 1993, Vickery 1994, Jones and Vickery 1995).

Loss of meadow habitats has been particularly acute in East Fishkill and neighboring towns where large areas of farmland and abandoned fields have recently been developed for residential and commercial uses. Figure 2 shows the locations of the few remaining meadows of 20 hectares (50 acres) and larger, including contiguous wet meadows and shrubby oldfields.

There are many compelling cultural and economic reasons to conserve active farmland and land with agricultural potential. Maintaining our ability to produce food locally has obvious advantages in the face of unstable and unpredictable energy supplies. Active farms may be important to the local economy and certainly make a huge contribution to the beauty of the Hudson Valley landscape. From an ecological standpoint, however, hayfields, lightly-to-moderately grazed pastures, and temporarily fallow fields can have important habitat values, and once the fields have been abandoned, their ecological values can be immense. Hence, it was both for the present ecological values of certain kinds of farmland meadows, and the future ecological values of active cropland that we mapped all of those kinds of meadow areas as "ecologically significant."

Upland meadows of all kinds are favored sites for new residential and commercial development. Abandoned fields are used for various kinds of passive recreation, and also frequently by ATV riders. Soil compaction by ATVs and other vehicles and equipment can reduce the habitat values of abandoned fields for soil invertebrates, small mammals, nesting birds, and nesting turtles. Destruction of vegetation can have obvious consequences to butterflies and rare plants.

Protecting upland meadows from human disturbances would help to protect sensitive species of conservation concern. For fields not in active agricultural use, it may be possible to schedule mowing activities to coincide with the post-fledging season for most birds (e.g., September and later) to reduce the impacts on the breeding birds of these habitats.

Shrubby Oldfield (sof)

In this project, we use the term "shrubby oldfield" 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 areas recently clearcut. These habitats often support diverse plant communities, including a great variety of meadow grasses and forbs, shrubs such as meadowsweet, gray dogwood, blackberries, and raspberries, and scattered seedlings, saplings, or sprouts of eastern red cedar, hawthorns, white pine, gray birch, red maple, quaking aspen, and oaks.

A few species of rare plants are known from calcareous oldfields in the region, such as stiff-leaf goldenrod,[T,H] butterflyweed,[RS] and shrubby St. Johnswort.[T,H] Many rare bird species nest in shrubby oldfields and adjacent upland meadow habitats: northern harrier,[T] blue-winged warbler, golden-winged warbler,[SC] yellow-breasted chat,[SC] clay-colored sparrow,[H] vesper sparrow,[SC] grasshopper sparrow,[SC] and loggerhead shrike.[E,H] Northern saw-whet owl[RR] may nest in groves of eastern red cedar in oldfields. Several species of hawks and falcons use shrubby oldfields and adjacent meadows for foraging. Rare butterflies such as aphrodite fritillary,[RR] dusted skipper,[H]

Leonard's skipper,[RR] and cobweb skipper[RR] may occur where their host plants are present. Shrubby oldfields and other non-forested upland habitats may be used by turtles (e.g. Blanding's,[T,H] painted, snapping, wood,[SC] spotted,[SC] and box[SC]) for nesting.

In East Fishkill, shrubby oldfields were often targetted for residential or commercial development, along with other abandoned agricultural land. These habitats are sometimes used for walking, birdwatching, and other passive recreation that has minimal effects on the habitat values. In East Fishkill, we found these habitats were sometimes brush-hogged to maintain their open character, and were often used by ATV riders. ATV use can destroy rare plants and host plants for rare butterflies, disturb nesting birds, and destroy turtle nesting habitat by compacting the soil and disrupting existing nests.

Protecting shrubby oldfields from human disturbances would help to protect sensitive species of conservation concern. Timing brush-hogging or mowing activities to coincide with the post-fledging season for most birds (e.g., September and later) would reduce the impacts on the breeding birds of these habitats.

Orchard/Plantation (or)

This habitat type includes fruit orchards and Christmas tree farms. We mapped this as an ecologically significant habitat type more for its future ecological values after abandonment than its current values, which are often compromised by frequent mowing and application of pesticides. These habitats have some of the vegetation structure and ecological values of upland meadows and shrubby oldfields, and will develop into young forests if left alone after abandonment.

Upland Forest (uf)

Upland forests in East Fishkill are extremely variable in terms of their species composition, size and age of trees, vegetation structure, soil drainage and texture, and other habitat factors, but we decided to map upland forests as a single habitat type for practical reasons. Different forest types (e.g. old forests, young forests, beech-maple forests, oak-hickory forests) are not easily distinguished on the aerial photographs at our disposal, and we could not consistently and accurately separate forests according to dominant tree species or size of overstory trees. Our "upland forest" type therefore includes non-wetland forests of all ages, at all elevations, and of all species mixes, with the exception that conifer stands were mapped separately as "conifer forest." Most of the areas mapped as "crest, ledge, and talus" (clt or cclt) were forested, share many of the same ecological values, and are part of the upland forest habitat.

Forests of all kinds are important habitats for wildlife. Extensive forested areas that are unfragmented by roads, trails, utility corridors, or developed lots are especially important for certain organisms, but are increasingly rare in the region. The decline of extensive forests has been implicated in the declines of numerous species of migratory songbirds in eastern deciduous forests (Wilcove 1985, Robbins 1980, Ambuel and Temple 1983, Hill and Hagan 1991), raptors (Bednarz and Dinsmore 1982, Billings 1990, Crocoll 1994, Weinberg and Roth 1998), and large mammals such as black bear (Godin 1977, Merritt 1987).

Extensive forests are now a limited and declining resource in East Fishkill. Figure 3 shows that only a handful of contiguous forest areas of 200 ha (500 ac) and larger (including both upland wetland forests) still exists in the town. The largest of these are in the Hudson Highlands region.

The ecological effects of forest fragmentation are manifold but often invisible to a casual observer. The adverse effects of a new road through a forest, for example, can extend hundreds of meters from the road, and can affect soil fauna, birds, amphibians, reptiles, mammals, and plant communities (Forman and Deblinger 2000). We know that fragmentation reduces the potential size of "territories," and thus affects the habitat suitability for the bird and mammal species that require large territories in which to breed and to raise their young successfully. The increased amount of forest "edge" in fragmented forests has multiple habitat effects, but some of the most harmful are the increased access for invasive plants, for human-adapted predators such as raccoon and striped skunk, and for the brown-headed cowbird, a brood parasite. Fragmentation of forests by roads can disrupt seasonal migrations of reptiles and amphibians, and lead to increased road mortality for many wildlife species in their ordinary daily and seasonal movements.

The most effective ways to protect forested habitats are to 1) protect large, contiguous forested areas wherever possible; 2) avoid development of forest interiors; 3) maintain the forest canopy and understory vegetation intact; 4) maintain standing dead wood, down wood, and organic debris; and 5) prevent disturbance or compaction of the forest floor.

Conifer Forest (cf)

This habitat includes both mature conifer plantations and naturally occurring (spontaneous) upland forests of conifer trees. The spontaneous conifer forests in East Fishkill were dominated by eastern red cedar, white pine, or eastern hemlock. Christmas tree plantations with young trees were mapped as "orchard/plantation." Wetland areas dominated by conifers were mapped separately as "conifer swamp."

Conifer stands and forests provide important habitat for a variety of raptor and songbird species, and are also used by ruffed grouse, eastern cottontail, and small mammals such as red squirrel, eastern chipmunk, and meadow vole (Bailey and Alexander 1960). Conifer stands are used by many species of owls (barred owl,[RR] great horned owl, long-eared owl,[RR] short-eared owl[E,H]) for roosting, and sometimes by long-eared owl for nesting. Pine siskin[RR] and red-breasted nuthatch,[RR] black-throated green warbler, evening grosbeak, Blackburnian warbler,[RR] and red-breasted nuthatch will nest in conifer stands. American woodcock[D] sometimes uses conifer stands for nesting and foraging. Some conifer stands provide winter shelter (deer yards) for white-tailed deer, and can be especially important during periods of deep snow cover.

Conifer forests were widely distributed in East Fishkill, but were generally small, rarely exceeding several hectares (several acres). Eastern red cedar forests had often developed from abandoned agricultural land on neutral or alkaline soils, but also occurred on carbonate crests. Eastern hemlock groves were scattered here and there throughout the Hudson Highlands, on acidic rock ledges and crests, and on cool slopes on acidic soils elsewhere.

To protect the habitat values of conifer forests for roosting and nesting owls and other wildlife, both the conifer stands and the surrounding habitats should be maintained intact.

Crest, Ledge, and Talus (clt, cclt)

In a single mapped type we combined three habitats that often occur together--rocky crest, ledge, and talus. Crest and ledge habitats occur where large areas of bedrock are exposed at the ground surface. Crests and ledges can occur at any elevation, but may be most familiar to local residents on hillsides, hilltops, and mountaintops in the region. Talus is the term for the fields of large rock fragments, blocks, or boulders that often accumulate at the base of steep ledges and cliffs. Vegetation in all these habitats is often sparse and patchy, and trees and shrubs may be somewhat stunted. We also included, however, well-forested areas with large amounts of exposed bedrock, such as the northwestern side of Hosner Mountain

Crest, ledge, and talus habitats may appear to be harsh and inhospitable, but they can support an extraordinary diversity of plants and animals. The physical inaccessibility of steep ledges and cliff faces has protected them from the effects of large grazing mammals (domestic and wild), certain predators, and intensive human activities. In the developed regions of the mid-Hudson Valley, these habitats may be the last remnant areas substantially unaltered by humans, and they provide refuge for certain plants and animals that may once have been more widely distributed, but cannot survive in a highly altered landscape. Some species, such as wall-rue, purple cliffbrake, five-lined skink, slimy salamander, and timber rattlesnake 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, aspect, exposure, slope, elevation, biotic influences, and kinds and intensity of human disturbance. Because distinctly different communities develop in carbonate and non-carbonate environments, we mapped carbonate bedrock exposures (cclt) wherever possible. Crest, ledge, and talus habitats on non-carbonate or unknown bedrock were mapped simply as "clt."

Carbonate crests often have trees such as eastern red cedar, hackberry, and basswood, shrubs such as bladdernut, American prickly-ash, and Japanese barberry, and herbs such as wild-columbine and ebony spleenwort. Carbonate crests can support numerous rare species, such as walking fern,[RR] yellow harlequin,[RR] Carolina whitlow-grass,[T,H] eastern hognose snake,[SC] and northern copperhead.[RR] Olive hairstreak[RS] occurs on carbonate crests with its host plant, eastern red cedar.

Non-carbonate crests often have trees such as red oak, chestnut oak, eastern hemlock, and occasionally pitch pine, shrubs such as scrub oak, low blueberries, and chokeberries, and herbs such as Pennsylvania sedge, little bluestem, hairgrass, bristly sarsaparilla, and rock polypody. Rare plants of noncarbonate crests include mountain spleenwort,[T,H] clustered sedge,[T,H] and slender knotweed.[R] Northern hairstreak occurs on acidic crests with oak species, its larval host plants. Timber rattlesnake[T,H] dens in ledges and forages in nearby forests and fields. Worm snake,[SC] eastern fence lizard,[T,H] five-lined skink,[RR] and slimy salamander[RS] also occur on non-carbonate crests. Breeding birds of noncarbonate crest habitats include Blackburnian warbler,[RR] cerulean warbler,[SC] and peregrine falcon.[E,H] Peregrines nest on steep ledges lacking a tree canopy and substantially inaccessible to ground-dwelling predators; we know of none nesting in East Fishkill, but they nest nearby and could occur here in the future. Bobcat and fisher use crests and ledges for travel, hunting, and cover.

Crest, ledge, and talus habitats in East Fishkill occur on knolls and ridges here and there throughout the town, but are most concentrated in the Hudson Highlands region along the southern edge of town (Figure 4). All the units we mapped as "clt" or "cclt" habitat should be interpreted as "potential" areas of crest, ledge, and talus; we were able to field-check only a small portion of the areas where these habitats were likely. Except for the most exposed ledges, these habitats do not have distinctive signatures on aerial photos, so we generally mapped areas with slopes exceeding 15% and with soils 20 inches deep or less as potential crest, ledge, and talus. The precise locations and boundaries of actual crest, ledge, and talus habitats should be determined in the field on a site-by-site basis.

Much of Shenandoah Mountain and the east side of Round Mountain is underlain by carbonate bedrock. The rest of the southern hills are underlain primarily by non-carbonate bedrock, especially gneiss, but with significant areas of other rock types, including amphibolite and calcsilicate rock which may be somewhat calcareous. Therefore, carbonate crests could occur not only in the areas mapped as "cclt," but also in areas mapped as "clt."

Crest, ledge, and talus habitats often occur in locations that are prized by humans for scenic vistas, and highly sought-after for house sites. In East Fishkill, there have been many development incursions into the crest, ledge, and talus habitats of Hosner Mountain, Shenandoah Mountain, Round Mountain, and other areas of the Hudson Highlands. Construction of roads and houses destroys crest, ledge, and talus habitats directly, and causes fragmentation of these habitats and the large forested areas of which they are a part. Rare plants of crests are vulnerable to trampling and collecting. Rare breeding birds of crests can be easily discouraged by human activities nearby. The shallow soils of these habitats are especially susceptible to erosion from construction and logging activities, and from foot trails and all-terrain-vehicle (ATV) trails. Human residences and activities near the den sites of timber rattlesnake, eastern hognose snake, or northern copperhead generally expose the snakes to killing or collecting.

To protect the fragile crest, ledge, and talus habitats, and the sensitive species associated with those habitats, activities in the vicinity should be designed to minimize fragmentation, soil erosion, and direct and indirect disturbance to wildlife.

Waste Ground (wg)

The "waste ground" habitat type encompasses a variety of highly altered areas such as abandoned, unreclaimed soil mines, rock quarries, mine tailings, unvegetated fill, soil stockpiles, illegal dumps, and abandoned parking lots. Many such areas have been stripped of vegetation and topsoil; others have been filled with soil or debris but remain substantially unvegetated.

While most "waste ground" areas are not important for biodiversity conservation, some have been found to support rare species associated with crests, ledges, talus, sand plains, or other infertile habitats. Rare plants, for example, sometimes occur in abandoned soil mines and rock mines in the region. Blanding's turtle,[T,H] wood turtle,[SC] painted turtle, and snapping turtle will nest in gravel mines and other disturbed areas where topsoil has been removed. Bank swallow[RS] and belted kingfisher will nest in relatively stable banks of soil mines. The potential for rare species on waste ground sites, therefore, should not be overlooked. However, on sites where species of conservation concern have been determined to be absent or unlikely, it is often preferable to site new development in these areas instead of in relatively unaltered habitats.

Streams

We obtained a data layer for streams in East Fishkill from the Dutchess County EMC. The data were automated by the EMC GIS laboratory from the New York State Department of Environmental Conservation (NYSDEC) 1991 Biological Survey Series Maps, originally created at 1:24000 scale. These data included both perennial and intermittent streams, undifferentiated by hydroperiod. Many streams were depicted as discontinuous where they flowed through ponds, other impoundments, or large wetlands..

We altered the stream layer in two ways: 1) we connected the sections of stream channel that had been depicted as discontinuous; and 2) based on our field observations and photointerpretation, we added some intermittent streams that had been omitted from the data layer. We expect, however, there are additional intermittent streams that we missed.

"Perennial" streams flow continuously throughout years with normal precipitation, but some may dry up during droughts. The fish and aquatic invertebrate communities of perennial streams may be diverse, especially in clean-water streams with unsilted bottoms. Brook trout[RS] and slimy sculpin[RS] are two native fish species that require clear, cool streams for successful spawning. We consider wild-reproducing populations of these species to be indicators of good stream quality. Wild brook trout are now confined largely to small headwater streams in the region, due to competition from brown trout (a non-native species) stocked in many streams by NYSDEC, and to degraded water quality downstream.

Streams provide essential water sources for wildlife throughout the year, and are used by many wildlife species for foraging. Perennial and intermittent streams provide breeding and larval habitat for northern dusky salamander,[D] and northern two-lined salamander. The forests and sometimes the meadows adjacent to streams provide nonbreeding habitats for adults and juveniles of these species. Wood turtle[SC] uses perennial streams, especially those with pools and recumbent logs (snags), undercut banks, and muskrat or beaver burrows. Parts of Fishkill Creek and Sprout Creek appear to have excellent habitat for wood turtle. Perennial streams and their banks and floodplains provide nesting and foraging habitat for many species of birds, such as spotted sandpiper, belted kingfisher, tree swallow, bank swallow,[RS] and Louisiana waterthrush, and foraging habitat for great blue heron, green heron, and many other birds. Bats use perennial stream corridors for foraging.

"Intermittent streams" flow only during certain times of year or after rains. We mapped only the intermittent streams present in the NYSDEC/EMC data layer, and a few additional streams that we noticed in our field observations or on aerial photographs. We recommend that other such streams be added to the database as information becomes available.

Intermittent streams represent the headwaters of many perennial streams, and are themselves significant water sources for lakes, ponds, and wetlands of all kinds. The condition of these streams hence 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 disappearance in a portion of the landscape can affect the presence and behavior of wildlife populations over a large area. Although intermittent streams have been little studied by biologists, they have nonetheless been found to support rich aquatic invertebrate communities, including regionally rare and state-listed rare mollusks (Gremaud 1977) and dragonflies. For example, two rare dragonflies -- the arrowhead spiketail and mocha emerald -- forage and breed in nearly-dry intermittent streambeds of the Hudson Highlands (Ken Soltesz, Cranberry Lake Preserve, personal communication), and could occur in the southern hills of East Fishkill.

The habitat quality of a stream is affected not only by direct disturbance to the stream or its floodplain, but also by other land disturbances in the watershed, even considerable distances from the stream itself. For example, an increase in impervious surfaces (roads, parking lots, roofs) in the watershed may elevate runoff volumes, cause erosion of stream banks, and siltation of stream bottoms, degrading the habitat for invertebrates and for the fish and other animals that feed on them, and degrading habitat for spawning fish. Road runoff often carries contaminants such as petroleum hydrocarbons, heavy metals, road salt, and sand into streams. Any disturbances that reduce the floodwater capacity of the floodplain are likely to cause increased flooding downstream, increased scouring and bank erosion, and increased sedimentation of downstream reaches.

In a study examining relationships between land use and water quality in 15 Hudson River tributaries, Parsons and Lovett (1993) found a marked correlation between urbanization and water quality deterioration (urban land uses were defined as residential, commercial, and institutional areas, and major roads). In a 1988-1989 study of Fishkill Creek and other Hudson River tributaries (Stevens et al. 1994), Hudsonia found that water quality of Fishkill Creek had significantly deteriorated since previous studies in 1966 (Ayer and Pauszek 1968) and 1985 (Schmidt and Kiviat 1986). Stevens et al. stated:

> It is not premature to warn planners, regulators, and other decision makers that there is a lot stream pollution and habitat degradation occurring in Hudson River tributaries, and...the overall picture is one of streams under considerable stress from both point and non-point pollution sources. Environmental planners and managers should worry less about what is happening at particular point sources and more about the cumulative

> impacts of pollutants from sources such as sewage discharges, septic leachate, and runoff from construction sites, agricultural lands, and highways. Planners and regulators should not wait to act; it is more difficult to restore streams than to protect them....Although a pristine ideal may not be achievable given the intensity of land development in this region of the Hudson Valley, restoration and maintenance of viable functioning communities of native stream organisms is a realistic objective.

Protection of stream habitats requires attention not only to the stream channel and floodplain, but also to land uses throughout the stream's watershed. Activities in the watershed that cause soil erosion, increased surface water runoff, reduced groundwater infiltration, or contamination of surface water or groundwater are likely to affect stream water quality and habitats adversely. Along the stream itself, removal of trees or other shade-producing vegetation can lead to elevated stream temperature, that can adversely affect the invertebrate and fish communities of the stream. Clearing of floodplain vegetation can lead to soil erosion, can diminish the floodplain's capacity for floodwater attenuation, and can reduce the important exchange of nutrients and organic materials between the stream and the floodplain. Hardening of the streambanks (e.g., with concrete, riprap or gabions) reduces the biological and physical interactions between the stream and floodplain, and tends to be harmful to both stream and floodplain habitats. Removal of snags from the streambed degrades habitat for fishes, turtles, and their food organisms.

Emergent Marsh (em)

An emergent marsh is a wetland dominated by rooted herbaceous vegetation that emerges above the water surface, and with standing water for most or all of the growing season. Emergent marshes often occur at the fringes of deeper water bodies (lakes and ponds), or in the midst of or adjacent to other wetland habitats, such as wet meadows or swamps. The edges of emergent marshes, where standing water is less permanent, often grade into wet meadows. Cattails, tussock sedge, arrow arum, arrowheads, and water-plantain are some typical emergent marsh plants in this region. Deep pools within emergent marshes may have floating-leaved plants such as pond-lilies, or submerged aquatic plants such as pondweeds, bladderworts, and watermilfoils.

Emergent marshes are important nesting and nursery habitats for numerous birds species, such as marsh wren,[RR] American bittern,[SC] least bittern,[T,H] great blue heron, Virginia rail,[RS] sora,[RR] American black duck,[D] and wood duck.[V] Many raptor, wading bird, and mammal species use marshes for foraging. Marshes are important habitats for reptiles and amphibians, including eastern painted turtle, snapping turtle, spotted turtle,[SC] green frog, pickerel frog, spring peeper, and northern cricket frog.[E,H] Blanding's turtle[T,H] uses marshes for summer foraging, for drought refuge, and for rehydration during nesting migrations. Several rare and uncommon plant species are known from emergent marshes in the region; we found several of these-- spiny coontail,[T,H] pale alkali-grass,[RS] and shortawn foxtail,[RR]--in calcareous marshes of East Fishkill.

In addition to direct disturbance such as filling or draining, marshes are subject to stresses from offsite (upgradient) sources. For example, polluted stormwater runoff from roads, parking lots, lawns, and other surfaces in developed landscapes carry sediments, nutrients, toxins, and other contaminants into the wetland. Alteration of surface water runoff or of groundwater flows can lead to dramatic changes in the plant and animal communities of marshes. Nutrient and sediment inputs can alter the plant community, and promote the spread of invasive plants such as purple loosestrife and common reed. 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 include protection of surrounding habitats.

Wet Meadow (wm)

A wet meadow is a wetland dominated by herbaceous (non-woody) vegetation and lacking standing water for most of the year. It is thus intermediate in wetness between an upland meadow and an emergent marsh. Some wet meadows are dominated by purple loosestrife, common reed, or reed canary-grass, while others have a diverse mixture of wetland grasses, sedges, forbs, and scattered shrubs. Bluejoint, mannagrasses, woolgrass, tussock sedge, blue flag, and marsh fern are some typical plants of wet meadows.

Wet meadows provide nesting and foraging habitat for many songbirds, wading birds, and raptors, rare and uncommon species such as sedge wren,[E] American bittern,[SC] and northern harrier.[T] Wet meadows that are part of extensive meadow areas (both upland and wetland) may be especially important to an array of grassland breeding birds that has suffered from loss of habitat throughout the Northeast. Wet meadows with diverse plant communities may have especially rich invertebrate faunas. Blue flag and certain sedges and grasses of wet meadows are larval food plants for a number of regionally-rare butterflies. Large and small mammals use wet meadows and a variety of other habitats for foraging.

Wet meadows are frequently drained or excavated for agricultural or ornamental purposes. Some wet meadows are able to withstand light to moderate grazing by livestock, but heavy grazing can destroy the structure of the surface soils, eliminate sensitive plant species, and invite non-native weeds. Wet meadows are often part of the large complexes of meadows and shrubby oldfields habitats that are prime sites for development, and, because many wet meadows are omitted from state, federal, and site-specific wetland maps, they are frequently overlooked in the environmental reviews of development proposals.

Fen and Calcareous Wet Meadow (f and cwm)

A "fen" is a wet meadow and low-shrub habitat maintained by calcareous groundwater seepage. Fens tend to occur in areas influenced by limestone bedrock, and are identified by their low, often sparse vegetation, and their distinctive plant community. Fens often contain small rivulets of seepage water, and some fens have substantial areas of bare soil. Typical plants of fens include shrubby cinquefoil, alder-leaf buckthorn, autumn willow, spike-muhly, sterile sedge, porcupine sedge, yellow sedge, woolly-fruit sedge, grass-of-Parnassus, and bog goldenrod. Fens can support many rare species of plants and animals, and are the primary habitat of the bog turtle east of the Hudson River, a state-listed Endangered species, and federally-listed as Threatened. Few remaining fens still support bog turtle populations in southeastern New York, but the species has been confirmed recently in East Fishkill. The bog turtle is nearly extinct in Westchester and Orange counties, apparently due to habitat loss and degradation. Many other species of conservation concern are known to occur in fens in the region, including plants, invertebrates, amphibians, reptiles, and breeding birds.

A "calcareous wet meadow" has a less distinctive plant community (although it often shares some of the plant species of fens), and may be supported by water sources other than groundwater seepage. Vegetation is often lush and tall, and dominated by ordinary wet meadow plants, but contains some combination of calcicolous plants (those of calcium-rich environments) such as New York ironweed, spreading goldenrod, lakeside sedge, small-flowered agrimony, and sweetflag.

Although we mapped these as two distinct habitats, they often occur together in the landscape. Where calcareous wet meadows occur adjacent to fens used by bog turtles, we expect that the turtles use both habitats to some degree. We recommend that the calcareous wet meadows be treated as potential bog turtle habitat in those situations. Bog turtles sometimes persist in calcareous wet meadows that appear to have been fen formerly, or to have been associated with fens that are no longer present.

We mapped 10 fens in East Fishkill (Figure 5). Fens are difficult to identify using remote techniques such as map and air photo analysis. Unmapped fens could occur at the edges or interiors of some of the larger calcareous wet meadows, or at the edges of wooded swamps, emergent marshes, or wet meadows in low-elevation areas with calcareous bedrock or soils. The perimeters of circumneutral bog lakes (Penneywater Pond, HJ-19) could contain some areas of fen.

Fens seem to be quite vulnerable to degradation from influences originating offsite, such as runoff from roads, lawns, and agricultural fields, or alterations of shallow groundwater quality or quantity. Nutrient pollution, disruption of groundwater sources, or direct physical disturbance can lead to changes in the character of the vegetation and other aspects of the habitat that can render it unsuitable for the bog turtle and for other fen plants and animals. Conservation of fens therefore requires attention not only to the fen footprint, but also to land uses outside the fen.

Intermittent Woodland Pool (iwp)

An "intermittent woodland pool" is partially or entirely surrounded by forest habitat, and has standing water during winter and spring that dries up by mid- to late summer in a normal year. (Intermittent woodland pool is a subset of the "vernal pool" habitat which may or may not be surrounded by forest.)

Intermittent woodland pools are breeding habitat for a variety of amphibians, but are virtually the only breeding and nursery habitat for wood frog,[V] Jefferson salamander,[SC] marbled salamander,[SC] and spotted salamander.[V] These salamanders belong to the genus Ambystoma, the "mole salamanders" which spend most of their juvenile and adult lives in the soils and organic litter of upland forests. Despite the small size of intermittent woodland pools, they can support amphibian diversity equal to or higher than that of much larger wetlands (Semlitsch 2000). The seasonal drying of these pools ensures that the habitat supports no fish (fish are major predators on amphibian eggs and larvae), and the surrounding forest provides habitat for adult amphibians during the non-breeding seasons. The best habitats for adult salamanders are deciduous forests with plenty of downwood, rocks, leaf litter and other organic debris, and soft organic duff at the soil surface to provide cover and invertebrate food sources.

These salamanders are known to migrate seasonally hundreds of meters from their breeding pools (Downs 1989, Semlitsch 1998) into surrounding forests. For conservation purposes, therefore, we consider the forested area within a 200 m radius of the intermittent woodland pool to be the minimum potential salamander habitat associated with the pool. The salamanders are vulnerable to vehicle mortality where roads or driveways cross these habitat areas. Removal of organic debris from the forest floor, or soil compaction, as from all-terrain vehicles or logging equipment, diminishes the value of forest habitats for these species.

Reptiles such as spotted turtle[SC] and Blanding's turtle[T,H] use intermittent woodland pools for foraging, rehydrating, and resting. Wood duck,[V] mallard, and American black duck[D] use intermittent woodland pools for nesting and brood-rearing, and a variety of other waterfowl and wading birds use them for foraging. The sometimes rich invertebrate communities of these pools provide abundant food for songbirds such as yellow warbler, common yellowthroat, and northern waterthrush. Large and small mammals also use these pools for foraging and water sources.

Intermittent woodland pools are often excluded from federal and state wetland protection due to their small size (many pools are 1/10 acre or smaller), their temporary 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. Moreover, the populations of many amphibian species depend, not just on a single woodland pool, but on a landscape dotted with such wetlands, to which juvenile amphibians can disperse (Semlitsch 2000). The loss of these small wetlands can cause local extinctions of species.

We consider intermittent woodland pools to be one of our most imperiled habitats in the region. Although they are widely distributed, the pools are so small (often less than 1/10 acre), and their ecological importance is so undervalued that they are frequently drained or filled by landowners and developers, and frequently overlooked in environmental reviews of proposed developments. Even when the pools themselves are spared in a development plan, the surrounding forests so essential to the ecological functions of these pools are frequently destroyed. Density of roads has been associated with reduced amphibian populations (Findlay and Bourdages 2000), and amphibians associated with forest habitats (such as the mole salamanders of intermittent woodland pools) have been found to be especially sensitive to urbanization (Richter and Azous 1995).

The importance of small wetlands and their position in the landscape should not be overlooked. Indeed, the more isolated a wetland, the more crucial its role may be in connecting distant wetlands ecologically (Semlitsch 2000). If maintaining native biodiversity becomes one of the conservation goals of the Town of East Fishkill, then small, high quality wetlands should be considered no more expendable than large wetlands. In addition to protecting the woodland pool footprint from filling, draining, or dredging, other conservation measures include 1) preserving the intermittent hydroperiod of the pools; 2) protecting forested areas within a 200 meter radius around the pool (for juvenile and adult salamander habitat); 3) preserving the spatial distribution of woodland pools in the landscape; and 4) protecting forested corridors between intermittent woodland pools.

Kettle Shrub Pool (ksp)

A "kettle shrub pool" is a seasonally-flooded, shrub-dominated pool in a glacial kettle, a depression formed by the melting of a stranded block of glacial ice. Buttonbush, an aquatic shrub, is typically the dominant shrub, but other shrubs such as highbush blueberry, swamp azalea, and willows may also be abundant. Often a shrub thicket in the middle of the pool is entirely or partly surrounded by an open water moat. The kettle shrub pool is usually ringed with mature hardwoods, and may have some small trees such as red maple or green ash in the pool interior, but otherwise lacks a forested canopy.

Kettle shrub pools typically have no stream inlet or outlet, or, at most, an intermittent outlet. Standing water is usually present in winter and spring but often disappears by late summer, or remains only in isolated puddles. The pools thus have many of the habitat attributes of intermittent woodland pools, and are used by many of the same wildlife species. The water in some Dutchess County kettle shrub pools studied by Hudsonia is alkaline; we suspect that most such pools in the county are neutral to alkaline. Hudsonia has found two state-listed rare plants -- spiny coontail[T,H] and buttonbush dodder[E,H] -- and three regionally-rare plants --*Helodium paludosum,* short-awn foxtail, and pale alkali-grass -- in kettle shrub pools in nearby towns.

Kettle shrub pools are part of the critical habitat of the Blanding's turtle, a Threatened species in New York. The turtles typically spend winter and spring in a kettle shrub pool. Then, in late spring and early summer, they move overland to their upland nesting sites, which are usually on coarse, gravelly, friable soils in locations lacking a tree canopy. The turtles are known to travel up to 1000 meters and more, from their winter and springtime wetland to their nesting sites. During the summer, they use a variety of other wetlands for foraging and resting, including emergent marshes, swamps, intermittent woodland pools, and circumneutral bog lakes. During drought periods, they may move into constructed ponds or other water bodies that retain standing water.

The Blanding's turtle is known to occur in East Fishkill, but the number of sites occupied by the turtles is not known. Turtle surveys have not been conducted in most of the potential habitats. By identifying the kettle shrub pools throughout the town, however, we have probably identified most of the winter and spring habitats used by Blanding's in normal years. Many of the kettle shrub pools in East Fishkill are now entirely or partially surrounded by developed land, including several that were identified in 1987 as "good to excellent" potential Blanding's turtle habitat (Kiviat1987). We expect that those pools and others in intensively developed areas no longer support Blanding's turtle, if they ever did.

To delineate the potential extent of the habitat complex used by a Blanding's turtle population, we draw a 1000 m radius around their winter and spring wetland habitat (Kiviat 1997). Figure 6 shows the locations of kettle shrub pools in East Fishkill, and the potential Blanding's turtle habitat area surrounding each. Wherever land use changes are anticipated in the vicinity of one of these pools, we recommend that the pool and other nearby wetlands with suitable hydrology be surveyed for Blanding's turtle by qualified biologists early in the planning process. Where Blanding's turtles are found, the potential habitat complex, including upland nesting areas, should be evaluated and delineated more precisely so that any development can be designed to accommodate the needs of the turtles as they move between habitats.

Acidic Bog (ab) and **Acidic Bog Lake** (abl)

An acidic bog is a distinctive subset of shrub swamp habitat that is very wet, very acidic, and very low in nutrients. Leatherleaf, sheep laurel, swamp azalea, cranberries, highbush blueberry, chokeberries and peat moss (*Sphagnum*) are typical bog plants in this region. Bogs are often characterized by floating (or "quaking") mats of vegetation. The highly acidic, perennially wet environment retards decomposition of organic matter, often leading to deep accumulations of peat (partially decomposed organic matter). Bogs are habitat for many uncommon and rare plants and animals.

Acidic bogs are very rare in Dutchess County. In East Fishkill, we found only two occurrences: one in a small glacial kettle hole just west of Hopewell Junction, and one in a larger basin (perhaps also a kettle), surrounding a large pond. We mapped the latter complex as an "acidic bog lake.

The smaller bog (Figure 7) comprised approximately 1 ha (2.7 acres) in a depression near a large circumneutral bog lake (wetland HJ-19, see below), and surrounded by upland forest. It had a dense stand of highbush blueberry with small red maples in the center, and sizable patches of leatherleaf at the north and south ends. At the perimeter was a partial moat of variable width, with tussock sedge, bittersweet nightshade, and other marsh species. Buttonbush was common shoreward of the moat, and small stands of water-willow were scattered in the near-shore zone, along with swamp azalea, poison sumac, highbush blueberry, and winterberry holly. Peat moss was abundant.

During a visit in the 1970s, Erik Kiviat (personal communication) found an apparently large population of spotted turtles[SC] in this bog. Other rare and uncommon species of plants and animals are likely to occur here. Approximately 480 m southwest of the bog is a large kettle shrub pool. If Blanding's turtles use that pool for winter and spring habitat, then this bog may be used for foraging, for drought refuge, and for rehydration during nesting migrations in the spring and early summer. It is even possible that the bog is used for winter and spring habitat by Blanding's.

Wetland HJ-18, located just northeast of Hopewell Junction, is a 12-ha (30-ac) wetland containing hardwood and shrub swamp, emergent marsh, an extensive acidic bog, and an open water area of approximately 0.8 ha (2 ac). We mapped the bog and pond areas together as an "acidic bog lake" (Figure 7), the only example of that habitat found in East Fishkill. According to the Dutchess County soil survey (Natural Resources Conservation Service, unpublished) the bog area is underlain by Carlisle muck, a deep, calcareous, organic soil.

The bog area was dominated by leatherleaf, sweet-gale, swamp azalea, and highbush blueberry. Peat moss was abundant. Chokeberry, alder, and red maple were common. Pitcher-plant, [RS] an insectivorous plant of bogs and fens, was common on woody hummocks. We did not examine the pond area at close range, but could see that it had abundant fragrant water-lily. A kettle shrub pool lies approximately 200 m northeast of the bog lake area. Either of these habitats could be used by Blanding's turtle for winter and spring habitat, for summer foraging, for drought refuge, and for rehydration during nesting migrations.

The biological communities of acidic bog habitats seem to be closely tied to the water chemistry, water temperature, and hydroperiods of these environments. Alterations to the watershed, such as tree removal, soil disturbance, applications of fertilizers or pesticides, or alterations to groundwater or surface water drainage could adversely affect this habitat.

Circumneutral Bog Lake (cbl)

A circumneutral bog lake is a spring-fed, calcareous water body supporting vegetation of both acidic bogs and calcareous marshes. This is a rare habitat type in the Hudson Valley, and is known to support many species of rare and uncommon plants and animals. Several species of rare sedges and submerged aquatic plants, northern cricket frog[E,H], Blanding's turtle,[T,H] blue-spotted salamander[SC], and marsh wren[RR] occur in other circumneutral bog lakes in Dutchess County. Elsewhere in the region, these habitats have also been found to have diverse communities of mollusks, dragonflies, and damselflies. We found only two circumneutral bog lakes in East Fishkill: Penneywater Pond and wetland HJ-19. We did not field-check all water bodies in the town, however, so other such lakes may be present. We know of no biological surveys conducted at either of these locations.

Penneywater Pond (wetland HJ-44) is approximately 5 ha (13.5 ac), with a large open water area of 2-2.5 ha (5-6 ac), and a fringe of herbaceous vegetation that is partially on floating mats (Figure 7). The fringe varied in width from a few meters on the west side to approximately 70 meters on the east, and had such species as cattail, beakrush, twig-rush,[RR] lakeside sedge and other sedges, water-willow,[RR] mermaidweed, silky dogwood, shrubby willows, poison sumac, and shrubby cinquefoil. In 1987, Kiviat (1987) found pitcher-plant[RS] abundant at one location on the herbaceous fringe, and pale spikerush,[RR] on peat rafts in the open pond area. According to the Dutchess County soil survey (Natural Resources Conservation Service, unpublished), the herbaceous fringe is underlain by Palms muck, a deep, calcareous, organic soil, and the surrounding swamp is underlain by Sun and Wayland silt loams (also calcareous).

Although the pond is immediately surrounded by a 19-ha (46-ac) hardwood swamp, residential developments are located 60-140 meters south, west, and east of the pond. We believe that circumneutral bog lakes are very sensitive to changes in surface and groundwater chemistry and flows, and could be affected by water pollution from septic leachate, and lawn and garden fertilizers or pesticides, and any significant alterations to the watershed such as clearing of trees, soil disturbance, or altered drainage. Mechanical disturbance or changes in surface water levels or chemistry could disrupt the floating vegetation mats. The plant and animal communities in general are likely to be adversely affected by dredging, by motorized watercraft, or other significant intrusions to the pond.

Wetland HJ-19 is a 7-ha (18-ac) wetland containing hardwood swamp, emergent marsh, and a 1.6-ha (4-ac) area of open water. The wetland is fed in part by a small stream entering at the northwest and exiting at the south end, flowing ultimately into Fishkill Creek about 1 km (0.6 mi) downstream. We suspect that the pond is also fed by calcareous springs in the pond bottom. We saw the pond only in early spring, when most herbaceous plants were not visible. The pond was surrounded by emergent marsh and hardwood (red maple) swamp. The open water area had patches of fragrant pond-lily. Peat rafts in the pond and at the pond edge supported emergent marsh vegetation. A narrow band of emergent marsh and shrub swamp at the eastern pond edge had abundant peat moss, patches of lakeside sedge, tussock sedge, spikerush, blue flag, purple loosestrife, cattail, meadowsweet, steeplebush, and northern arrowwood.

Both these lakes lie within 1000 m (3200 ft) of a kettle shrub pool. If Blanding's turtles use either of those pools for winter and spring habitat, then they may use the circumneutral bog lakes for foraging, for rehydration during nesting migrations, or for drought refuge. Blanding's turtle is known to use another circumneutral bog lake in Dutchess County for these purposes. It is also possible that they would use parts of these lakes for overwintering.

To protect these unusual habitats, we recommend that remaining forests and other habitats be maintained intact as much as possible within 300 meters of the lakes. Special attention should be paid to the siting and effectiveness of septic systems in the vicinity, and to other potential sources of contamination of groundwater or surface water entering the ponds. If any significant land use changes are proposed in the vicinity, we recommend that rare species surveys be conducted in the pond and surrounding forests early in the planning process, so that development designs can accommodate the needs of sensitive species. Surveys should include, at a minimum, rare plants (including submerged aquatic plants), amphibians, reptiles, and breeding birds. The kettle shrub pools near each of these circumneutral bog lakes should also be surveyed for Blanding's turtles.

Hardwood and Shrub Swamp (sw)

A "swamp" is a wetland dominated by woody (as opposed to herbaceous) vegetation. We combined hardwood forested and shrub swamps into a single "swamp" habitat type because the two often occur together and were difficult to separate using our remote sensing tools. We mapped conifer swamps separately, however, because they were easily distinguished from deciduous swamps on aerial photographs. Red maple, green ash, American elm, slippery elm, and swamp white oak were the most common trees of hardwood swamps in East Fishkill. Typical species of shrub swamps were silky dogwood, alder, shrubby willows, and northern arrowwood.

Hardwood swamp is by far the most extensive wetland habitat type in East Fishkill. Swamps are important to a great variety of birds, mammals, amphibians, and reptiles, especially when they are contiguous with streams or with large areas of upland forests. Swamp cottonwood[T,H] is a very rare tree of hardwood swamps, known only from four locations in the Hudson Valley. Red-shouldered hawk,[SC] barred owl,[RS] great blue heron, wood duck,[V] prothonotary warbler,[H]

Canada warbler,[RS] and white-eyed vireo[RR] are potential nesters in hardwood or mixed swamps. Pools within swamps are used by a variety of amphibian species for breeding. Four-toed salamander, believed to be regionally rare, uses swamps with plenty of moss-covered downwood, rocks, and woody hummocks. The species could occur in pools of other swamp habitats in the town. Great blue heron is a common species that forages in a variety of wetland and stream habitats, but its nesting sites are scarce in the region. It typically nests in colonies, called rookeries, established in stands of dead or partially-dead trees in standing water. Heron colonies are very sensitive to human disturbances during the nesting season. Also, colonies will depart if the wetlands are drained, because the standing water provides an important protection against nest predators such as raccoons.

Maintaining the water quality, quantity, and flow patterns in swamps is important to the plants and animals of swamp habitats. Protection of the surrounding upland habitats can be important to the amphibians that may breed in the swamp, and maintaining connectivity between swamp habitats and other intact upland and wetland habitats may be important to other resident and transient wildlife of swamps. Direct disturbance, such as logging, can damage soil structure, plant communities, and microhabitats, and provide access to invasive plants. Any timber harvest of swamps should be timed to avoid the seasons most critical to sensitive organisms.

Springs and Seeps (ss)

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 to the bottom of a pond, a stream, or into a wetland such as a fen, we mapped only springs and seeps that discharged conspicuously into upland locations. Their occurrence is difficult to predict by remote sensing, so we mapped only the few springs and seeps that we happened to see in the field; we expect there are many more such habitats in East Fishkill that we did not map.

Springs and seeps originating from deep groundwater sources flow more or less continuously, and those from shallower sources flow only intermittently. The habitats created at springs and seeps are determined in part by the chemistry of the soils and bedrock through which the groundwater flows before emerging.

Springs and seeps provide important water sources for many organisms during droughts, and during winter when these habitats may remain free of ice. Because groundwater discharges at a fairly constant temperature, spring and seep habitats tend to be warmer than surrounding habitats in winter, and cooler than surrounding habitats in summer. This enables them to support certain organisms that occur rarely or not at all in other habitats in the region. The fauna of springs and seeps has been poorly studied. A few rare invertebrates are restricted to springs in the region. Springs emanating from carbonate bedrock or carbonate-rich surficial deposits sometimes support abundant and diverse snail fauna. Northern dusky salamander[V] uses springs and cold streams. Gray petaltail[SC] and tiger spiketail[H] are two rare dragonflies of seeps in the region.

Springs are easily disrupted by disturbance to upgradient land or groundwater, altered patterns of surface water infiltration, or pollution of infiltering waters.

Riparian Corridor

For the purposes of this project, the "riparian corridor" is loosely defined as the zone along a perennial stream that includes the stream banks, the floodplain, and adjacent steep slopes.

To create the riparian zone overlay, we started with the 100-year floodplain shown on the Federal Emergency Management Agency (FEMA) floodplain map (Q3 Digital Flood Data, 1996), and amended it to include the apparent floodplains of perennial streams omitted from the FEMA map, and adjacent steep slopes as appropriate. We conducted no hydrological studies, and consulted no existing data, but estimated the floodplain limits solely on the basis of elevation contours. For most small perennial streams, we drew the floodplain limits approximately at the first elevation contour (10 ft) above the stream channel. For some of the larger streams, we extended the floodplain limits to the second contour (20 ft) above the stream channel. These conventions approximate many (but not all) of the 100-year floodplain limits delineated on the FEMA map, but we extended them to perennial stream reaches not included on that map.

The riparian zone is a good example of a landscape component that provides ecological services disproportionate to its size at any location. Floodplains act to store floodwaters, decrease stream velocities at flood stages, and decrease the potential for catastrophic flooding downstream. They capture sediments and nutrients, help to stabilize riverbanks, release nutrients and organic materials to the stream, and provide critical habitats for wildlife and aquatic species. Riparian zones may contain many different habitat types, including rocky crest or ledge, bottomland forest, hardwood swamp, emergent marsh, fen, wet meadow, and upland meadow. Riparian zones tend to have high species diversity and biological productivity, and many fish and wildlife depend upon riparian habitats one way or another for their survival (Hubbard 1977, McCormick 1978). We know of many state-listed rare plants of riparian zones, such as Davis' sedge,[T,H] cattail sedge,[T,H] goldenseal,[T,H] and diarrhena[E,H] (a grass). Wood turtle[SC] uses certain kinds of perennial streams and their floodplains. Red-shouldered hawk[SC] and cerulean warbler[SC] nest in areas with extensive riparian forests, especially those with mature trees. Wood duck,[V] pileated woodpecker, red-bellied woodpecker, and many songbirds also use riparian forests for nesting. Muskrat, mink, beaver, and river otter, and many other mammals use riparian corridors regularly or intermittently.

Portions of the riparian zone are subject to irregular disturbances from flooding, which can scour stream channels and cut new channels, erode streambanks and floodplain soils, uproot and carry away plants and organic debris, and deposit sediments and debris. These disturbances are important to the instream habitats, and help to create some of the specialized habitats of floodplains. Any alteration of flooding regimes, stream water volumes, timing of runoff, and water quality can profoundly affect the habitats and species of streams and riparian zones.

Extensive floodplain swamps and bottomland forests still remain along Fishkill Creek, Sprout Creek, and some of their larger tributaries in East Fishkill. Most of East Fishkill's largest swamps are in riparian corridors. These riparian forests, both upland and wetland, should be prized by the town, both for their ecological importance to the East Fishkill landscape, and for their contributions to the water quality of local 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, paving, soil mining, clearing of vegetation, creating lawns, and other disruptive activities in and near riparian zones can eliminate riparian functions and adversely affect the species that depend on streams, riparian zones, and nearby upland habitats. One of the most important means of protecting stream quality is to protect the riparian zones from human disturbance, and restore and maintain the natural riparian habitats wherever possible.

DISCUSSION

While other towns of Dutchess County contain many of the same habitat types, few have such an array of unusual habitats as East Fishkill. The dramatic crest, ledge, and talus of the Hudson Highlands are shared only by the few towns along the southern edge of the county, and East Fishkill may be the only town in the county to contain all four of the regionally-scarce habitats--fen, acidic bog, kettle shrub pool, and circumneutral bog lake--within its boundaries. Although the intensive land development of recent decades has depleted and degraded many of the important habitats in the town, there still remains much worth protecting.

In this project we have undertaken only the first phase of a standard biodiversity assessment: the identification of habitats. We made no attempt to find occurrences of rare species of plants and animals, but have identified the habitats where rare species are most likely to occur. Rare species surveys may be appropriate where proposed land use changes would alter existing habitats. The surveys should be conducted by biologists who are specialists in the particular species or groups of species of concern (e.g., vascular plants, butterflies, mollusks, birds, reptiles, amphibians, fishes, or mammals) during seasons appropriate to the species of interest. Where rare species surveys are deemed necessary, they should be conducted in the early planning stages for a project, so that the location and design of the project can most cost-effectively accommodate the needs of the species of concern.

Biodiversity and Land Use Planning

Most local land use decisions in the Hudson Valley are made on a site-by-site basis without the benefit of information about surrounding lands. The incremental losses of biological resources from any single development site often seem trivial compared to the apparent economic benefits of site development. In most towns, there is no systematic way to assess offsite impacts of habitat loss from a development site, or to assess cumulative impacts of similar losses from many such sites. Years of piecemeal decision-making have led to the disappearance of certain habitats from whole segments of the landscape, the fragmentation and degradation of many other habitats, and the depletion of overall biodiversity resources in the region. Because habitats, biological communities, and ecosystems do not respect property boundaries, the best approach to biodiversity conservation is from the perspective of whole landscapes. The habitat map produced for this project facilitates that approach by depicting the general ecological setting of sites throughout the Town of East Fishkill.

Landscape patterns can have a profound influence on populations of animal and plant species. Size of habitats, isolation of habitats, connectivity between habitats, and juxtaposition of habitats in the landscape all have important implications for regional biodiversity. Certain wildlife species require large areas of contiguous habitat, and many, perhaps most, wildlife species need to travel among different habitats to satisfy their basic needs for, e.g., food, water, cover, nesting and nursery areas, and population dispersal. Landscapes that are fragmented by roads, railroads, utility corridors, and developed land parcels limit the movements of and interactions between animals, and can change the patterns of dispersal, reproduction, competition, and predation. According to Wilcove et al. (1986), fragmentation may be "the principal threat to most species in the temperate zone." Broad corridors of relatively undisturbed vegetation, soils, and waterways support the movement of organisms, materials, and energy, and the hydrologic and disturbance regimes that help to maintain habitats. Landscapes with interconnected networks of open space are more likely to support the long term viability of diverse biological communities.

The East Fishkill landscape has been highly fragmented by transportation and utility corridors, and residential and commercial development. There are few remaining contiguous undeveloped areas exceeding 200 ha (500 ac), and residential development continues to make incursions into the most extensive of those areas. Nonetheless, East Fishkill still retains areas of great ecological importance, both to local ecosystems, and to the region as a whole.

Establishing Conservation Goals and Priorities

Conservation goals that are compatible with other planning goals, and with the character of existing, anticipated, and desired land uses in the town have the greatest likelihood of being achieved successfully. Goals should be realistic and practical, but need not be merely reactive. For example, instead of setting a goal of merely minimizing habitat losses in the future, consider the goal of reversing habitat loss and fragmentation by restoring habitats and links between habitats. Goals may include protection and restoration of rare, declining, and vulnerable habitats and species, as well as protection of an array of representative and exemplary communities and habitats that are not necessarily rare. In the more intensively developed areas of town, conservation goals should probably include protection of habitats that are compatible with moderate to intensive human recreational uses.

The Town of East Fishkill and most landowners and developers have limited financial resources to devote to conservation purposes, and will need to decide how best to direct those resources to achieve the greatest conservation results. While it may be impossible to protect all significant habitats, there are reasonable ways to prioritize conservation efforts. Some obvious considerations are ecological importance, and the risk of disappearance (rarity and vulnerability of habitats and species). Conservation priorities could include the protection of the rarest habitats and species, and those habitats that are most vulnerable to future development trends (such as upland meadows, rocky crests, and intermittent woodland pools and their surrounding forests). They could include protection of habitats associated with resources of special economic, public health, or aesthetic importance to the town, such as streams, riparian zones, lakes and ponds, farmland, and groundwater aquifers. They could include protection of one or more "flagship" species such as the Blanding's turtle or the bog turtle, which occur in only a few towns in southeastern New York. The final lists of conservation goals and priorities should be developed according to current concerns and conditions, but should be reviewed and revised periodically to accommodate new information about biodiversity status, and changes in the environmental setting.

Conservation Strategies

A variety of regulatory and non-regulatory means can be employed by a municipality to achieve its conservation goals (see Section 4 of the *Biodiversity Assessment Manual*). Several recent publications of the Metropolitan Conservation Alliance (mca@wcs.org) and the Pace University Land Use Law Center describe some of the tools and techniques available to municipalities for these purposes. One publication (Metropolitan Conservation Alliance 2002), for example, offers a model local ordinance to delineate a conservation overlay district that can be integrated into a Master Plan and adapted to the local zoning ordinance.

Strategies can include land acquisition, conservation easements, land stewardship incentives, public education, and local regulations. We hope that the habitat map produced for this project will help landowners and developers understand how their land fits into the larger ecological landscape, and will inspire them to implement habitat protection measures voluntarily. To that end, the town could compile and issue recommendations for voluntary measures to promote protection of natural systems and biodiversity.

In addition to zoning restrictions and permit conditions designed to protect specific types of habitat, the town could apply some general practices on a townwide basis to foster biodiversity conservation. Some of these could be incorporated into the Master Plan as general statements of intent, and used to help guide the environmental reviews of permit applications. The examples listed below are adapted from the *Biodiversity Assessment Manual* (Kiviat and Stevens 2001).

- Protect large, contiguous, unaltered tracts wherever possible.
- Preserve existing links, and create new links between natural habitats on adjacent properties.
- Preserve natural disturbance processes, such as fires, floods, seasonal drawdowns, landslides, and wind exposure, wherever possible.
- Restore and maintain broad buffer zones of natural vegetation along streams, around other water bodies and wetlands, and around other sensitive habitats.
- In general, encourage development of ecologically degraded land instead of unaltered land wherever possible.
- Promote redevelopment of brownfields, other post-industrial or post-commercial sites, and other previously altered sites; "infill" development; and adaptive reuse of existing structures wherever possible, instead of breaking new ground in unaltered areas.
- Encourage pedestrian-centered developments that enhance existing neighborhoods, instead of isolated developments requiring new roads or expanded vehicle use.
- Concentrate development along existing roads; discourage construction of new roads in undeveloped areas. Promote clustered development wherever appropriate to maximize the extent of unaltered land.
- Direct human uses toward the least sensitive areas, and minimize alteration of natural features, including vegetation, soils, bedrock, and waterways.
- Preserve farmland potential wherever possible.
- Plan landscapes with interconnected networks of open space. When considering protection for a particular species or group of species, design the open space networks according to the particular needs of the species of concern.
- Minimize areas 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 intact habitats.
- Encourage and provide incentives for developers to consider environmental concerns early in the planning process, and incorporate conservation principles into their choice of development sites, their site design, and their construction practices.

As a rule, it is best not to rely on "mitigation" approaches to "replace" natural habitats with constructed ones. Even though the practice of wetland construction for mitigation purposes is now widespread, our ability to construct habitats that duplicate the complex ecological <u>functions</u> of a natural habitat is still unproven. The most prudent approach for biodiversity conservation is to protect the most important habitats wherever possible, and assume that loss of natural habitats cannot be adequately compensated by construction of new habitats.

*   *   *   *   *

Conservation of habitats is one of the best ways to protect biological resources of the region. The "habitat approach" to conservation, however, 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 natural forces (e.g., wind, floods, fires) that help to maintain habitats, the juxtaposition of habitats in the landscape, their size, their degree of connectivity or isolation, the kinds of biological communities they support, and the needs of the associated plants and animals. Incorporating this approach into planning and decision making will help minimize the adverse effects of human activities, integrate the needs of the human community with those of the natural landscape, and protect the ecological patterns and processes that support the human community and the rest of the living world.

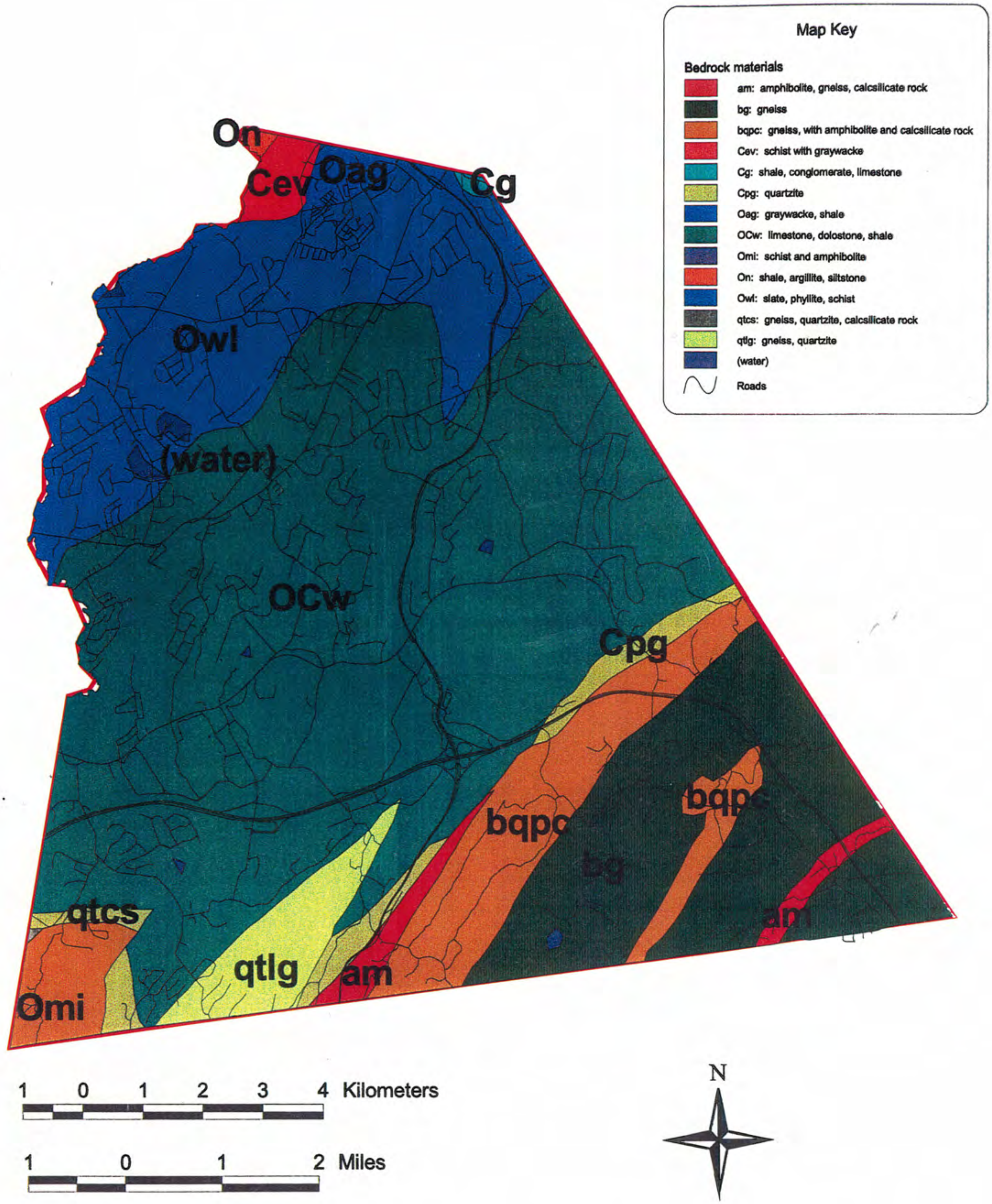

Figure 1. Generalized bedrock geology of East Fishkill, NY. Digital data originated from the New York Geological Survey. Hudsonia Ltd., 2001-2002.

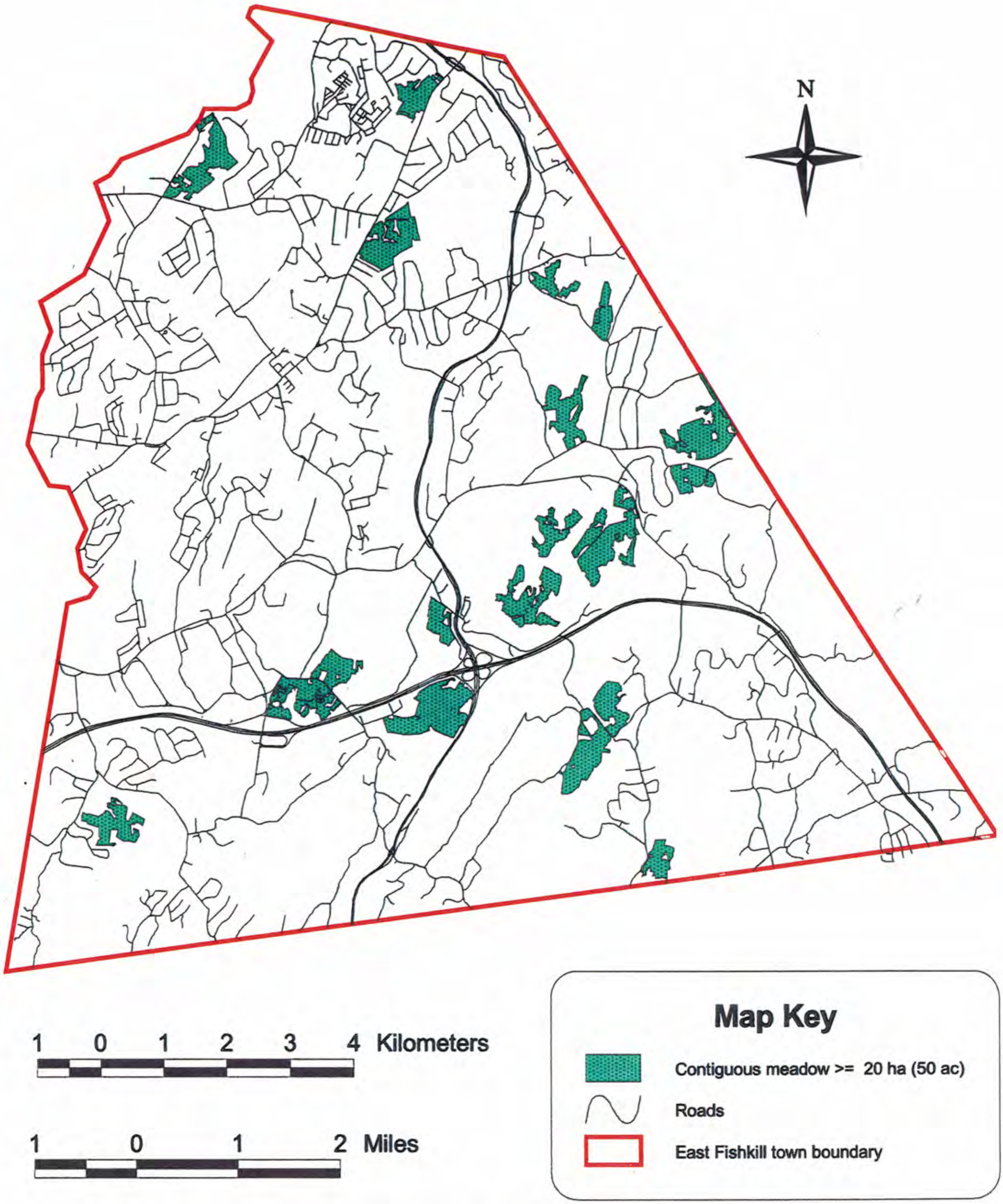

Figure 2. Contiguous meadow areas (including upland meadows, wet meadows, and shrubby oldfields) 20 hectares (50 acres) and larger, East Fishkill, NY. Hudsonia Ltd., 2001-2002.

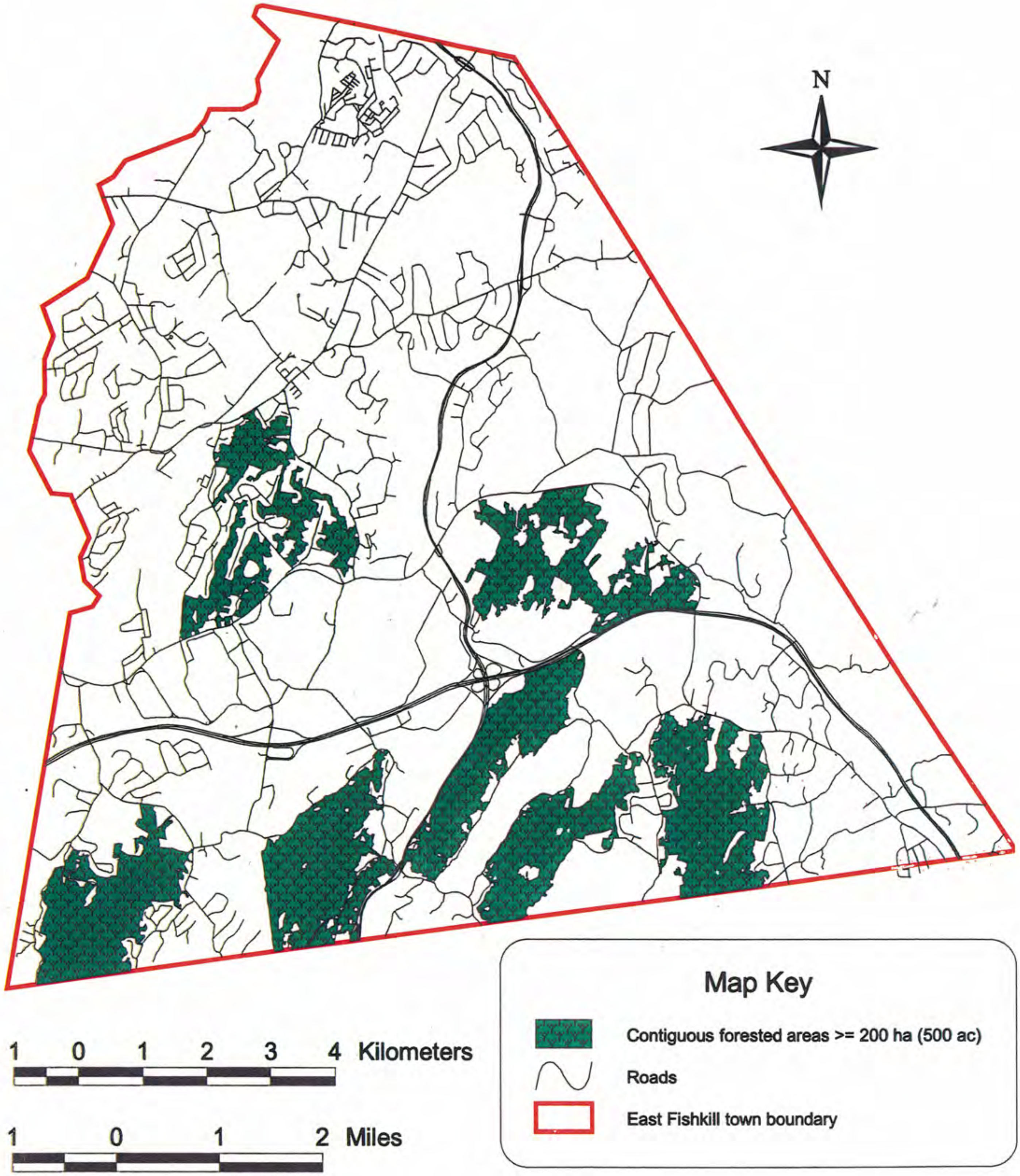

Figure 3. Contiguous forested areas 200 hectares (500 acres) and larger, East Fishkill, NY. Hudsonia Ltd., 2001-2002.

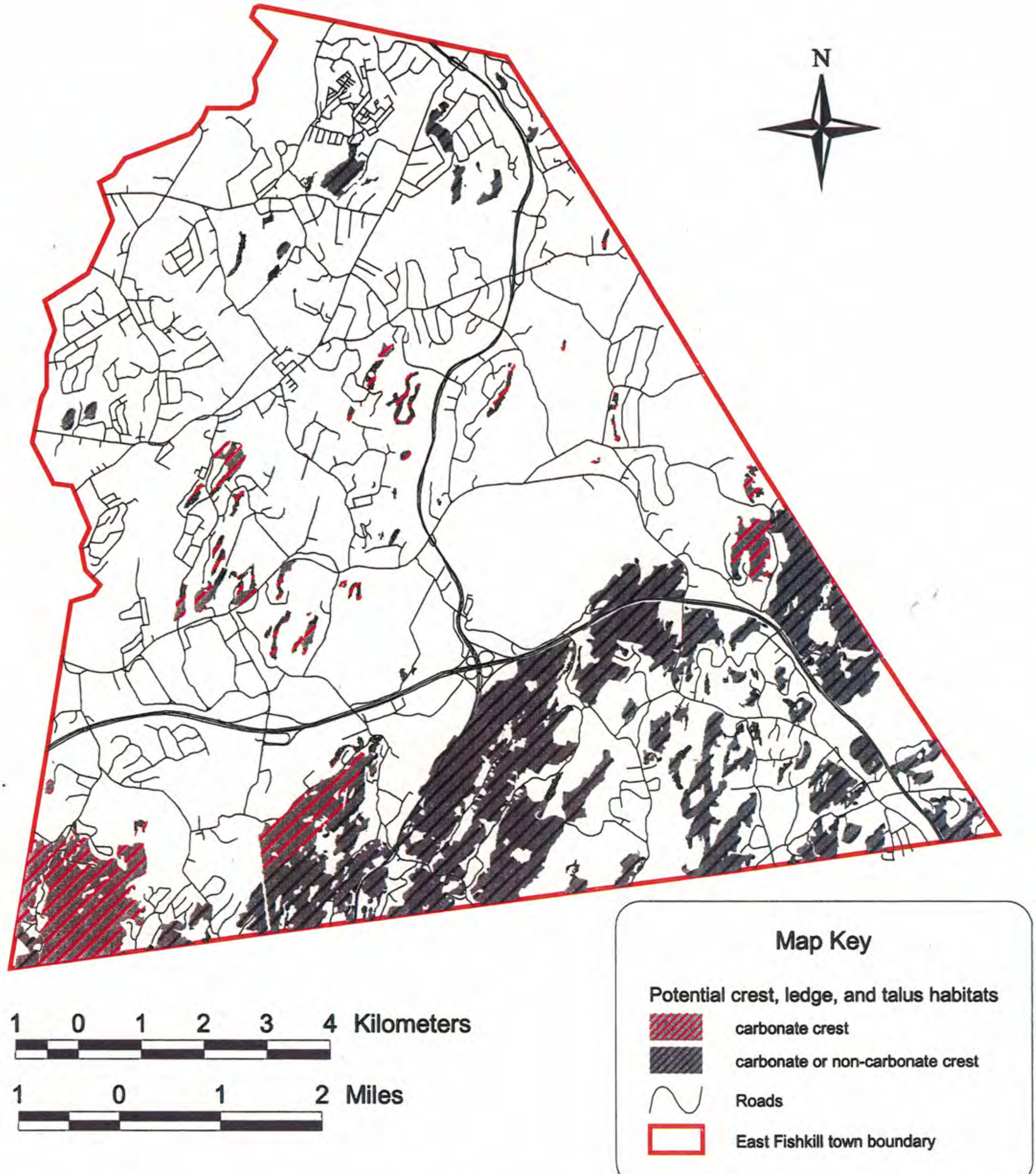

Figure 4. Potential areas of rocky crest, ledge, and talus habitats, East Fishkill, NY. Hudsonia Ltd., 2001-2002.

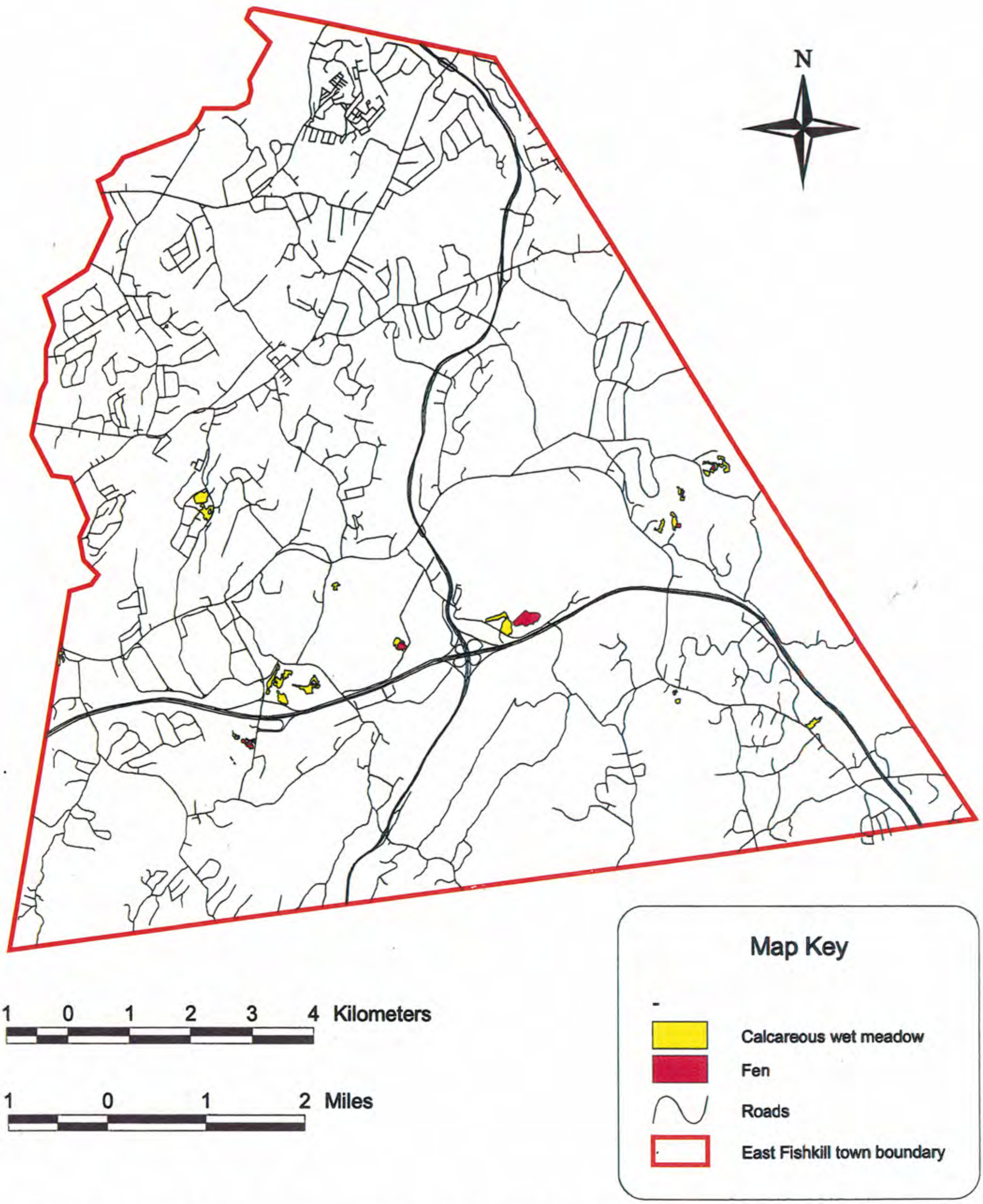

Figure 5. Fens and calcareous wet meadows, East Fishkill, NY. Hudsonia Ltd., 2001-2002.

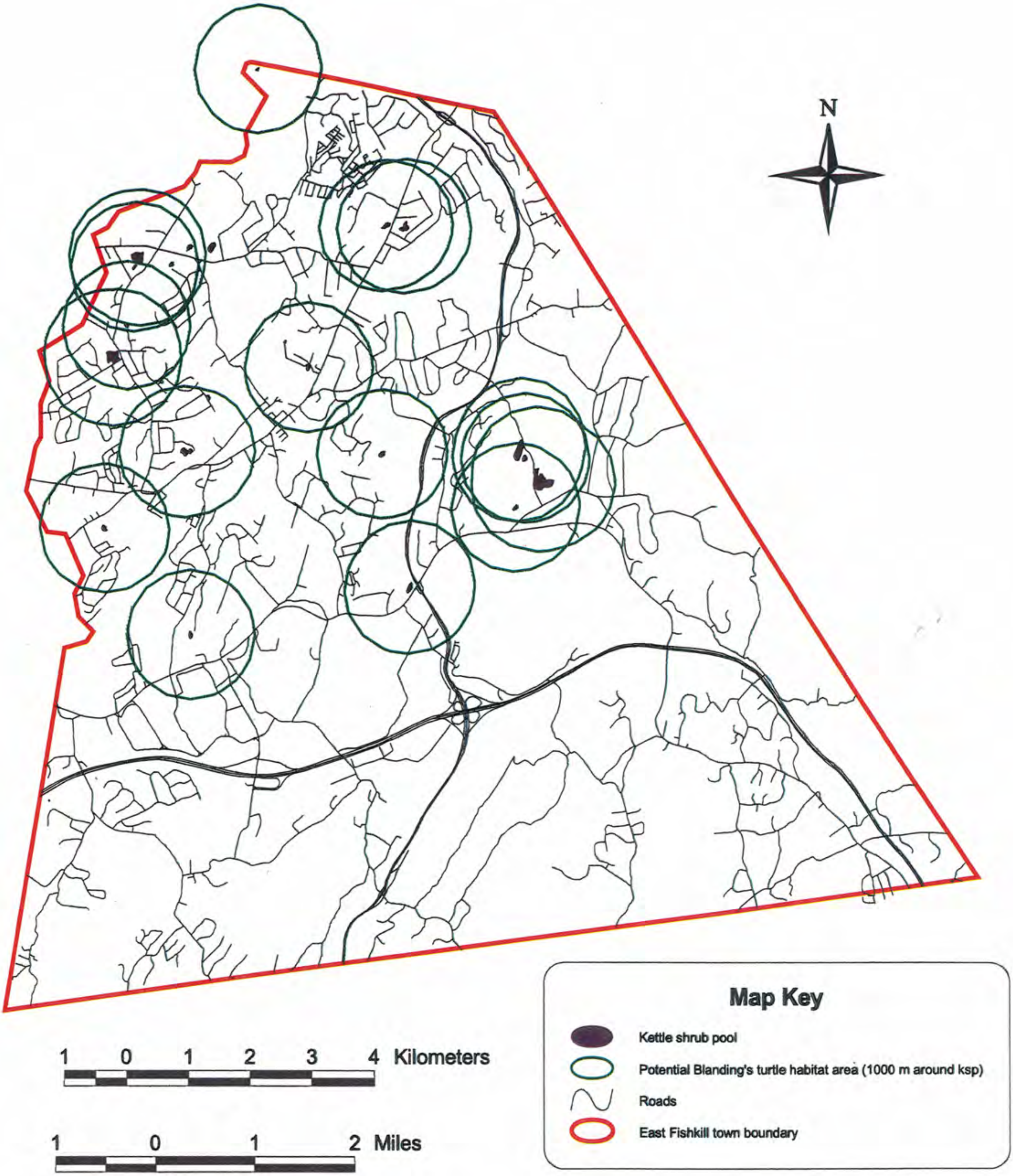

Figure 6. Kettle shrub pools, and potential Blanding's turtle habitat area surrounding each pool, East Fishkill, NY. (Habitat areas are omitted around pools that are completely surrounded by developed land uses.) Hudsonia Ltd., 2001-2002.

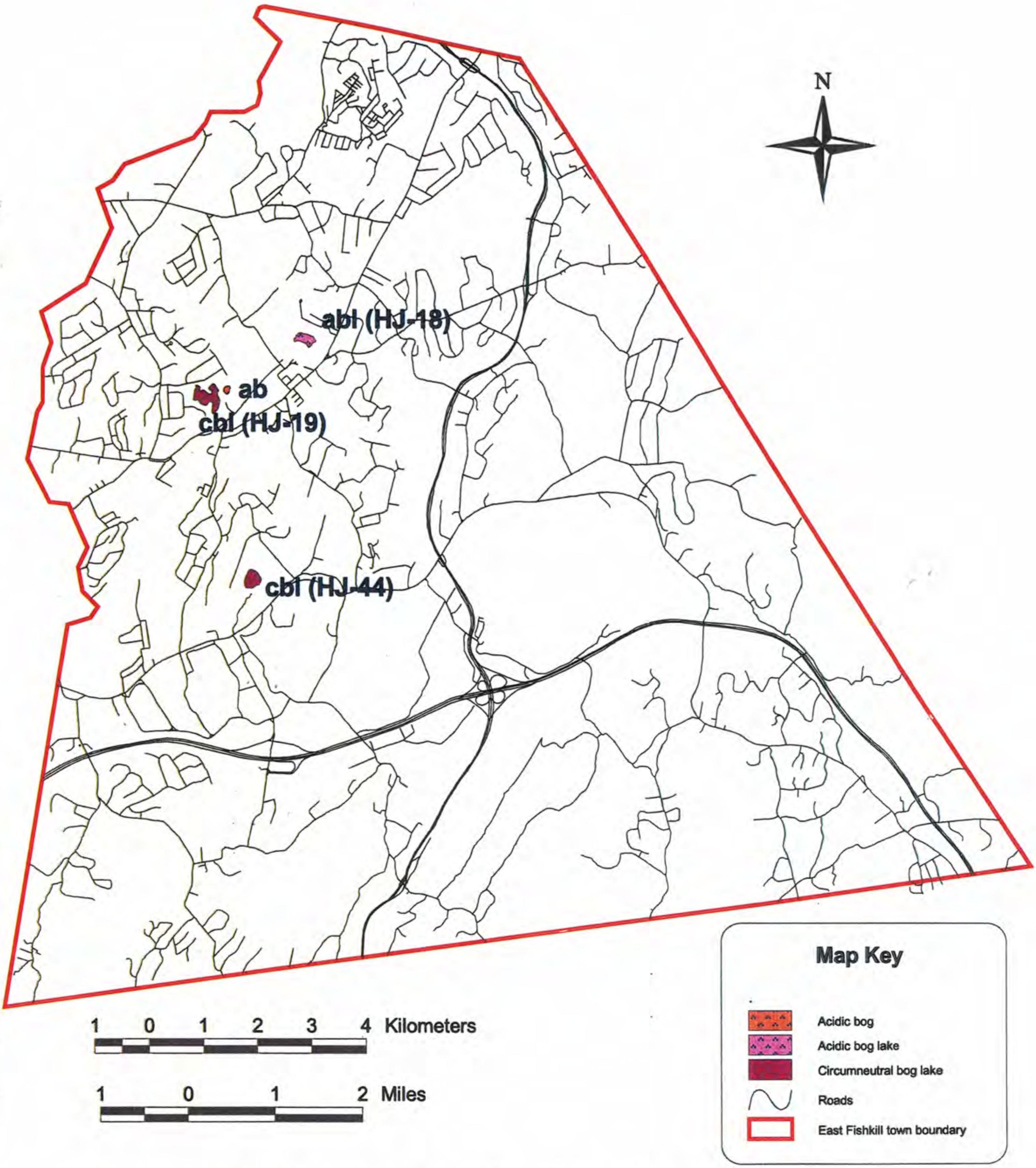

Figure 7. Acidic bog (ab), acidic bog lake (abl), and circumneutral bog lakes (cbl), East Fishkill, NY. Hudsonia Ltd., 2001-2002.

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APPENDIX 1

Explanation of ranks of species of conservation concern*

New York State Ranks referred to in this report.

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

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 United States 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 United States Department of the Interior, as enumerated in the Code of 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).

New York Natural Heritage Program Ranks (statewide) referred to in this report.

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.

(continued)

*Explanations of New York State Ranks and New York Natural Heritage Program Ranks are taken from the New York Natural Heritage Program website, updated March 2002. Explanations of regional ranks are taken from the *Biodiversity Assessment Manual for the Hudson River Estuary Corridor* (Kiviat and Stevens 2001).

APPENDIX 1 (cont.)

Regional Ranks

Hudsonia has compiled preliminary lists of native plants and animals that are rare in the Hudson Valley but do not appear on statewide or federal lists of rarities. We use criteria similar to those used by the NYNHP for ranking statewide rare elements, 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 provisional only, and subject to change as we gather more information about species occurrences in the region. The regional ranks were first published in Kiviat and Stevens (2001).

We use the following criteria for regional ranks:

regionally rare: 20 or fewer occurrences in the Hudson Valley (south of the Troy Dam) or a very few individuals of highly mobile species.

regionally scarce: 21-100 occurrences in the Hudson Valley (south of the Troy Dam).

regionally declining: Species believed to have declined in the Hudson Valley (south of the Troy Dam) during the past 1-4 decades. Some of these species are still common. Examples are smooth green snake, American black duck, and American kestrel.

regionally vulnerable: Species that are not necessarily rare but are vulnerable to habitat loss and degradation, or to other likely changes in their environment. Some of these species have declined and recovered during the past 100-200 years. Examples are wood duck, eastern bluebird, and spotted salamander.

APPENDIX 2

Common and scientific names of plants mentioned in this report. Scientific names follow the nomenclature of Mitchell and Tucker (1986).

Common Name	Scientific Name	Common Name	Scientific Name
alder	*Alnus*	elm. slippery	*Ulmus rubra*
arrow-arum	*Peltandra virginica*	fern, marsh	*Thelypteris palustris*
arrowhead	*Sagittaria*	fern, walking	*Asplenium rhizophyllum*
arrowwood, northern	*Viburnum dentatum var. lucidum*	flag, blue	*Iris versicolor*
ash, green	*Fraxinus pensylvanica*	foxtail, short-awn	*Alopecurus aequalis*
aspen, quaking	*Populus tremuloides*	goldenrod, stiff-leaf	*Solidago rigida*
azalea, swamp	*Rhododendron viscosum*	goldenseal	*Hydrastis canadensis*
barberry, Japanese	*Berberis thunbergii*	grass-of-Parnassus	*Parnassia glauca*
basswood	*Tilia americana*	grass, pale alkali-	*Torreyochloa pallida v. pallida*
beech	*Fagus grandifolia*	hackberry	*Celtis occidentalis*
birch, gray	*Betula populifolia*	hairgrass	*Deschampsia flexuosa*
blackberry	*Rubus allegheniensis*	harlequin, yellow	*Corydalis flavula*
bladdernut	*Staphylea trifolia*	hawthorn	*Crataegus*
bladderwort	*Utricularia*	hemlock, eastern	*Tsuga canadensis*
blueberry, early low	*Vaccinium pallidum*	hickory	*Carya*
blueberry, highbush	*Vaccinium corymbosum*	knotweed, slender	*Polygonum tenue*
blueberry, late low	*Vaccinium angustifolium*	leatherleaf	*Chamaedaphne calyculata*
bluejoint	*Calamagrostis canadensis*	loosestrife, purple	*Lythrum salicaria*
bluestem, little	*Schizachyrium scoparium*	mannagrass	*Glyceria*
boldenrod, bog	*Solidago uliginosa*	maple	*Acer*
buckthorn, alder-leaf	*Rhamnus alnifolia*	maple, red	*Acer rubrum*
butterflyweed	*Asclepias tuberosa*	meadowsweet	*Spiraea latifolia*
buttonbush	*Cephalanthus occidentalis*	mermaidweed	*Proserpinaca palustris*
canary-grass, reed	*Phalaris arundinacea*	(moss)	*Helodium paludosum*
cattail	*Typha*	moss, peat	*Sphagnum*
chokeberry	*Aronia*	oak	*Quercus*
cinquefoil, shrubby	*Potentilla fruticosa*	oak, chestnut	*Quercus montana*
cliffbrake, purple	*Pellaea atropurpurea*	oak, red	*Quercus rubra*
coontail, spiny	*Ceratophyllum echinatum*	oak, scrub	*Quercus ilicifolia*
cottonwood, swamp	*Populus heterophylla*	oak, swamp white	*Quercus bicolor*
cranberry, large	*Vaccinium macrocarpon*	pickerelweed	*Pontederia cordata*
cranberry, small	*Vaccinium oxycoccos*	pine, pitch	*Pinus rigida*
diarrhena	*Diarrhena americana*	pine, white	*Pinus strobus*
dogwood, gray	*Cornus foemina ssp. racemosa*	pitcher-plant	*Sarracenia purpurea*
dogwood, silky	*Cornus amomum*	polypody, rock	*Polypodium virginianum*
elm, American	*Ulmus americana*	pondweed	*Potamogeton*

(continued)

Appendix 2 (cont.)

Common Name	Scientific Name	Common Name	Scientific Name
prickly-ash, American	*Zanthoxylum americana*	spikerush	*Eleocharis*
raspberry, black	*Rubus occidentalis*	spikerush, pale	*Eleocharis flavescens*
raspberry, red	*Rubus idaeus*	spleenwort, ebony	*Asplenium platyneuron*
red cedar, eastern	*Juniperus virginiana*	spleenwort, mountain	*Asplenium montanum*
reed, common	*Phragmites australis*	steeplebush	*Spiraea tomentosa*
sarsaparilla, bristly	*Aralia hispidus*	St. Johnswort, shrubby	*Hypericum prolificum*
sedge	*Carex*	sumac, poison	*Toxicodendron vernix*
sedge, cattail	*Carex typhina*	sweet-gale	*Myrica gale*
sedge, clustered	*Carex cumulata*	twig-rush	*Rhyncospora*
sedge, Davis'	*Carex davisii*	wall-rue	*Asplenium ruta-muraria*
sedge, lakeside	*Carex lacustris*	water-lily, fragrant	*Nymphaea odorata*
sedge, Pennsylvania	*Carex pensylvanica*	watermilfoil	*Myriophyllum*
sedge, porcupine	*Carex hystericina*	water-plantain	*Alisma triviale*
sedge, sterile	*Carex sterilis*	water-willow	*Decodon verticillata*
sedge, tussock	*Carex stricta*	whitlow-grass, Carolina	*Draba reptans*
sedge, woolly-fruit	*Carex lasiocarpa*	wild-columbine	*Aquilegia canadensis*
sedge, yellow	*Carex flava*	willow	*Salix*
sheep-laurel	*Kalmia angustifolia*	willow, autumn	*Salix serissima*
spike-muhly	*Muhlenbergia glomerata*	woolgrass	*Scirpus cyperinus*