Wildlife Habitats, Natural Communities, and Rare Species Analysis for Concord, New Hampshire

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October 2010

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Cover: Red maple floodplain forest along the Soucook River
Above: *Pontederia cordata* (pickerel weed) dominates the border of Turtletown Pond

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ACKNOWLEDGEMENTS

Ellen Snyder provided critical perspectives and input in the interpretation of wildlife data, identification of conservation priorities, and edits and additions to report text regarding wildlife. Many thanks to Pete Ingraham of Exeter, NH for production of all maps. Thanks to Peter Ellis for providing initial GIS support. I also thank Michael Tardiff, Becky Hebert, Vanessa Goold, and Chris Kane for their support during this project. Thanks to the NH Fish and Game Department and the NH Natural Heritage Bureau (DRED) for the use of their models and data.

This project was funded through the Central New Hampshire Planning Commission in support of CTAP planning efforts for the City of Concord.

OVERVIEW

This project contains a detailed analysis of wildlife habitats, natural communities, and rare species in Concord, New Hampshire. New Hampshire Fish and Game Wildlife Action Plan (WAP) habitat maps were refined based on GIS analysis and field work. Rare species and natural community data were obtained from NH Natural Heritage Bureau and interpreted to help identify important habitats and conservation areas. Other key ecological features of the landscape, such as ecological regions, large wetland complexes, unfragmented forest blocks, and wildlife corridors were considered along with the WAP and NHB data to identify conservation priorities for Concord, New Hampshire that are critical to biodiversity protection.

1 - METHODS

1.1 - WAP HABITAT MAP REFINEMENT

Data compilation: The 2010 release of New Hampshire Fish & Game's Wildlife Action Plan (WAP) habitat and assessment data were compiled, clipped to the bounds of Concord, and shape files set up for the purposes of validating and refining the WAP habitat polygons. Other GIS data were compiled from GRANIT and other sources to enable interpretation of the WAP and NHB data, including color and black and white ortho-photos, wetlands (Concord and NWI data), roads, hydrography, geology, soils, and public lands data from GRANIT and the City of Concord.

Seven habitats are mapped in Concord, including two "matrix" forest types (which cover large areas of the state and in Concord), and five smaller "patch" habitats (which typically cover areas on a scale of several to perhaps a hundred acres for most patches). The two matrix forest types are Hemlock - Hardwood - Pine Forest; and Appalachian Oak - Pine Forest. The five patch types are Pine Barrens, Floodplain Forests, Marshes, Peatlands, and Grasslands. Certain habitats were not predicted in Concord, such as Spruce – Fir Forest, Rocky Ridges, Dunes, and Cliffs.

Refinement prioritization: I prioritized the WAP habitat map refinements based on habitat rarity and importance for species diversity, as well consideration of time that would be required to complete a comprehensive and even refinement of the habitat. Pine Barrens and Floodplain Forests are relatively rare at a statewide scale, followed by Peatlands, which are uncommon; Marshes and Grasslands are more common statewide than the other three patch habitats. As such, I focused most of my revision efforts on Pine Barrens, Floodplain Forests, and Peatlands because they have a restricted statewide distribution, they contain important biological diversity (plants, animals, and natural communities), and therefore, represent potentially higher conservation significance than more common types. I made some modest but significant improvements to the marsh habitat layer. Relatively little effort was expended on improving or verifying the Grasslands habitat layer. In general, the Grasslands layer depicts open agricultural and field habitats reasonably well, and considerable time and effort would be required to modify the boundaries via air photos for improved gains in resolution and ultimately only modest improvement in conservation information.

As far as matrix forest types, Hemlock - Hardwood - Pine Forests are common in central and southern New Hampshire, whereas Appalachian Oak - Pine Forests are less common and restricted to southern portions of the state. I executed some large area changes to the matrix forest types, particularly the less common Appalachian Oak - Pine Forest layer, but these changes represent only a fraction of the improvements that could result from additional effort. Improvements to the matrix forest types are relatively more difficult than the patch types because they involve lots of polygons, cover much more area, and are more difficult to verify remotely via GIS scanning.

Refinement process: I validated and improved the habitat maps by an iterative process beginning with desktop scanning with air photos and other GIS layers, followed by field work, and finally additional desktop scanning. There were two broad types of refinements: 1) confirmation, rejection, or correction the identity of the habitat type; and 2) refinement of the boundaries of polygons to more accurately depict their extent on the ground (for example, in cases where the boundaries were inaccurate, or they over- or under-predicted the known or probable extent on the ground). Signatures evident from ortho-photos were universally useful for both validating identity and improving boundaries of all habitats. Soil types, surficial geology, wetland and hydrography layers, topographic maps, and personal familiarity with sites on the ground were also important collateral references. The combination of layers used varied with habitat type and the degree of uncertainty.

An initial GIS scan of the patch-habitat types yielded both identity and boundary improvements. During this initial scan, I identified both general areas and individual polygons to investigate in the field, including some of the many areas where WAP habitat types overlapped (i.e., more than one habitat predicted for one location). Field work was useful for determining general patterns of over- and under-prediction for the type, as well as a basis to validate and improve boundaries of individual polygons and correspondence with other GIS layers during the final scan. Ultimately, I made field observations at more than 150 locations, in addition to dozens of other locations observed prior to this project.

1.2 - PREDICTED EXEMPLARY NATURAL COMMUNITIES

Two limitations of NHB data are: 1) they do not represent a comprehensive inventory of most parts of the state, including Concord; and 2) the policies of NHB prevent potentially valuable conservation information in the Biotics database from reaching conservation entities in their most specific, useful form.

However, it is still useful to look at the WAP habitat polygons through the “lens” or approach used by NHB to identify exemplary natural communities or systems. Thus, I applied NH NHB exemplary natural community ranking criteria for natural communities associated with predicted WAP Floodplain Forest, Pine Barrens, peatland, and marsh habitat polygons. These criteria use a combination of rarity, size, ecological condition, and the surrounding landscape context to evaluate natural community systems. Using these criteria, I identified habitat polygons (or groups of them) that appear to meet the criteria for exemplary natural community or system status. Many of these areas are not presently identified as exemplary in the NHB database.

It should be emphasized that additional data would need to be compiled and submitted to NHB for validation and inclusion in the NHB data base. Some areas may not quite meet the specifications required. Regardless of which side of the fence these areas may ultimately fall, they do represent some of the more intact systems of natural communities and wildlife habitats apparent from the refined WAP habitat maps, and should help prioritize sites for additional data collection.

1.2 - Rare Species and Exemplary Natural Communities

Data compilation and interpretation: I attempted to obtain site- and species-specific data from the NH NHB for Concord. However, NHB was only willing to provide data according to one of their standard protocols involving "fuzzed" data. In this case, the data request was filled by GRANIT, and contained species and community ("elements") locations, randomly displaced by up to 500 feet, with the identity revealed only to broad group (plant, reptile, amphibian, bird, insect, mollusk, natural community, or natural community system). Any maps produced from these data are required to be buffered by one or 1-1/2 mile diameter circles around each dot (depending on mapping accuracy), which would be of limited utility for specific town level conservation planning.

I also obtained a list of all the known rare species and exemplary natural communities in Concord from the NHB website. This list is not location-specific. However, by considering this list together with the data from GRANIT, ranks of species, and various GIS layers, I was able to derive the species or type with a high degree of confidence for all reptile, amphibian, bird, mollusk, and natural community locations in Concord, and nearly all plant locations (a total of 93 element locations). It was not possible to interpolate the butterfly and moth data with as much success since there are so many species with similar rarity or legal status. However, all of the insects are pine barren species (59 occurrences) associated with pitch pine habitat remaining in Concord (mostly on the Concord Heights). These specific data will not be displayable or reportable in the report; however, their derivation had an important influence on recommendations in this report.

Next, I identified the broad habitats and groups of natural communities associated with each species (sandplain/pine barren, aquatic, Floodplain Forest, peatland, marsh, etc). I attributed each species and community type in GIS shape files as well as in the results section below. These species-habitats are either the same or very similar to the scale of WAP habitats and to broad groups of natural communities. Somewhat more specific habitats are listed in the results section when applicable for a particular species.

1.3 - Conservation Recommendations

A Word About the WAP Habitat Quality Assessment

The WAP contains a Habitat Quality Assessment for New Hampshire. This assessment represents an analysis of the statewide habitat maps and various indicators of habitat condition and diversity. The maps associated with this assessment break the state down into a prioritized scheme: "Tier 1" areas are the highest priority areas from a statewide perspective; "Tier 2" are important regionally within the

state; and “Supporting Landscapes” are those that buffer or provide additional biological support to the core Tier 1&2 landscapes. The remaining areas of the state are unranked.

I did not attempt to revise or modify the WAP habitat quality assessment maps directly. It would be difficult to determine the appropriate score adjustment for a given pixel, patch, or group of habitat patches that have been revised without re-running the analysis based on the revised data (a task only Fish & Game could perform). For example, if an area mapped as Pine Barrens in the 2010 WAP maps turned out to be a common matrix forest type, this would presumably result in a diminishment of the polygon score, and could potentially affect the score of the larger un-fragmented block the polygon occurs in. It is also difficult to determine the appropriate score adjustment in areas where a habitat patch was enlarged greatly, and whether the change was great enough to indicate a shift, for example, from Tier 2 to Tier 1.

I encourage the users of this report to consult the results and maps of both analyses, and to view them as complimentary pieces of information. The WAP analysis provides important statewide and regional perspective for the greater Concord area.

Conservation Priorities

The conservation recommendations in this report are based on a fresh, relatively straightforward interpretation of the revised data, in addition to other ecological inputs. This process did not attempt to replicate the methods and various factors used by F&G, which included a complex suite of data inputs to evaluate ecological condition. These methods are calibrated to the statewide scale and would be time intensive to replicate at a local scale.

Emphasis was placed on the following factors:

- Revised WAP polygons and predicted exemplary NCs
- Complexes of communities/habitats, including larger wetland complexes and diverse upland-wetland complexes
- Rare species and exemplary natural community locations
- Large un-fragmented forest blocks
- Degree of fragmentation and development (sources of stress to ecological integrity)
- Known and potential wildlife corridors between major areas of protected land (including consultation of Statewide Wildlife Connectivity Model for New Hampshire developed by NH Fish and Game and NH Audubon)
- Location of existing conservation lands

2 - Results

2.1 - Ecological Regions of Concord, New Hampshire

Concord is an amazingly diverse and interesting area ecologically. Physical features of the land have an important influence on the patterns of biological diversity in the landscape. Delineation of landscape scale patterns in Concord can help frame and interpret the ecological data and conservation priorities presented in this report. To this end, I submit a preliminary classification of ecological regions of Concord. Seven ecological regions are presented here (Figure 1) based on different combinations

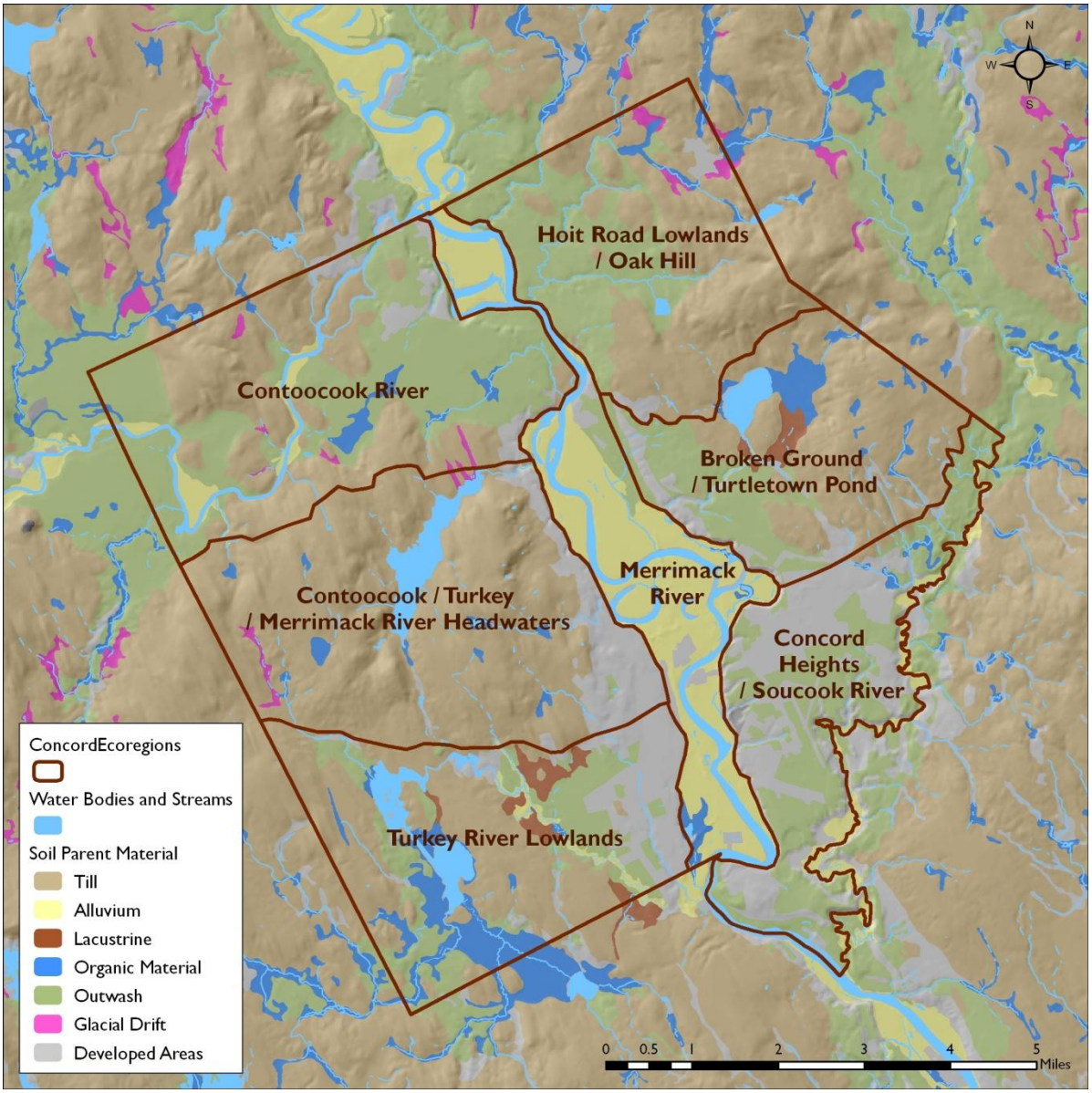

Figure 1. Ecological Regions of Concord, New Hampshire.

of surficial geology and landscape position, hydrography, and natural communities that occur in different parts of the City. Secondarily, I used roads that follow or approximate ecological transitions. Each of the regions can be broken down into subregions based on finer scale divisions of features. Most of these regions and subregions revolve around familiar landmarks of Concord. The delineation and naming of regions is certainly debatable. Different boundaries could be generated if different factors and patterns are emphasized over one another. However, the precise boundaries are less important than the landscape-level ecological patterns and systems they draw attention to. Table 2 describes the key features of these ecological regions.

The surficial deposits, or parent materials, depicted in Figure 1 are the raw material that soils developed from. These parent materials consist of different combinations of rock, gravel, sand, and silt that were deposited by glaciers or various meltwater environments. **Glacial till**, or simply till, consists of a an unruly mix of boulders, stones, gravel, sand, silt, and clay once trapped within or beneath a glacier. **Alluvium** consists of fine materials, typically sand or silt, that were deposited by moving water in former or current riverine environments. **Lacustrine** deposits are fine silts and clays laid down in quite-water environments of the former glacial Lake Merrimack that occupied the Merrimack Valley during glacial meltdown. **Organic materials** are poorly decomposed plant matter that has accumulated in saturated basins over the thousands of years since glacial retreat. **Outwash** consists of coarse sand and gravel deposited beyond the terminus of melting glaciers. The Concord Heights is a huge, former delta of a river that poured into Glacial Lake Merrimack. The term **sandplain** as used in this report refers to outwash or other relatively flat sandy soil areas. **Glacial drift** is a mix of rocky material deposited by glaciers, often mixed with finer sediments deposited by meltwater flowing from a glacier. These various parent materials can range from extremely dry to very wet, depending on the proximity of the water table to the surface.

Table 1. Attributes of Ecological Regions of Concord, including parent material, geologic setting, and key ecological features (wildlife habitats and natural communities).

Ecological Region & Subregions	Parent Material/Geologic Setting	Key Ecological Features
1) Merrimack River	Alluvium (Floodplains & high terraces)	Intact riparian river corridor: major migratory route for ducks, geese, and songbirds; roosting & foraging sites for bald eagle and osprey; exposed banks (bank swallow nest sites); associated backwaters, oxbows, and fields are potential or known habitats for wood and spotted turtles; wildlife corridor for otter, mink, & beaver; Floodplain Forest habitat for several uncommon songbirds such as blue-gray gnatcatcher and red-shouldered hawk; associated fields offer food sources for southbound migrating sparrows. The Merrimack River is a designated Important Bird Area
a) Hannah Dustin-Sewalls Falls	Alluvium	Agriculture, river, upland forest border
b) Sewalls Falls – Garvins Falls	Alluvium, floodplains	Extensive silver maple floodplain & terrace forests, agriculture, river
2) Contoocook River Valley	Outwash plains and till uplands	Large forest blocks embedded with wetlands and open lands and near river corridor: important to snakes and turtles susceptible to road mortality, including black racer, spotted turtle, wood turtle, Blanding's turtle; extensive sandplain peatland supports large population of the rare inflated sedge
a) Horse Hill	Till uplands	Large unfragmented forest block, Peatlands
b) Mast Yard outwash	Outwash (various drainage classes)	Pine Barrens, floodplain & terrace forest
c) Bog Road/Penacook Plains	Outwash (well to poorly drained), Organic materials	Extensive sandplain peatland/sedge meadow, swamp & upland forest on outwash
d) Contoocook River corridor	Aquatic, limited floodplain	River
3) Contoocook/Turkey/ Merrimack River Headwaters	Till uplands	Large forest blocks embedded with wetlands and open lands: important to snakes and turtles susceptible to road mortality, including known or potential habitat for black racer, spotted turtle, wood turtle, Blanding's turtle; provides connectivity to Turkey Ponds and Turkey River
a) Penacook Lake/Rattlesnake Hill	Till uplands, headwater drainages	Large unfragmented forest block, municipal water supply
b) Beech & Pine Hill headwaters	Till uplands	Large unfragmented forest block, headwaters & corridor between Contoocook & Turkey River watersheds, small pocket wetlands
4) Turkey River Lowland	Outwash, floodplain, lacustrine deposits, low till hills	Large, interconnected wetland complex critical to maintaining viable population of rare turtles; associated fields and other disturbed areas serve as turtle nest sites
a) Turee Brook/Turkey Ponds	Ponds & wetland complexes	Large ponds, large wetland complex

b) Turkey River Plains	Outwash & lacustrine deposits, floodplain (moderately well drained to poorly)	Floodplain Forest, agriculture, small river
5) Hoit Road Lowland/Oak Hill	Outwash and till uplands, marshes and organic material	Wetland complex within upland forest block: habitat and connectivity potential for Blanding's, spotted, and wood turtles
a) Oak Hill	Till uplands	Appalachian oak – pine and Hemlock - Hardwood - Pine Forests
b) Hoit Rd. Marsh/Hackard Bk.	Till uplands, large wetland complexes	Marshes & Peatlands along brooks
c) North Concord Plains	Outwash (somewhat excessively to moderately well drained)	Appalachian oak – pine and Hemlock - Hardwood - Pine Forests
6) Broken Ground/Turtletown Pond	Till uplands, large peatland complex and pond, lacustrine deposits	The largest unfragmented forest block, embedded with wetlands and open lands (powerline corridor): habitat and connectivity for wide-ranging species such as moose, black bear, bobcat, fisher, northern goshawk; Large forest blocks embedded with wetlands and open lands and near river corridor: important to snakes and turtles susceptible to road mortality, including black racer, spotted turtle, wood turtle, Blanding's turtle. Habitat potential for early successional species such as black racer, smooth green snake, American woodcock
a) Turtletown Pond	Large pond & wetlands, glacial lake deposits	Large pond and wetland (peatland, swamp, marsh)
b) East Concord Plains	Outwash (excessively to moderately well drained)	Appalachian Oak - Pine Forest on outwash, pitch pine fragments, river bluffs
c) Broken Ground Headwaters	Till uplands	Large unfragmented forest block, pocket wetlands (Peatlands and Marshes)
7) Concord Heights/Soucook River Valley	Outwash, minor river floodplain, sandy river bluffs and terrace slopes	Large grassland and Pine Barrens complex: supports nesting habitat for several uncommon bird species including state threatened grasshopper sparrow; known or potential habitat for state endangered eastern hognose snake, and the only habitat in NH for federally endangered Karner blue butterfly and many rare moths. Concord Airport Grasslands is a designated Important Bird Area
a) Concord Heights	Outwash (excessively drained)	Pitch Pine Barrens; Grasslands around airport
b) Soucook River Valley	Outwash (excessively drained), floodplain	Red maple floodplain & terrace forests, river bluffs, Pine Barrens
c) Garvins Falls Peninsula	Till upland, outwash	Appalachian Oak - Pine Forest, Pine Barrens, river corridor

2.2 - WAP Habitats and Natural Communities

Descriptions of WAP Habitats/Natural Communities

The WAP identified 19 different habitat types for NH (WAP 2005), seven of which occur in Concord NH: Grasslands, Pine Barrens, Peatlands, Floodplain Forest, Marsh and Shrub Wetlands, Appalachian Oak - Pine Forest, and Hemlock - Hardwood - Pine Forest. Most WAP habitats are naturally occurring, such as Marshes and various types of forest; a few, including Grasslands, require human intervention to maintain.The WAP list of 19 critical habitats was developed by NHFG based on the habitat requirements of associated wildlife species of conservation concern in the state. Many wildlife species require multiple habitat types, hence the importance of implementing wildlife habitat conservation at larger scales, such as at the ecological region and subregion scales described in this report. Other species, including many insects and other invertebrates, are specific to certain natural communities, micro-habitats within them, or plant species that occur in them.

Natural communities are recurring assemblages of plants and animals found in particular physical environments (Sperduto and Nichols 2004). WAP habitats consist of one or more types of natural communities. These habitats usually represent a broader range of vegetative and structural conditions than natural communities, which typically correspond to more specific plant species composition and physical conditions. Some natural communities correspond directly to habitats, while others are embedded features within a habitat type. Both habitats and their component natural communities occur in specific settings in the landscape. As physical settings change from one location to another, such as from a wind-exposed rocky summit to a forest below, there is a corresponding shift in the composition of plants and animals, producing different habitats and component natural communities that form predictable patterns across the landscape.

Below are abbreviated descriptions of the WAP habitats in Concord, key natural communities (or systems of natural communities) that correspond to them, and groups of species that occur in them, including rare species know to occur or that could potentially occur in Concord (see Table 2 for details).

WAP Patch types

These habitats typically occur in patches at a scale of tens to hundreds, or sometimes thousands of acres. Although collectively they cover a minority of the landscape, they contribute a great amount of biological diversity and critical habitat conditions within the larger landscape of upland forests and networks of streams, rivers, lakes and ponds.

Pine Barrens: Pine Barrens occur on excessively well drained sand soils with a history of frequent fire. Fire maintains pitch pine, scrub oak, wild lupine, and numerous other sandplain plants that require open conditions created by fire, or otherwise maintained by human activity in these areas. Pine Barrens also support a tremendous diversity of Lepidoptera (butterflies and moths) including the federally-endangered Karner blue butterfly, as well as vertebrate species such as Fowler's toad, eastern towhee, eastern hognose snake, and smooth green snake. Fire suppression and harvesting practices have eliminated pitch pine, scrub oak, and other Pine Barrens species in some areas, transforming former

Pine Barrens into either Appalachian Oak - Pine Forests or Hemlock - Hardwood - Pine Forests (see habitat descriptions below). Despite extensive development in and around the Concord Pine Barrens, many rare sandplain species persist, indicating the importance of remaining patches of Pine Barrens.

Examples of Pine Barrens natural communities that occur in Concord: pitch pine sand plain system; pitch pine - scrub oak woodland; dry river bluff.

Grasslands: Grasslands are created and maintained by human activity. They include mowed hayfields, pasture, croplands, and other maintained openings such as airport runways and capped landfills. A few natural communities contain small patches of native grasslands, such as riverwash gravel bars, but these are rare and form miniscule portions of the landscape.

Several breeding birds require large grassland habitat. Fifty to 75% of the statewide population of the threatened grasshopper sparrow is documented at the Concord Airport. Grassland management at the airport appears to be compatible with the sparrows' continued presence, and ongoing management related to restoration of the Karner blue butterfly may even create new habitat for sparrows as well. The shorter grass at the airport also supports several other species of conservation concern: vesper sparrow, eastern meadowlark, horned lark. The extensive Grasslands around the airport and smaller patches elsewhere in the Concord Heights are mapped as Pine Barrens habitat because of the many rare plant and invertebrate species rely on sand-soil grasslands openings.

Cropped fields can be important to migrating or wintering birds. In October 2002, hundreds of sparrows of a dozen species frequented the fields behind the Concord Post Office. These birds were joined by smaller numbers of indigo buntings, red-winged blackbirds, bobolinks, palm warblers, American pipits, and dickcissels. Other fields throughout the area regularly host small flocks of most of these species, in addition to horned larks.

Floodplain Forests: Floodplain Forests occupy the margins of streams and rivers throughout the state on flat terraces that flood regularly. The lowest Floodplain Forests flood every 1-2 years (or less frequently), with longer flood return intervals at higher elevations. They are generally better drained than swamps, but more poorly drained than upland forests. Tall trees and a dense layer of flood-tolerant herbs characterize Floodplain Forests. Non-native plants are abundant in many Floodplain Forests.

Several rare plants occur in Floodplain Forests. *Lygodium palmatum* (climbing fern) is one that occurs in Concord. Floodplain Forests along major rivers, such as the Merrimack River through Concord, provide some of the most critical wildlife habitat for spring and fall migrants and for aquatic-dependent species such as turtles and many amphibians. The complex of backwaters, oxbows, vernal pools, flooded forests, marshes, shrub wetlands, and nearby meadows and fields form suitable habitat for northern leopard frog, bald eagle, wood turtle, and dozens of species of migrating ducks, geese and songbirds. Floodplain Forests and open water along the Merrimack River provide roost and foraging sites for bald eagles and ospreys. Exposed banks offer nest sites for bank swallows.

Examples of Floodplain Forest natural communities that occur in Concord: major river silver maple floodplain system; silver maple - false nettle - sensitive fern floodplain forest; sugar maple - silver

maple - white ash floodplain forest; temperate minor river floodplain system; red maple floodplain forest; alder - dogwood - arrowwood alluvial thicket.

Peatlands: Peatlands are very poorly drained wetlands that occur in depressions or along sluggish drainage ways, where soils remain saturated throughout the year. As a result, organic matter decomposes slowly, eventually accumulating into thick deposits of organic soil (peat). Heath shrubs and peat mosses dominate in open bogs, which are extremely acidic types of peatlands. A more diverse mix of plants occurs in open fens, including non-heath shrubs, sedges, and other herbaceous plants. Fens are less acidic than bogs, but most are more acidic than marshes. Fens look similar to marshes superficially, but they are more nutrient-poor and have less pronounced water level fluctuations. WAP Peatlands also include conifer swamps. Large wetland complexes often contain both marsh and peatland habitats, with peatlands occurring in portions of a wetland with less overbank flow from streams and limited upland runoff.

Certain rare plants are restricted to peatlands, including several uncommon to rare orchids, and many sedges, such as *Carex bullata* (inflated sedge), a state endangered coastal plain plant recently discovered in Concord. Important wildlife that occur in peatlands (or peatlands and marshes) in Concord or have the potential to occur here include Blandings turtle, spotted turtle, eastern towhee, ribbon snake, and migrating songbirds including the palm warbler.

Examples of Peatland natural communities that occur in Concord: Poor level fen/bog system; medium level fen system; temperate peat swamp system; large cranberry – short sedge moss lawn; winterberry - cinnamon fern wooded fen; black spruce – larch swamp.

Marsh and Shrub Wetlands: Marsh and Shrub Wetlands (simplified as “Marshes” here) occupy wetland basins with broadly fluctuating seasonal water levels. Water remains near or above the surface for substantial portions of the growing season. Marshes are wetter than swamps, and better drained and more nutrient-rich than peatlands. Herbaceous plants and shrubs dominate Marshes. Trees are sparse or absent, but flood tolerant shrubs, grasses, sedges, forbs, and aquatic plants are common, depending on the range of hydrologic conditions within the wetland. Overall Marshes are more common than peatlands in the state. Large wetland complexes often contain both marsh and peatland habitats, with Marshes occurring in portions of a wetland with more influence of runoff from uplands and overbank flow from streams.

Wetlands complexes that are interconnected and unfragmented by roads are essential to maintaining viable populations of some species including Blanding’s and spotted turtles. A diverse mix of wetland types and hydroperiods (length of time inundated with water) including emergent marsh, shrub wetland, vernal pools, and river corridors are particularly important. Larger wetlands with areas of open water mixed with emergent vegetation can support marsh birds such as common Moorhead, pied-billed grebe, herons, and rails. Rare plants historically documented in aquatic marsh habitats in Concord include *Sagittaria rigida* (sessile-fruited arrowhead) and *Potamogeton nodosus* (knotty pondweed).

Examples of Marsh natural communities that occur in Concord: emergent marsh - shrub swamp system; alder - dogwood - arrowwood alluvial thicket; cattail marsh; emergent marsh; aquatic

bed; meadowsweet – robust graminoid sand plain marsh; sedge meadow marsh; mixed tall graminoid - scrub-shrub marsh.

WAP Matrix Forest Types

Hemlock – Hardwood – Pine Forests: As defined in the WAP, this habitat includes a great diversity of upland forest and wetland swamp communities, and covers much of central and southern New Hampshire. The core upland forest types are characterized by combinations of hemlock, American beech, white pine, birches, red maple, and red oak. Appalachian oak species, such as white oak and black oak, are absent or sparse. As this type is so broadly defined and covers large areas of the state, it supports a wide diversity of plant and wildlife species. Large, unfragmented tracks of forest are important to wide-ranging species such as moose, black bear, fisher, bobcat, and northern goshawk. The larger the forest block, typically the greater the diversity of smaller patch habitats embedded within. Interior forest birds such a veery, wood thrush, scarlet tanager, and ovenbird are more successful breeders in larger forested areas. Patches of small openings, powerline corridors, and wetlands further diversify the forest habitat, offering potential habitat to black racer, American woodcock, migrating birds, turtles and amphibians.

Examples of Hemlock – Hardwood – Pine Forest natural communities that occur in Concord: hemlock - hardwood - pine forest system; hemlock - beech - oak - pine forest; hemlock - cinnamon fern forest; dry red oak - white pine forest; a wide variety of swamp natural communities.

Appalachian Oak - Pine Forests: Appalachian Oak - Pine Forests are uncommon statewide and restricted to southern and coastal New Hampshire, and approach their northern limit in the Concord area of the Merrimack River valley. They are indicated by the presence of oak trees other than red oak, such as white, black, and scarlet oak, as well as a variety of shrubs and understory plants that also reach their northern terminus in southern NH. These are relatively common types of forest in Concord. Some are oak and hardwood dominated with relatively little white pine, especially those on glacial till soils; others are dominated or co-dominated by white pine, particularly those on sandy outwash soils. This forest type offers similar wildlife benefits as the Hemlock - Hardwood - Pine Forests. The presence of diverse patches within the forest and other microhabitat features such as coarse woody debris, rock crevices, burrows, standing dead trees, determines the suitability of the larger forested landscape for many wildlife species.

Examples of Appalachian Oak – Pine Forest natural communities that occur in Concord: Appalachian oak - pine forest system; dry Appalachian oak forest; pitch pine - Appalachian oak - heath forest.

HABITAT POLYGON REFINEMENT

The refined habitat maps are depicted in Map 1 (pdf). This map also depicts the predicted exemplary natural community polygons.

Patch types

The refined WAP habitat polygons are illustrated in the attached pdf map (Map 1). The discussion below summarizes modifications to each layer.

Pine Barrens: I concluded that Pine Barrens were greatly over-predicted in Concord by the WAP habitat model. Their original WAP map predicted Pine Barrens included 90+ polygons totaling close to 5,000 acres. My refined pine barren layer contains 38 polygons, totaling roughly 1,000 acres.

Given the significance of these habitats, I refined the boundaries of all of the remaining areas in some detail to reflect apparent current extent using the NAIP 2008 color ortho photos. I included forest, woodland, and shrubby expressions of Pine Barrens, as well as adjacent areas of maintained Grasslands, such as the margins of runways at the Concord Airport. Many sandplain plants and animals require or utilize fire- or human-maintained openings such as these, and therefore these areas are important for the short and long-term maintenance of Pine Barrens species.

There is good reason to suspect that Pine Barrens were more extensive in pre-settlement and early-settlement periods. However, I found only scattered or no pitch pine trees in the areas investigated near Bog Road, north Concord, and East Concord, all areas with extensive patches of predicted Pine Barrens. Many of these areas supported stands of white pine with co-dominance or sub-canopies of white oak, black oak, red oak, and other hardwoods. These areas are more appropriately classified as Appalachian Oak - Pine Forests, and I changed the classification accordingly. In addition, while many of these areas contain outwash parent material, they are mostly poorly to moderately well drained or somewhat excessively drained – generally too mesic to sustain frequent fire return intervals. There may well be some small- to modest-sized patches of pitch pine still extant in these parts of Concord, but any formerly extensive areas of pitch pine have probably been eliminated by a combination of a) the absence of frequent fire, which is necessary to maintain pitch pine and scrub oak; b) forest management practices favoring white pine and hardwoods; and c) displacement by urban development. In addition, given the lack of local seed source of pitch pine, scrub oak, and other Pine Barrens plants, restoring these areas to Pine Barrens would be a substantial, expensive, and long-term prospect.

Floodplain Forests: Floodplain Forests were also over-predicted in Concord by a factor of approximately two. Many of the predicted Floodplain Forest polygons (or large portions of them) occupied high terraces adjacent to the Contoocook, Merrimack, and Soucook Rivers that apparently do not flood. I refined the boundaries of most of the Floodplain Forest polygons based on interpretation of a combination of air photos, topographic maps, field work, and NRCS soils maps. Some of the polygons

may still contain some high terrace forests (i.e., that do not or only rarely flood) adjacent to floodplains, such as some of the Sunday sand soils along the Soucook River.

Peatlands: Most predicted Peatlands were fairly small, and those that were field-checked were reasonably good fits to the habitat type. One very large peatland along Bog Road was added (originally predicted as Hemlock - Hardwood - Pine Forest). This is one of two large Peatlands in Concord, both of which are dominated by tall shrub or sparse swamp peatland communities. The Bog Road example is a temperate peat swamp system, including various peatland communities such as basin swamp, tall shrub fen, and some large areas of sandplain sedge fen. The peatland contains what is apparently the largest population of *Carex bullata* (inflated sedge) in the state, a rare coastal plain sedge known currently from only a few sites.

Marshes (marsh and shrub wetlands): I made relatively few modifications to the marsh layer. Some polygons were changed to peatland habitat based on field work, and one very large marsh and shrub thicket system was added near Turkey Pond.

Grasslands: I made relatively few modifications to the Grasslands layer. For the most part, the habitat polygons reflected open fields, cropland, and Grasslands reasonably well at a coarse scale. Considerable time would be required to clean up the boundaries to match actual extent on the ground more closely, and to make meaningful distinctions between types of grassland openings.

Matrix forest types

The matrix forest types overlap considerably with the patch types. In general, the patch types should prevail in areas of overlap, and they are depicted this way in the maps associated with this report.

Hemlock - Hardwood - Pine Forests. This is the most common predicted habitat for Concord. While indeed common, I concluded that it is over-predicted. I encountered many areas of this mapped type that were better classified as Appalachian Oak - Pine Forest.

Appalachian Oak - Pine Forests: This type is mapped less extensively than Hemlock - Hardwood - Pine Forests. Field observations suggest that this type is under-predicted for Concord, and may even be as common as Hemlock - Hardwood - Pine Forests. Many of the originally predicted Pine Barrens in north and East Concord were re-classified as Appalachian Oak - Pine Forest. A large patch of predicted Hemlock - Hardwood - Pine Forest around Garvins Falls was also changed to Appalachian Oak - Pine Forest. These modifications are by no means complete: accurate corrections would require much more field work and/or refinements based on additional interpretation of soil types. Overall, Appalachian Oak - Pine Forests are less common in the state and therefore of somewhat higher conservation significance than Hemlock - Hardwood - Pine Forests.

2.3 - Rare Species and Exemplary Natural Communities

The interpreted rare species and exemplary natural communities data obtained from the NH NHB (July 2010) are presented in Table 2 (attached pdf). These data are supplemented with several newly discovered rare species found during the course of this project. The discovery of these species underscores the fact that there has not been a comprehensive inventory of rare species and communities in Concord. This is also reflected in the NHB database by numerous historical records (not confirmed within 20 years), and the bias towards Pine Barrens, certain riparian areas, and some large wetlands.

The data are organized to reflect the importance of certain systems and ecological regions, rather than taxonomic groups alone. In addition, while NHB could not allow me to reveal the ecological region for individual species or natural communities, they did permit me to identify the number of occurrences in ecological regions for groups of species (e.g., sandplain plants, riparian vertebrates). These numbers appear in the far right column and indicate some broad patterns of diversity of habitat-species groups across the City.

Exemplary natural communities represent the best or only remaining examples in the state for all types of natural communities. They include all examples of rare types, better examples of uncommon types, and the best examples of common types. NHB maintains criteria based on size, condition, and landscape context for each system or natural community type, which are applied to occurrences to determine if they are exemplary.

Predicted exemplary natural communities identified in this project are based on application of NH Natural Heritage Bureau (NHB) ranking specifications to refined WAP polygons, resulting in the identification of potentially exemplary natural communities or systems. Many of these areas are not presently verified as exemplary by NHB, nor do they represent NHB data directly.

2.4 - Conservation Recommendations

Proposed Conservation Priorities

The proposed conservation areas are summarized and framed within each of seven ecoregions in Table 3, and depicted in the pdf map attached with this report.

The selection of proposed conservation areas reflects consideration of the following factors:

- Revised WAP polygons
- Rare species and exemplary natural community locations
- Predicted exemplary natural communities
- Riparian zones
- Complexes of communities/habitats, including larger wetland complexes and diverse upland-wetland complexes
- Large un-fragmented forest blocks
- Degree of fragmentation and development
- Known and potential wildlife corridors between major areas of protected land
- Location of existing conservation lands

The information in Table 3 indicate the key important features of each area, and can help inform future discussions concerning modifications or alternative protection scenarios in these areas.

Although the specific areas of rare species and exemplary communities in the NHB database cannot be displayed on the attached map, it can be said that the combination of existing and proposed conservation lands would capture the actual locations or associated key habitats for the great majority of extant (observed in last 20 years) rare species and exemplary natural communities documented in Concord.

In addition, other worthy or alternative conservation areas not depicted in this map could be identified. Two examples involve the immediate corridors along the Contoocook River and the upper Soucook River (floodplain and terraces east of Route 106 and north of the Airport). The Contoocook River is clearly an important feature of northwest Concord. The reason the immediate Contoocook River corridor was not identified as a higher priority is because the floodplain riparian zone is less well developed than other Concord rivers, and because the upland forests on high terraces have lots of roads and houses close to the river. Similarly, the upper Soucook was not identified because of impacts from development on the patchy floodplain extent, and the narrow potential strip of conservation land available between Rt. 106 and the river. That said, the Loudon side of the river is more intact, and greater opportunities exist there to retain ecological values associated with the river.

Wildlife Corridors: The analysis of wildlife habitat and other ecological data to identify priority areas for conservation included an assessment of habitat connectivity and wildlife travel corridors. Protecting and maintaining these landscape linkages between key habitat patches is important to the long-term sustainability of wildlife populations. The assessment included use of the Connectivity Model for New Hampshire developed by NH Fish and Game and NH Audubon. This model was used to confirm potential

linkages identified through the analysis of WAP and other ecological data and knowledge of the habitat, range, and movement of species of concern known or thought to occur in the City of Concord. Land cover (i.e., habitat types), distance to roads and riparian areas, and proximity to existing conserved lands are key criteria used to identify potential pathways (and barriers) for wildlife movement.

Maintaining habitat connectivity and minimizing habitat fragmentation are particularly critical to turtles. Blanding's and spotted turtles are highly susceptible to road mortality and to predation by mid-sized predators such as raccoons and skunks, which thrive in fragmented landscapes. In addition, these turtles utilize a variety of wetland types throughout the year, requiring large wetland complexes unfragmented by roads. Wide-ranging species, such as fisher, black bear, and bobcat also require corridors as their ranges usually extend well beyond even the largest remaining habitat blocks. Migratory birds follow riverine-riparian corridors, such as the Merrimack River, during spring and fall migration.

OTHER RECOMMENDATIONS

- Comprehensive Inventory of species, habitats, and natural communities: Concord has not benefited from a recent, comprehensive inventory of species, habitats, and natural communities. The identification of several rare plants and probable exemplary natural communities during the conduct of model-verification field work underscores the limitations to current NHB data in the City. In the absence of comprehensive inventory, partial inventories can help fill information gaps: pursuit of targeted inventories of particular areas (for example, City owned properties), particular groups of species, or to refine or validate predicted exemplary natural communities or protection priorities. Good inventory information is also useful for evaluation of stressors and restoration needs (see below). Bats are an example of a group of species that we know relatively little about in Concord and other parts of the state. It is possible that the Merrimack River corridor and its Floodplain Forests, for example, could contain roost sites, foraging areas, migration routes for bats.
- Limitations of the WAP habitat model: While the WAP habitat maps represent a tremendous and useful effort to predict locations of important habitats across the state, the results of this study serve as a reminder that it is essentially a model of habitat that requires on-the-ground validation in many areas. Although many polygons were field checked during this study, most have not been, and additional field verification and refinement would improve accuracy and confidence in applied uses of the data. Future habitat mapping efforts would benefit from broadening the range of mapped categories to include natural communities or systems. One strategy would be to structure revisions hierarchically or at two levels, where more detailed natural community maps are produced to reflect important details where this information is available or desirable. For example, most swamps and some other wetlands are lumped into matrix forest habitat types, thereby potentially missing certain important biological resources in conservation planning exercises. Bog Road is a classic example of this: the original WAP model typed this large and significant peatland as a Hemlock - Hardwood - Pine Forest. Without delineation of this feature as a peatland, the area would be of equal value to forest types that are extremely common.
- Improve biological information and management planning on easement lands: Securing easements is an important strategy for land protection. Easement monitoring is critical, and protection is enhanced if good information on property resources is available, such as locations of rare species or special resources, and if landowners can be engaged as partners in land stewardship.

- Opportunities for conservation work across town boundaries and with partner conservation land holders: Many of the conservation priorities identified abut neighboring towns. Protection can be enhanced by engaging neighboring towns concerning each other's priorities, and by exploring possibilities for collaboration. The Pine Barrens habitat between the Soucook River and Route 106 in Pembroke, and the Broken Ground region adjacent to Loudon are good examples. Protection can also be enhanced by working with other large land owners, such as St. Pauls, to better understand management goals and the opportunities for securing long-term protection.

- Evaluation of stressors to natural areas: There are many stressors to natural systems, which threaten or disrupt their ecological integrity. Development, invasive species, pollution, heavy recreational use, inappropriate ATV use, harvesting in sensitive areas, poor forestry practices, and flood control policies of dams along rivers are a list of just a few. Some stressors can be mitigated by environmental regulations; others require on the ground management actions. Good information on the resources and threats on each property, and all conservation lands collectively, will help prioritize stressors and appropriate management and mitigation strategies. State and federal agencies and certain conservation organizations are concerned with these same issues, and there may be opportunities to partner with them to achieve common goals.

- Restoration Opportunities: Pine Barrens and floodplains are the primary systems that may require special management to maintain or restore ecological conditions necessary for the survival of component species, including certain rare species. These areas have considerable threats or stressors that are impacting or have the potential to impact species diversity and overall ecological integrity of the systems.

  Pine Barrens: the long term integrity of the Pine Barrens and its component species will depend on whether conservation partners can 1) combine efforts to secure additional remaining Pine Barrens fragments; and 2) commit to and institute a creative, long-term management strategy for the Pine Barrens restoration. Short of this, it may still be possible to retain and manage for certain species on smaller, isolated parcels, but it will not necessarily represent a fully functioning, diverse pine barrens system. For the pine barrens to be retained and restored to its fullest potential, management will need to involve a combination of mechanical vegetation management, prescribed fire, and other restoration efforts, such as nectar plant management and propagation. Such efforts would no doubt require considerable resources over the long term.

  Floodplain Forests: Invasives species are nowhere more prevalent in Concord than on floodplains and terraces of the Merrimack River, particularly in and along edges of Floodplain Forests and agricultural fields. Invasives species management is resource intensive, and given the scale of the problem, efforts should focus on priority Floodplain Forests or other riparian habitats that are most threatened, and where management efforts have the potential to succeed.

  Other stressors to Floodplain Forests are impacts of flood control dams. It is uncertain how the current and historic flood regimes have and continue to affect the dynamics and perpetuation of Floodplain Forests along the Merrimack Rivers. Other conservation organizations (including the Nature Conservancy) are involved in restoration of flood regimes appropriate for natural systems on some NH rivers, and they may be a good resource for the City.

  The agricultural fields and Floodplain Forests along the Merrimack are important resources in and of themselves. However, one resource lost from most of New Hampshire, including Concord, are infrequently- or un-flooded high river terraces on alluvial soils. Most of these areas are agricultural

soils of statewide importance, and it is no surprise that most of them are either developed or in agriculture. It might take a visionary to restore large and intact forests on high floodplains of the Merrimack River – areas that at one time grew what were probably some of the most beautiful, diverse, and impressive forests in the state.

REFERENCES

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CONSERVATION PRIORITIES

Concord, New Hampshire

Concord Boundary

Conservation and Public Lands

Summits

Roads
- Highway
- Local Road
- Unmaintained Road

Railroad

Utility Lines

Water Body

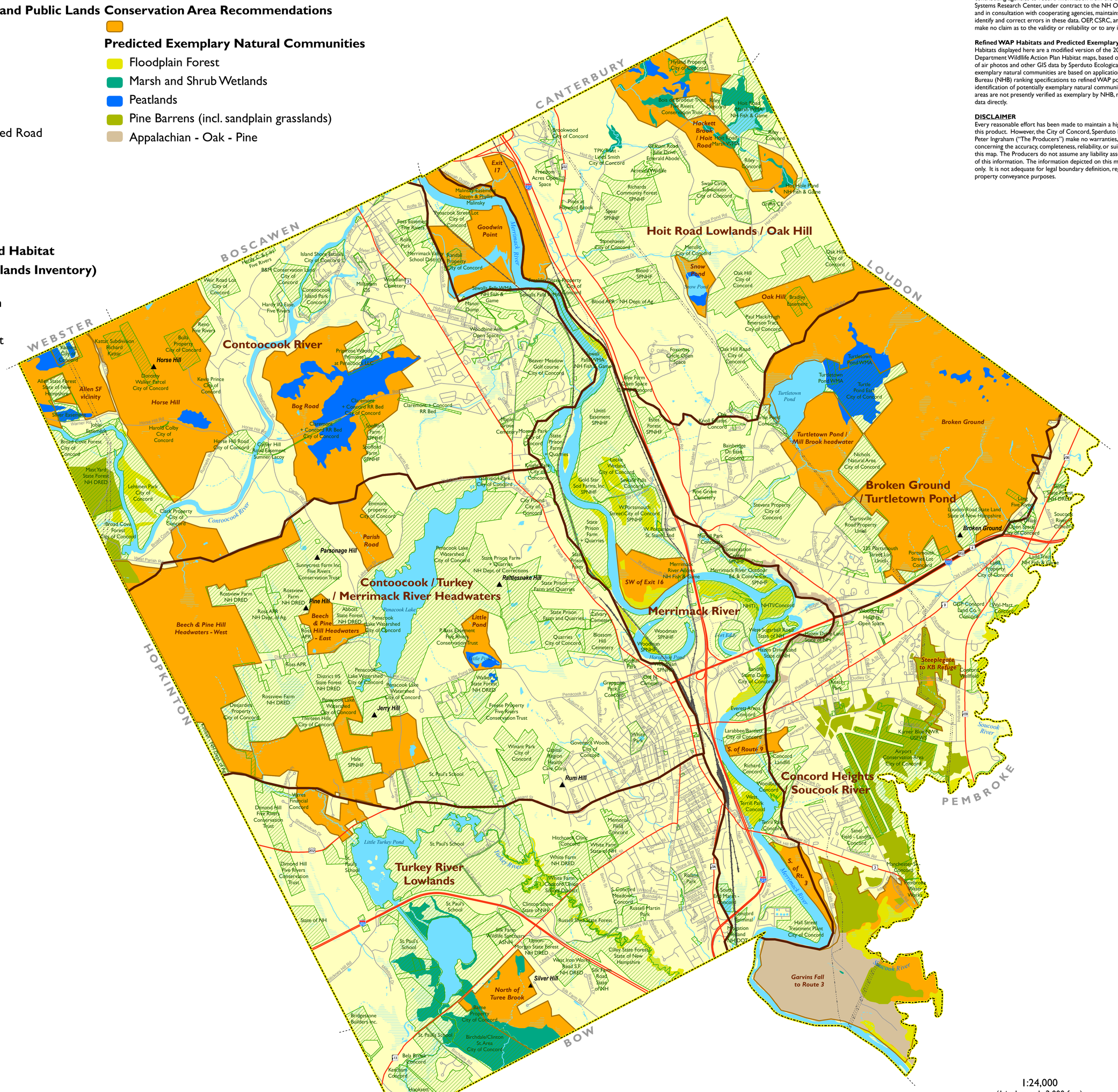
Other Wetland Habitat (National Wetlands Inventory)

River / Stream
- Perennial
- Intermittent

Ecological Regions

Conservation Area Recommendations

Predicted Exemplary Natural Communities
- Floodplain Forest
- Marsh and Shrub Wetlands
- Peatlands
- Pine Barrens (incl. sandplain grasslands)
- Appalachian - Oak - Pine



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Refined WAP Habitats and Predicted Exemplary Natural Communities
Habitats displayed here are a modified version of the 2010 NH Fish and Game Department Wildlife Action Plan Habitat maps, based on field work and interpretation of air photos and other GIS data by Sperduto Ecological Services LLC. Predicted exemplary natural communities are based on application of NH Natural Heritage Bureau (NHB) ranking specifications to refined WAP polygons, resulting in the identification of potentially exemplary natural communities or systems. Many of these areas are not presently verified as exemplary by NHB, nor do they represent NHB data directly.

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(1 inch equals 2,000 feet)

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0 0.5 1 2 3 Miles

CONSERVATION PRIORITIES - *Concord, New Hampshire*
October, 2010

Central New Hampshire Regional Planning Commission

Sperduto Ecological Services, LLC.

Ibis Wildlife Consulting

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ecology. geography. cartography.