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Wildlife Habitat GIS Modeling Study

Society for the Protection of New Hampshire Forests

TECHNICAL REPORT

Wildlife Habitat GIS Modeling Study

Piscassic and Lower Lamprey River Watersheds of New Hampshire

Prepared for:

The New Hampshire Chapter of The Nature Conservancy

in partnership with:
New Hampshire Fish & Game Department Non-game & Endangered Wildlife Program
The Audubon Society of New Hampshire
The New Hampshire Living Legacy Project

Prepared by:

The Society for the Protection of New Hampshire Forests
Research Department

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New Hampshire Estuaries Project

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Introduction

Background

This technical report is part of a larger study entitled *Protecting Wildlife and Significant Habitat in Coastal New Hampshire*, an initiative of the Great Bay Resource Protection Partnership (GBRPP), funded by the New Hampshire Estuaries Project. The fieldwork component of the study was implemented by the Audubon Society of New Hampshire (ASNH) and the N.H. Fish & Game Department Non-game and Endangered Wildlife Program (NHF&G) in 2002, in cooperation with The Nature Conservancy of New Hampshire (TNC). This report focuses on the GIS mapping and predictive habitat modeling developed by the Society for the Protection of N.H. Forests (SPNHF) in support of the fieldwork component of this study and the larger land conservation efforts of the GBRPP in the Seacoast region.

The results of this project are intended to help direct the conservation activities of the GBRPP and our local partners by providing on-the-ground data on the occurrences of significant biological and ecological resources in the Piscassic, and the lower and middle Lamprey river watersheds. It is also a goal of this project that the GIS modeling applications created for this project be transferable to other watersheds in the Great Bay region and the state. The project also provides valuable data for Federal, State, and local natural resource regulators and managers working to protect sensitive coastal resources.

Goals and Objectives

The goal of this study has been to develop a predictive GIS model and map potentially significant wildlife habitat for the ecologically linked landscape of the Piscassic River (~14,500 acres), lower Lamprey River (~13,700 acres), and upper Lamprey River (~26,000 acres) sub-watersheds. The Piscassic River, in particular, is a priority area for the GBRPP, as it supports significant waterfowl concentrations and wetland resources and is highly threatened. Areas of particular interest include freshwater wetland complexes, intact riparian corridors, and high quality upland forests.

Specific study objectives were:

- To focus predictive modeling on three sub-watersheds, and thus producing much larger-scale and finer resolution maps that better pinpoint high priority habitat areas on the landscape;
- To incorporate new and dramatically improved GIS data layers including New Hampshire land cover (available June 2001) into the analysis;
- To utilize a large volume of new and updated plant, animal, and natural community occurrence data, including on-the-ground data collected during the summer of 2001;
- To use a balanced analysis of terrestrial, palustrine, and aquatic ecosystems in light of past regional studies that emphasized palustrine and aquatic systems; and,
- To provide a habitat modeling tool and map products that can be replicated in other watersheds in the Great Bay region and coastal zone, and elsewhere in the state.

Report Organization

- **Part One** of this report details the GIS data and methods utilized in this project, including the development of new, specialized datalayers.
- **Part Two** covers the landscape-scale GIS analysis of significant wildlife habitat features using the NH Fish & Game mapping methods laid out in the *Identifying & Protecting N.H.'s Significant Wildlife Habitat* manual.
- **Part Three** contains summary narratives and predictive habitat maps generated for 20+ species of concern targeted for this study.

Steering Committee

A study team drawn from several state agencies and non-profit conservation organizations was formed at the early stages of project implementation to pool expert knowledge of wildlife habitat preferences and to help guide and evaluate the development of the GIS predictive model and mapping. Team members and affiliations included:

- Mark Zankel — The NH Chapter of The Nature Conservancy
- John Kanter — NH Fish & Game Dept Non-game Program
- Laura Deming — Audubon Society of New Hampshire
- Carol Foss — Audubon Society of New Hampshire
- Ellen Snyder — New Hampshire's Living Legacy Project
- Dan Sundquist — Society for the Protection of NH Forests

Ellen Snyder headed the literature search and polling of wildlife experts that generated the listing of preferred habitat features used in the GIS models for target species. Dan Sundquist was responsible for the development of the GIS model, mapping and analysis for this study.

Additional reviews and input were received from Drs. Kim Babbit and John Litvaitis (UNH Department of Natural Resources, David Carroll, Doug Grant and Tracy Tarr (NHF&G), Chris Martin and Pam Hunt (ASNH), Dr. Barry Wicklow (St. Anselm's College), and Dr. Robert Askins (Connecticut College).

Study Area Definition

Although this project is titled after the Piscassic River, the intent has been to conduct an analysis of the entire lower Lamprey River, comprised of three watersheds including the Piscassic River, and stretching from the mouth of the Lamprey on Great Bay upriver to Candia. The study area is therefore defined by watershed boundaries, including more than 85 square miles and portions of eleven towns in the Seacoast region. For the purposes of GIS modeling, a buffer of one-half mile was added around the outermost watershed boundary for contextual information and to allow important habitat features on or near the watershed boundary to be included in the analysis.

The extent of the study area is shown in **Figure 1** below:

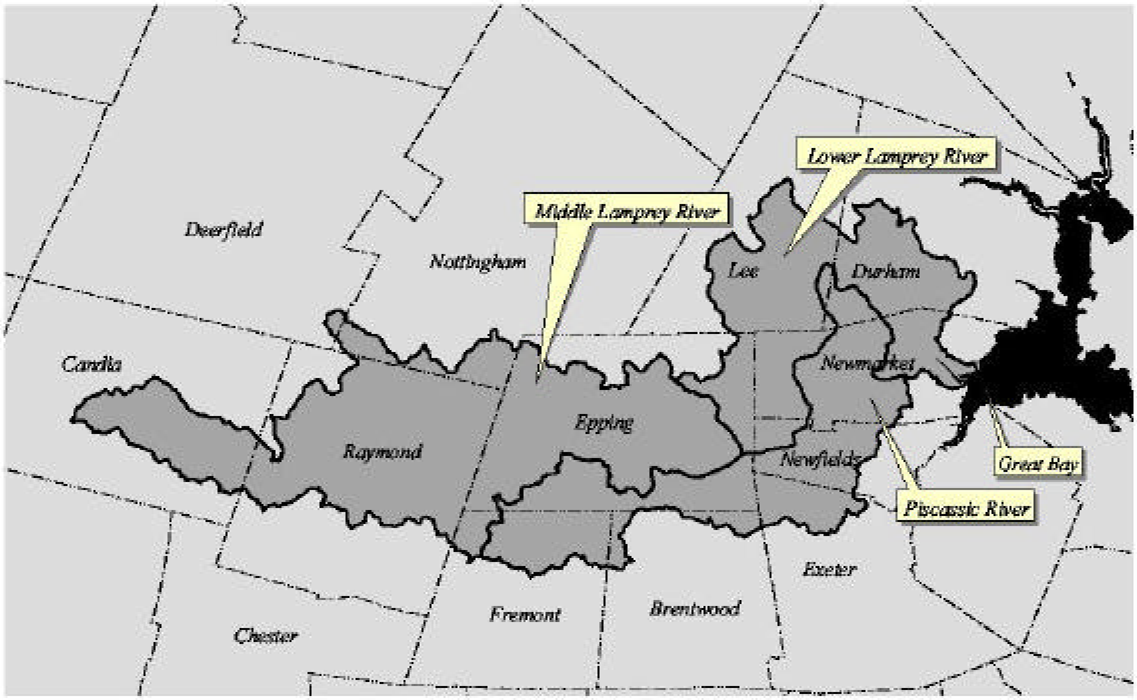

Figure 1: *Study Area Watersheds and Communities*

Part One: Data Factors & Techniques Utilized in Modeling Preferred Habitats

Overview of GIS Processing & Modeling Techniques

ESRI's ArcView 3.3 and associated extensions (Spatial Analyst, Xtools, Spatial Tools, etc) was used for all GIS mapping, analysis, and modeling for habitat features in this study. The following technical narrative assumes that the reader has a working knowledge of GIS generally and the software specifically. Where instruction or techniques are discussed, key operational terms are used consistent with the many functions and processes of the GIS software. However, it is not the intent of this report to provide detailed, step-by-step instruction in use of the software. A basic familiarity with the New Hampshire GRANIT data system and datasets is also assumed. Links to websites and an introductory guide to GRANIT and a brief summary of the Xtools and Spatial Tools extensions not available with ArcView may be found in **Appendix A** of this report.

A generic process used to map habitat features and rank conservation priorities is as follows:

- Assemble all datalayers (shapefiles) relevant to the modeling effort
- Theme Define shapefiles to key habitat elements, e.g., preferred wetland types
- Table Edit each shapefile to add a Value field and a numerical value reflecting the relative importance of the particular habitat feature(s) within that shapefile
- Convert shapefiles to grids coordinated with master grid (see Land Cover Types below) and using the Values field to assign cell values
- Process grids to convert No Data cells to "0" values (see below)
- Use Map Calculation to add all grid values into a composite scoring grid
- Incorporate the composite into a base map depicting the co-occurrence of all habitat feature values across the study area
- Edit the Legend to a Color Ramp classified appropriate to the score range and refine graphics as necessary to enhance legibility or emphasize high-scoring grids in the co-occurrence map

Although somewhat over-simplified, this process is typical of GIS modeling and analysis that utilizes both vector (shapefile) and raster (grid) data. The vector data allows for a wide range of definition and distinction of feature classes, e.g., many types of wetlands can be coded according to ecological structure, function and process as in the National Wetlands Inventory, which in turn allows for a high degree of selectivity in characterizing habitat features. Grids, on the other hand, allow for a greater processing speed and mathematical modeling flexibility in combining datasets of varying values.

The scoring system used is quite straightforward, being limited to a range of 0 to 5 points, with 5 reflecting the highest possible score and therefore the highest predicted habitat value or importance. Zero values typically correspond to the No Data portion of any grid, which is generated for all areas without features. Whole integers are used to keep the co-occurrence scores as simple as possible. The project study team of wildlife experts verified the relative values of features after a first pass GIS model was run and draft maps were reviewed.

Since this study is research-oriented and since varying degrees of complexity in terms of habitat preferences and data availability are inherent in the many species investigated, the GIS mapping, analysis and modeling was iterative and experimental in nature. As will be seen in the species profiles later in this report, some habitat modeling was extremely simple and limited; others were much more complex, and use more advanced GIS techniques (see **Density Analysis** below). One finding of this work, then, is that no single wildlife habitat model is appropriate or possible for all species, but rather must flex to accommodate the breadth (or limitations) of knowledge about a given species and the limits of the digital data readily available.

Base Map

A simple base map of the study area was generated by clipping stock GRANIT datasets to the buffered watershed boundary noted above. Datalayers used in the base map were:

- Political boundaries derived from GRANIT
- Highways & local road systems derived from GRANIT NHDOT datalayer
- Surface water features, derived from GRANIT Hydrology datalayer
- Perennial streams, derived from GRANIT
- A mask datalayer derived from the buffered study area boundary, used to "mask out" extraneous grid data that the GIS automatically generates beyond the interest area

Key Data Factors & Processing

What follows is a discussion of the most important GIS datalayers used in this study, with guidance on processing rationale and techniques, where unique or critical, used to create specialized shapefiles for habitat modeling. **Appendix B** contains one-page descriptions of each datalayer used in this study and available from the GRANIT data library at the UNH Complex Systems Research Center.

Land Cover Type Mapping

Since much of the GIS analysis and modeling in this study was conducted using raster-based grids, the GRANIT land cover type map dataset was the most important first-step data processing task. In its native form, the GRANIT land cover type mapping encompasses the entire state and is composed of grid cells 93.5' x 93.5' (nominally 30 meters), but this vast amount of data needs to be trimmed down to a more manageable size suited to the study area limits. Care should be taken in clipping the land cover grid since it becomes the framework and basis for generating and coordinating all other grids used in the modeling.

It is recommended that an intermediate grid be created, allowing enough fringe data past the buffered study area boundary to include all unfragmented natural land cover blocks that extend beyond the study area boundary, since these will form the basis for a derivative grid used many times in the course of the study. This can be determined by overlaying the road datalayer on the land cover type grid, and scanning for the outermost edges of the blocks of natural land cover bounded by traveled roadways (see discussion on defining the Transportation & Utilities datalayer below). Then a rectangle frame is drawn that closely bounds all the unfragmented blocks, and using the Spatial Tools extension, the graphic is used to clip the dataset to the size of the rectangle. *Note: a shapefile should be first created from the graphic using the Xtools extension, and the Area of Interest (AOI) should be defined as that rectangle; doing so will eliminate a huge No Data collar that would normally be created as an artifact of clipping the statewide dataset.*

Once a derivative grid is created that will suffice for mapping all unfragmented blocks extending beyond the study area boundary, a second frame and clipped grid dataset tailored to the buffered study area boundary can be generated. This smaller dataset will serve as the basis for many other grids used in the study for which the one-half mile context buffer is sufficient.

The GRANIT land cover mapping contains a great deal of useful information that can be segregated or combined in different ways to approximate habitat structure and composition. For example, pitch pine and other pine species cover types can be selected to create specialized grids for use in co-occurrence mapping. Conversely, all natural land cover types can be combined to generate a homogeneous " block" of land cover, for use as a broad-scale habitat feature; the same cover types can also be selected for an expression of "upland forest" only.

Care must be taken to use this cover type data appropriately, however. Due to the resolution of the data (30m cell size) and the manner in which the data was processed from satellite imagery and "trained" for accuracy, it should not be used to indicate actual on-the-ground site conditions within any given grid cell. Rather, it is most appropriate for broad-scale, regional depiction of prevailing land cover type patterns.

The following table lists all the land cover types in this dataset, as clipped to the buffered watershed for use in the GIS analysis.

Description of Land Cover Type	**Gridcode**	**Cell Count**	**Acres Total**	**Acres by Cover Type Classes**	**% Study Area**
Residential/Commercial/Industrial	100	11,445	2,297.1		
Transportation	140	15,645	3,140.1	*5,437.2 Built Environment*	10.1%
Row Crops	211	518	104.0		
Hay/Pasture	212	12,031	2,414.8		
Orchards	221	330	66.2	*2,585.0 Agricultural Lands*	4.8%
Beech/Oak	412	26,839	5,386.9		
Other Hardwoods	419	18,400	3,693.1		
White/Red Pine	421	20,473	4,109.2		
Spruce/Fir	422	45	9.0		
Hemlock	423	6,133	1,231.0		
Pitch Pine	424	41	8.2		
Mixed Forest	430	99,762	20,023.3	*34,460.7 Upland Forest*	63.8%
Water	500	11,781	2,364.6	*2,315.6 Water*	4.3%
Forested Wetlands	610	6,739	1,352.6		
Non-forested Wetlands	620	6,275	1,259.5		
Tidal Wetlands	630	17	3.4	*2,615.5 Wetlands*	4.8%
Disturbed Land	710	4,182	839.4		
Cleared/Other Open Land	790	28,476	5,715.5	*6,554.9 Disturbed, Cleared & Other*	12.1%
			54,017.9		

Transportation & Utilities

Traveled roadways, railroads and utility right-of-ways are the key barrier features used to define unfragmented blocks of natural land cover in this study. Four GRANIT datasets must be combined and processed in several steps in order to create a template that can be "burned into" the land cover type data, in turn generating the unfragmented lands datalayer:

- Road & Trails (USGS digital line graphs, rev. 1993)
- NHDOT Smartmap (the official NH road & highway system datalayer)
- Railroads (USGS digital line graphs, rev. 1993)
- Pipelines & Transmission Lines (USGS digital line graphs, rev. 1993

The USGS-derived and NHDOT road coverages each includes traveled roadways not shown on the other dataset, so for the purposes of this study they were merged into a single, derivative datalayer. First, however, they must be theme-defined in order to display only traveled roadways. This is done by removing all "jeep trails" (Class < 5) from the USGS DLG and by removing all town roads not regularly maintained (S_class<> 66) in the NHDOT data. (The S_class = 66 theme definition is the closest approximation possible to legislative Class 6 status, ie., unmaintained local roads closed subject to gates and bars.)

The merged road network is then buffered by 500' either side[1] to account for the possibility of road frontage development that is not captured by the land cover type mapping due to tree cover and/or resolution issues. This buffer shapefile is then converted to a grid, registered to the land cover type grid as noted above, which is then combined with grids of other fragmenting features described below.

Both active and abandoned railroads (all Rra classes) are included in the mapping since it was determined that it is the railroad bed and embankments that provide obstacles to wildlife movement, especially amphibians and reptiles. Railroads were buffered by 50' either side in order to create a sufficient "footprint" to allow a grid to be created from the vector data.

Transmission lines and pipelines are selected from the GRANIT Pipeline datalayer (Pia=1 and Pia= 2) that includes several other utilities such as airports, telephone lines, and power stations. These features were classed according to right-of-way widths that in turn formed the basis for a buffer distance from the vector centerline of each feature. These dimensions were derived from measurements of cleared right-of-ways visible on digital orthophoto quads. Grids were generated for both the railroad and pipeline/transmission line right-of-way buffers.

All three sets of buffer grids can then be combined with the land cover grid (using the Spatial Analyst Map Calculation function) to define all unfragmented natural land cover blocks in a new, master land cover type grid. A corresponding shapefile can also be generated at this point by using another Map Calculation conversion in Spatial Analyst (see .AsPolygonFTAB request in the ArcView help). The resulting shapefile will match the cell configuration of the land cover grid exactly, and will allow for block area calculations that are not possible with raster data. *Note: It is necessary to create a subsequent, simplified shapefile of unfragmented land cover*

[1] Per the NHF&G manual, *Identifying & Protecting N.H.'s Significant Wildlife Habitats*

types by dissolving out all internal land cover type classes in order to calculate the total acreages by block.

National Wetlands Inventory Mapping

Wetlands are a critical habitat feature for many wildlife species, so the National Wetlands Inventory (NWI) mapping is a key element in many modeling schemes. Fortunately, NWI mapping is available for the entire state via GRANIT on a tile-by-tile basis. However, since the information is tiled, the stock datasets must be merged into a seamless wetlands datalayer spanning the entire study area. This is easily done using either the Geoprocessing extension within ArcView and the Xtools extension. Tile lines must be removed by Dissolving on the "wetcode" field in order to obtain accurate acreage data and true feature boundaries for merged polygons for each type of wetland. *Note: Using the Dissolve function results in a "multi-part shape", ie., a single polygon comprised of many parts. This polygon cannot be used for wetland area classification, obviously, but it is also problematic in converting to grids for use in modeling. Therefore, another step is necessary to convert the multi-part shape to a single-part shape that is done in Xtools.*

The NWI datalayer contains a wealth of information that can be queried and defined in various ways to identify suitable or preferred habitat features for wildlife, but doing so requires familiarity with the NWI wetlands classification system. It is not possible to review that system here, but a detailed description of each "wetcode" used in this study may be found in the USFWS publication *A Classification of Wetlands & Deepwater Habitat of the United States*[2]. The extensive legend found at the bottom of all official NWI quad-tile maps is also useful in understanding the coding scheme at a glance.

An example of querying the NWI datalayer for a general habitat type would be querying for all PEM wetcodes, regardless of secondary modifiers, to locate all instances of Palustrine Emergent Marsh, which is a very important wetland, but relatively common habitat type, for numerous wildlife species. Special or highly localized habitat features may also be selected from the datalayer, for example, "beaverflows", ie., wetlands created by beavers building dams and flooding land. These wetlands are coded with a "b" modifier suffix, and it is a relatively simple matter to select all such polygons from the NWI attribute table. Once highlighted in the datalayer, derivative datalayers can be created that can be used for a series of wildlife habitat modeling analyses where specific wetland types are key elements.

Soils

Soils datalayers are available statewide for seven of ten counties. For this study area, portions of the Strafford County and Rockingham County soils surveys were clipped and merged to remove boundary lines transecting adjacent soil type map units. A master database of soils (available upon request from GRANIT) must be joined to the stock GRANIT soils datalayers to allow querying and sorting for various soils characteristics that relate to habitat structure and

[2] Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. *Classification of wetlands and Deepwater Habitats of the United States*. U.S. Fish & Wildlife Service, FWS/OBS – 79/31. 103 pp.

suitability, e.g., soils associated with certain plant communities, alluvial soils as a proxy for floodplains, and so on.

Key derivative datalayers generated from the county soils surveys for use in modeling selected wildlife species of concern (see Part Three) include:

- Dry soils (excessively well-drained soils and sandy/gravelly surface textures)
- Hydric A & B soils (very poorly drained & poorly drained drainage classes)
- Gravel and Sand Pits
- Exposed ledge and cliff faces

<u>Slope and Solar Aspect</u>

Slope and solar aspect data were derived from a Digital Elevation Model dataset obtained from GRANIT. This data is in the form of a 30-meter grid of surface elevations interpolated from USGS topographic maps, and must be processed using Spatial Analyst to generate slope and/or aspect grids (see ArcView's Help index for detailed instructions on creating slope maps in percent gradients and solar aspect maps).

Slope and aspect calculations are output as continuous grids and must be selectively reclassified to extract the particular criteria to be used in habitat modeling. For example, bobcats are known to utilize steep, south-facing slopes for sunning and as den sites. Relative steepness must be defined (>10%, >25%, >50%) to reflect the terrain features to be located, and "south-facing" must be defined in terms of the combination of solar aspects that are appropriate (south- and southwest-facing slopes are warmest in terms of solar heat gain).

<u>Imagery</u>

Three imagery datasets were utilized in this study:

- USGS digital orthophoto quarter quads (DOQQ)
- USGS digital raster graphs (DRG)
- Color infrared aerial photography (CIR)

The first two datasets are available on a quad-tile basis from GRANIT; the CIR photography was made available upon special request from the UNH Cooperative Extension office in Rockingham county. The DOQQ's are gray tone (panchromatic) photo images scaled to match the USGS DRG's that are digitized USGS topographic quads. Used in concert with each other and GRANIT datalayers, the DOQQ's and DRG's are valuable in verifying the location and extent of various natural and cultural features. The DOQQ's and CIR photography are also key in developing new datasets (see discussion on creating an Early Successional Habitat datalayer below).

Density Analysis

Many wildlife species utilize clusters of suitable habitat features in close proximity to one another, or distributed over a wide area. The spatial patterns of such features are evident in the mapping, especially where densely clustered; where patterns are more evenly distributed over the landscape, judging relative habitat value is much more difficult. In order to understand the relative value of patterns and clusters of features in a more quantifiable manner, a GIS density analysis was conducted for certain key features, such as wetlands. A typical example for Blanding's turtle is described below.

Research shows that Blanding's turtles favor certain wetland types, and that clusters of smaller wetlands in close proximity are utilized over time. Since the Density Calculation function in ArcView uses points to interpolate density, a shapefile of centroids for each wetland polygon must be generated using the Xtools extension (312 points in this case). These centroids represent the geographic center of each polygon, and carry with them the attributes of the polygon shapefile, including the Acres field that is used in creating the density map.

Using the Calculate Density function in the Spatial Analyst extension, a density surface similar to a topographic map is generated. In generating the density grid, several inputs are required, as follows:

First, since the density map output is a grid, it must be coordinated with the other grid regimes in the project in terms of extent and cell size inputs. Second, the Population Field is set to Acres, a Search Radius is specified (this may be an arbitrary distance, e.g., 1000', or it may correspond to a species range distance which in the case of the Blanding's turtle is 1200 meters), a Density type is specified (Kernel is used to produce smoothed graphics similar to topographic contours), and Area Units are specified (in this case Square Miles so that the density calculation is Acres/Square Mile).

The output grid defaults to nine (9) classes of density. In order to make this grid more manageable and to emphasize the "targeting" value of the density analysis, the number of classes is reduced to (6) equal interval classes within Reclassify function of the Analysis menu and new integer values of 0 to 5 are assigned (the final 0 class contains the lowest density values, and so is not a true 0 value, but is discounted as 0 for model value purposes).

This simplified density grid may then be used with other grid data factors in a co-occurrence map calculation. The effect of including the density grid, particularly with the higher point values rated where density is greatest, is to focus the analysis results on those areas where the greatest clustering of suitable habitat features exist.

Care must be taken, however, not to judge the density mapping as spatially precise in terms of the location of actual on-the-ground features; the density surface is only an interpolation of acres of wetlands, and thus is a generalized representation that helps to provide a quantifiable context in the overall scheme of the mapping and modeling. Thus, a grid of the original preferred wetlands for the Blanding's turtle is also included in the mapping to preserve the actual extent and distribution of all the wetland polygons, and to help in "reading' the overall patterns of habitat features.

A sample density map of preferred wetland for Blanding's Turtle is shown in **Figure 2**.

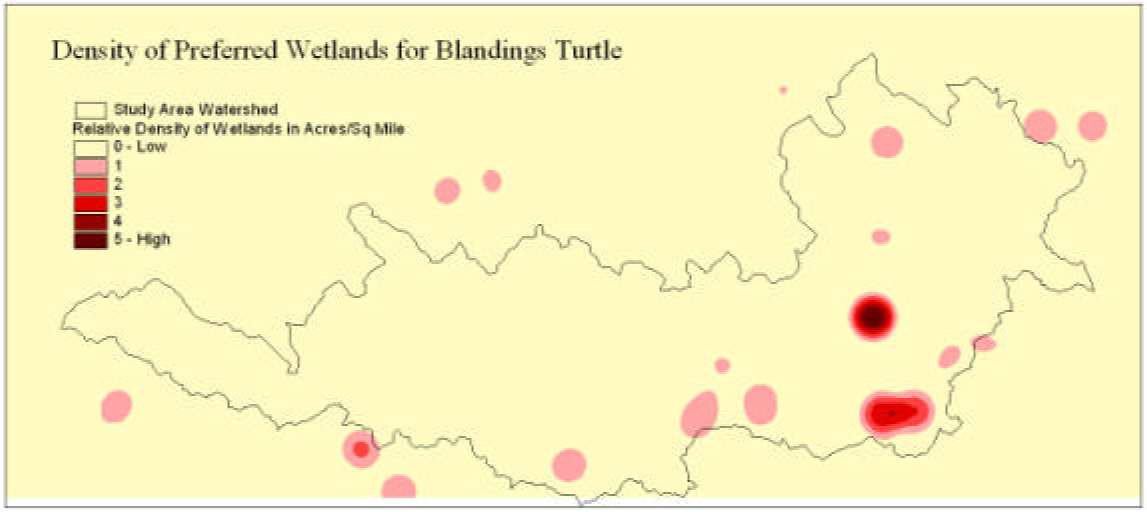

Figure 2*: Sample GIS density map of preferred habitat features.*

The same type of density analysis was also used in the modeling for the upland sandpiper to calculate comparative densities of old field/undisturbed grasslands (preferred habitat) versus active agricultural fields (secondary habitat) aggregating to >150 acres/square mile. Since there was no favorable grassland in a single unit, the density analysis revealed the only two locations in the entire study area with a cluster effect of >150 acres.

Open Lands and Early Successional Habitat Mapping

Land cover types that can be characterized as "open lands and early successional habitats" are declining in both distribution and extent in New Hampshire, and are thought to represent only about 4% of the land cover of the state overall. These habitat types include a range of both natural land cover, such as abandoned hay lots and pastures (old field habitat) grading into early successional shrub and tree species, and managed land cover such as actively cropped agricultural fields, orchards, hay meadows, and disturbed areas associated with gravel pits and powerline right-of-ways.

These habitat features are important to a number of wildlife species that depend on field and early successional habitats for breeding, foraging, and shelter, including the blue-winged and golden-winged warblers, New England cottontail rabbit, upland sandpiper, and several other species-of-concern that are included in this study. Unfortunately, very little detailed geographic information delineating these cover types is available from GRANIT or other sources.

Accordingly, an experimental, low-tech/rapid assessment procedure was developed using ArcView GIS software to identify and delineate early successional habitat features and other open land cover types features. A unique datalayer comprised of 679 polygons was produced for the entire lower Lamprey River watershed using a combination of conventional aerial photo interpretation and delineation, followed by digitizing of delineated features directly in the GIS, as follows:

Image Data Sources

Two digital imagery data sources were used in concert with one another in the development of this datalayer:

- geo-referenced digital orthophoto quads (DOQ's) available from GRANIT, and
- color infrared (CIR) aerial photography currently available statewide on request from the UNH Cooperative Extension county offices.

Detail resolution and color rendition is far superior in the CIR images as compared to the panchromatic DOQ's, so they were used as the initial basis for delineation and coding of various open land and early successional features. However, the CIR photos are not available as digitally-mosaiced images nor are they geo-referenced for use in the GIS, so the GRANIT DOQ imagery was used as the "spatial backdrop" against which features identified in the CIR imagery could be accurately located and digitized on-screen. Since both image datasets were acquired in 1998/1999, features are consistent from one image to the other, with few exceptions.

Note: DOQ's can be used alone for delineation, but features such as field edges and details such as the texture of ground surfaces (important in clarifying cover types and early successional canopy closure) tend to be somewhat unclear, especially at larger scales, thus making interpretation difficult at times.

For the purposes of this project, the steps in generating the open lands/early successional habitat datalayer are as follows:

1. Stock 9x9 CIR photos were first scanned at 300 dpi on a flatbed scanner and then converted to TIFF graphic files that can be inserted into an MSWord document or into ArcView layouts for reprinting. These files were output on a color laser printer at close to the original 9" x 9"format for use as stereo photo pairs, and also at larger scales measuring up to 18" x 18" on a large-format inkjet plotter for detail viewing and reference without magnification. The color laser prints yield the best resolution – at near photographic quality – and thus are used as the basis for delineation.

   Note: Photographic prints made from the original negatives may be obtained from the DRED Division of Forests and Lands for interpretation purposes for $15 each, thus eliminating this step and providing the best possible reference images; however, the scanning approach appears to be more cost effective and as adequate.

2. Agricultural fields, hay meadows, old fields in varying stages of natural succession, and other features such as gravel pits and cleared/disturbed areas are outlined and coded with felt-tip pen directly on each 9 x 9 CIR print, with allowances for the inherent overlap from image to image. Stereo viewing glasses and matching pairs of photos can be used to view three-dimensionally to confirm field patterns and/or verify early successional stands of trees embedded within a larger forest context.

3. An ArcView project view is then built with the DOQ's displayed as an image background on which other reference datalayers (roads, streams, NWI wetlands, etc) are overlaid in

color to help in orientation and "pattern-seeking" as the CIR photo delineations are transferred into the GIS environment. A view scale of 1:12,000 is typically a good starting point for identifying field patterns and delineating edges, but larger scales are helpful in situations where shapes are complex and overlapping polygons are to be avoided.

4. Working systematically from the CIR images, various features and spatial patterns on the CIR's are located visually in the context of the DOQ image, and at least one graphic polygon is first drawn according to field edges and other defining features. The Draw Polygon tool is used for this purpose.

5. Then, using the Xtools convert-graphic-to-polygon function, a shapefile theme is created on which the remainder of open land/early successional habitat datalayer is built. Using the Theme Edit function in ArcView and the Draw Polygon tool, all remaining polygons can be rapidly added to the initial shapefile, digitizing "on-the-fly" and on-screen.

6. During digitizing, delineations on the CIR imagery are checked against reference datalayers, such as the NWI wetlands, and interpretive errors are corrected. In some cases, as with identification of old gravel pits, toggling between the DOQ and the corresponding USGS topographic quad digital raster graph (DRG) helps to verify the type and location of features. Similar toggling with the GRANIT land cover type grid can also be used to check feature and cover types.

7. Since the attribute table is also actively being built while the theme is being edited, habitat type codes and any other data associated with each polygon may be entered into the attribute table, as each polygon is digitized, or in small batches as all the polygons from one CIR are digitized and before moving on to the next image.

8. Area and perimeter data for each polygon must be updated periodically using the Xtools extension. This may also be done on-the-fly and while in the Theme Edit mode.

9. A redundant back-up system is recommended while the datalayer is being developed. Periodically converting the shapefile to another filename, e.g., version 1, version 2, etc., is an easy method of saving data frequently as work progresses. The ArcView .apr file should also be backed up frequently to guard against corruption of the project file, which is a possibility when working with large image datasets and several extensions.

Identifying and classifying open land and early successional habitats from aerial photography requires a certain amount of skill and experience in interpreting spatial details and patterns visible in the imagery. However, in the predominately forested landscape of New Hampshire, field patterns and other types of openings in the tree cover are clearly evident in most aerial photography. The tendency to "read" emergent wetlands as early successional habitat is probably the most likely error in interpretation, but features in the photography can easily be checked against NWI wetlands mapping in the GIS and discounted. Similarly, cemeteries were easily recognized and culled from delineation by comparing to USGS DRG mapping on-screen.

Figure 3 below depicts a typical CIR image on the left and a corresponding DOQQ image for comparison.

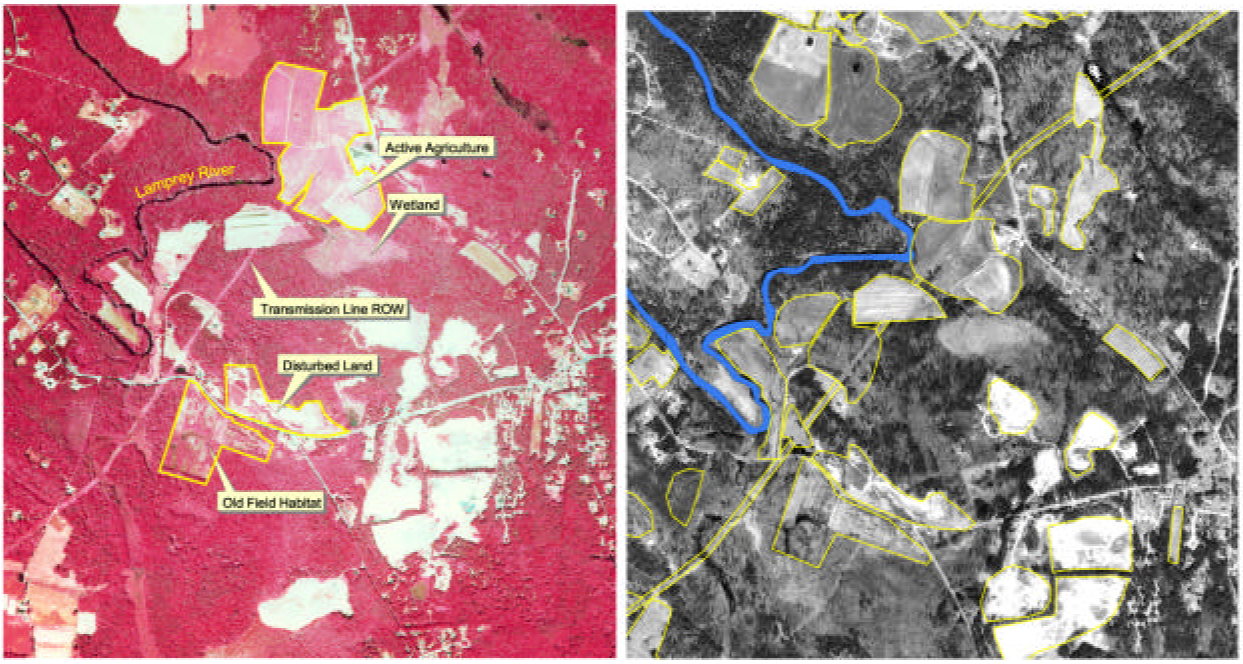

***Figure 3**: Color infrared source photography with selected habitat features noted on the left, and typical GRANIT DOQQ geo-referenced imagery on the right with all features digitized.*

<u>Classification Scheme – Open Lands & Early Successional Habitats</u>

The initial tendency in experimenting with a method to generate this datalayer was to classify features in the simplest terms and according to broad groupings of habitat features, as follows:

- "open lands" in the form of fields and meadows,
- "early successional habitats" in the form of overgrown hay meadows and pastures, and fields becoming dominated by tree and shrub canopy,
- disturbed or cleared lands of various types, and
- gravel pits.

However, it quickly became evident in viewing the aerial photos that a continuum of open land and early successional cover types exists, ranging from actively-worked agricultural fields and croplands to advanced early successional stands of tree canopy moving into later seral stages of forest cover. The same was true of gravel pits, which also include sand and clay pits and associated disturbed or cleared land, and which can be actively worked, newly reclaimed, or abandoned and reverting to vegetation. Thus, the need to make distinctions along such a continuum generated seventeen (17) discrete classes of habitat features in the initial digitizing of the datalayer, which added qualitatively to the usefulness of the final dataset.

A total of 679 polygons were digitized and attributed in approximately 30 hours of work, covering the entire 85 square mile watershed and extending beyond the study area boundary in cases where significant habitat features and patterns exist within the half-mile context buffer. Generally, a two-acre minimum size was used to avoid including residential yards and other small openings with little habitat value. Exceptions occur where clusters of small openings were evident in a predominately natural land cover context, e.g., a series of small meadows surrounded by woodland, with probable habitat value in the aggregate, or where smaller units were associated with larger units in a cluster.

An overview of the seventeen habitat features, a working definition, polygon count and total acreage in the study area is found in the table below.

Habitat Feature	Definition	Count	Acres
Old field	Abandoned fields with <50% tree/shrub canopy cover	86	656.1
Old field/Early successional	Old fields with >50% but <100% canopy cover	8	70.6
Early successional	Old fields or openings with 100% sapling tree cover	81	887.4
Advanced early successional	Homogenous patterns of distinctly younger tree canopy	5	150.2
Powerline ROW	ROW clearings through forested/other natural land cover	4	348.6
Fields	Active agricultural uses, including row crops and hay fields	398	3,797.8
Fruit	Small fruit farming, eg., blueberries	2	6.8
Orchard	Apple orchard	3	70.6
Gravel pit	Active gravel extraction and workings	15	145.1
Sand pit	Active sand extraction and workings	9	67.3
Clay pit	Active clay extraction, including ponded areas	1	45.6
Old gravel pit	Abandoned/revegetating or reclaimed gravel pits	5	71.0
Old sand pit	Abandoned/revegetating or reclaimed sand pits	10	45.6
Disturbed land	Land cleared of all or most vegetation; timber harvests	27	259.2
Disturbed/Gravel pit	Land cleared in associated with active gravel extraction	9	112.9
Wet Field	Fields with tile lines or ditching evident, adjacent wetlands	15	60.9
Man-made Wetland	Obvious constructed wetlands with regularized forms	1	37.7
	Totals	**679**	**6,732.3**

Discussion

The open land/early successional land cover categories provide a range of functions as wildlife habitat. For example, 3.2% of the area contains critical shrub habitat that supports species such as New England cottontail, golden/blue-winged warblers, and American woodcock. However, active gravel pits provide nesting areas to species such as kingfisher and bank swallows (albeit sometimes to their demise). Additionally, active hay and cropland provides important nesting habitat to bobolink, meadowlark, and rare grassland-dependent species such as upland sandpiper. Although the habitat value for these ground-nesting birds may vary depending on the intensity of human use and habitat alteration, each open land category (and all 12% of open land) provides some level of wildlife habitat.

As can be seen in the polygon counts and acreage distribution, “Fields” are the dominant feature mapped, accounting for more than 50% of both the polygon count and the total acreage. However, even within this habitat feature class, a wide range of cover types exist. It is clear in the aerial photos that many of these fields are being worked intensively for row crops or hay, and thus have limited habitat value for certain species such as ground-nesting birds. Still, some fields are likely utilized much less intensively, primarily for occasional hay crops or pasture. Older meadow openings that are likely mowed only once in a few years are also evident in the photos, but have been classed as “Fields” in this study. Thus, this cover class tends to be quite inclusive of a number of open field types, with differing habitat qualities, but the class as a whole cannot be more finely delineated without extensive fieldwork to rate the fields for type and intensity of use.

The “Old Field” cover type class is relatively easy to pick out in the aerial photos due to the spotty patterns of pasture juniper and invading shrub and tree canopy. These features are also mapped most often associated with other field patterns and farming activities; some of the polygons as old fields are clearly overgrown pastures still being used as part of a working farm.

“Early Successional” habitat features were delineated from three sources:

- true old field environments progressing to later seral stages,
- openings created by timber harvest, and
- powerline right-of-ways.

The break point for old field-versus-early successional habitat features was determined to be 50% combined tree and/or shrub canopy cover across the area seen as a field unit. Determining percentage of canopy closure on old field sites was done visually; no image processing and quantification was used, nor is it warranted because field patterns and edges are generally well-defined and the eye can easily judge distinctions of less-than and more-than 50% cover.

Timber harvests are readily decipherable as patterns of openings and skid road trails in the context of the prevailing forest canopy patterns. Lighter harvests, as with selective cuts, were not mapped as early successional habitat due to relatively minor openings created. However, several heavy cuts where more than 50% of the entire harvest zone is composed of openings, and a few clear-cut harvests, were evident in the photography. These were mapped as early successional habitats for the purposes of this study, but were not coded as timber harvest sites. In hindsight, it would be valuable to document timber harvest sites clear-cut habitat differs in structure and function from old field sites and because the early-successional composition and structure of the feature can be assumed to be more ephemeral (i.e., area is being managed for timber and will likely be allowed to return to a forested condition).

Three major electric transmission right-of-ways traverse the study area from west to east, with cleared areas ranging from 85 feet to more than 200 feet in width. Although the ground cover under the powerlines is heavily managed to keep vegetation low, these right-of-ways were mapped as early successional habitat due to their similarity to old field environments. Powerline right-of-ways were mapped according to the prevailing cover type where the line crosses agricultural fields or other cover classes that have no woody growth.

Identifying active “gravel/sand/clay pit” sites is not difficult in the photography since the working face of the pit is often visible and haul roads are evident; they are also easily checked against USGS DRG images which label such extraction sites. Reclaimed pits are seen as smoothed, open areas, most often adjacent to active mine workings, as are a number of cleared/disturbed areas also associated with mining. Old or abandoned extraction sites are not readily seen, however, and these unique habitat sites were located by toggling from the DOQ’s to the USGS DRG images that date from 1987. As a related cover class, “Disturbed” areas are sites that are clearly unvegetated or sparsely vegetated. In some cases, these areas might be temporary site clearings in advance of new construction, but others are more permanently "cleared", as with the seasonal parking lot at the Epping speedway.

"Wet field" identification was made possible by scanning the field patterns for regularly spaced, darker strips of vegetation, signally the wetter soils in ditches or over drain tile lines. These fields are almost always immediately adjacent wetlands, as well. Although all wet fields appeared to be under active agricultural management, the cover class was distinguished because wetland plants such as sedges could be present on wetter sites, and wildlife utilization could be enhanced.

The "Made Wetland" class was created to account for a single instance of a clearly manmade wetland constructed as a mitigation project near Route 101.

<u>Summary</u>

While field checking of habitat delineation remains to be done in upcoming field seasons, these data have proved extremely useful in targeting geographic priorities for wildlife habitat conservation purposes. Land cover type mapping available from GRANIT is useful in determining broad-scale patterns of habitat type and structure, and to a limited degree in validating features digitized from aerial photography, but the relatively coarse resolution and definition in the land cover grid does not reveal the true extent and distribution of field and early successional habitat patterns on-the-ground.

Diversifying the open lands/early successional classification system is also important since it allows the datalayer to be queried for specific habitat types, and thus helps to pinpoint the modeling to only the most suitable habitat feature co-occurrences. However, ground-truthing the initial delineation, and "training" the data and method is very critical to the accuracy of the modeling effort.

New, alternative imagery is now available that would likely enhance the accuracy and perhaps the precision of open lands/early successional feature delineation. For example, geo-referenced digital images from *Emerge* ä [3] with a sub-meter resolution show plant and land cover types in much more detail than either the CIR or DOQ imagery used in this study, and would obviate the need for back and forth referencing while digitizing on-screen.

Taken to a higher level, the use of high resolution spectral imagery and more sophisticated GIS processing than is possible with ArcView would allow the development of an open lands and early successional habitat datalayer at regional scale, or even statewide, with periodic updates of this baseline data to detect change in location and maturity of the habitat features.

However, as noted above, the functionality ESRI's Arcview software can yield very satisfactory results in landscape-scale conservation planning with relatively low material and labor costs and less demanding technology in terms of utility and user skills.

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[3] *Emerge* ä is a proprietary name for a commercially available, high-resolution/high-definition digital imagery product; other products of equal quality are available from other digital image service providers.

Part Two: Creating a "Coarse Filter" Co-Occurrence Map Using the NHF&G Method For Identifying NH's Significant Wildlife Habitat

Introduction

In order to generate a landscape-scale conservation planning framework and to help familiarize the study team with the extent and distribution of the key ecosystems within the 85-square mile watershed study area, a first-phase GIS analysis was made using a method laid out in the *Identifying and Protecting New Hampshire's Significant Wildlife Habitat* guide recently published by the Non-game and Endangered Wildlife Program of the N. H. Fish and Game Department (NHF&G).

This manual helps community decision-makers to create a so-called "coarse filter" co-occurrence map of the most important wildlife habitat features in their town, using GIS data and technology to identify, evaluate, and protect wildlife and wildlife habitat. In addition, the manual provides detailed descriptions of threatened, endangered, and special concern wildlife species in New Hampshire, as well as their habitat associations. Datalayers to map potential habitat are provided for each species. These potential rare species habitat maps, combined with the "coarse filter" maps are designed to provide a community planners with a map of significant wildlife habitat.

Methods & Data

Several natural resource and habitat feature data factors are typically mapped in the NHF&G method, and were used for this project, including:

- Unfragmented blocks of natural land cover >500 acres
- Wetlands > 20 acres
- Emergent wetlands <20 acres
- Riparian buffer zones of 300' from all lakes, ponds, rivers and streams
- Agricultural and other open lands/early successional habitat
- Additional significant habitats, e.g., steep south-facing slopes > 10%, floodplains

More information on each of these datalayers, along with the rationale for classification, mapping guidelines, and a case study, can be found in the extensive narrative presented in the NHFG manual, and is therefore not duplicated in this report. However, this study provided an excellent experimental test case for using the NHF&G method at a landscape-scale, and the study team elected to explore other mapping and analysis options within the general approach laid out in the manual, as follows.

Unique Datalayers

In this project, very poorly drained soils (Hydric A) were also overlaid with the wetlands features noted above in order to provide an extra "placeholder" for wetlands ecosystems and associated natural communities, and to emphasize a systems context for and connectivity among wetlands clusters. Also, since little digital floodplain data were available for use in the GIS, alluvial soils were selected from the soil survey mapping as a proxy for floodplains, with the understanding that using such soils does not represent the entire hydrological or ecological floodplain in its entirety. However, it does aid in predicting the existence of rare natural communities and critical wildlife habitat features that exist in floodplains.

The NHF&G manual utilizes the GRANIT land cover type mapping as a starting point for identifying agricultural and other open lands, and lays out a suggested method for refining the land cover mapping by using aerial photography and field work to develop a unique datalayer that delineates agricultural land uses, various types of open, natural land covers, and true early successional habitats (old fields, shrublands, and young tree stands). Because of the importance and scarcity of these habitat types statewide, and the lack of digital data for use in GIS analysis, a low-tech, rapid assessment method for creating an open lands and early successional habitats datalayer was developed experimentally for this study (see Part One of this report for a detailed description). The GRANIT land cover mapping does not and cannot reflect the true detail shape, form and pattern of fields, meadows, gravel pits, disturbed lands and various stages of early successional habitat features that can be identified and delineated using aerial photos in the GIS environment. Consequently, the more enhanced datalayer generated for this study area was used in the resource co-occurrence mapping for the NHFG method.

Land Ownership Patterns

Data on land ownership patterns was available in the form of digital municipal tax parcel maps for seven (7) of eleven (11) towns included within the project study area. Although not used in the NHFG manual method as part of the GIS mapping and co-occurrence analysis, the study team decided to investigate the effect of including a data factor for parcel size at part of the landscape-scale analysis. All available tax maps were merged into a single shapefile, and the following criteria were applied:

- All parcels less than 10 acres in size were backed out of the mapping and analysis as ecologically insignificant, and;
- All remaining parcels were classified and scored, as follows:

10 to 100 acres	1 point
100 to 250 acres	2 points
250 to 500 acres	3 points
> 500 acres	4 points

Co-Occurrence Map: Discussion & Recommendations

Two composites of NHFG data factors were generated for this study: one without the landowner parcel data, and another with that data. In both maps, eight separate data factors are overlaid, with each data factor having an equal score of one (1) point.

The effect of using this scoring system can be seen in the first map which is typical of a NHFG method co-occurrence map using grids and a color ramp to depict increasing conservation values. The emphasis on aquatic ecosystems in the data factors (and the method) is clearly evident in the darker colors along the Lamprey and Piscassic Rivers and other watercourses. The influence of the special open lands and early successional habitat features datalayer can also be seen in places where field patterns "read" clearly as geometric forms in the overall scheme of colors used in the co-occurrence map. However, the few other upland habitat features, such as south-facing steep slopes and large, unfragmented blocks of natural land cover, do not accumulate enough score value to raise the importance of these terrestrial habitat elements.

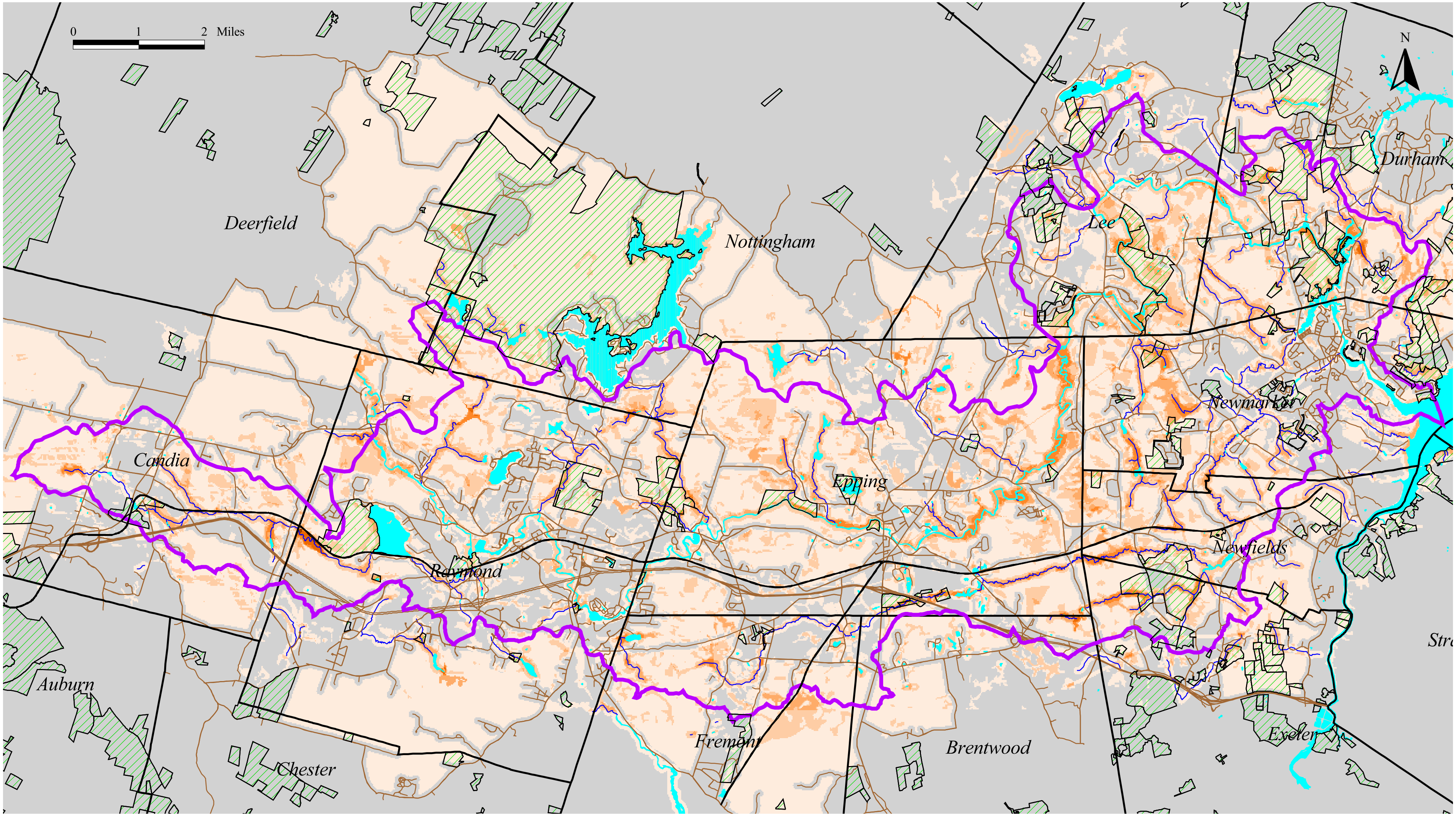
As can be seen in the second map with the parcel datalayer included, the range of score values has a very definite effect on the perception of relative importance in viewing the co-occurrence mapping, and must be taken into account when weighing other conservation values and priorities embedded within the co-occurrence map. Nevertheless, where larger parcels occur, especially in the >500 acres range, a greater *potential* for a broader range of ecological structures, functions, and processes exists, and so this datalayer is an important adjunct to the other data factors used in the NHFG method for identifying significant wildlife habitat

The scoring dynamics in each version of the co-occurrence map tend to create a bias in priority setting for conservation, favoring aquatic ecosystems in the first and larger parcels of land in the second. Future experiments to enhance the NHF&G manual method might take up the following recommendations:

- *The one-point-fits-all approach to scoring should be revised to reflect more of a weighted range of importance values.* The BioMap project in Massachusetts has incorporated this more complex method of assigning value to a range of habitat features, using a nested series of scoring and relative importance values (see the *BioMap Technical Report* published by the Massachusetts Division of Fisheries & Wildlife). In extending the NHFG method, for example, unfragmented blocks of natural land cover might be classified according to several factors, including size, ecological "blockiness", diversity or proportion of land cover types, and embedded water features. This would lend a more qualitative approach to the overall analysis, and would help balance the importance of upland sites versus aquatic sites.

- *Linkage opportunities and ecological connectivity should be factored into the analysis.* As can be seen in the maps, conservation and public lands already protect some of the higher-scoring areas on the co-occurrence maps, and when analyzed in concert with the parcel data, key expansion and linkage opportunities become evident. The parcel datalayer can be classified in terms of proximity to existing conservation lands, and when factored with size of parcels (favoring larger parcels,) the spatial priorities for land protection become even clearer.

  Ecological connectivity is a similar enhancement, but functions apart from land ownership patterns. In this case, unfragmented blocks of natural land cover can be classified in terms of how significant the fragmenting feature may be as an obstacle to wildlife movement in the larger landscape. In more rural settings, a less-travelled town road may have relatively little effect on many wildlife species, and so two or more adjoining blocks may actually function more as a single large unit of natural land. Thus,



Data Factors Mapped:

The following natural resource values are included in the co-occurrence composite depicted in this map:

Unfragmented blocks of natural land >500 acres in size.
Open land and early successional habitat features.
Riparian and shoreland buffers of 300 feet.
Wetlands of all types >20 acres in size as mapped by the National Wetlands Inventory (NWI).
Emergent wetlands as mapped in the NWI.
Hydric A soils (very poorly drained) as mapped by the National Resource Conservation Service (NRCS).
Alluvial soils mapped by NRCS as a proxy for floodplain habitat.
South- and southwest facing slopes with slopes >10%.

Each data factor above was assigned a point value of (1).

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Conservation & Public Land

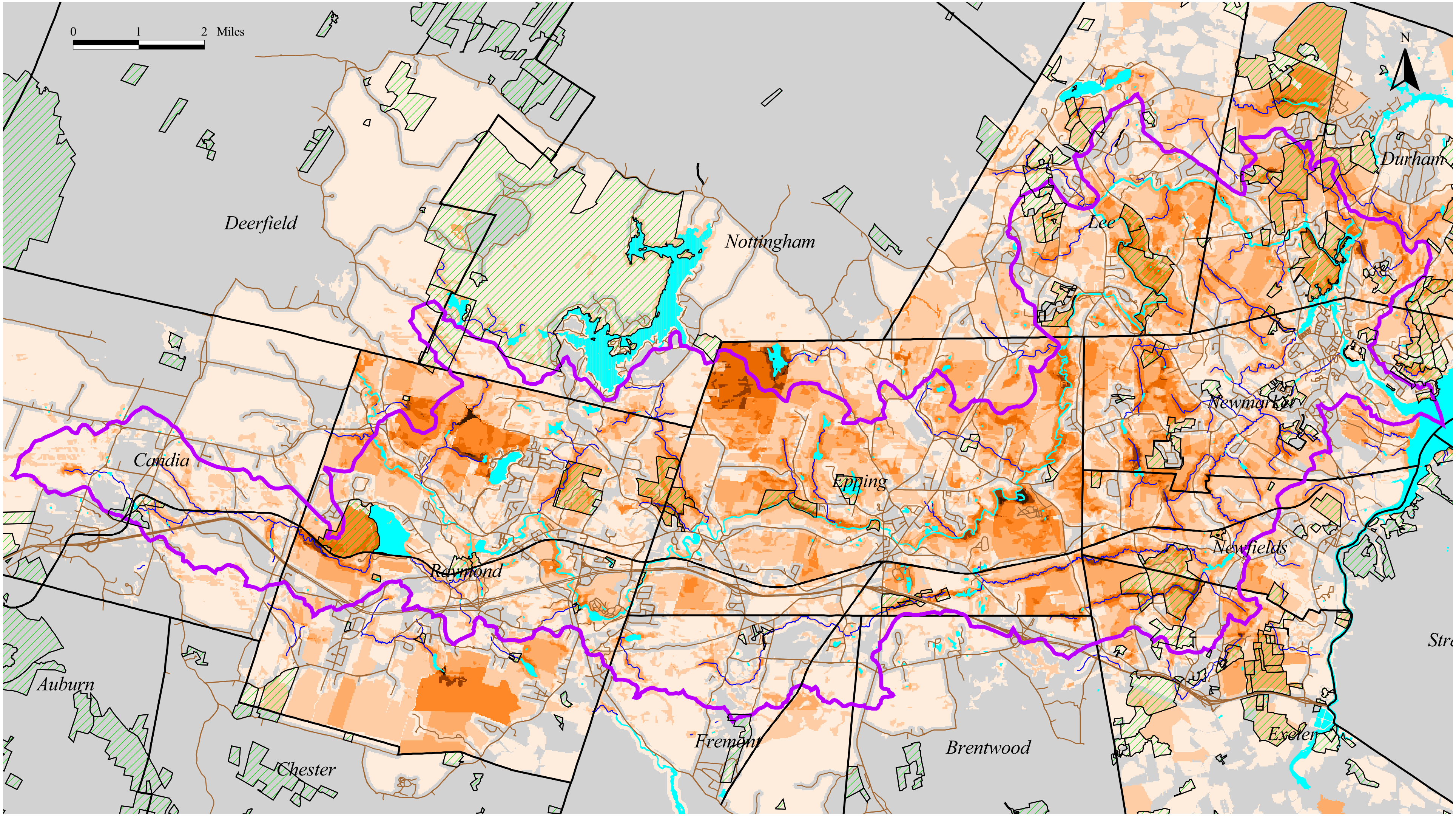
NHFG Habitat Value Co-Occurrence
- 0
- 1
- 2
- 3
- 4
- 5
- 6 Points

Piscassic River Wildlife Habitat Study

NHF&G Method:
Resource Values Co-Occurrence without Parcel Data

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project



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The following natural resource values are included in the co-occurrence composite depicted in this map:

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Open land and early successional habitat features.
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Wetlands of all types >20 acres in size as mapped by the National Wetlands Inventory (NWI).
Emergent wetlands as mapped in the NWI.
Hydric A soils (very poorly drained) as mapped by the National Resource Conservation Service (NRCS).
Alluvial soils mapped by NRCS as a proxy for floodplain habitat.
South- and southwest facing slopes with slopes >10%.

Each data factor above was assigned a point value of (1).

Parcels were assigned points as follows;
10 to 100 acres = 1, 100 to 250 = 2, 250 to 500 = 3, and 4 points for parcels >500 acres.

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Conservation & Public Land
NHFG Habitat Value Co-Occurrence
0
1
2
3
4
5
6
7
8 Points

Piscassic River Wildlife Habitat Study

NHF&G Method: Resource Values Co-Occurrence with Parcel Data

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

as with less evident opportunities in land ownership patterns as noted above, higher value connectivity among natural lands can also be extracted from such a GIS analysis.

Land Protection Status v. Resource Co-Occurrence

As part of the final analysis of significant wildlife habitat in the study area, and analysis was made of the extent of co-occurrence score values on and off the existing mosaic of conservation and public lands with the watershed. This was accomplished simply by correlating a gridded coverage of the current GRANIT Conservation and Public Lands datalayer with the version of the resource co-occurrence map (without the tax parcel data factor included in order to give a clear picture of the extent and distribution of natural resource values contributing to wildlife habitat). The co-occurrence grid was clipped to the watershed boundary proper to yield all values actually within the study area, versus within the buffer zone "context" outside the watershed boundary, as displayed on maps in this report.

Tabulated results of this analysis are shown on the next page, along with histograms to help visualize the differences among the extent of:

- habitat values presently under protection;
- habitat values not protected; and,
- existing conservation land not presently protecting any significant wildlife habitat values, as modeled in the GIS for this study.

Both "coarse filter" co-occurrence datasets are presented here for comparison, but the version without the tax parcel data factor added to the analysis is perhaps the more meaningful to the two since it directly addresses the importance of the various natural resource data factors contributing to significant wildlife habitat in the study area, and the mapped values are not biased by the higher-scoring parcels.

Looking at the top table, a little more than 30% of the total study area did not score any resource value, which is not surprising given the rapidly changing land use trends in the region. More than 63% of the study area contains significant wildlife habitat resource values that are not yet protected; however, 57% of the study area contains only one or two resource values, and only 6.5%of the area has three or more resource values unprotected. On the land conservation side of the equation, almost 5% of the study area with significant wildlife habitat resources is currently protected. Only 1.3% of the study area is now protected, but contains no resource values according to this analysis.

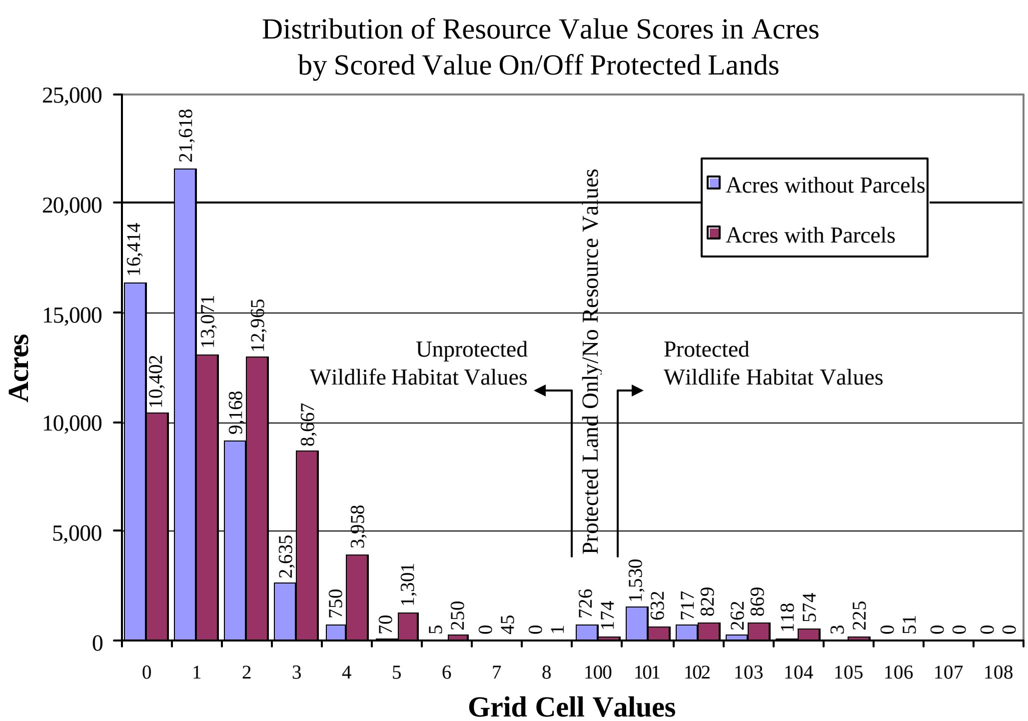
If the role of land ownership and parcel size is factored in, as shown in the second table on the next page, the numbers change a little. About 19% of the study area does not score, and nearly 75% of the study area with significant wildlife habitat values remains unprotected at this time. The spread of percentages across the unprotected values appears to be more well-distributed, but due only to the 1 to 5 point scoring scheme for parcels. In terms of overall protection of resource values, the fraction remains quite similar at about 6%.

Analysis of Significant Wildlife Habitat Resource Values On & Off Protected Lands in the Lower Lamprey River Watershed
(Without Tax Parcel Data Factor Added to Co-Occurrence Mapping)

Protection Status	Cell Score Values	Cell Count	Acres	Percent of Study Area	Summary
Unprotected Lands	0	81788	16,414.4	30.4%	**30.4%** *Study Area with No Score*
	1	107714	21,617.6	40.0%	
	2	45680	9,167.7	17.0%	
	3	13131	2,635.3	4.9%	
	4	3735	749.6	1.4%	
	5	347	69.6	0.1%	
	6	27	5.4	0.0%	**63.4%** *Study Area Wildlife Habitat Resource Values Unprotected*
Protected Lands	100	3616	725.7	1.3%	**1.3%** *Study Area Protected with No Significant Wildlife Habitat Values*
	101	7622	1,529.7	2.8%	
	102	3574	717.3	1.3%	
	103	1304	261.7	0.5%	
	104	586	117.6	0.2%	
	105	14	2.8	0.0%	
	NA	NA	0.0	0.0%	**4.9%** *Study Area Wildlife Habitat Resource Values Protected*
Totals			**54,014.5**	100.0%	

Analysis of Significant Wildlife Habitat Resource Values On & Off Protected Lands in the Lower Lamprey River Watershed
(With Tax Parcel Data Factor Added to Co-Occurrence Mapping)

Protection Status	Cell Score Values	Cell Count	Acres	Percent of Study Area	Summary
Unprotected Lands	0	51829	10,401.8	19.3%	**19.3%** *Study Area with No Score*
	1	65129	13,071.0	24.2%	
	2	64601	12,965.1	24.0%	
	3	43184	8,666.8	16.0%	
	4	19720	3,957.7	7.3%	
	5	6483	1,301.1	2.4%	
	6	1247	250.3	0.5%	
	7	225	45.2	0.1%	
	8	4	0.8	0.0%	**74.5%** *Study Area Wildlife Habitat Resource Values Unprotected*
Protected Lands	100	869	174.4	0.3%	**0.3%** *Study Area Protected with No Significant Wildlife Habitat Values*
	101	3148	631.8	1.2%	
	102	4133	829.5	1.5%	
	103	4328	868.6	1.6%	
	104	2862	574.4	1.1%	
	105	1122	225.2	0.4%	
	106	253	50.8	0.1%	
	107	1	0.2	0.0%	**5.9%** *Study Area Wildlife Habitat Resource Values Protected*
Totals			**54,014.5**	100.0%	



Part Three: Species of Concern Profiles & Habitat Mapping

Overview

The second stage of this study involved research into critical habitat requirements and/or preferences and GIS mapping and analysis on twenty-five (25) "species of concern" selected for the lower Lamprey River study area by an inter-agency team of scientists and wildlife biologists (see **Part One** of this report for a list of reviewers). The primary purpose of this effort was to use GIS to predict potentially suitable or optimal habitat for each focal species across a large area in three watersheds. A spreadsheet of the selected species, their respective habitat features/associations, and the GIS mapping guidelines generated by this team is found in **Appendix C.**

The accompanying co-occurrence maps prepared for each species are based on a series of mapped data factors listed in each species profile, using the information in **Appendix C** as a starting point, and scored according to best estimates of importance for each factor. The maps are generated using the same methods described earlier in this report. Each " habitat feature value co-occurrence" map is displayed as a graded series of colors that correspond to the accumulation of data factor scores for each grid cell in the composite: the darker the color, the higher the scores. To aid in interpreting the extent and importance of higher scores, a histogram has been generated from the attribute table for each co-occurrence grid.

Note that in many cases the higher scores make up a relatively small proportion of the overall number of cells, and the low- and mid-range values appear to predominate. This in turn may indicate that the modeling illustrates either comparatively localized instances of the most suitable habitat features – i.e., places where the "pinpointing" goal is working – or it may mean that the full range of suitable habitat features being modeled simply do not co-occur sufficiently enough to score in the highest numbers. In the latter case, therefore, the low- and mid-range values may be the best combinations of suitable habitat features possible, given the quality and range of data that can presently be mapped.

The range and relative importance of the co-occurrence scoring values for each species of concern mapped may be viewed in a histogram at the bottom of each species profile page following this introduction.

Scoring Schemes and Co-Occurrence Mapping

As explained in more detail in **Part One**, the GIS modeling technique assigns a point value score to each habitat feature mapped in each species profile. Generally, a 1 to 5 point scoring scheme was used, with (1) being the lowest possible score and (5) reserved for very important habitat features. Lower scores were also assigned by the team where confidence as to the significance of the particular habitat feature or preference was not well established in the literature or by expert interviews. As with the "coarse filter" mapping described in **Part One**, each data factor in the species maps was then overlaid and all values were added to generate a habitat feature co-occurrence value composite, as shown in the maps accompanying each specie of concern profile.

Primary Data Sources

In addition to expert opinions noted above, habitat profiles for each species of concern were also developed from a number of sources, including:

- *Identifying and Protecting New Hampshire's Significant Wildlife Habitats: A Guide for Towns and Conservation Groups.* 2001. Kanter, et al. NHF&G. 144 pp.
- *New England Wildlife: Habitat, Natural History, and Distribution*. 2001. Degraaf and Yamasaki. University Press of New England. 482 pp.
- *Priority Sites and Proposed Reserve Boundaries for Protection of Rare Herpetofauna in Massachusetts.* 2001. S. C. Fowle. MA Dept. of Environmental Protection. 107 pp.
- *BioMap Technical Report: A Supplement to BIOMAP: Guiding Land Conservation for Biodiversity in Massachusetts.* 2001. MA Natural Heritage & Endeangered Species Program. 72 pp.
- *USFWS Gulf of Maine Watershed Habitat Analysis.* 2001. http://gulfofmaine.fws/gov/gomanalysis
- V*ermont-New Hampshire GAP Analysis*. 2002. D. Capen. University of Vermont.

Species of Concern

One-page narrative profiles and habitat feature co-occurrence maps for each species of concern have been prepared, listed and organized taxonomically and by groupings sharing the same map, as follows:

Mollusks
Brook Floater Mussel[4]

Fish
American Brook Lamprey

Amphibians [5]
Marbled Salamander
Blue-spotted/Jefferson's Salamander

Reptiles
Blanding's Turtle
Spotted Turtle
Wood Turtle
Hognose Snake
Black Racer Snake

Birds
Pied-billed Grebe & Common Moorhen
American Bittern, Least Bittern & Sora
Sedge Wren
Grasshopper Sparrow
Blue-winged Warbler
Golden-winged Warbler
Red-shouldered Hawk
Osprey
Upland Sandpiper
Whip-Poor-Will
Woodcock

Mammals
New England Cottontail Rabbit
Bobcat

[4] The Brook Floater mussel was not mapped due to a lack of data about river substrates
[5] The two salamanders have not been mapped due to a similar lack of vernal pool data and a unreliability of soils data in predicting potential for vernal pools

Species:
Blanding's Turtle (*Emydoidea blandingii*)

Habitat Preferences:
A variety of wetland systems including rivers, beaver flowages, and isolated pools. Prefers deeper water habitats with soft, mucky bottoms, but will utilize shallower depths. Nests in loose soils, beaches, sandy substrates such as gravel pits and roadside edges.

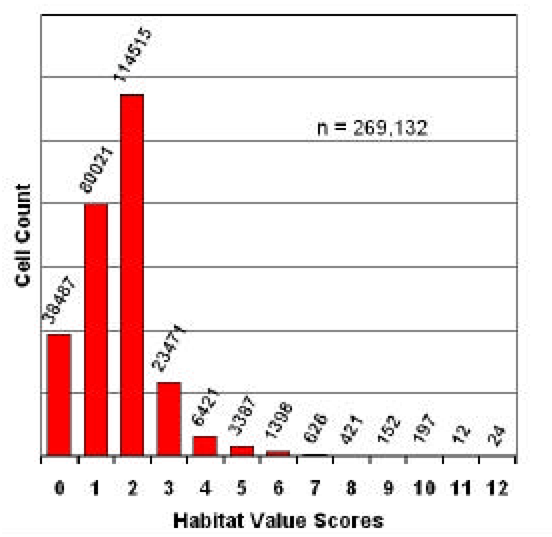
GIS Data Factors Utilized:

- Preferred wetlands types (R2US, L2AB, L2EM, PAB, PUS, PEM, PSS, PFO, PUB/PFO5, PUBHx, PSS1E, PUBF, PSS/EM1E, and PEM1/FO1/4E wetcodes)
- 1200 m buffer[6] around preferred wetlands, or less where limited by fragmenting land uses
- Density analysis of preferred wetlands in acres/square mile
- Related wetlands (all wetcodes associated with above) & beaverflows ("b" suffix codes)
- Open water (rivers, ponds, lakes)
- Streams, especially as connecting wetland complexes
- Natural land cover blocks re: matrix within which habitat features are embedded
- Roadsides adjacent wetlands & open water, and gravel pits re: nest sites

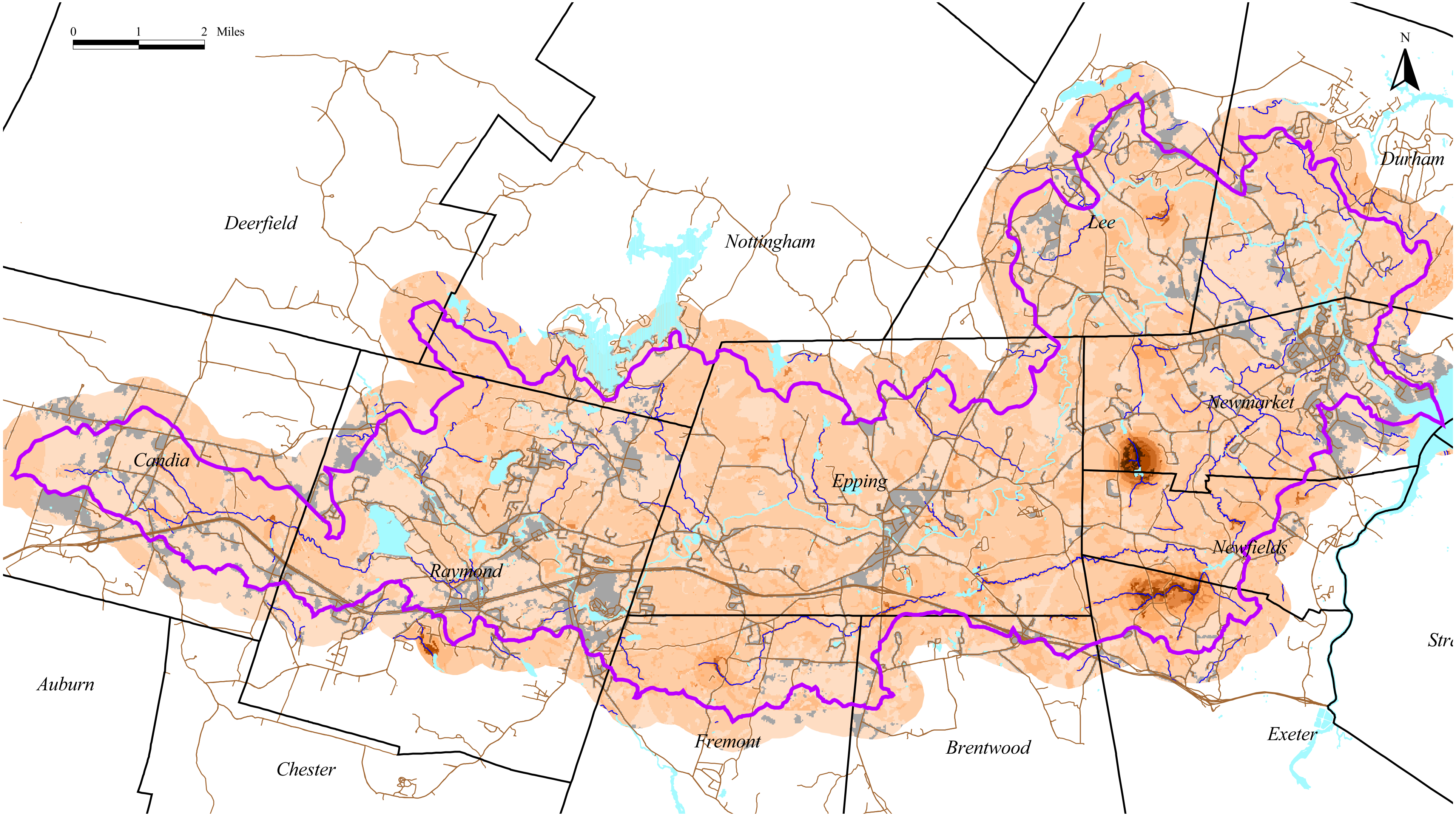
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Preferred wetlands	2
1200 meter buffer around preferred wetlands	1
Density of preferred wetlands	1 - 5
Related wetlands	1
Beaverflows	1
Open water (rivers, ponds, lakes)	2
Streams	2
Natural land cover blocks	1
Roadsides & gravel pits	1

Comments:
The primary focus of this model is on breeding/life zone habitats, but nesting habitats are included as a minority component. Beaverflows are added to the wetlands factors as a special element since they represent suitable habitat and are not included in the preferred wetlands list. The natural land cover blocks are added as context to the overall patterns of wetlands, in addition to the 1200 meter buffer designed to accommodate turtle movements among suitable habitat features. A density of preferred wetlands analysis was made to help target clusters of preferred wetland habitat.



[6] From *Priority Sites and Proposed Reserve Boundaries for Protection of Rare Herpetofauna in Masschusetts*. 2001.



Data Factors Mapped:

Preferred wetlands (see profile narrative)
1200 meter buffer around preferred wetlands
Density of preferred wetlands in acres/sq mile
Related wetlands (see profile narrative)
Beaverflows
Open water features
Streams connecting wetlands
Natural land cover blocks as matrix
Roadsides & gravel pits

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9
10
11
12 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Blanding's Turtle

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Spotted Turtle (*Clemmys guttata*)

Habitat Preferences:
Marshes, ponds and streams containing aquatic vegetation. Occasionally found in brackish water. Favors clusters or series of small, shallow interconnected or adjacent wetlands and associates with vernal pools where three or more pools are within a distance of 1000 meters. Prefers shallow water environments.

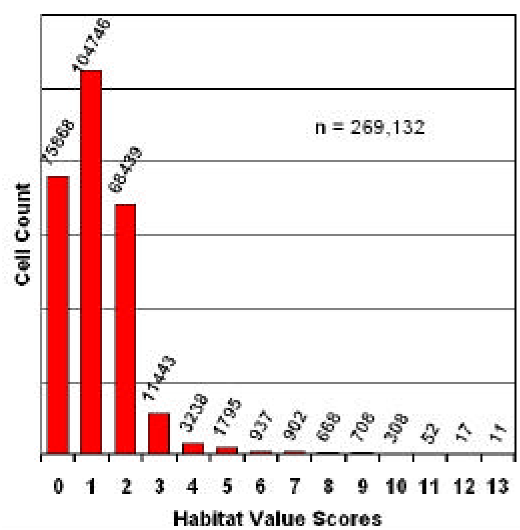
GIS Data Factors Utilized:

- Preferred wetlands types (R2US, PAB, PUS, PEM, PSS, PFO, PUBF, PUBH, and FO1/4E)
- 570 meter buffer[7] around preferred wetlands, limited by fragmenting land uses
- Density analysis of preferred wetlands in acres/square mile
- Related wetlands (all wetcodes associated with above)
- Vernal pools, per ASNH point data (partial coverage only)
- Vernal pools from selected NWI wetcodes (PEM & PUB) not drained by stream net.
- 1000 meter buffer[8] around all vernal pool sites
- Streams, especially as connecting wetland complexes
- Ponds < 10 acres in size

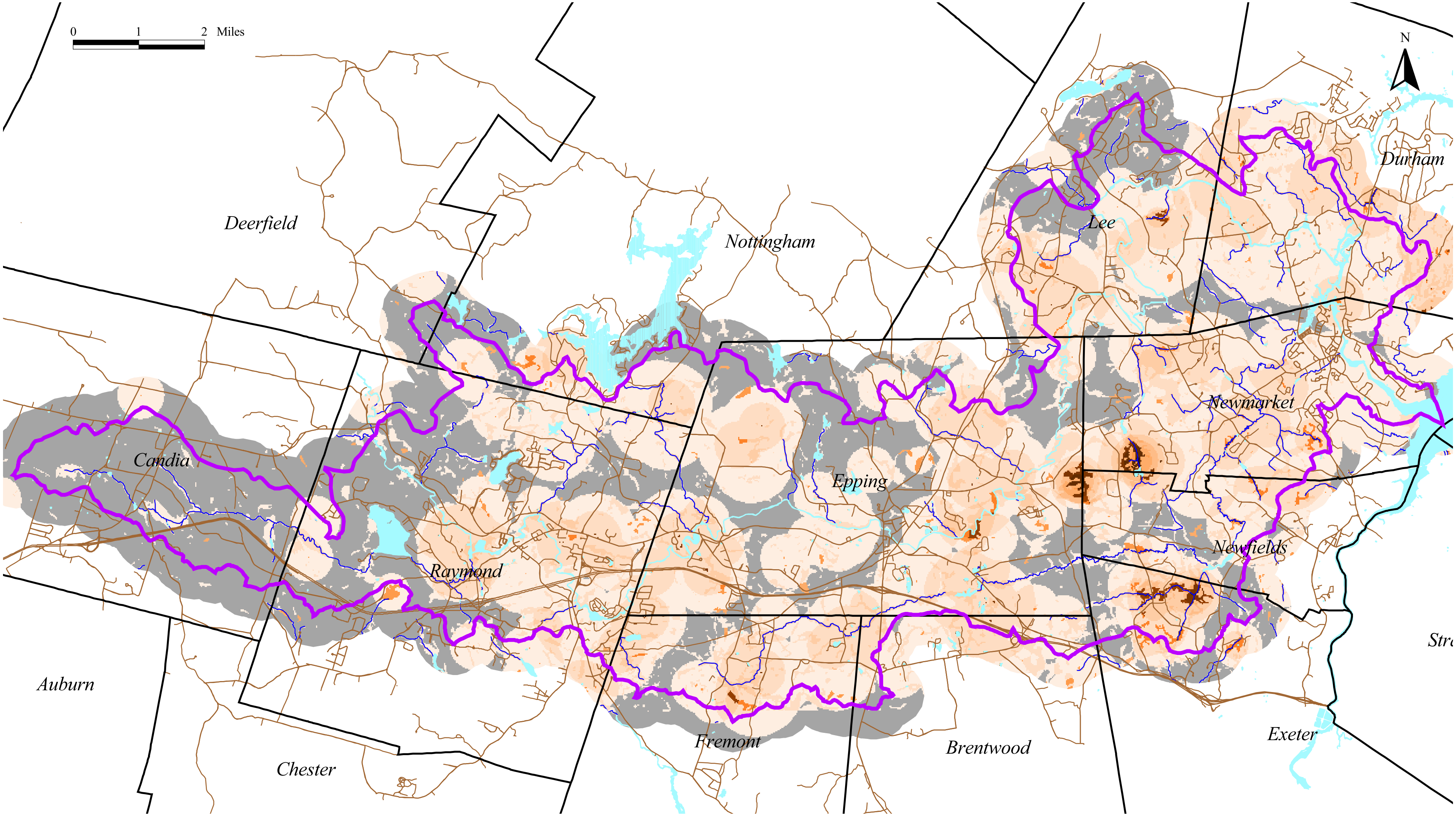
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Preferred wetlands	2
570 meter buffer around preferred wetlands	1
Density of preferred wetlands	1 - 5
Related wetlands	1
Vernal pools	2
1000 meter vernal pool buffer	1
Streams	2
Ponds < 10 acres	2

Comments:
The primary focus of this model is on breeding/life zone habitats; nesting habitats are not included in model. Beaverflows are added to the wetlands factors as a special element since they represent suitable habitat and are not included in the preferred wetlands list. The 570 and 1000 meter buffers are designed to accommodate turtle movements among suitable habitat features. A density of preferred wetlands analysis was made to help target clusters of preferred wetland habitat. A density calculation of vernal pools was not made due to the unevenness of the two data sources across the study area.



7 From *Priority Sites and Proposed Reserve Boundaries for Protection of Rare Herpetofauna in Massachusetts*. 2001.
8 Ibid.



Data Factors Mapped:

Preferred wetlands types (see profile narrative)
570 meter buffer around preferred wetlands
Density of preferred wetlands in acres/sq mile
Related wetlands
Vernal pools
1000 meter vernal pool buffer
Streams
Ponds <10 acres

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Features Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9
10
11
12
13 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Spotted Turtle

Mapping & GIS Analysis by the
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Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Wood Turtle (*Clemmys insculpta*)

Habitat Preferences:

Slow-moving rivers and streams with sandy, cobbled and gravelly substrates, bordered by dense shrubland (particularly silky or red-osier dogwood) and forested margins. Nests and spends time in upland from 300 meters to 600 meters from watercourse. Nests in gravel banks, old gravel pits, and edges of fields.

GIS Data Factors Utilized:

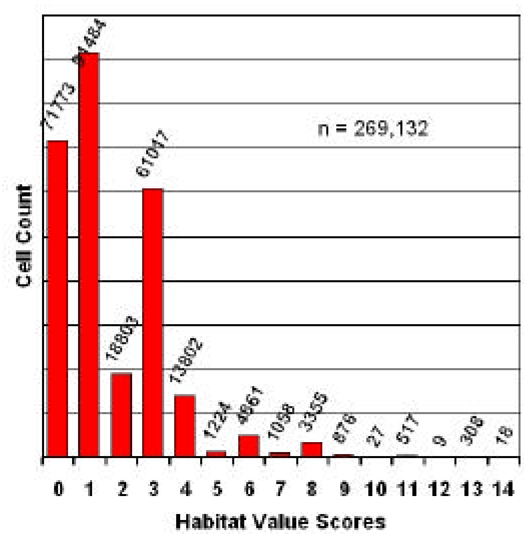
- Preferred wetlands types (PFO, PSS, & RU wetcodes)
- Rivers & perennial streams
- 300 meter & 300 to 600 meter buffer zones along rivers and streams
- Upland forest land cover type class re: qualifying the riparian buffers
- Dry soils & old fields or gravel/sand pits (old & active) re: nest sites

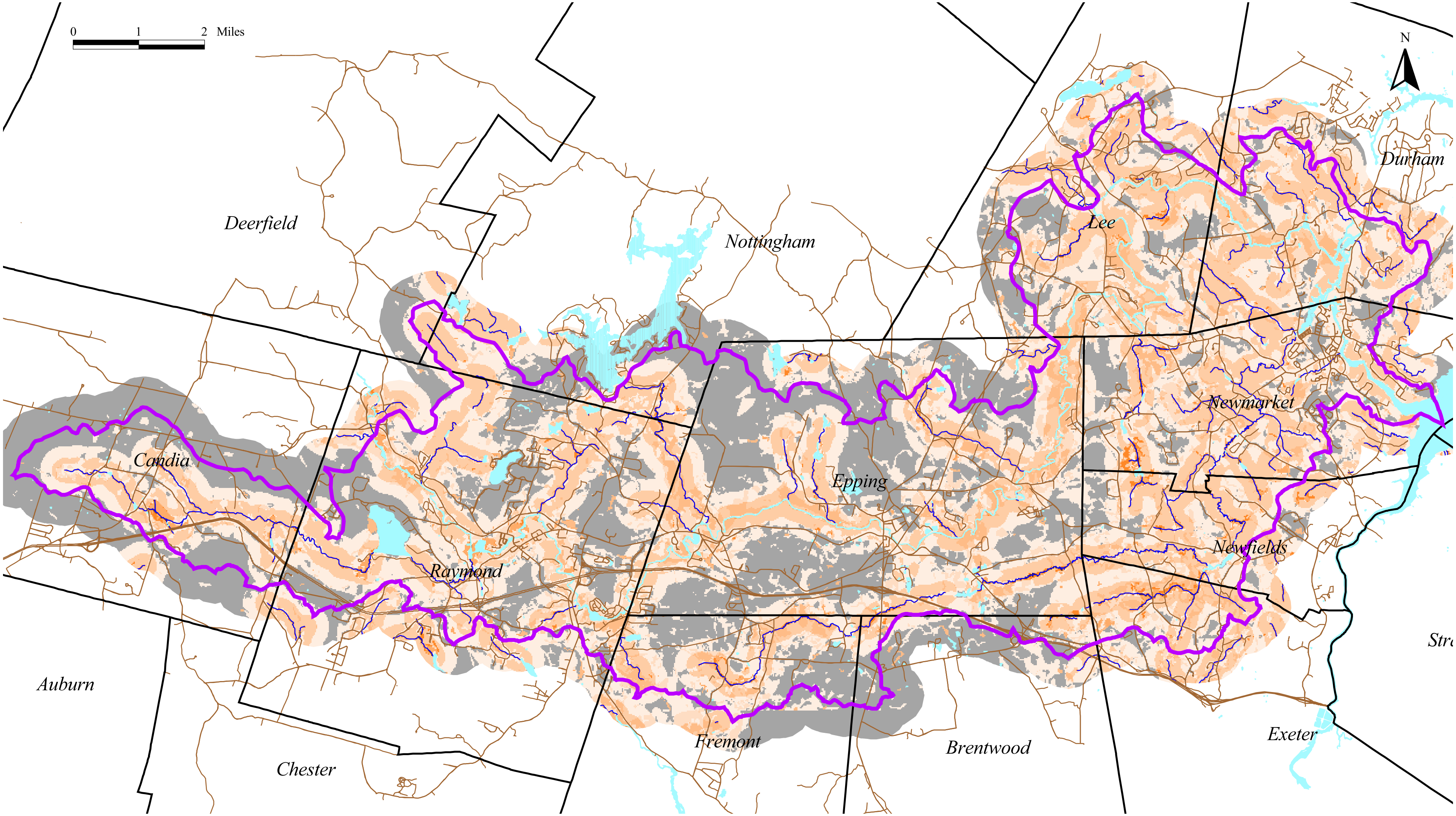
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Preferred wetlands (PSS wetcodes)	5
Preferred wetlands (RU wetcodes)	2
Preferred wetlands (PFO wetcodes)	1
Rivers & streams	5
0 to 300 meter watercourse buffer (forested)	3
300 to 600 meter watercourse buffer (forested)	1
Dry soils & old fields or gravel/sand pits (old & active) re: nest sites	1

Comments:

The primary focus of this model is on breeding/life zone habitats, but nesting habitats are included as a minor component and are shown on the mapping as cross-hatched areas for informational purposes. The 300 and 600 meter buffers are designed to accommodate turtle movements to and from upland habitat, with an emphasis on the 300 meter buffer zone. Palustrine scrub/shrub swamps bordering rivers and streams are of particular importance to this species; hence, the watercourse and the PSS wetcodes are rated very high, in part to help target PSS swamps along watercourses.





Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16 Points

Data Factors Mapped:

Preferred wetlands (PSS, RU, PFO codes)
Rivers & streams
300 meter & 300 to 600 meter watercourse buffer (forested)
Dry soils & old fields, gravel pits

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Wood Turtle

Mapping & GIS Analysis by the
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N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Eastern Hognose Snake (*Buteo lineatus*)

Habitat Preferences:

Dry sandy soils in pitch pine or white pine stands.

GIS Data Factors Utilized:

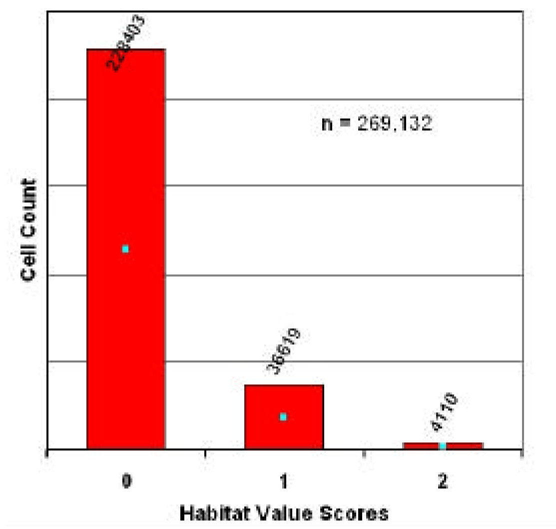
Excessively well-drained & somewhat excessively drained soils re: dry soils
Pitch pine & white pine forests, as derived from GRANIT land cover mapping

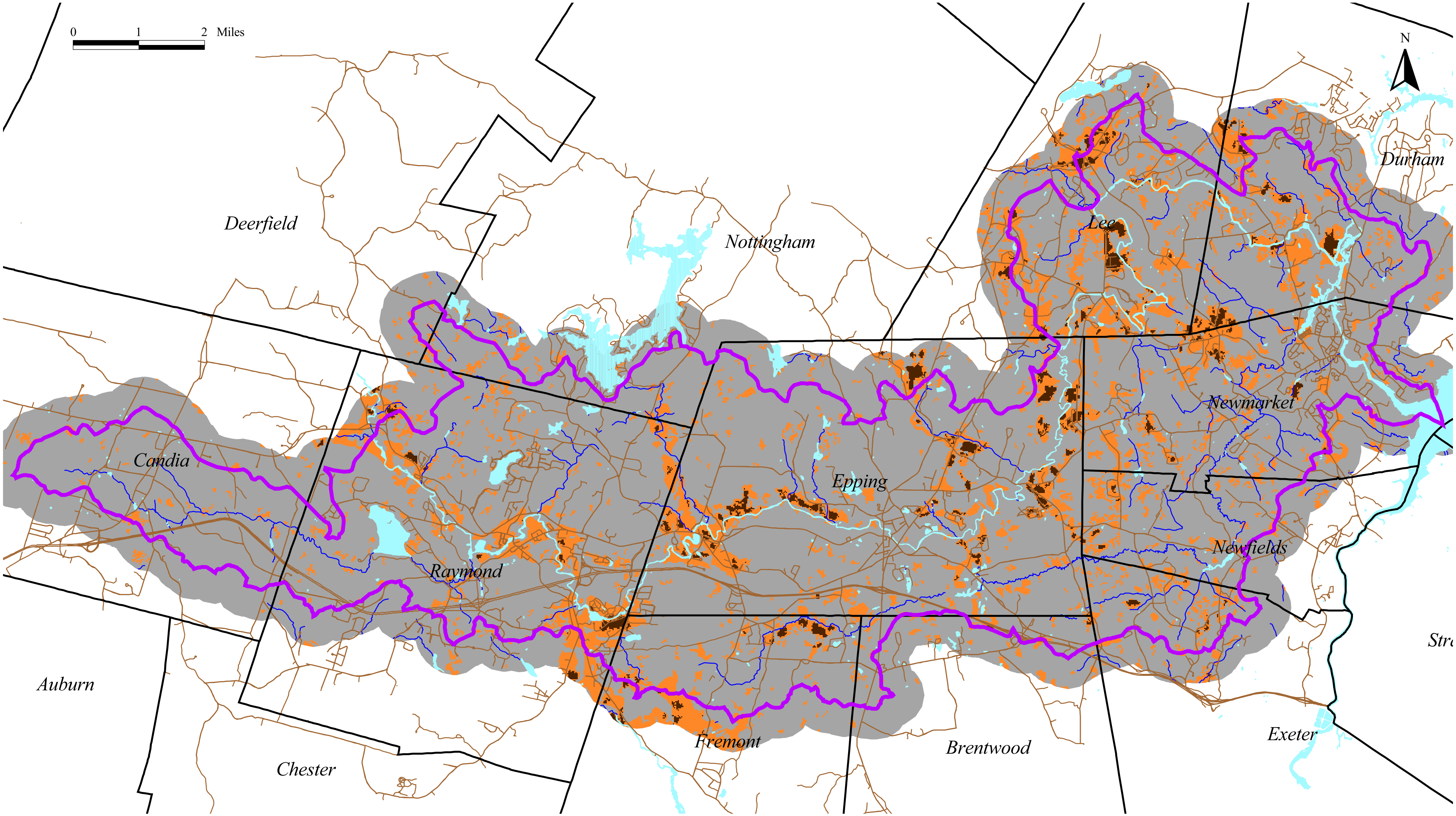
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Dry soils	1
Pitch pine & white pine stands (424 & 421 cover codes)	1

Comments:

Very little pitch pine land cover type exists within the study area. The white pine cover type includes an unspecified proportion of red pine.





Data Factors Mapped:

Excessively well-drained and well-drained soils
Pitch pine & white pine land cover types

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Eastern Hognose Snake

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Society for the Protection of NH Forests
in Partnership with:
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N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Black Racer Snake (*Coluber constrictor*)

Habitat Preferences:

Dry brushy areas associated with agriculture, orchards, powerlines, and early successional habitats.

GIS Data Factors Utilized:

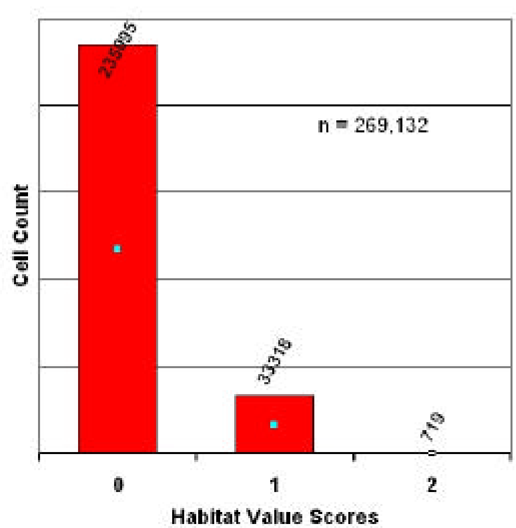
- Excessively well-drained & somewhat excessively drained soils re: dry soils
- Old fields, old fields/early successional habitat & early successional habitats; orchards & powerline ROW.

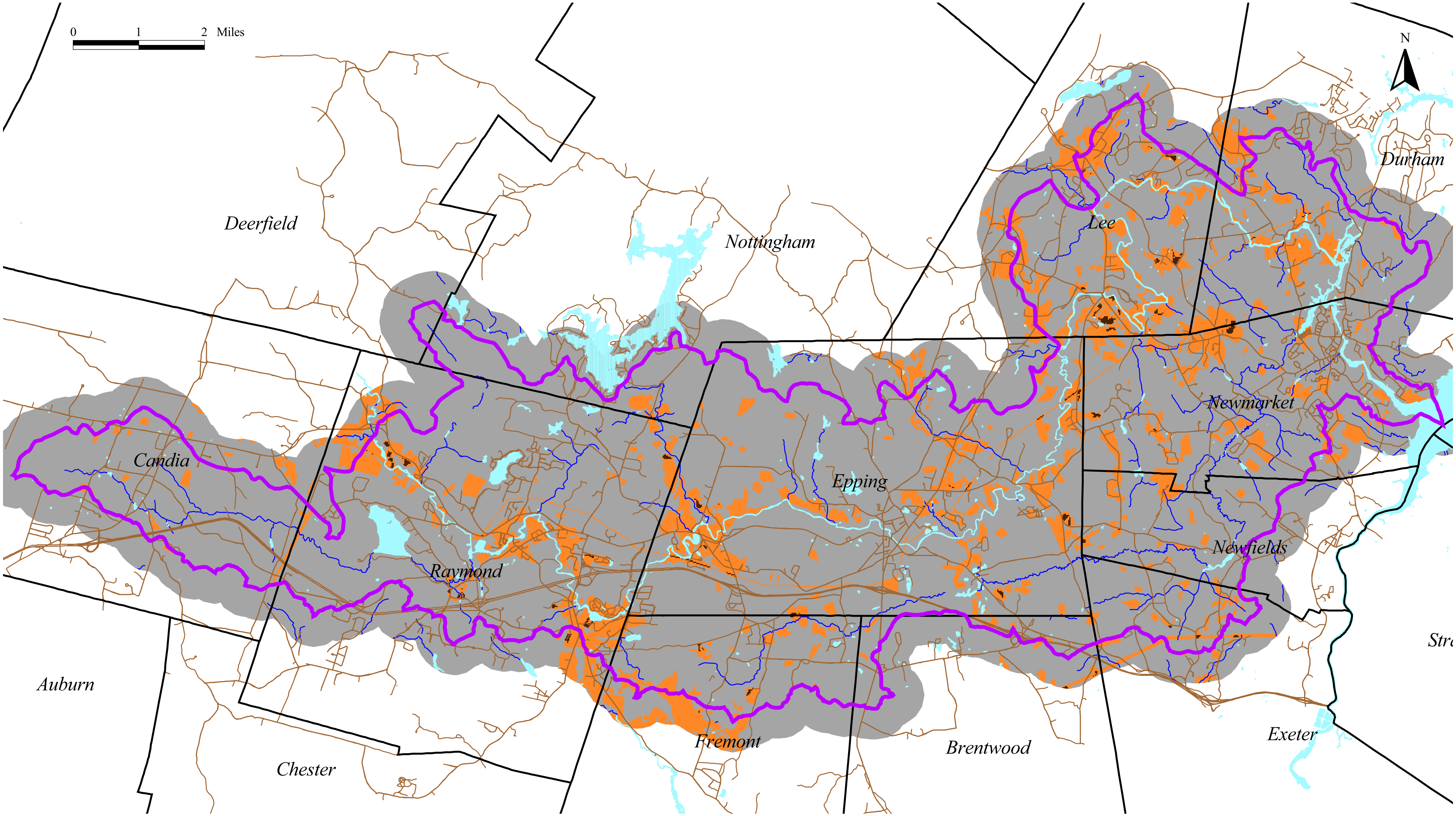
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Dry soils	1
Old fields, early successional habitats, & powerline ROW	1

Comments:

The precision of this model depends heavily on the accuracy of the open land/early successional habitats datalayer. Specifically, the presence or absence of brushy habitat structure cannot be reliably mapped at the scale and resolution available in current imagery. Field verification of mapped features (old fields, early successional habitats, etc.) and refinement of the datalayer classification system to include brushy habitats as a subset would be necessary.





Data Factors Mapped:

Excessively well-drained & well drained soils
Old fields, early succesional habitats, powerline ROW

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Black Racer Snake

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N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:

Pied-billed Grebe (*Podilymbus podiceps*)
Common Moorhen (*Gallinula chloropus*)

Habitat Preferences:

The grebe prefers emergent palustrine marsh with some open water, especially deep water habitat, or ponds > 10 acres with an extensive fringe of emergent vergetation. The Moorhen utilizes similar habitat, preferring dense emergent vegetation interspersed with pools, or shallow ponds with extensive emergent fringes.

GIS Data Factors Utilized:

- Palustrine emergent marshes (PEM wetcodes)
- Palustrine unconsolidated bottom (PUB wetcodes) re: open water utilization
- Streams and rivers connecting wetlands re: open water utilization
- Ponds <10 acres re: open water utilization, especially within or adjacent to wetlands
- Ponds >10 acres as preferred open water habitat

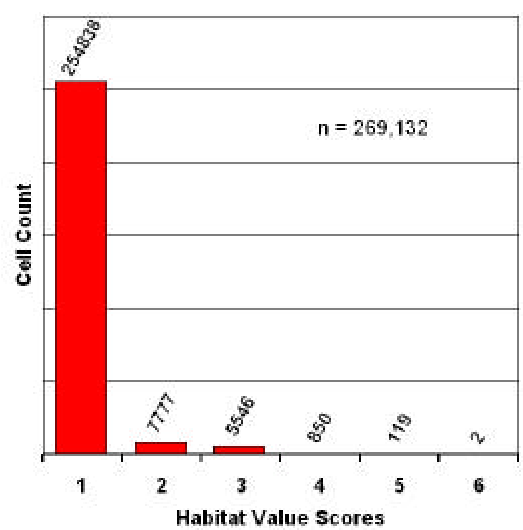
GIS Model Weighting Assumptions:

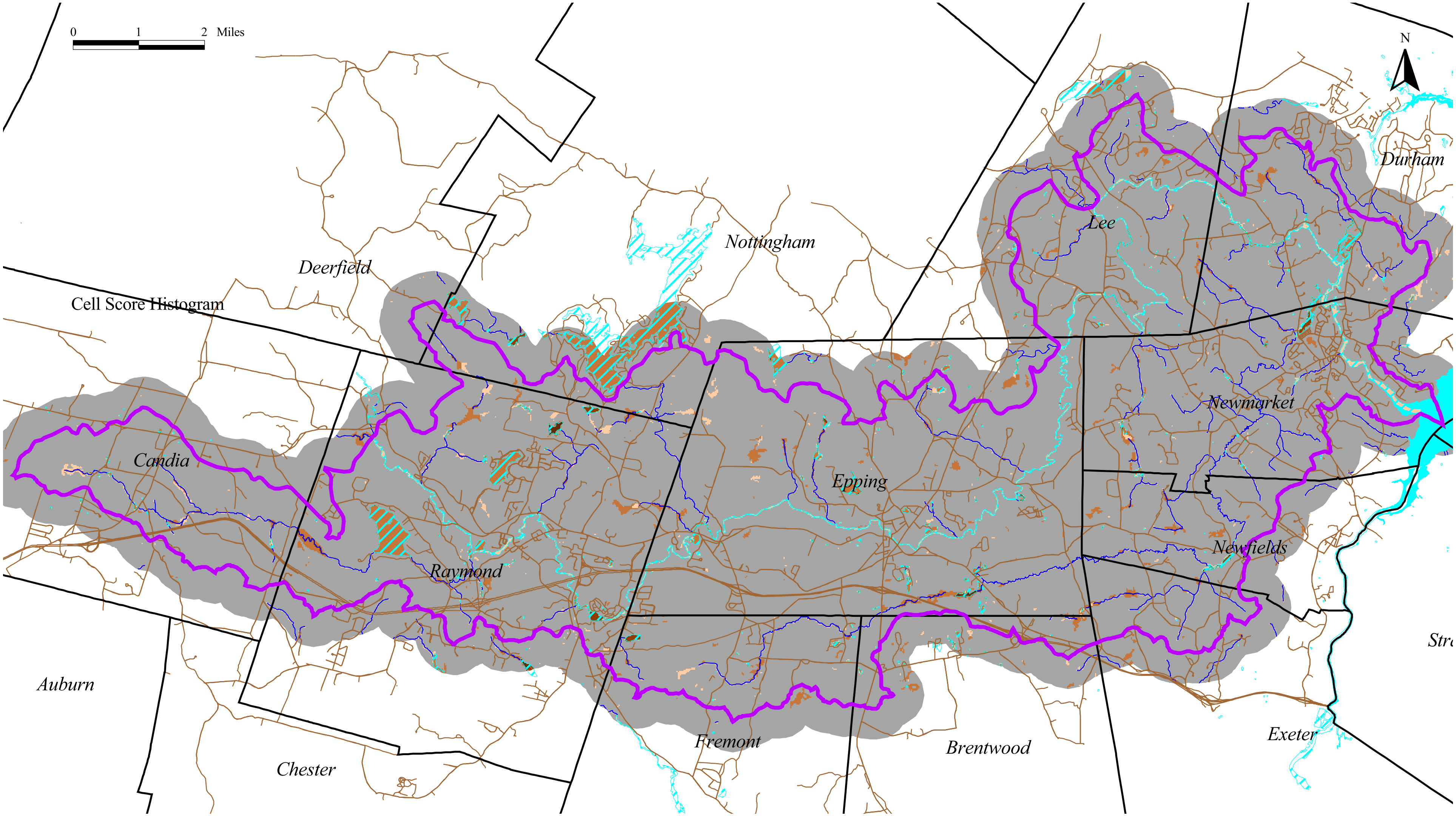
Data Factor	*Weight*
Palustrine emergent marshes (PEM wetcodes)	2
Palustrine unconsolidated bottom (PUB wetcodes)	1
Streams and rivers connecting wetlands	1
Ponds >10 acres	2
Ponds <10 acres	1

Comments:

Although the grebe and moorhen tend to favor ponds larger than 10 acres in size, ponds <10 acres were included in this model at a lower weighting in order to allow for potential utilization of water bodies of approximately the preferred size or clusters of ponds offering suitable habitat in the aggregate.

Current data layers do not allow for distinguishing deepwater pond habitat from shallow water, except as is inherent in the NWI PUB codes which imply the presence of unconsolidated bottom substrates (muck, sands and gravels), and open water. Some double counting of open water features occurs due to coincident features in the hydrological and NWI datalayers, but the NWI features tend to predominate.





Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Pied-billed Grebe & Common Moorhen

Data Factors Mapped:

Palustrine emergent marshes (PEM)
Palustrine unconsolidated bottom wetlands (PUB)
Streams and rivers connecting wetlands
Ponds >10 acres
Ponds <10 acres

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams

Habitat Feature Co-Occurrence Values

0
1
2
3
4
5 Points

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N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
American Bittern (*Botaurus lentiginosus*)
Least Bittern (*Ixobrychus exilis*)
Sora (*Porzana Carolina)*

Habitat Preferences:

Bitterns prefer cattail or other emergent marshes with tall, dense vegetation. Bittern nest sites are adjacent to open water. Sora favor emergent palustrine marshes with dense vegetation and open water channels. Marsh area should be >3 acres.

GIS Data Factors Utilized:

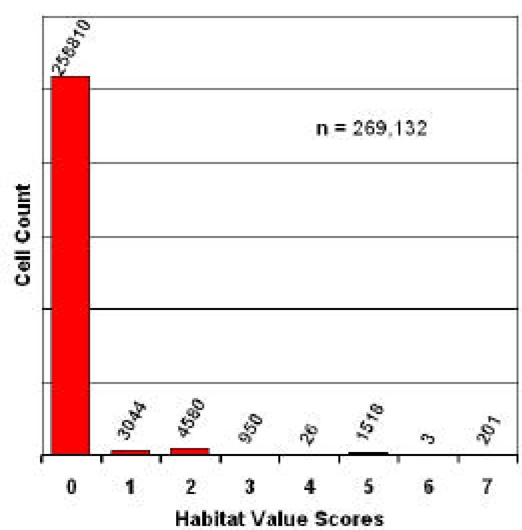
- Palustrine emergent marshes (PEM wetcodes) greater than 3 acres in size
- A subset of PEM wetcodes >10 acres to emphasize preference for extensive marshes
- Streams and rivers connecting wetlands to emphasize connectivity
- Ponds <10 acres for open water utilization, especially within or adjacent to wetlands

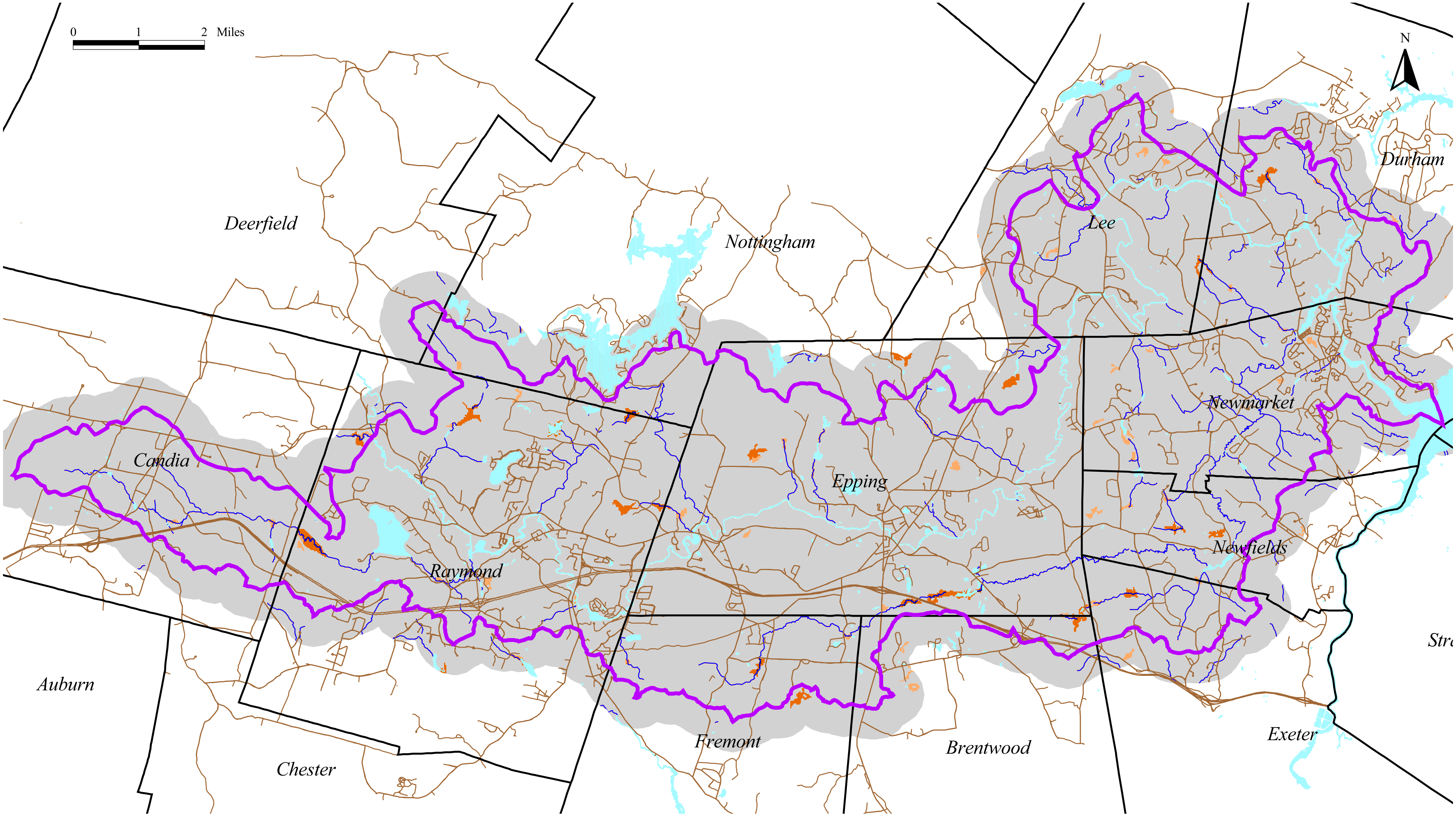
GIS Model Weighting Assumptions:

Data Factor	**Weight**
Palustrine emergent wetlands >3 acres	3
Palustrine emergent wetlands >10 acres	2
Streams connecting wetlands	2
Rivers	1
Ponds < 10 acres	1

Comments:

Current data layers do not allow for distinguishing deepwater habitat from shallow water, except as is inherent in the NWI PUB codes which imply the presence of unconsolidated bottom substrates (muck, sands and gravels), and open water. Some double counting of open water features occurs due to coincident features in the hydrological and NWI datalayers, but the NWI features tend to predominate.





Data Factors Mapped:

Palustrine emergent marshes > 3 but < 10 acres
Palustrine emergent marshes > 10 acres
Streams connecting wetlands
Rivers
Ponds <10 acres

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: American & Least Bittern, and Sora

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
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N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Sedge Wren (*Cistothorus plaeanis*)

Habitat Preferences:
Moist meadows, pastures, hayfields with dense sedges and grasses. Favors emergent marsh or sedge meadow with a stream running through it.

GIS Data Factors Utilized:

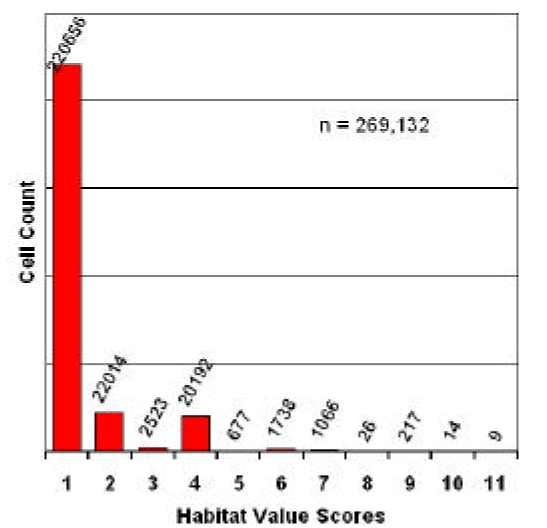
- Palustrine emergent wetlands, persistent (PEM wetcodes)
- Very poorly drained soils (Hydric A)
- Poorly drained soils (Hydric B)
- Muck and peat soils
- Streams running through PEM wetlands and connecting wetlands
- Wet fields, as mapped from aerial photography and DOQ's

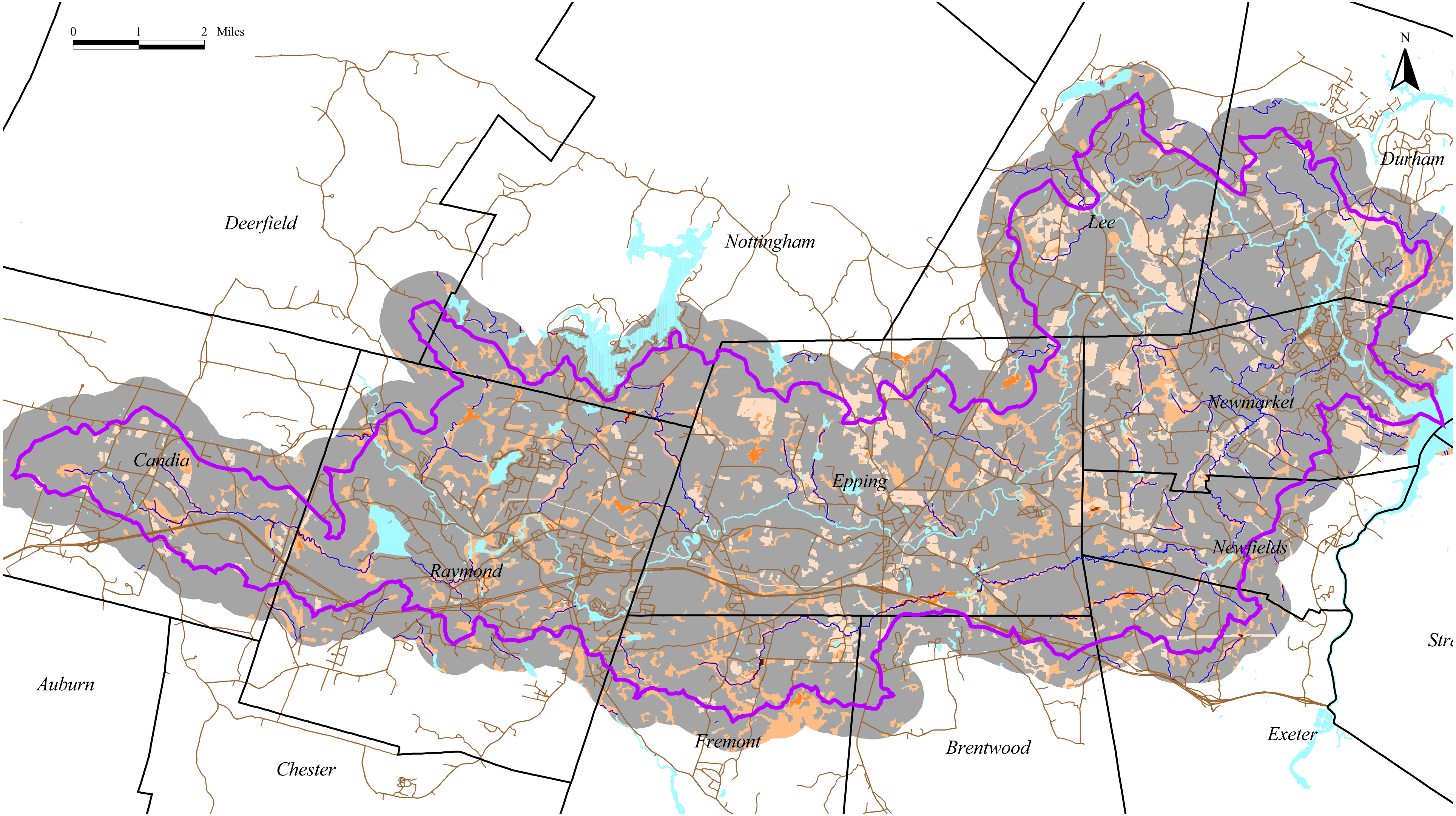
GIS Model Weighting Assumptions:

Data Factor	*Weight*
PEM wetlands (persistent)	3
Hydric A soils	1
Muck & peat soils	2
Streams connecting wetlands	2
Wet fields	3
Fields, old fields & Powerline ROW	1

Comments:

Persistent PEM wetlands favored due to presence of water. Muck and peat soils are emphasized in this model because tussock and other sedges favor this substrate.





Data Factors Mapped:

Palustrine emergent wetlands (PEM)
Very poorly drained soils (Hydric A)
Muck & peat soils
Streams connecting wetlands
Wet fields
Fields, old fields, powerline ROW

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9
10
11 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Sedge Wren

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Grasshopper Sparrow (*Ammodromus savannarum)*

Habitat Preferences:
Dry grasslands and other barren areas such as old gravel pits, generally >30 acres with short, sparse grasses and forbs. Will utilize smaller grasslands to a minimum of 24 acres, and perhaps closely clustered smaller meadows with total area > 30 acres. Utilizes taller weeds as perch points as a "vista space" for territorial purposes.

GIS Data Factors Utilized:

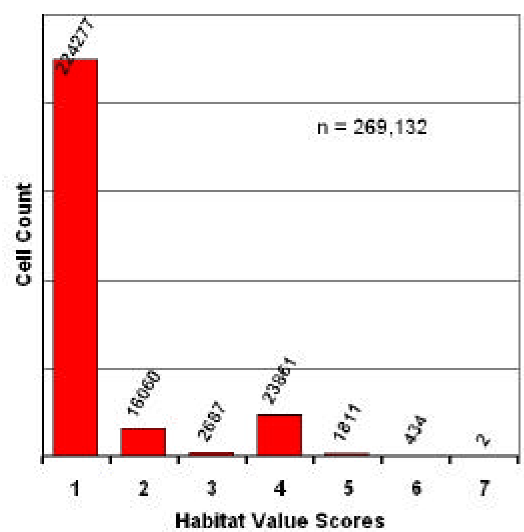
- Old fields, old fields in transition to early successional habitats, old gravel and sand pits, and disturbed land associated with gravel pits, as mapped from aerial photography & DOQ's
- Agricultural fields & powerline ROW re: potentially suitable open land habitat
- Excessively well-drained and somewhat excessively well-drained soils re: drier sites

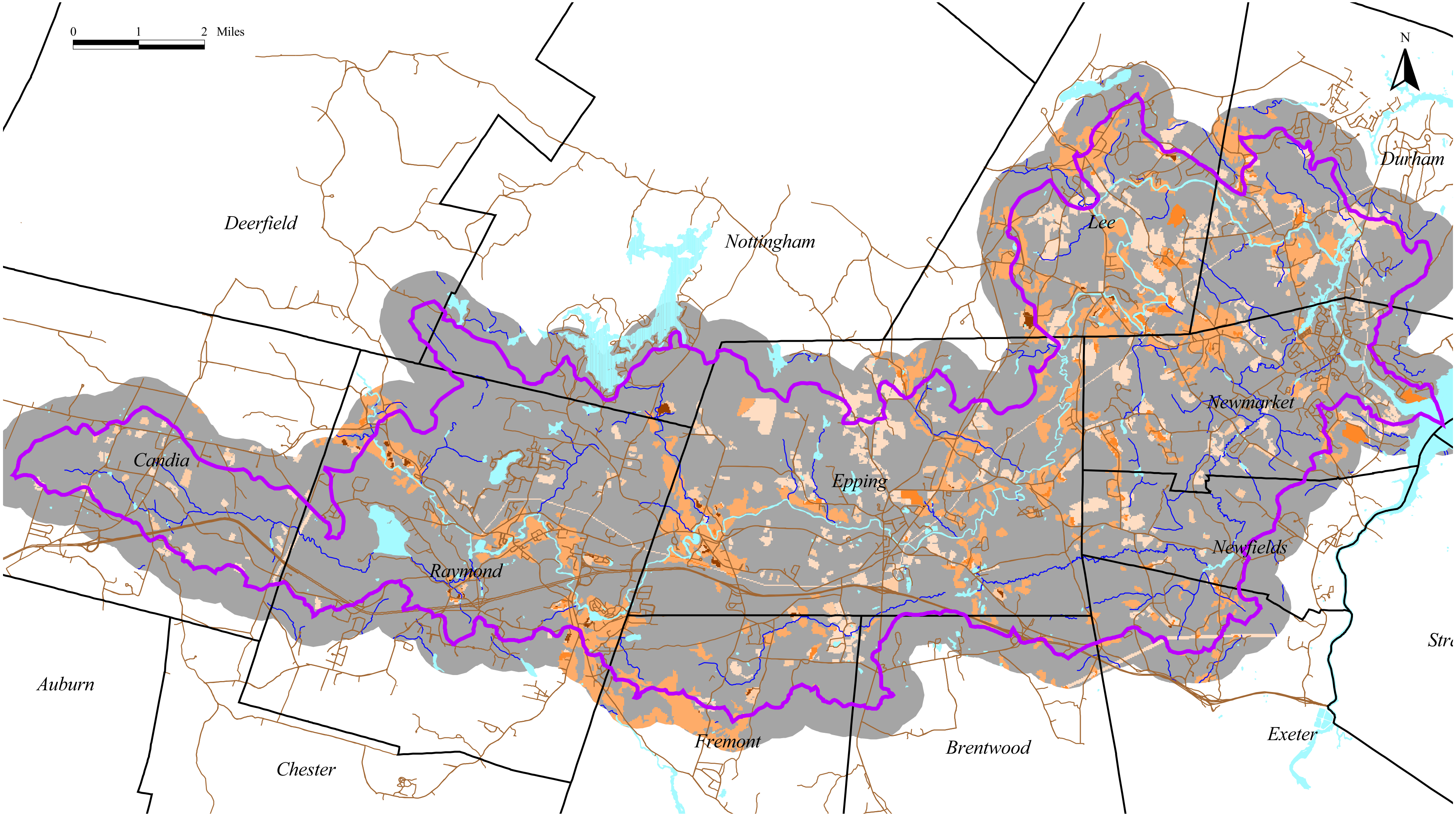
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Old fields & old fields/early successional habitat > 30 ac	4
Old fields & old field/early successional habitat >24 ac and < 30 ac	3
Old fields & old field/early successional habitat <24 ac	2
Old gravel/sand pits & associated distrubed land	2
Powerline ROW & Agricultural fields	1
Dry soils	3

Comments:

Agricultural fields and powerline ROW features are included in this model since potentially suitable habitat may exist in those datasets. The "Field" classification covers a wide range of intensity and types of agricultural uses, including infrequently mowed hay meadows that might support this species. Powerline ROW may also support appropriate habitat on drier sites where weedy "vista space" is found. Both factors are scored at minimum levels accordingly.





Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Grasshopper Sparrow

Data Factors Mapped:

Old fields & old field/es habitats > 30 acres
Old fields & old field/es habitats >24 and <30 acres
Old fields & old field/es habiats <24 acres
Old gravel/sand pits & associated disturbed land
Powerline ROW & agricultural fields
Dry soils

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7 Points

Mapping & GIS Analysis by the
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Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Blue-winged Warbler (*Vermivora pinus*)

Habitat Preferences:
Old fields and overgrown pastures, dense scrubby thickets and old fields in transition to early successional tree species within second growth forests. Tends to prefer old field sites or moist, brushy meadow bordering swamps or water.

GIS Data Factors Utilized:

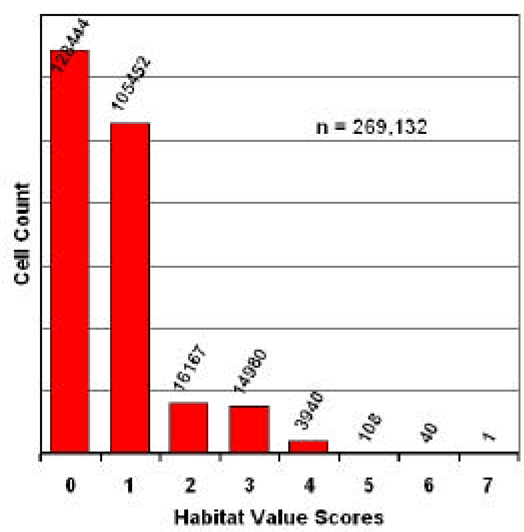
- Old fields and old fields in transition to early successional habitats, as mapped from aerial photography & DOQ's.
- Powerline right-of-way (ROW)
- Wet fields, as mapped from aerial photography & DOQ's.
- Wet soils (Hydric A very poorly drained)
- Stream and river network re: water association
- 300 meter buffer along streams and rivers re: terrestrial habitat zone near water
- Ponds re: water association

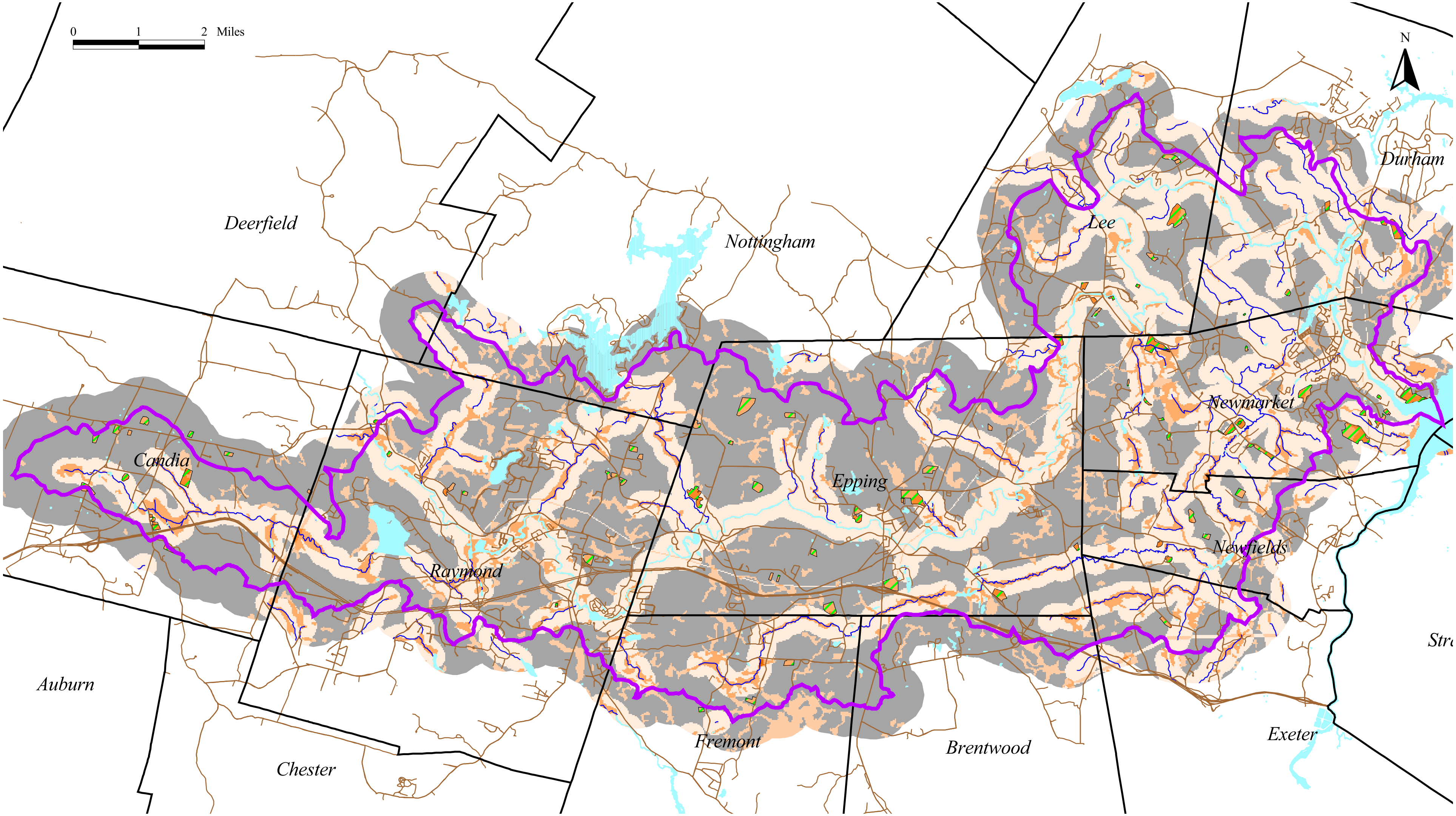
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Old field habitat	3
Wet fields	2
Wet soils (Hydric A)	2
Streams & rivers	1
300 meter buffer along streams & rivers	1
Ponds	1
Powerline ROW	1

Comments:

Early successional habitat with >50% tree/shrub canopy was not mapped due to preference for shrubbier and herbaceous cover types. Powerline ROW was deemed marginal habitat due to potential use of herbicides, which reduces insect forage, but nesting is favorable on some ROW sites. Note: Blue-winged warbler and golden-winged warbler are known to hybridize readily and are thought to be evolving as a hybrid species. Either species is known to utilize the preferred habitat features of the other. See also species profile and mapping for golden-winged warbler.





Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Blue-winged Warbler

Data Factors Mapped:

Old field habitat
Powerline ROW
Wet fields
Wet soils (Hydric A)
Streams & rivers
300 m buffer along streams & rivers
Ponds

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Old Field Habitats
Habitat Feature Co-Occurrence Values (BW Warbler)
0
1
2
3
4
5
6
7
8 Points

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Golden-winged Warbler (*Vermivora chrysoptera*)

Habitat Preferences:
Old fields and pastures, dense scrubby thickets and grey birch stands in second growth forests. Tends to prefer drier sites. Favors 50% to 60% herbaceous cover type mixed with shrubs and early successional tree species.

GIS Data Factors Utilized:

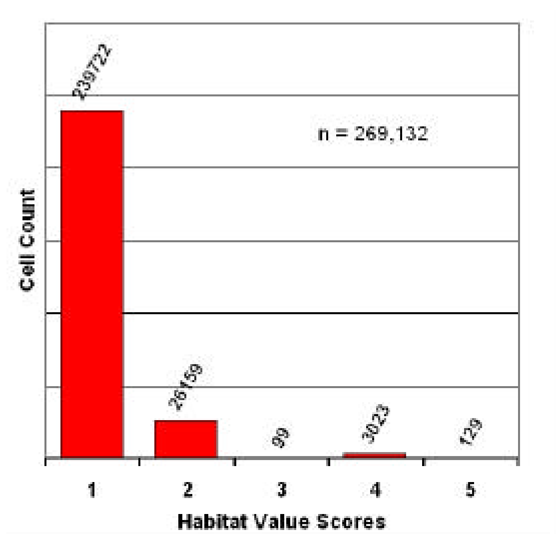
- Old fields and old fields in transition to early successional habitats, as mapped from aerial photography & DOQ's.
- Powerline right-of-way (ROW)
- Excessively well-drained and somewhat excessively well-drained soils re: drier sites

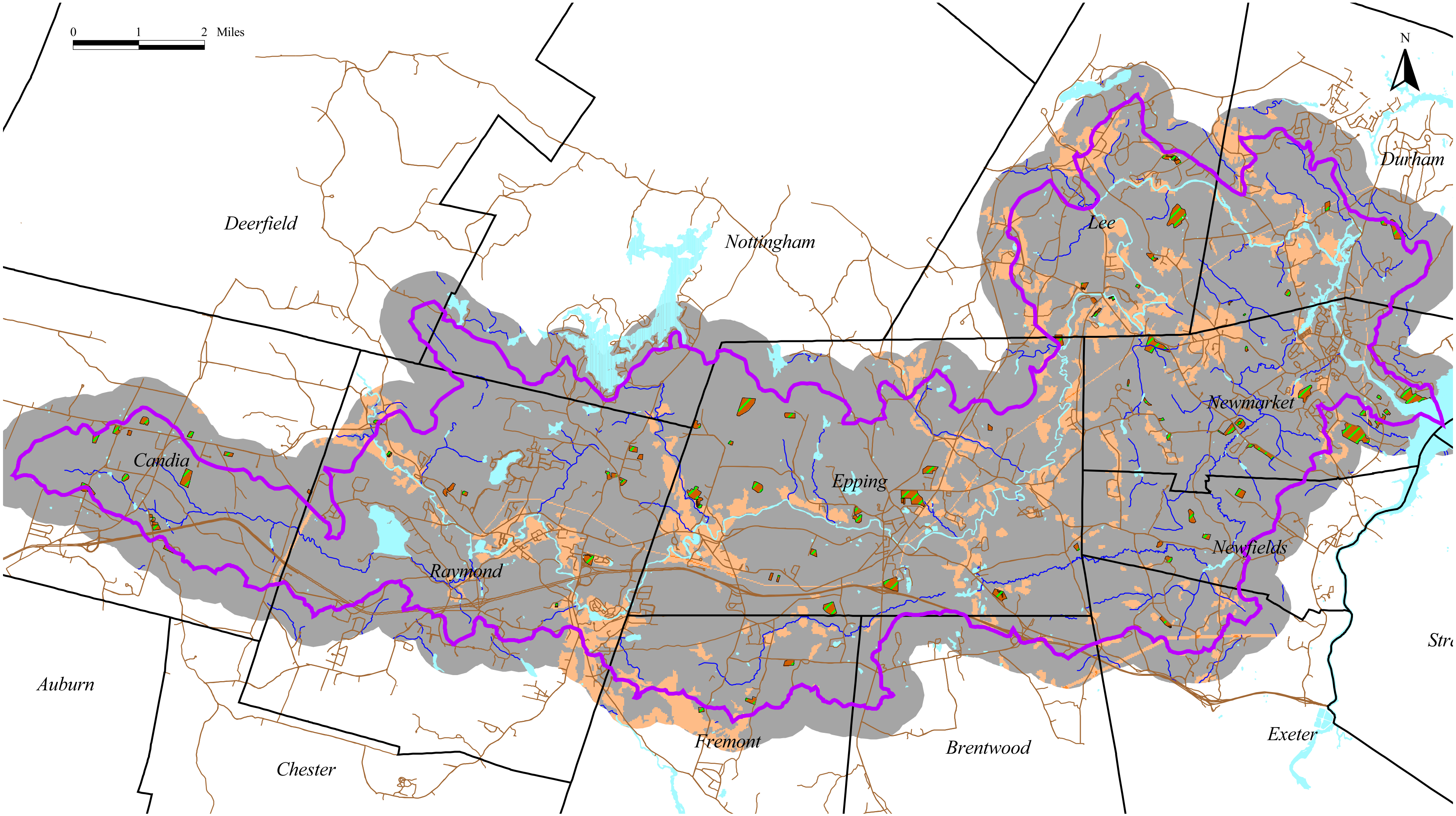
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Old field habitat	3
Powerline ROW	1
Dry soils	1

Comments:

Early successional habitat with >50% tree/shrub canopy was not mapped due to preference for shrubbier and herbaceous cover types. Powerline ROW was deemed marginal habitat due to potential use of herbicides, which reduces insect forage, but nesting is favorable on some ROW sites. Note: Golden-winged warbler and blue-winged warbler are known to hybridize readily and are thought to be evolving as a hybrid species. Either species is known to utilize the preferred habitat features of the other. See also species profile and mapping for blue-winged warbler.





Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Golden-winged Warbler

Data Factors Mapped:

Old field habitat
Dry soils

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Old Field Habitats
Habitat Feature Co-Occurrence Values (GW Warbler)
0
1
2
3
4 Points

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Red-shouldered Hawk (*Buteo lineatus*)

Habitat Preferences:
Mature forested wetlands, especially deciduous forest.
Utilizes large wetland complexes and open water associated with large blocks of forest cover. River corridors through forests and wetland clusters comprising 20% or more of aggregate cover types embedded within forests are preferred. Nests in forest cover, but proximity to open water is < ½ mile. Often associated with heron rookeries.

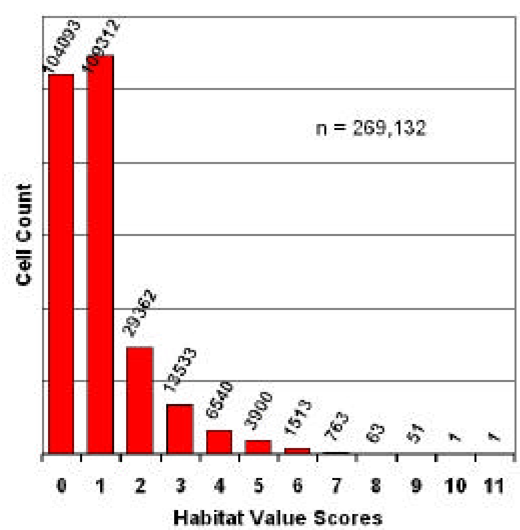
GIS Data Factors Mapped:

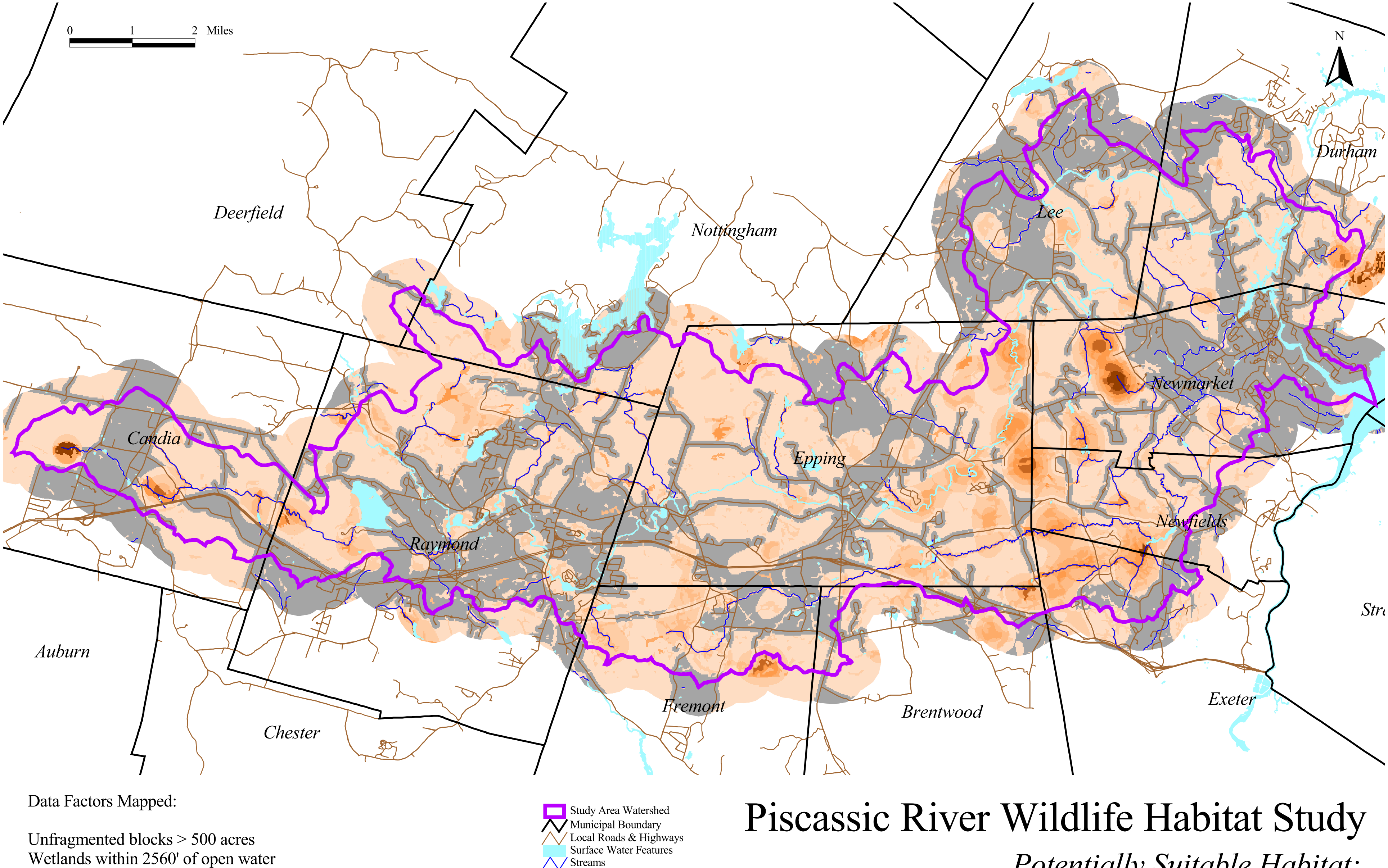
- Unfragmented forest blocks > 500 acres including forested wetland cover type
- Palustrine wetlands >3.374 acres (mean size, see below) within ½ mile of open water
- NWI wetcodes for beaverflows (suffix "b"), as a preferred wetland habitat type
- Ponds, lakes, rivers, and streams flowing through wetland complexes
- Heron rookery sites derived from ASNH mapping, buffered at 1000' for graphic emphasis

GIS Model Weighting Assumptions:

Data Factor	*Weight*
Unfragmented natural land cover blocks > 500 acres	1
Wetlands within 2560' of open water	1
Beaverflows	2
Open water features, including ponds, lakes, reservoirs, & rivers	2
Heron rookeries	2
Wetlands clusters (see comment below)	1 to 5

Comments:
The mean size of all wetlands within ½ mile of open water was calculated at 3.374 acres, and this size was used as a minimum size for mapping purposes. The importance of wetlands clusters was evaluated by generating a datalayer of centroid points from all palustrine wetlands polygons >3.374 acres (using the Xtools extension), then calculating a 5-step equal interval density surface grid representing acres of wetland per square mile. This grid was then added into the data factor co-occurrence composite to emphasize locations where wetlands clusters have higher significance/probability for red-shouldered hawk utilization.





Data Factors Mapped:

Unfragmented blocks > 500 acres
Wetlands within 2560' of open water
Beaverflows
Open water features, including ponds, lakes, rivers
Heron rookeries
Wetlands density in acres/sq mile (see profile narrative)

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Red-Shouldered Hawk

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Osprey (*Pandion haliaetus*)

Habitat Preferences:
Breeds in the vicinity of coastal and fresh water with suitable fishing habitat. Utilizes beaver flowages and/or heron rookeries >24 acres within five (5) miles of Great Bay and/or lakes > 100 acres.

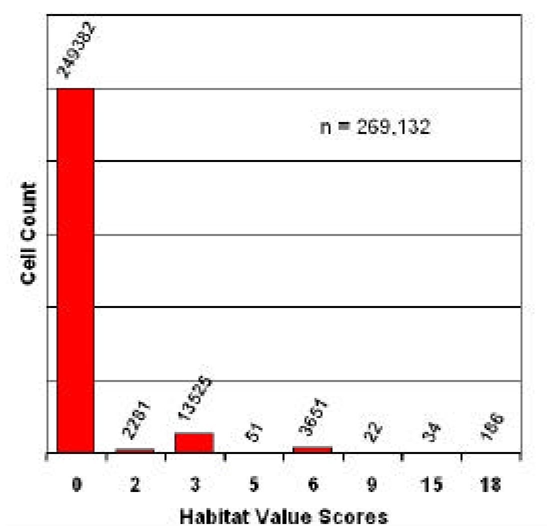
GIS Data Factors Utilized:

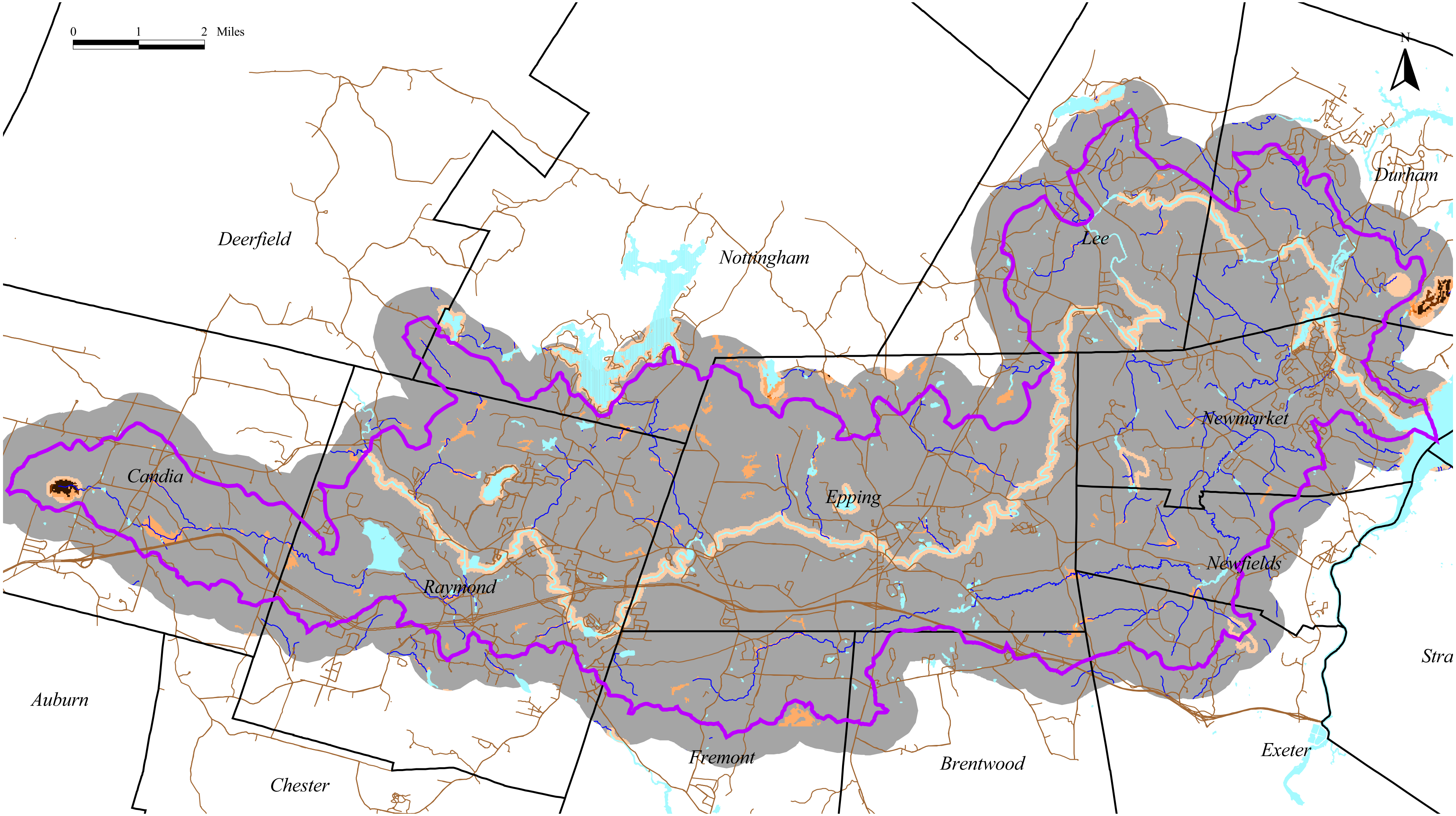
- Beaverflows (all "b" suffix wetcodes)
- Open water (rivers, ponds, lakes, reservoirs, or tidal water) >24 acres & >100 acres
- Known heron rookeries, from ASNH point data

GIS Model Weighting Assumptions:

Data Factor	*Weight*
Beaver flows coincident with existing heron rookeries	5
All other beaver flows	3
Water features >100 acres	3
Water features >24 acres and <100 acres	2
Rivers	2
300' buffers at beaver flows & water features	3
1000' buffer at known heron rookeries	3

Comments:
Heron rookeries were mapped from ASNH data points. Rookeries coincident with beaver flows > 24 acres were ranked highest. Water features <100 acres were mapped as potential fishing habitat, with 24 acres selected as the minimum size consistent with osprey preference for beaver flow/heron rookeries. All rookery points were buffered at 1000' for pattern emphasis in the mapping. Beaver flows were buffered at 300' as a protective life zone. Rivers not mapped as part of the water features >100 acres were included as potential fishing sites and for the sake of continuity of habitat; the 300' buffer is used for graphic emphasis.





Data Factors Mapped:

Beaver flows coincident with existing heron rookeries
All other beaver flows
Water features >100 acres
Water features >24 acres & >100 acres
Rivers
300' buffer at beaver flows & water features
1000' buffer at known heron rookeries

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
2
3
5
6
9
12
15
18 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Osprey

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Upland Sandpiper (*Bartramias longicauda)*

Habitat Preferences:
Extensive grasslands >150 acres with low vegetation. May utilize suitable smaller grassland clusters in close proximity to one another that total >150 acres in the aggregate.

GIS Data Factors Utilized:

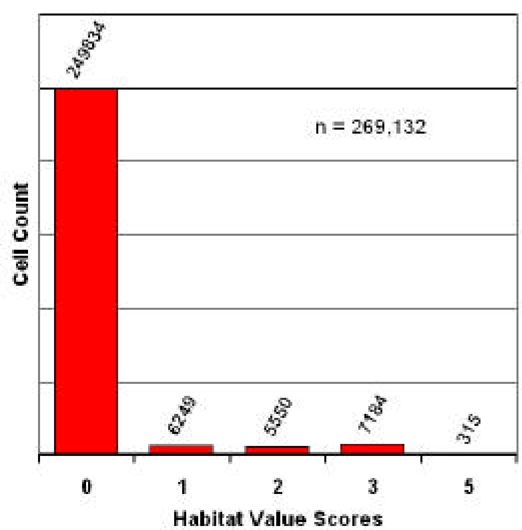
- Old fields & disturbed open land as mapped from aerial photography & DOQ's
- Agricultural fields
- Density analysis of old field/disturbed lands clusters, as mapped from aerial photos and DOQ's
- Density analysis of Agricultural Field clusters, as mapped from aerial photos and DOQ's

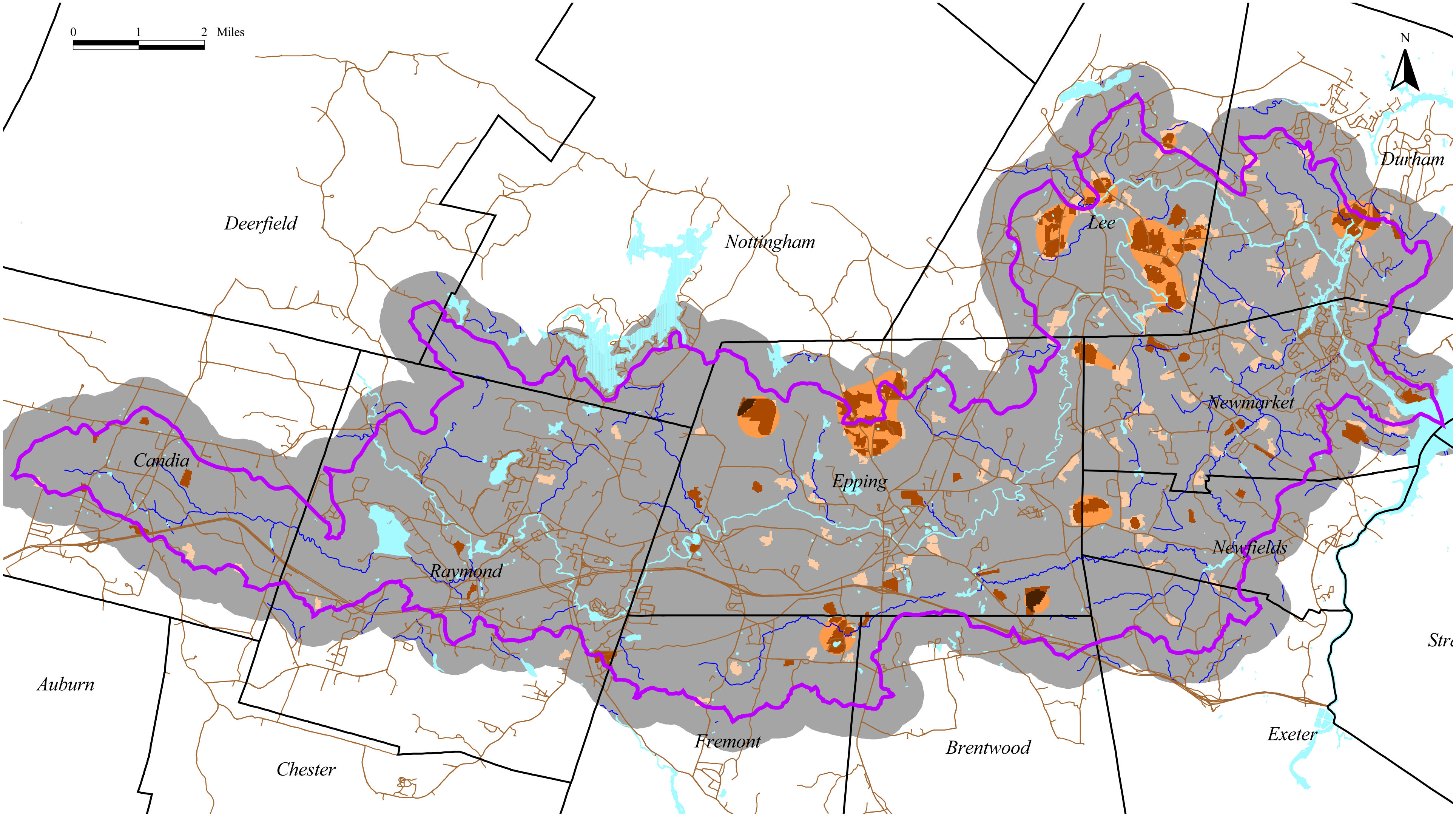
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Old fields & disturbed lands	3
Fields	1
Density of old field/disturbed lands @ >150 acres/square mile	2
Density of agricultural fields @ >150 acres/square mile	2

Comments:

Agricultural fields were added into this model due to the scarcity of old field/disturbed lands habitat and since a significant number of infrequently mowed hay meadows exist in the "Fields" class, but they were ranked lower in the scoring. The largest old field/disturbed land polygon is only 60 acres, and the largest agricultural field is a little more than 100 acres. Consequently, a density analysis was incorporated into the model to determine if any clusters >150 acres/ square mile of old fields & disturbed lands, or of agricultural fields, exist in the study area. Only one was found for the old field/disturbed land factor, and that is comprised mainly of a grassy parking area at the Epping Speedway. Another suitable density of agricultural fields exists in the north-central portion of the study area, but the quality of the field cover type was not evaluated.





Data Factors Mapped:

Old fields and disturbed lands
Fields
Density of old field/disturbed lands @ 150 acres/sq mile
Density of agricultural fields @ 150 acres/sq mile

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Upland Sandpiper

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Whip-poor-will (*Caprimulgus vociferus)*

Habitat Preferences:
Dry, open woodland and early successional forest adjacent to large clearings or brushy field edges. Also utilizes gravel pits and orchards.

GIS Data Factors Utilized:

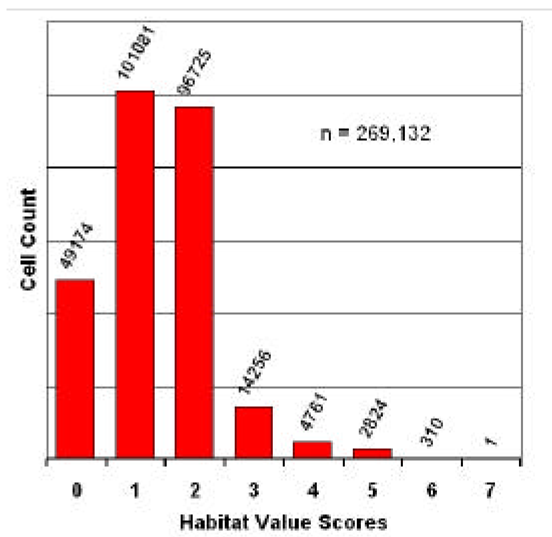
- Old fields, old fields in transition to early successional habitats, & early successional habitats, powerline ROW, as mapped from aerial photography & DOQ's, and 100' buffer around all these features
- Upland forest blocks (no forested wetlands)
- Well-drained & excessively well-drained soils re: drier sites

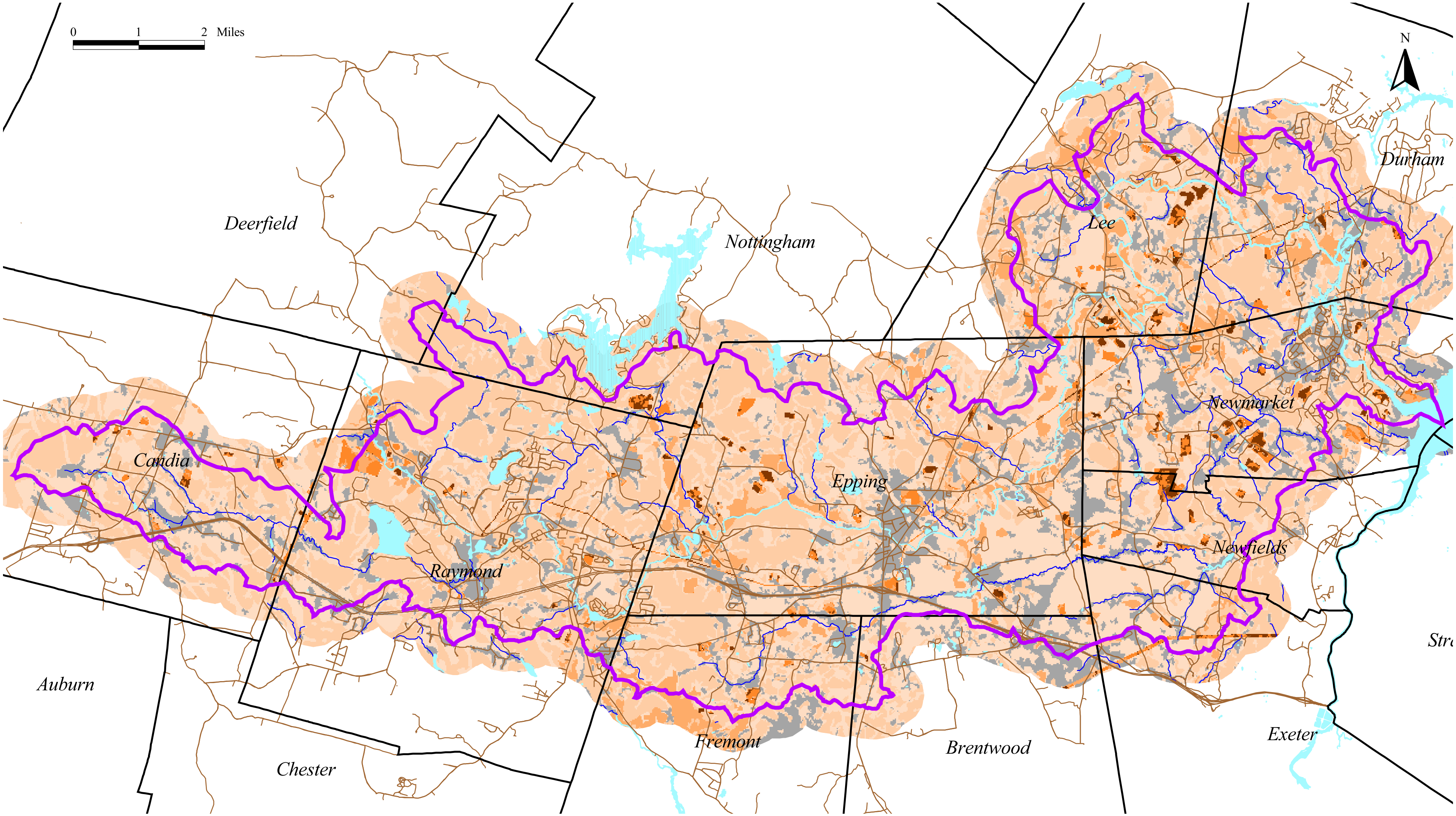
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Early successional habitats (old fields, early successional, ROW etc)	3
Gravel/sand pits, disturbed/gravel pits & orchards	2
Upland forest blocks	1
Excessively well-drained soils	2
Well-drained soils	1

Comments:

This model favors drier, old field and early successional habitats. Upland forest sites on dry soils could be emphasized by increasing the dry soil score.





Data Factors Mapped:

Open lands habitats (old fields, early successional, etc)
Gravel/sand pits, diturbed/gravel pits, orchards
Upland forest blocks (no forested wetlands)
Excessively well-drained soils
Well-drained soils

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Whip-Poor-Will

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
American Woodcock (*Scolopax minor)*

Habitat Preferences:
Upland forest edges meeting areas of aspen or birch saplings, alders (scrub/shrub swamp), overgrown fields, burned or recently logged areas, and wetlands.
Moist soils.

GIS Data Factors Utilized:

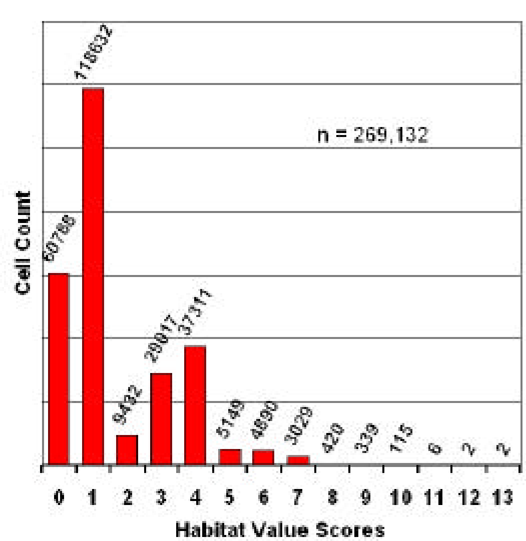
- Old fields, old fields in transition to early successional habitats, early succesional habitats, powerline ROW,& wet field, as mapped from aerial photography & DOQ's, and 100' buffer around all these features
- Palustrine scrub/shrub swamps (PSS wetcodes), with 100' buffer
- Very poorly and poorly drained soils re: moist sites
- Wetlands > 20 acres
- Upland forest blocks

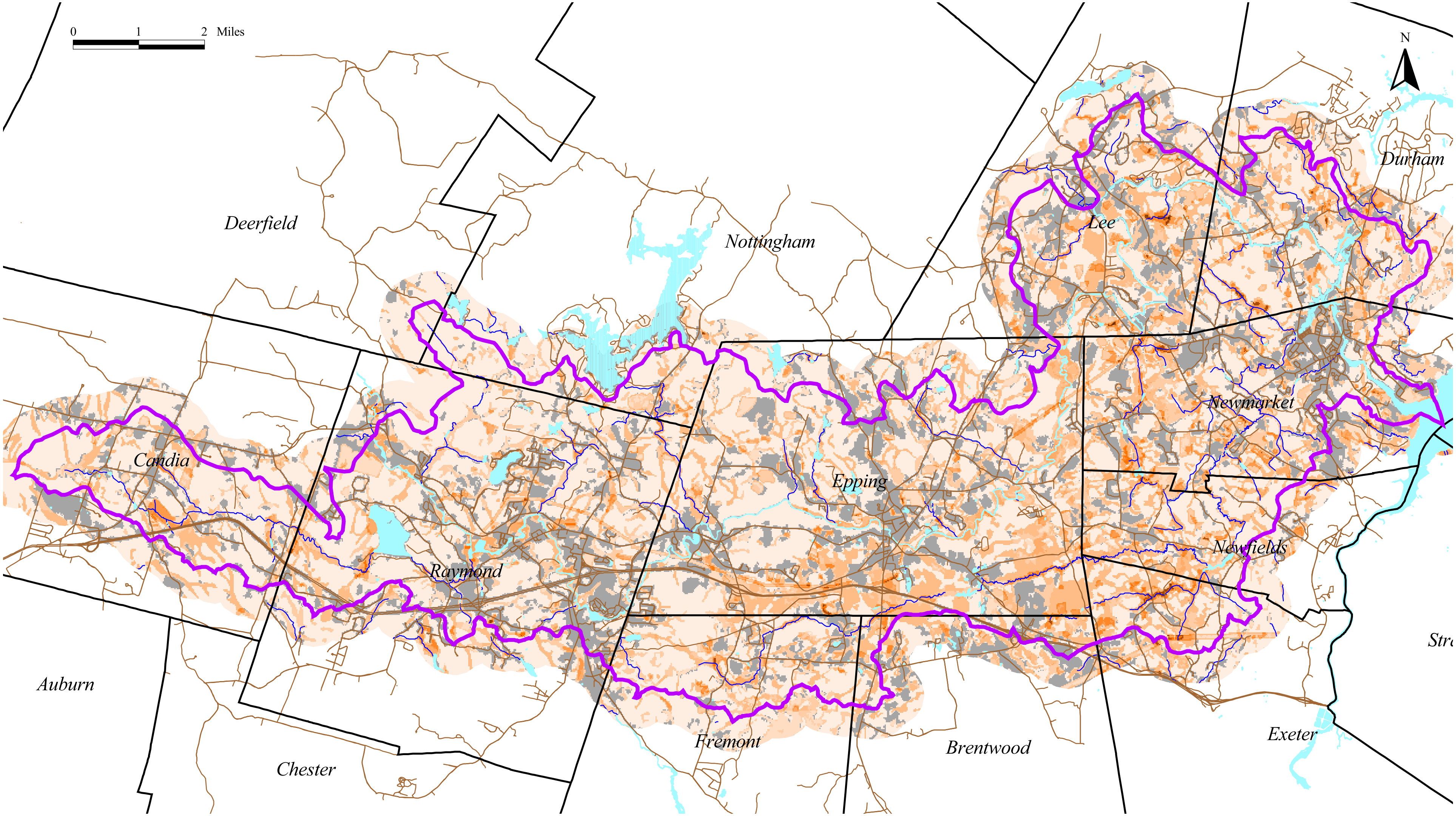
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Open lands habitats (old fields, early successional, wet fields, etc)	2
Open lands/woodland edge buffer	3
Scrub/shrub swamps (PSS wetcodes)	3
Scrub/shrub swamps buffer	3
Very poorly drained soils	3
Poorly drained soils	2
Wetlands > 20 acres	1
Upland forest blocks	1

Comments:

This model attempts to underscore the importance of edge habitat for this species by the use of high-scoring 100' buffers that emphasize the intersection of habitat features which might not overlap consistently or at all. Scrub/shrub swamps are also emphasized since these moist sites are typically associated with alder species, and are known to be a critical and naturally occurring woodcock habitat preference.





Piscassic River Wildlife Habitat Study

Potentially Sutiable Habitat: American Woodcock

Data Factors Mapped:

Open lands habitats (old fields, early successional, wet fields)
Open lands/woodland buffer 100'
Scrub/shrub swamps (PSS)
Scrub-shrub swamp buffer 100'
Very poorly drained soils (Hydric A)
Poorly drained soils (Hydric B)
Wetlands >20 acres
Upland forest blocks

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9
10
11
12
13 Points

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
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N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
New England Cottontail (*Sylvilagus transitionalis*)

Habitat Preferences:
Early successional habitats with grassy areas and dense ground cover; old fields with dense understory, shrublands, powerline corridors, and saltmarshes. Prefers habitat >12 acres.

GIS Data Factors Utilized:

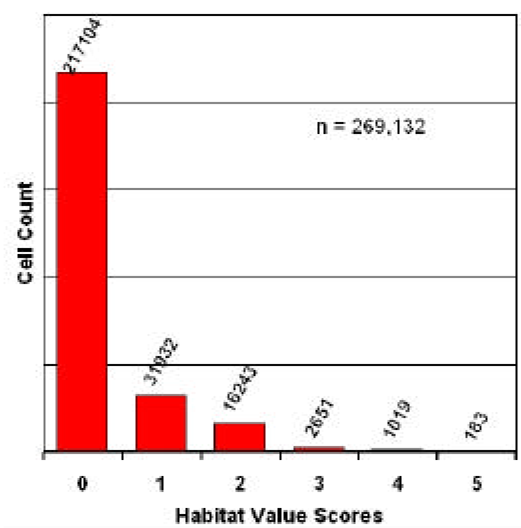
- Old fields, old fields/early successional habitat >12 acres
- Early successional habitat & advanced early successional habitat, as mapped from aerial photography and DOQ's
- Hay fields & pasture, and orchards, derived from GRANIT land cover type mapping
- Cleared/other open land, derived from GRANIT land cover mapping

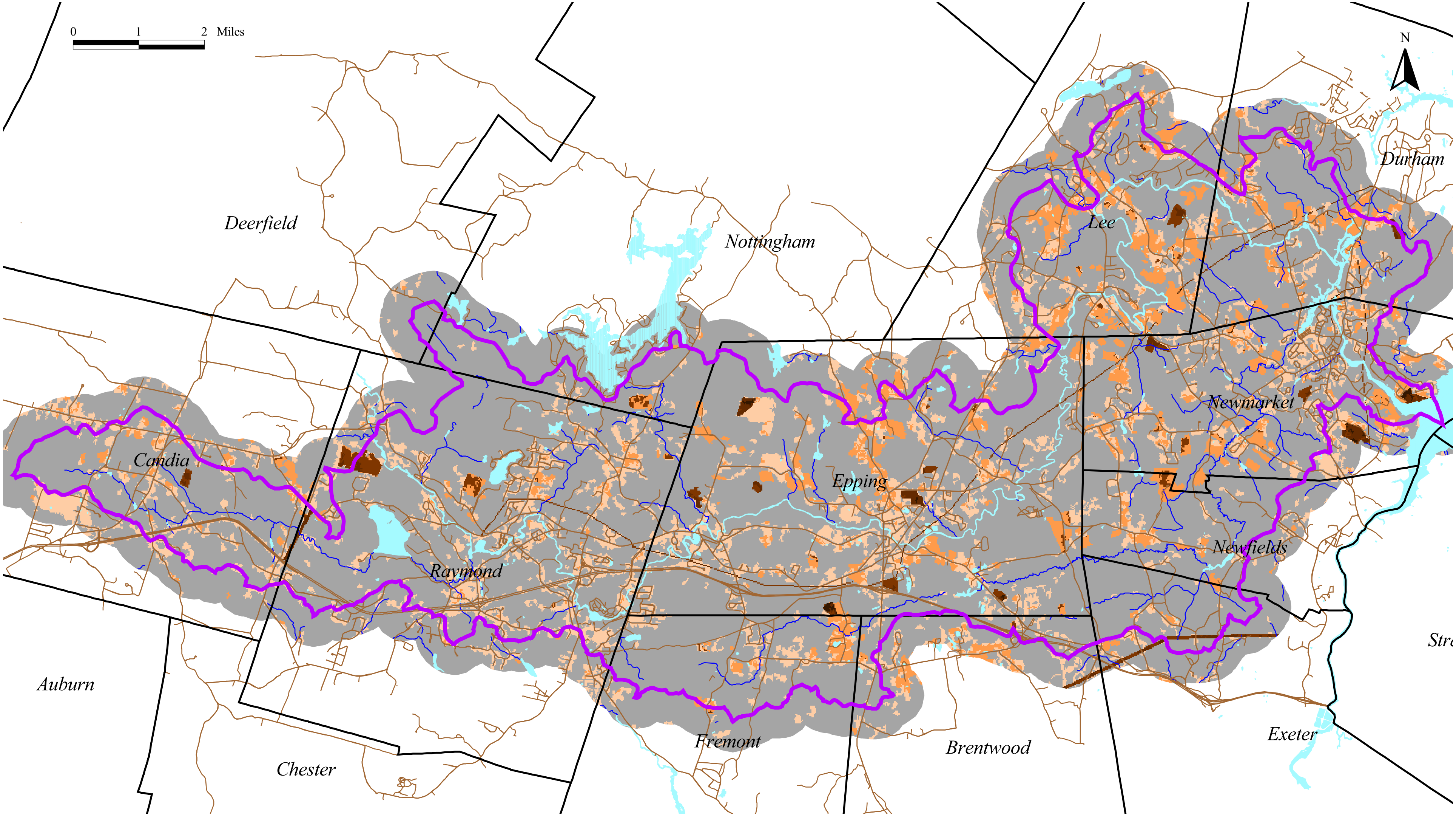
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Old fields, old fields/early successional habitat	3
Early successional habitat & advanced early successional habitat	2
Hay fields & pasture	1
Orchards	2
Cleared/other open land	1

Comments:

Old field habitats >12 acres are considered the primary preferred habitat in this model and ranked highest in score. Early successional habitat polygons < and >12 acres in size are included as secondary habitat features. Hay fields, pasture & orchard habitat derived from GRANIT land cover mapping has been added into the model to broaden the modeling effort even though the accuracy of mapping is not as precise as the Open Lands datalayer. Cleared/other open land cover type class has also been included for similar reasons, although this cover type class is not specific as to presence/absence of low-growing vegetation favored by this species and is ranked lower.





Data Factors Mapped:

Old fields, old fields/early successional habitats
Early successional and advanced es habitats
Hay fields & pastures
Orchards
Cleared/Other open land covers

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams

Habitat Feature Co-Occurrence Values
0
1
2
3
4
5 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: New England Cottontail Rabbit

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

Funding for this project was provided by the N.H. Estuaries Project

Species:
Bobcat (*Lynx rufus)*

Habitat Preferences:
Mixed deciduous/coniferous hardwood forests with dense understory growth, especially where forests form a margin with wetlands or early successional habitats. South-facing, steep slopes favored for sunning in winter, especially ledge outcrops.

GIS Data Factors Utilized:

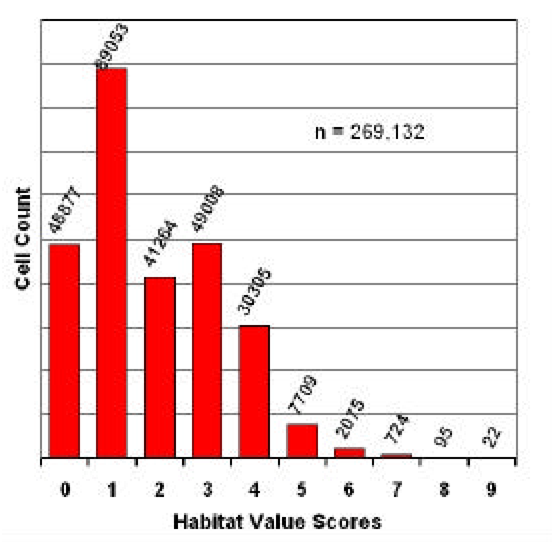
- Forest blocks, including embedded forested wetland cover type, >500 acres
- Palustrine scrub/shrub swamps (PSS wetcodes) & palustrine emergent marshes (PEM wetcodes)
- Early successional habitat
- Steep slopes >10%, >25%, and >35%
- South-facing aspects (S & SW)

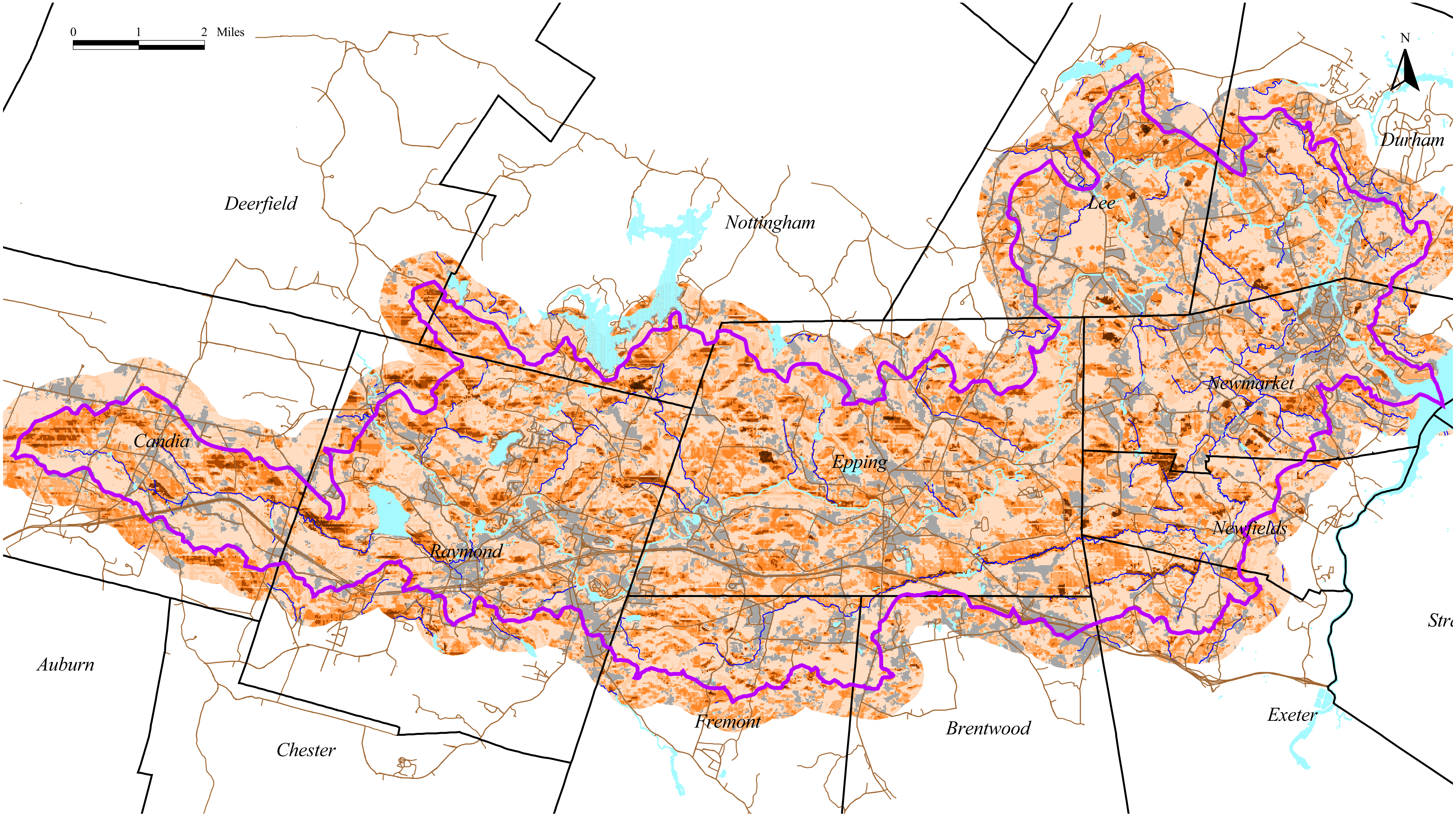
GIS Model Weighting Assumptions:

Data Factor	*Weight*
Forest blocks > 500 acres	1
Palustrine scrub/shrub swamps & palustrine emergent marshes	2
Early successional habitat	3
South-facing slopes	2
Southwest-facing slopes	3
Slopes >10%	1
Slopes >25%	2
Slopes >35%	3

Comments:

Ledge outcrops could not be isolated by querying soils datalayer for this study area, but shallow-to-bedrock soils and map units of ledge may be found in other regions of the state with more pronounced topography. South- and southwest-facing slopes have the greatest solar gain, so are the best choice for sunning habitat; southwest slopes are the warmest in winter. Steeper slopes have greater solar gain and are more likely to include rock ledges and boulder talus slopes favored by bobcat.





Data Factors Mapped:

Forest blocks >500 acres
Palustrine scrub/shrub swamps & emergent marshes
Early successional habitats
South- and southwest-facing slopes
Slopes >10%, >25% & >35%

Study Area Watershed
Municipal Boundary
Local Roads & Highways
Surface Water Features
Streams
Habitat Feature Co-Occurrence Values
0
1
2
3
4
5
6
7
8
9 Points

Piscassic River Wildlife Habitat Study

Potentially Suitable Habitat: Bobcat

Mapping & GIS Analysis by the
Society for the Protection of NH Forests
in Partnership with:
N.H. Chapter of The Nature Conservancy
Audubon Society of New Hampshire
N.H. Fish & Game Department Non-Game Program
N.H. Ecological Reserve System Project

New Hampshire Estuaries Project

The Nature Conservancy

Audubon Society of New Hampshire

University of New Hampshire Cooperative Extension

Funding for this project was provided by the N.H. Estuaries Project

Summary & Method Evaluation

Overall, the goal of using desktop GIS functionality and commonly available datasets to develop a predictive model for wildlife habitat has met with mixed results, both in terms of "operability" – which has a direct bearing on the "technology transfer" aspect of the methods used – and the ability of the GIS to pinpoint critical wildlife habitat.

Although this study made use of ESRI's ArcView, a relatively user-accessible and widely available GIS software platform, the predictive methodology relies upon ESRI's Spatial Analyst extension for ease of data manipulation and processing speed. It also assumes a high level of proficiency in use of both the core ArcView software and the extension; special training and/or significant hands-on experience using these software is required. This limits the outreach potential of the method for use by community activists, natural resource professionals, and agency staff responsible for land conservation planning and management. It is within the reach of skilled GIS analysts and a variety of GIS service providers.

In this study, a gap also became apparent between the specificity of the preferred habitat of the target species to be modeled (see **Appendix C**) and the user's ability to extract those characteristics from one or more of the available datalayers in the GIS. For example, rivers and streams are easily mapped, but little or no data exist that define substrate conditions (or stream gradients as a proxy) sufficient to locate the riverine environments where the Brook Floater Mussel or American Brook Lamprey might be found.

In another example, the soils datalayers contain an abundance of information relative to the physical characteristics of soils and their suitability for various land uses, but the relationship of soil types to specific plant communities is not easily correlated, and habitat features of special interest such as ledge outcropping and talus slopes are not well mapped. Similarly, a detailed and higher resolution subset of the land cover type mapping that addresses the need for open land and early successional habitat classification is a critical missing element in refining a predictive habitat model for many species of concern.

And finally, the high degree of *specificity* in a few datalayers, such as the National Wetlands Inventory mapping given its many classes of wetland coding, may tend to create a bias in the modeling, in this case towards higher conservation priority being placed on aquatic ecosystems, in this case, when in fact it is the scarcity of habitat feature information on upland sites that drives the modeling in that direction. Modeling for bobcat or woodcock are good examples of this since both species utilize a mix of wetland and upland habitats, but there is little to map on the terrestrial side of the equation.

The *generality* of other datalayers also worked against the success of certain habitat modeling. The need to identify potential vernal pool locations is critical in predicting critical habitat for a wide array of amphibians. However, the standards used in mapping soil types tend to generalize the actual mosaic and blending of soil types and micro-topographic condition. Known and potential vernal pools sites documented under separate study[9] correlated very poorly with the broader map units in the soils datalayer where drainage class and slope factors suggested that the presence of vernal pools might be expected.

And in at least a few instances, having *both* detailed habitat feature preferences and data factors well-suited to discriminating among feature classes did not always guarantee accuracy and precision using the GIS. This became apparent in comparing the mapping for Blanding's (and spotted turtles) against the results of a scientific study of Blanding's turtle conducted by Dr. Kim Babbitt and coordinated by NHF&G[10]. The mapping accurately predicted Blanding's turtle in a wetland complex in the southwest corner of Newmarket, but seemingly failed to pinpoint proven habitat only a short distance further north in the same drainage system. This is due in part to the modeling technique, which relied heavily on a wetlands density calculation and therefore was weighted more heavily towards wetlands complexes than more isolated or singular instances of suitable wetlands types, but it is a due to the relatively small area of the documented wetland itself, which does not "read" in the mapping as an important feature.

One key finding in this study, therefore, is that a great deal of work remains to be done to scientifically identify or characterize the complexities of habitat utilization on a species by species basis as they relate to the lexicon of currently available GIS data, and to development needs for new and enhanced data. One specific and key example of this need is description and mapping of turtle nesting habitats; the addition of this data would not only make the habitat analysis more robust for these species, but it would also bring the modeling for turtles more on a par with bird species, where breeding and nesting habitat preferences are principle drivers in the analysis.

Correlating the New Hampshire Natural Heritage Inventory's *Natural Communities of N.H.: A Guide and Classification* manual to a range of mapped characteristics in the physical environment (soils, hydrology, landscape position, elevation, geology, etc.) would also be a valuable aid in improving predictive modeling of wildlife habitat. Advanced work on this has already been accomplished by the U.S Forest Service in the form of Ecological Land Units mapping for the White Mountain National Forest, and by The Nature Conservancy's research into characterizing and mapping small- and medium-sized patch communities in New England using a similar ecological land unit classification system.

Next Steps

Additional follow-up fieldwork is planned in the study area for the 2003 field season to verify presence/absence of species in their predicted habitat. Initial fieldwork in 2002 on golden-winged warblers found a singing male at a predicted site. A comparison of other known locations of several species of concern mapped in this study will also be made by partnering agencies and organizations, based on current documentation on-hand and new data developed by

[9] Deming, L., T. Diers, and J. Kanter. 1999. *Great Bay Reptile and Amphibian Habitat Protection Project: Final Report to the US EPA & NHF&G Nongame and Endangered Species Program*. Audubon Society of NH, Concord, NH.

[10] *Southern New Hampshire Wetlands Assessment Project* – Blanding's Turtle Habitat Study.

planned and ongoing field work. The design of such validation studies (i.e., standardizing sample intensity, etc.) needs further discussion and coordinated planning, however, to be most effective.

The data and maps developed for this study are also of immediate use and value to resource agencies such as the New Hampshire Fish and Game Non-Game and Endangered Wildlife Program and partnering conservation organizations in their ongoing efforts to identify and protect significant wildlife habitat not only in the communities of the Lamprey River watershed, but in similar landscapes and contexts statewide.

End.

Appendix A

Information about NH GRANIT
&
ArcView Extension Scripts Used in this Study

GRANIT

About GRANIT | GRANIT Data | Create A Map | Projects | Related Resources

Contact Us

Site Map

Search

Welcome to NH GRANIT

Welcome to the NH GRANIT Web Site, providing access to New Hampshire's statewide geographic information system (GIS). Through this site we offer you access to a range of resources, including:

- search and retrieval of GRANIT data descriptions (metadata)
- retrieval of primary GRANIT data layers
- posting of news related to database developments
- announcements of upcoming meetings and events
- mapping of core data sets
- access to a catalog listing of photography covering various geographic units of New Hampshire.

The Create a Map service is now available,

and provides public access to interactive maps about the state's protected lands.

The Digital Orthophoto Quarter Quads (DOQs) available for download are now clipped to the 3.75-minute (i.e. quarter-quad) boundary. This eliminates the overlap and the black strip around the individual quads.

NH Department of Transportation has announced a new capability to deliver **GPS corrections data** via the internet. GRANIT is hosting the FTP server for this dataset.

GRANIT is pleased to announce that two new data sets are now available. Please visit the Data page for information on accessing these data sets:

Statewide Digital Orthophotoquad (DOQ)s - available by tile or in pre-packaged format
Statewide Land Cover Assessment

1999 **color infrared photos** available statewide!

If you are a GIS user or administrator, check out the New Hampshire GIS e-mail list. It is a forum for announcements, questions, and discussion of GIS topics that affect New Hampshire. To subscribe, send a message to Nhgis-request@webster.state.nh.us with the word "subscribe" (without quotes) in the subject or body of the message. To send a message, simply send an e-mail to Nhgis@webster.state.nh.us.

Topical help can be found wherever you see this icon:

Please explore this site, and take advantage of the resources it offers. We invite you to provide any feedback you may have.

This site is developed and maintained by the Complex Systems Research Center, Institute for the Study of Earth, Oceans, and Space, University of New Hampshire.

About GRANIT

The New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT) is a cooperative project to create, maintain, and make available a statewide geographic data base serving the information needs of state, regional, and local decision-makers. A collaborative effort between the University of New Hampshire and the NH Office of State Planning, the core GRANIT System is housed at the UNH Institute for the Study of Earth, Oceans, and Space in Durham. It includes a geographic database, hardware and software to build, manage, and access the database, and a staff of experts knowledgeable in geographic information systems, image processing, and computer analysis. In addition to database development and maintenance, the GRANIT staff offers a range of application development, training, and related technical services to GIS users in the state and the region.

The GRANIT approach to a statewide GIS depends upon the cooperative efforts of a host of agencies, collaborating on various elements of database design and construction as well as application development. The collaboration occurs formally through the NH GIS Advisory Committee, and informally through daily interactions between the growing body of GIS users in the state and the region.

Last Updated: May 30 2000

GRANIT Data

The GRANIT data distribution policy is to provide access to all data for the cost of reproduction. Data is made available through a number of mechanisms, including:

1. **Search** the online data archive through the metadata search tool. Once a data set(s) is located, it may be downloaded or ordered on CD/ROM through this page. GRANIT staff is presently documenting and archiving all data sets within the database. The following layers are currently accessible through the Search tool:

Town boundaries

Surface water

Roads and trails

Railroads

Pipelines

Digital raster graphics (DRGs)

Digital elevation models (DEMs)

NEW - Digital orthophoto quads (DOQs)

NEW - Land cover assessment 2001

2. **Identify** one or more pre-packaged sets (DOQs, Land Cover 2001, DRGs, the entire vector dataset, etc.). These data sets may also be downloaded or ordered on CD/ROM.

3. **Email** Jennifer Lessard, the GRANIT Database Manager, for access to all other available GRANIT data sets. Note: Please allow two weeks when ordering data. All GRANIT vector data ordered through the GRANIT Database Manager will be provided to the user as Arc export (e00) files. Raster data is in either TIFF, MrSID, or ASCII format.

Data downloaded from the web site is provided at no charge, while requests for CD's incur nominal charges. Please see the GRANIT Data Fee Structure page for further details.

Digital data in NH GRANIT represent the efforts of the contributing agencies to record information from the cited source materials. Complex Systems Research Center (CSRC), under contract to the Office of State Planning (OSP), and in consultation with cooperating agencies, maintains a continuing program to identify and correct errors in these data. OSP, CSRC, and the cooperating agencies make no claim as to the validity or reliability or to any implied uses of these data.

All products created using the data should credit the documented source agency and the GRANIT System. Downloading or ordering data from GRANIT assumes you agree with and will adhere to this.

If this is your first visit to the site:

- Go to Data Catalog to review the list of data holdings in a catalog format.
- Go to Access the Database to search and query metadata, or descriptions, of available data layers.

Last Updated: Nov 11 10:01

About GRANIT | GRANIT Data | Create A Map | Projects | Related Resources

Data Catalog

Access the Database

Data Catalog

Photo/Image Index

Tile Index Maps

Data Users Guide

FAQs

The GRANIT data base contains a set of data layers, each representing a single characteristic (or set of characteristics) describing the natural or built environment. In addition to traditional GIS data layers, other data available through GRANIT includes images (raster scans, digital photography or satellite imagery), database files, and ASCII files. These data are described in the GRANIT Data Catalog, which is available by request in hardcopy.

Our plan is to make most GRANIT data available on-line for immediate retrieval. However, at the present time, many layers are still being migrated to the web environment. Access the Database will notify you what data can be downloaded immediately and what data needs to be ordered.

The GRANIT data base is continually growing, as funding is secured for the development and archival of data sets. We encourage you to check the Data Catalog or the GRANIT News at regular intervals for additions to the system.

View the Data Catalog

Alphabetical Listing of Layer Names

Functional Listing of Layer Names

Last Updated: Jan 26 2001

Alphabetical Listing of Data Layers

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Access the Database
Data Catalog
Photo/Image Index
Tile Index Maps
Data Users Guide
FAQs

A

Aquifer Boundaries
Aquifers/Low Flow Stream Measurements
Aquifers/Saturated Thickness
Aquifers/Seismic Lines
Aquifers/Transmissivity
Aquifers/Water Table
Aquifer/Wells, Borings and Spring Sites

B

Bathymetry
Bedrock Geology

C

Clear Cut Inventory
Coastal Wetlands
Conservation/Public Lands

D

Dams
Developed Shorelines
Digital Elevation Models (DEMs)
Digital Orthophoto Quads (DOQs) - 1992

Digital Orthophoto Quads (DOQs) - 1995
Digital Orthophoto Quads (DOQs) - 1998
Digital Orthophoto Quads (DOQs) - Best Available Data
Digital Raster Graphics (DRGs)

E

Elevation/Digital Elevation Models (DEMs)
Elevation/Hypsography
Elevation/Tagged Vector Contours

F

Floodplains

G

Geodetic Control
Glacial Features
GNIS - Geographic Names Information System
Graveyards
Great Bay Wetlands
Groundwater Hazards Inventory

H

Historic and Cultural Features Inventory
Hydrography
Hypsography

I

J

Junkyards

K

L

(NH) Land Cover Assessment 1995
(NH) Land Cover Assessment 2001
Land Use Change
Low Flow Stream Measurements

M

Miscellaneous Surficial Materials Features

N

National Register of Historic Places
National Wetlands Inventory
Natural Heritage Inventory
NPDES Outfalls
NH Land Cover Assessment 1995
NH Land Cover Assessment 2001

O

OSP Recreation Inventory

P

Pesticides - Agricultural

Q

R

S

T

U

V

W

X

Y

Z

Last Updated: Jan 23 2002

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Contribute to ArcScripts

ArcScripts now uses ESRI's Global Accounts System. You can use the same login for ArcScripts and the ESRI Community Forums, and in the coming months you will be able to use it for ESRI Virtual Campus, the Geography Network, and other ESRI Web applications. If you have uploaded any scripts with one or more old ArcScripts accounts, we need you to link them to your new Global Account. You can link your scripts from the edit my scripts section. This section requires you to have a Global Account; if you don't have one yet, you will need to create an ESRI Global Account. You can request your Global Account access information to be emailed to you if you've forgotten it.

- upload a script
  Do you want to share a script with the ESRI user community? Upload it here!
- edit my scripts
  Here you can view, edit or delete scripts you have uploaded.

Top Ten ArcScripts

Show scripts written for All software

scripts **1-10** of **10**

	Title	Software	Language	Author	Modified	Downloads
1	XTools	ArcView GIS	Avenue	Mike DeLaune	Oct 10 2002	60169
2	201 Scripts	ArcView GIS	Avenue	Howie Sternberg	Dec 28 2001	30727
3	Image Georeferencing Tools	ArcView GIS	Avenue	George Raber	Nov 15 1999	27903
4	Spatial Tools	ArcView GIS	Avenue	Spatial Tools	Oct 1 1998	25206
5	Cadtools Extension	ArcView GIS	Avenue	Adena Schutzberg	Oct 1 1998	23618
6	ImageWarp 2.0 Updated March 16, 1999	ArcView GIS	Avenue	Kenneth R. McVay	Mar 16 1999	19994
7	XTools 3.0	ArcGIS Desktop	Visual Basic	Max Chikinev, Igor Popov (TaigaGIS, Inc)	Jan 7 2002	19974
8	Polylines to polygons 2.3	ArcView GIS	Avenue	Studio A&T s.r.l.	Jun 23 2000	18953
9	Raster to Vector Conversion	ArcView GIS	Avenue	Kenneth R. McVay	Oct 1 1998	18354

10	Create DXF files from feature themes (FTheme)	ArcView GIS	Avenue	ESRI	Oct 1 1998	17900

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XTools

Download download help

Author:	Mike Delaune contact author
File Name:	AS11526.zip
Language:	Avenue
Last Modified:	Oct 10 2002
Software:	ArcView GIS
File Size:	211.13 kb
Downloads:	60169

Summary:

Available for free download here is the 6/1/2001 version of XTools for ArcView 3.X.

(Note: this version of XTools will not work in ArcView 8.X. Go Here : http://arcscripts.esri.com/details.asp?dbid=11731 for an 8.X version of XTools written by another author.)

XTools is a package of tools useful in vector spatial analysis. Included are various overlay, shape conversion and table tools. Go to http://www.odf.state.or.us/DIVISIONS/management/state_forests/GIS/Documents/xtools.htm for a more complete description of XTools.

Go to http://www.odf.state.or.us/DIVISIONS/management/state_forests/XTools.asp for a Frequently Asked Questions (FAQ) page, documentation, and a comparison of XTools overlay operations to ArcInfo overlay operations.

esri.com > online support center > arcscripts > search results > script details

ArcScripts home | help

Spatial Tools

Download download help

Author:	Spatial Tools contact author
File Name:	AS11190.zip
Language:	Avenue
Last Modified:	Oct 1 1998
Software:	ArcView GIS
File Size:	767 bytes
Downloads:	25206

Summary:

Spatial Tools is an ArcView extension that contains a collection of 18 tools that extend the capabilities of Spatial Analyst. The majority of tools are implementations of functions available in spatial analyst from avenue programming or awkwardly in the map calculator but not from the menu, button, or tool interface. These include functions to clean up, assemble, aggregate, warp and
analyze grids. The current version is 2.1 available at
www.absc.usgs.gov/glba/gistools/index.htm

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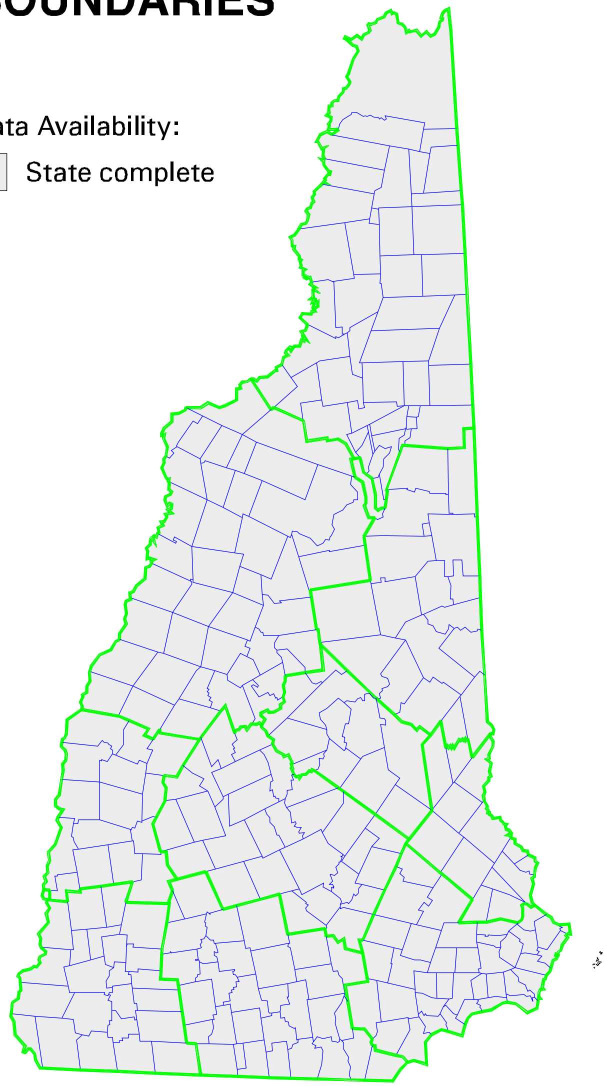
Appendix B

Abstracts of Key Datalayers Used in this Study

POLITICAL BOUNDARIES

Data Availability:

State complete



Data Layer: POLITICAL BOUNDARIES

Primary Layer Name: PB
Layer Content: TOWN BOUNDARIES
Data Structure: VECTOR
Layer Type: POLY, LINE

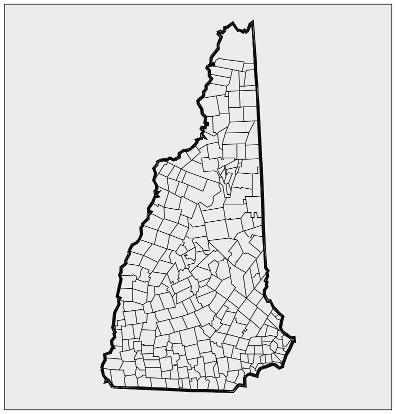
Source: DIGITAL LINE GRAPHS, USGS
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: STATE

Status: COMPLETE
Last Revision: June 20, 1996
Available From: Complex Systems Research Center, UNH

Associated Coverages: PBNHANNO (statewide annotation)

NEW HAMPSHIRE POLITICAL BOUNDARIES



GENERAL DESCRIPTION

The PB coverage provides a digital representation of the town boundaries mapped on standard 7.5-minute USGS quadrangles. The data was distributed by the USGS in Digital Line Graph (DLG) format. It was then processed in ARC/INFO to generate the GRANIT data layer. The processing involved a series of steps, including assigning a GRANIT id to each feature, refining/streamlining attributes, and naming features. The modifications were made in conformance with standards adopted by the NH GIS Advisory Committee.

The streamlined polygon attributes identify towns with both the FIPS (Federal Information Processing Standard) Code and the town name. The format of the numeric FIPS code allows users to digitally derive county boundaries from the PB coverages. The line coverages are coded to allow hierarchical boundaries (e.g. town, county, state) to be represented with different symbology. In both cases, the availability of the GRANIT id allows users to link back to the original full attribute list, if desired.

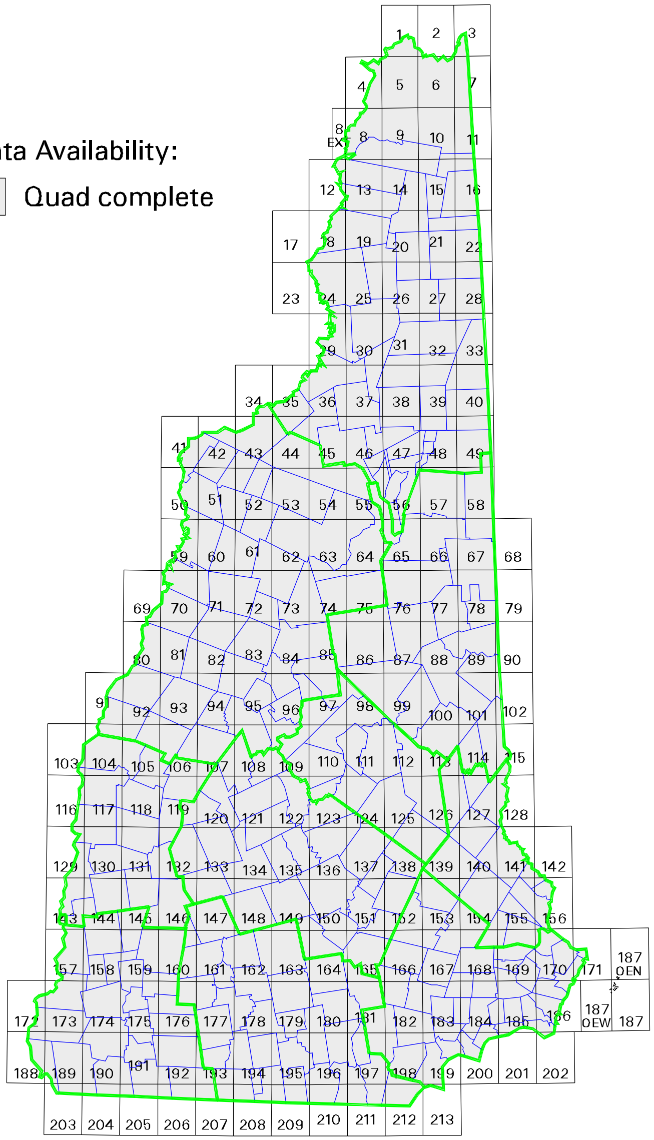
As indicated on the status map, full coverage of the state is now available through the GRANIT database. Modifications, updates, and enhancements to the spatial and attribute data will continue to be made. For example, there are known discrepancies in the alignment of town boundaries.

March, 2000

HYDROGRAPHY

Data Availability:

Quad complete



Data Layer: HYDROGRAPHY

Primary Layer Name: HYDROnnn
Layer Content: COMBINED HYDROGRAPHY
Data Structure: VECTOR
Layer Type: POLYGON, LINE

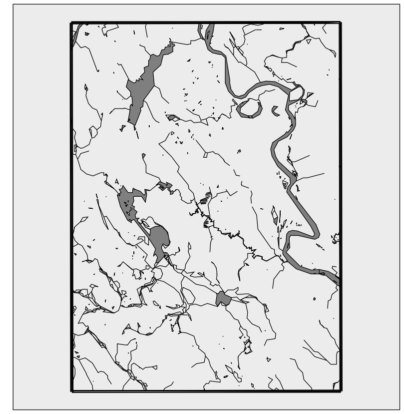
Source: DIGITAL LINE GRAPHS, USGS
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: 7.5-MINUTE QUADRANGLE

Status: COMPLETE
Last Revision: October, 1995
Available From: Complex Systems Research Center, UNH

Associated Coverages: HYDRONHANNO (statewide annotation)

CONCORD QUADRANGLE HYDROGRAPHY



GENERAL DESCRIPTION

The HYDRO coverages provide a digital representation of the surface water features mapped on standard 7.5-minute USGS quadrangles. The data was distributed by the USGS in Digital Line Graph (DLG) format. It was then processed in ARC/INFO to generate GRANIT data layers. The processing involved a series of steps, including assigning a GRANIT id to each feature, refining/streamlining attributes, and naming lakes/ponds. The modifications were made in conformance with standards adopted by the NH GIS Advisory Committee.

The streamlined set of attributes allows users to identify lakes, ponds, wetlands, streams, intermittent streams, tidal bays, sewage and industrial impoundments, etc. The availability of the GRANIT id allows users to link back to the original full attribute list, if so desired, to generate additional data. For example, the full attribute list includes water surface elevations for a subset of the water bodies.

Feature names shown on standard USGS quadrangles have been entered in the associated coverage, HYDRONHANNO.

As indicated on the status map, full coverage of the state is now available through the GRANIT database. Modifications, updates, and enhancements to the spatial and attribute data will continue to be made. Future plans call for features to be tagged with a second set of hydrologic codes that will permit hydrologic network analysis to be performed.

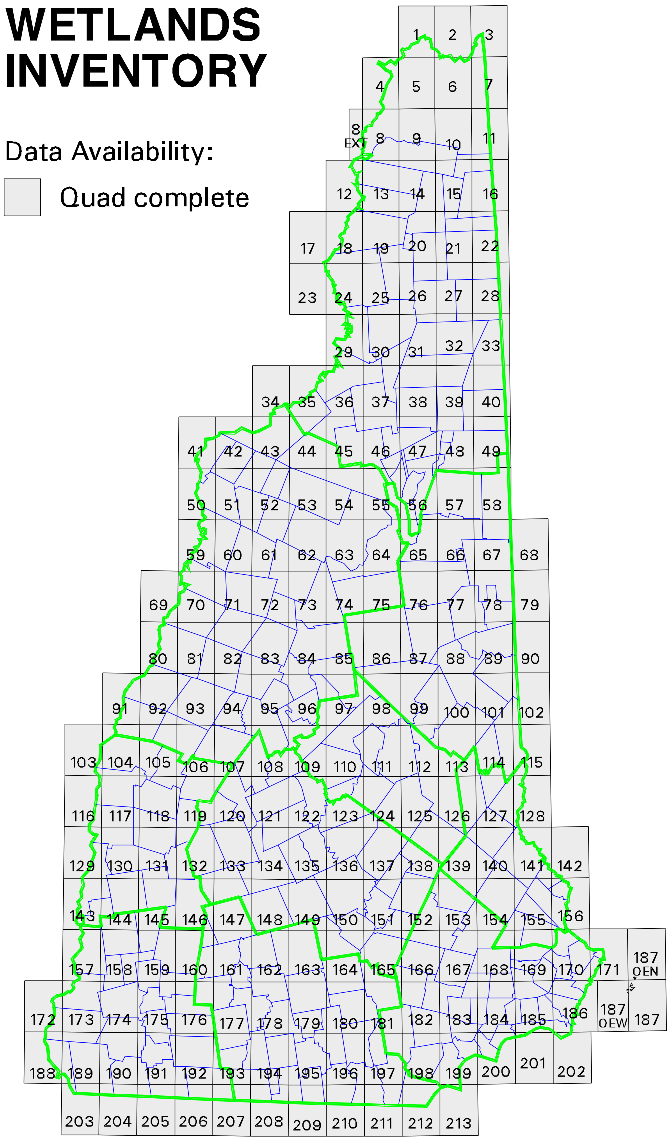
In addition to the data documented above, statewide coverage of DLG-derived hydrography generated at 1:100,000 is available. This data may be used for large area, regional analyses.

March, 2000

NATIONAL WETLANDS INVENTORY

Data Availability:

Quad complete



Data Layer: NATIONAL WETLANDS INVENTORY

Primary Layer Name: NWInnn
Data Content: WETLAND AREAS
Data Structure: VECTOR
Layer Type: POLYGON, LINE

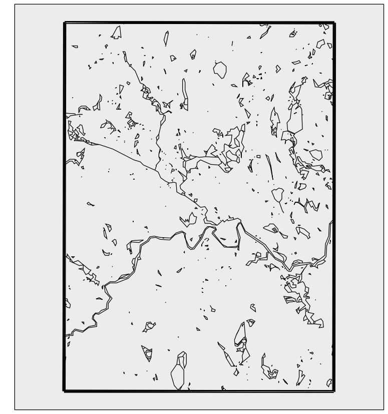
Source: US FISH AND WILDLIFE SERVICE
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US F&WS
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: 7.5-MINUTE QUADRANGLE

Status: COMPLETE
Last Revision: Summer, 2001
Available From: Complex Systems Research Center, UNH

Associated Coverages: NWIPT

HENNIKER QUADRANGLE NWI WETLANDS



GENERAL DESCRIPTION

Wetlands mapping by the US Fish and Wildlife Service in New Hampshire was started in the late 1970's. Approximately 25 percent of the state was completed at that time. Due to a lack of adequate aerial photography, this mapping was not finished. With the availability of new photography in 1985 and 1986, and additional funding, the US F&WS restarted this project, recompiling areas of the state done previously and completing those areas that had not been mapped earlier. Full coverage of the state became available as published maps in 1991.

The wetlands are classified using the Cowardin System.

The maps were automated by the US Fish and Wildlife Service and posted to an ftp site. The files were retrieved from that site by Complex Systems, and processed as necessary to comply with GRANIT standards. Generally, each quad map was automated into two coverages - a combined poly/line coverage and a corresponding point coverage.

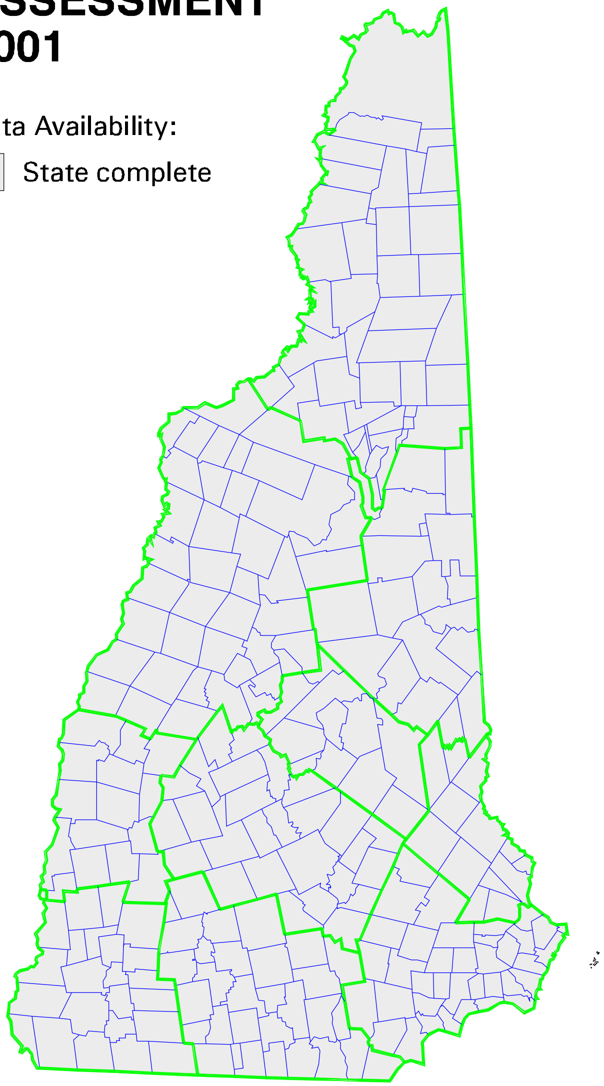
It should also be noted that the NH Fish and Game Department and the National Forest Service completed a mapping project, using aerial photo interpretation, of all wetlands in the White Mountain National Forest. The classification system used is the same as that employed by US F&WS.

September, 2001

NH LAND COVER ASSESSMENT 2001

Data Availability:

State complete



Data Layer: NH Land Cover Assessment 2001

Primary Layer Name: NHLC01
Layer Content: LAND COVER
Data Structure: RASTER
Layer Type: ASCII GRID

Source: LANDSAT THEMATIC MAPPER IMAGERY
Source Scale: N/A
Source Media: DIGITAL

Automated By: CSRC, UNH
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: STATE

Status: COMPLETE
Last Revision: DECEMBER, 2001
Available From: Complex Systems Research Center, UNH

GENERAL DESCRIPTION

The New Hampshire Land Cover Assessment 2001 is the most recent and most detailed classification of land cover and land use for the state of New Hampshire. Satellite images acquired by Landsat Thematic Mapper between 1990 and 1999 form the basis of the classification, augmented where possible by digital aerial photography, digital raster scans of USGS quadrangles, vector data layers archived in the GRANIT database, digital elevation models, and field data collection. The resulting data set categorizes land cover and land use into 23 targeted classes, with as much detail as possible in the forest and agriculture classes. Nearly 1,000 sites were evaluated for the accuracy assessment, yielding overall accuracies of 82.2% at the full, 23-class level, and 95.9% at the 7-class level. For more information on the classification methodology or the accuracy assessment, please see the project's final report.

This project was conducted by GRANIT staff, and made possible through the support and cooperation of many agencies, organizations, and individuals, including the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), USDA Forest Service, NH Department of Resources and Economic Development, NH Department of Fish and Game, USDA Natural Resources Conservation Service, NH Space Grant, UNH Cooperative Extension, volunteers, landowners, and others.

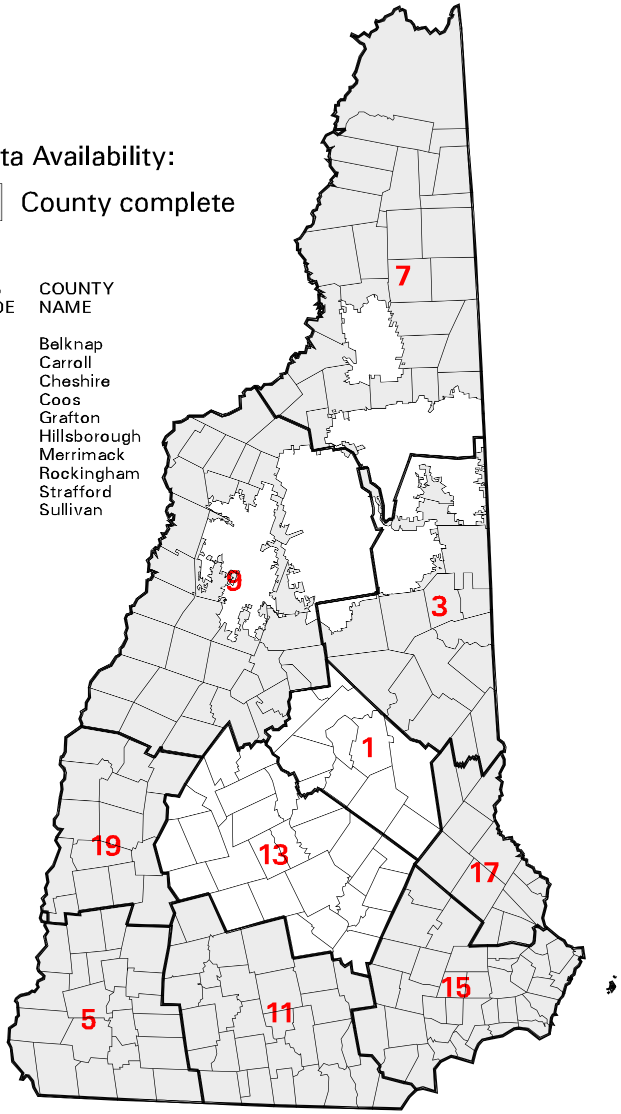
January, 2002

SOIL UNITS

Data Availability:

County complete

FIPS CODE	COUNTY NAME
001	Belknap
003	Carroll
005	Cheshire
007	Coos
009	Grafton
011	Hillsborough
013	Merrimack
015	Rockingham
017	Strafford
019	Sullivan



Data Layer: SOIL UNITS

Primary Layer Name: SOILnnn
where 'nnn' - County FIPS code
Layer Content: SOIL UNIT DELINEATIONS
Data Structure: VECTOR
Layer Type: POLYGON

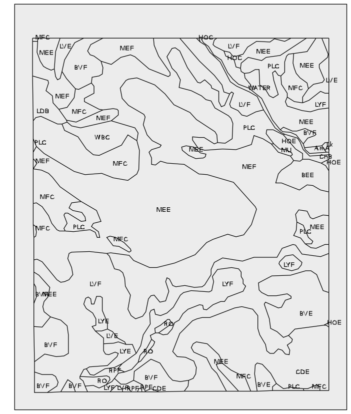
Source: NATURAL RESOURCES CONSERVATION SERVICE
Source Scale: 1:24,000/1:25,000
Source Media: MYLAR

Automated By: CSRC, UNH
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: COUNTY

Status: IN PROGRESS
Last Revision: September, 2002
Available From: Complex Systems Research Center, UNH

Associated Data Files: NHSoilMaster.dbf

JACKSON QUADRANGLE (SW) SOIL UNITS



GENERAL DESCRIPTION

The soil data layer provides a digital version of standard, county-based soil surveys prepared by the Natural Resources Conservation Service and cooperating agencies. These surveys identify areas of soils on maps and provide descriptions of the soils and their interpretations in accompanying text and tables. Most regions of the state have been mapped using field techniques that identify soil areas as small as about 4 acres in size. However, some extensive forestland regions in parts of Carroll, Coos and Grafton counties have been mapped using field techniques that identify soil areas only as small as about 40 acres in size.

Field work has been completed, or is underway and scheduled for completion by approximately 2005, in all parts of the state except for the White Mountain National Forest (WMNF). Excluding the WMNF, the following counties have been completed for release: Grafton, Carroll, Strafford, Rockingham, Hillsborough East and West, Cheshire, Sullivan and Coos.

The soil delineations are being digitized as polygonal features, with the soil code maintained as an attribute. Additional soil characteristics may be associated with the soil units to derive specialized data layers (e.g. hydric soils, important farmland soils, etc.).

Point and line symbols from the soil overlays have been digitized for the Grafton, Hillsborough East, Hillsborough West, Cheshire and Sullivan study areas. These represent cultural or natural features (e.g. wetlands, gravel pits, steep slopes) as mapped on the overlays.

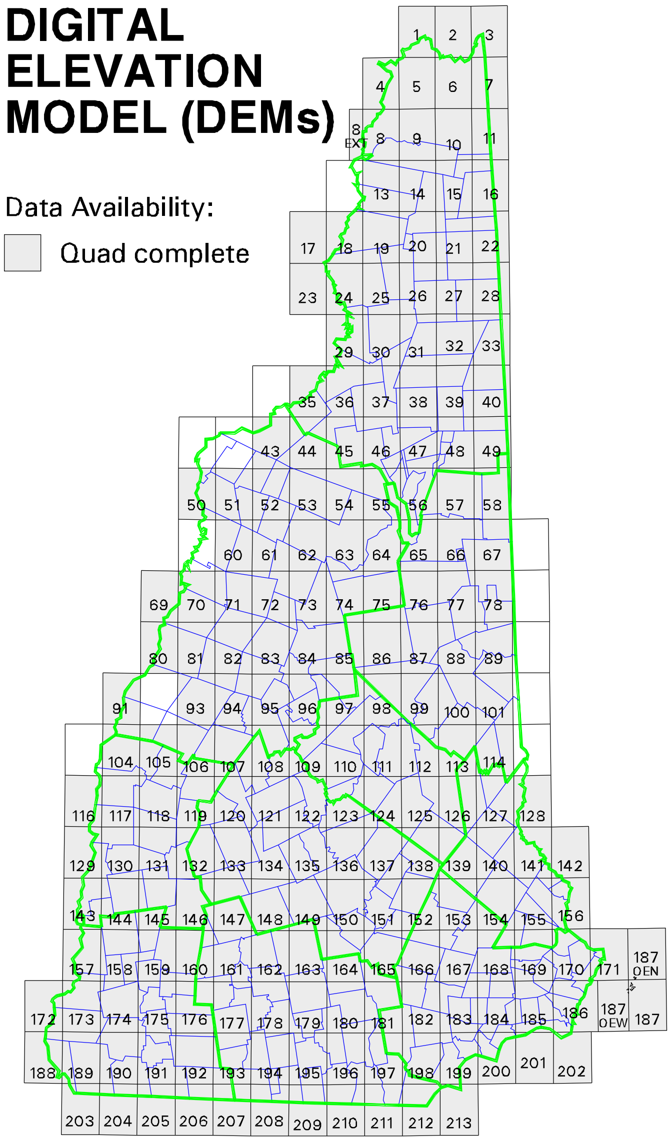
Each study area is maintained as a separate coverage as not all study areas have been re-mapped for the necessary edgematching.

November, 2002

ELEVATION - DIGITAL ELEVATION MODEL (DEMs)

Data Availability:

Quad complete



Data Layer: ELEVATION - DEM

Primary Layer Name: DEMnnn
Layer Content: DIGITAL ELEVATION MODEL
Data Structure: ASCII FILE
Layer Type: N/A

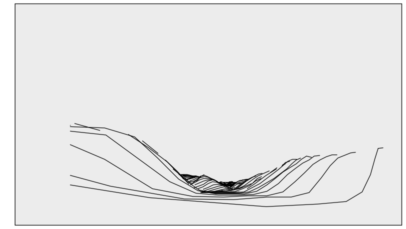
Source: US GEOLOGICAL SURVEY
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: UTM Meters
Horizontal Datum: 1927
Tile: 7.5-MINUTE QUADRANGLE

Status: IN PROGRESS
Last Revision: March, 1999
Available From: Complex Systems Research Center, UNH

Associated Coverages: HYPSOGRAPHY (HYPSO), TAGGED VECTOR CONTOURS (TVC)

TERRAIN MODEL
LOOKING TOWARDS MT. WASHINGTON



GENERAL DESCRIPTION

The USGS 7.5-minute digital elevation models (DEMs) contain regular arrays of surface elevations at a spacing of 30 meters in both the x and y directions. DEM data may be used to generate a number of products, including contour maps, slope and aspect maps and terrain models.

GRANIT is presently acquiring revised DEMs from the USGS site, and processing them to generate data sets that comply with GRANIT georeferencing standards (e.g. NH State Plane feet, NAD83). In addition, each DEM is being visually screened for consistency of content, missing data values, etc., and appropriate adjustments are being made.

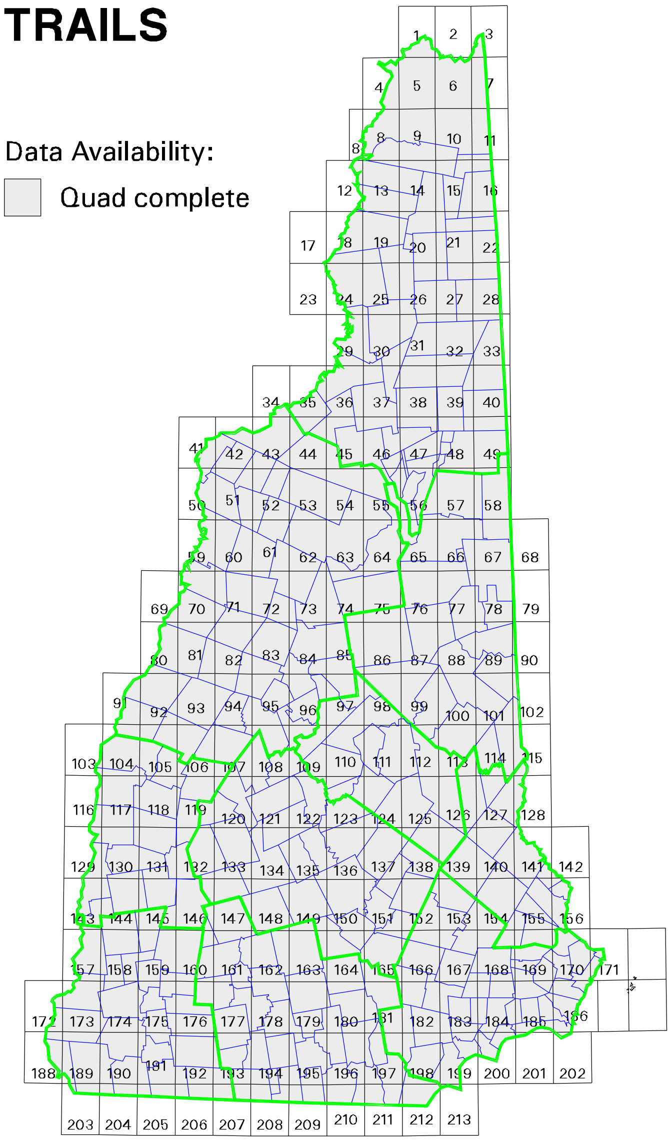
The GRANIT data base presently contains the core elevation files. Derivative products, such as the inset above, are generated as warranted by specific applications. The inset displays a terrain model generated from a point in Crawford Notch, and looking towards Mount Washington. The same data set could be used to produce topographic contours, but users should be aware that contours derived from DEMs may differ significantly from the contour lines displayed on the corresponding USGS topographic quadrangle.

A statewide mosaic from the National Elevation Database (http://gisdata.usgs.gov/ned) is also available from GRANIT as an exported Arc/Info GRID. As above, it has been re-processed to reference NH State Plane feet, NAD83.

Digital elevation models are also available from 1:250,000-scale source data. These files contain regular arrays of surface elevations at a spacing of 3 arc-seconds, or approximately 80-90 meters at the New Hampshire latitude. This data may be used for large, regional projects that require only coarse topographic information. All of the 1:250,000-scale DEMs necessary to provide statewide coverage are available from GRANIT.

March, 2000

ROADS AND TRAILS



Data Availability:

Quad complete

Data Layer: ROADS

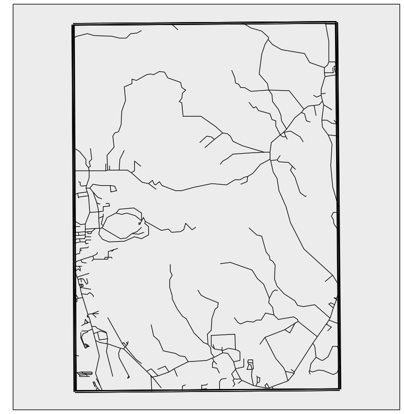
Primary Layer Name: ROADSnnn
Layer Content: ROADS AND TRAILS
Data Structure: VECTOR
Layer Type: LINE

Source: DIGITAL LINE GRAPHS, USGS
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: 7.5-MINUTE QUADRANGLE

Status: COMPLETE
Last Revision: January, 1993
Available From: Complex Systems Research Center, UNH

N. CONWAY EAST QUADRANGLE ROADS



Associated Coverages: ROADSNHANNO (point coverage consisting of shield locations for Interstates, US, and State routes and limited road annotation)

GENERAL DESCRIPTION

The ROADS coverages provide a digital representation of the roads and trails mapped on standard 7.5-minute USGS quadrangles. The data was distributed by the USGS in Digital Line Graph (DLG) format. It was then processed in ARC/INFO to generate GRANIT data layers. The processing involved a series of steps, including assigning a GRANIT id to each feature and refining/streamlining attributes. The modifications were made in conformance with standards adopted by the NH GIS Advisory Committee.

The streamlined set of attributes describes the road type (e.g. primary route, secondary route, class 3 or 4 road, etc.). The availability of the GRANIT id allows users to link back to the original full attribute list, if so desired, to generate additional data.

As indicated on the status map, full coverage of the state is now available through the GRANIT database. Modifications, updates, and enhancements to the spatial and attribute data will continue to be made. For example, future plans call for features to be tagged with the NH Department of Transportation Road Inventory System ID. This will allow users to extract and associate the extensive data maintained in the DOT road inventory data base, e.g. road class, surface type, or width of road.

In addition to the data documented above, statewide coverage of DLG-derived roads and trails generated at 1:100,000 is available. This data may be used for large area, regional analyses.

March, 2000

D. McGraw Note
This data description refers to the statewide roads.shp file. This represents the latest roads file as of May 2002. This data dictionary describing roads.shp was obtained 5/6/02 from NHDOT Dennis Fowler. It was copied to \GIS\Shapes\CulturalRes\Transpo\NHDOT.

The NHDOT SmartMap

The New Hampshire Department of Transportation is responsible for maintaining an inventory of every publicly owned road, street, and highway in the state. The inventory contains numerous fields of physical characteristics such as number of lanes, lane width, pavement type, and street name, as well as administrative characteristics such as functional classification owner, access control, and maintenance responsibility. Most of the information is maintained to satisfy our federal reporting requirements, and some information is required for calculating block grant funding for the municipalities or for the state transportation system management. Each road in the state is uniquely identified with a three digit town code; a four digit inventory number, unique within a town; a direction code required to identify divided highways; and a segment number used when an inventoried road is not contiguous. Each road is then divided into sections based on differences in the information in the inventory fields.

The SmartMap data is an intelligent map that is generated from the NHDOT Road Inventory database. For display purposes and portability, the NHDOT SmartMap is maintained as an ArcView shapefile set. Each graphic entity has a matching record in the Road Inventory database, and the graphic entity carries a select subset of the inventory information described above as attributes. Each graphic entity also carries a unique key attribute which allows us to link to the entire inventory. Periodically, as the Road Inventory database is updated and corrected, a new 'snapshot' of the database is taken and a new SmartMap coverage generated to keep the maps and attributes current. In the future, the SmartMap coverage will be replaced by a stable 'Link-Node' map base with the capability of defining the attribute information based on milepoint and/or coordinate positioning. The stable link-node base will then allow users to attach their own attribute data to the roadway links.

The following is a description of the attributes carried in the SmartMap ArcView Shapefiles:

Town_id: Three digit unique town code (leading zeros dropped)

Rdi_id: Four digit inventory number unique within a town (leading zeros dropped)

Direction: Divided highways will be coded 'N', 'E', 'S', or 'W' for the direction of barrel. Non-divided roads will be coded 'B' even if the road carries one-way traffic.

Segment: A sequential number used to identify roads that cannot be contiguous, such as a road that crosses into another town and then back into the original town or roads that are offset at an intersection.

Name: Street name. Where available, E-911 name is carried, otherwise, official name reported by the town is recorded. When no official name has been reported, then the name observed in the field, or reported by other sources is used.

S_Class: System/Class, The States roadway system and class description

Code	Descriptions
11	State maintained primary system.
14	State primary system within compact which is maintained by the Town or City (Urban extensions of Class I highways).
19	On the State primary system, maintained by the State Turnpike Authority.
22	State maintained secondary system.
24	State secondary system within compact maintained by the Town or City (Urban extensions of Class II highways).
25	Extensions of the designated State secondary system, uncompleted and Town maintained.
27	Designed State secondary system. Uncompleted and maintained by the Federal agencies.
29	On the State secondary system, maintained by the State Turnpike Authority.
33	State-maintained recreation roads.
44	Town and City maintained streets within compact areas.
55	Regularly maintained Town streets and roads outside of compact.
58	Town roads, or City streets maintained by Special Legislation.
66	Town or City streets **not** regularly maintained.
77	Federal agencies roads, maintained by the Federal agencies.
81	National system of Interstate and Defense highways, State maintained.
89	National system of Interstate and Defense highways, maintained by the State Turnpike Authority maintained.
99	Other highways and expressways not on the state primary or secondary systems maintained by the State Turnpike Authority.
00	Other toll roads not on the State Turnpike System i.e. private, Mt. Washington Toll Rd., Monadnock Toll Rd

LEGISLATIVE CLASS I - VI

Class	System / Class			
I	11	19	81	89
II	22	29	25	
III	33			
IV	14	24	44	
V	55	58		
VI	66			

Note:
Legislative Class I through VI are not carried in the Road Inventory Tables, but can be generally defined using the System / Class definitions.

F_Class: Functional Class codes

A code describing the use of the roadway, according to the character of service they are intended to provide. Function class codes have two classifications; Rural and Urban. Note: leading zeros are not carried in the Access tables.

Rural:

Code	Descriptions
00	Non-Public roads Example; Class VI
01	Principal Arterial -- Interstate
02	Principal Arterial -- Other
06	Minor Arterial
07	Major Collector
08	Minor Collector
09	Local

Urban:

Code	Descriptions
00	Non-Public roads Example; Class VI
11	Principal Arterial -- Interstate
12	Principal Arterial -- Other Freeways and Expressways
14	Principal Arterial -- Other
16	Minor Arterial
17	Collector
19	Local

GLC: Governmental Ownership (Governmental Level of Control)

A code used to identify the level of government that has responsibility for the facility. Where more than one code could be used for a section, the lowest numerical code shall be reported. Note: GLC relates to ownership of the road, not who maintains it.

Code	Description
01	State Highway Agency
03	Town or Township Highway Agency
04	Municipal Highway Agency
11	State Park, Forest, or Reservation Agency
12	Local Park, Forest, or Reservation Agency
21	Other State Agencies
25	Other Local Agencies
26	Private
31	State Toll Authority
32	Local Toll Authority
60	Other Federal Agencies (not listed below such as US Fish & Wildlife)
62	Bureau of Indian Affairs
64	US Forest Service
66	National Park Service
68	Bureau of Land Management
70	Military Reservation/Corps of Engineers

Surf_Type: Surface/Pavement Type
A code that describes the road surface type.

Code	Description
80	Brick, Block or Other Combination
72	Reinforced Portland Concrete (Rigid)
62	Composite (Flexible Over Rigid)
61	High Flexible (Bit. Concrete)
51	Bituminous Surfaced Treated
40	Gravel
20	Unimproved Road

Fac_type: Facility type.
A code to describe the traffic carrying purpose of the roadway.
Code 1 = One-way traffic
Code 2 = Two-way traffic

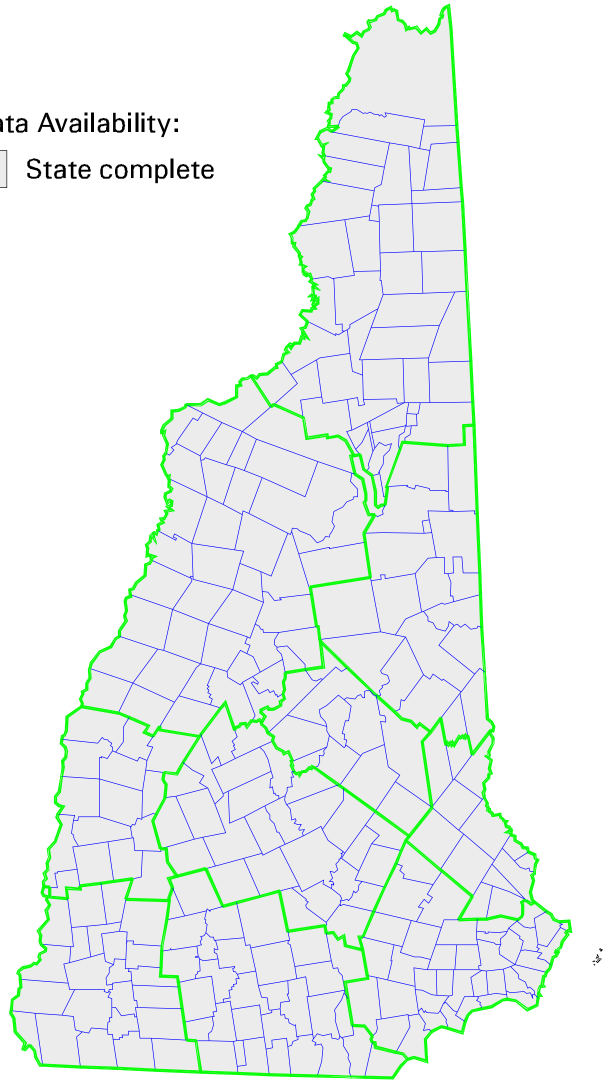
District refers to the NHDOT Maintenance District number

Access_con: Access control
Refers to the level of control for access points to the highway.
Code 1 = Full control (Interstate type)
Code 2 = Partial control (found on some state highways)
Code 3 = No control

PIPELINES

Data Availability:

State complete



Data Layer: PIPELINES

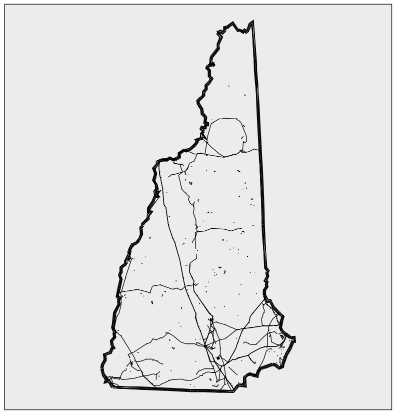
Primary Layer Name: PIPE
Layer Content: PIPELINES AND TRANSMISSION LINES
Data Structure: VECTOR
Layer Type: LINE

Source: DIGITAL LINE GRAPHS, USGS
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: STATE

Status: COMPLETE
Last Revision: January, 1993
Available From: Complex Systems Research Center, UNH

NEW HAMPSHIRE PIPELINES



GENERAL DESCRIPTION

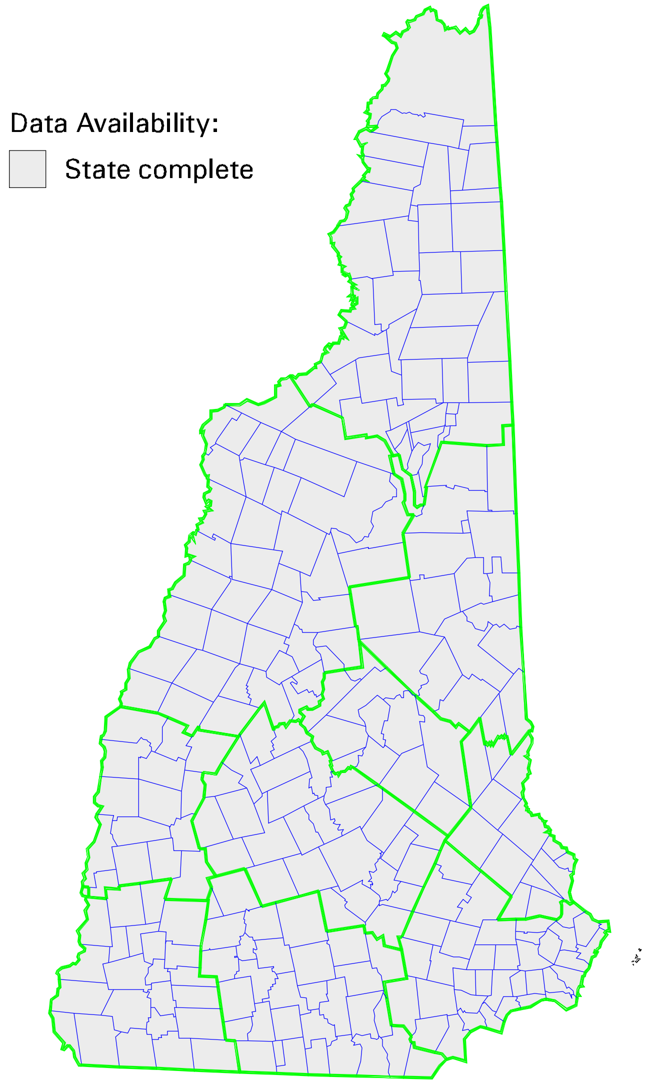
The PIPE coverage provides a digital representation of the pipelines and transmission lines mapped on standard 7.5-minute USGS quadrangles. The data was distributed by the USGS in Digital Line Graph (DLG) format. It was then processed in ARC/INFO to generate the GRANIT data layer. The processing involved a series of steps, including assigning a GRANIT id to each feature and refining/streamlining attributes. The modifications were made in conformance with standards adopted by the NH GIS Advisory Committee.

As indicated on the status map, full coverage of the state is now available through the GRANIT database. Modifications, updates, and enhancements to the spatial and attribute data will continue to be made.

In addition to the data documented above, statewide coverage of DLG-derived pipelines generated at 1:100,000 is available. This data may be used for large area, regional analyses.

March, 2000

RAILROADS



Data Layer: RAILROADS

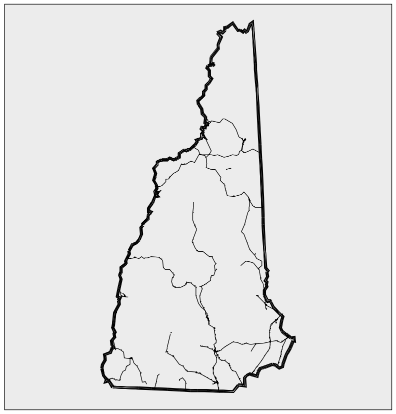
Primary Layer Name: RR
Layer Content: RAILROADS
Data Structure: VECTOR
Layer Type: LINE

Source: DIGITAL LINE GRAPHS, USGS
Source Scale: 1:24,000/1:25,000
Source Media: DIGITAL

Automated By: US GEOLOGICAL SURVEY
Coordinate Reference: NH State Plane Feet
Horizontal Datum: 1983
Tile: STATE

Status: COMPLETE
Last Revision: January, 1993
Available From: Complex Systems Research Center, UNH

NEW HAMPSHIRE RAILROADS



GENERAL DESCRIPTION

The RR coverage provides a digital representation of the railroads mapped on standard 7.5-minute USGS quadrangles. The data was distributed by the USGS in Digital Line Graph (DLG) format. It was then processed in ARC/INFO to generate the GRANIT data layer. The processing involved a series of steps, including assigning a GRANIT id to each feature and refining/streamlining attributes. The modifications were made in conformance with standards adopted by the NH GIS Advisory Committee.

As indicated on the status map, full coverage of the state is now available through the GRANIT database. Modifications, updates, and enhancements to the spatial and attribute data will continue to be made.

In addition to the data documented above, statewide coverage of DLG-derived railroads generated at 1:100,000 is available. This data may be used for large area, regional analyses.

March, 2000

Appendix C

Habitat Feature Associations & Map Units
Used in this Study

Habitat Feature Associations
for Species of Concern
in the Piscassic and Lower Lamprey River Watersheds

	Common Name	Habitat Features/Associations	What To Map
Mollusks	*Brook Floater*	Rapid and riffle areas on rocky, packed sand or gravel shoals of freshwater rivers. Shaded rivers likely important.	Rivers with rock, packed sand or cobble substrate OR Known locations, and 100' forested/shaded buffer
Fish	*American Brook Lamprey*	Coastal freshwater streams	?????
Amphibians	*Marbled Salamander*	Breeds in vernal pools in autumn, remains in surrounding (upland) woodlands during the rest of the year. Hardwood bottomlands with associated vernal pools.	Vernal pools with 350m buffer and 50% forested within the buffer
	Blue-spotted/Jefferson's Salamander	Breeds in vernal pools in mixed and deciduous forests	Vernal pools with 350m buffer and 50% forested within the buffer
Reptiles	*Eastern Hognosed Snake*	Dry sandy soils in pitch pine or white pine	excessively drained and somewhat excessively drained soils (in pitch pine and white pine forests)
	Blanding's Turtle	Variety of wetland systems including rivers, beaver flowages, and isolated pools. Shallow and deeper water with soft, mucky bottom. Nests in loose soils, beaches, sandy substrates such as gravel pits and roadside edges.	NWI: R2US, L2AB, L2EM, PAB, PUS, PEM, PSS, PFO, PUB/F05F, PUBHx, PSS1E, PUBF, PSS/EM1E, PEM1/FO1/4E; and 1200m buffer from wetland edge (stop at a fragmenting feature)
	Spotted Turtle	Marshes, ponds and streams containing aquatic vegetation. Occasionallly found in brackish water. Series of small shallow wetlands	NWI: R2US, PAB, PUS, PEM, PSS, PFO, PSS1E, PUBF, PUBH, FO1/4E; clusters of 3 or more vernal pools within 1000m of each other, and 570m buffer from wetland edge.
	Wood Turtle	Slow-moving rivers and streams with sandy, cobbled and gravelly substrates, bordered by dense shrubland (particularly silky or red-osier dogwood) and forest. Nest and spend time in uplands. Nest in gravel banks, old gravel pits, edges of fields	Rivers and streams with moderate currents with sandy, gravelly or cobble substrate bordered by thick shrubs and forest with 300m buffer and 600m buffer of mostly shrub/forest.
	Black Racer	Dry brushy areas.	Agricultural areas, orchards, powerlines, rights of ways, early successional habitat
Birds	*Pied-billed Grebe*	Emergent palustrine marsh with some open water, or ponds with extensive fringe of emergent vegetation. Deep water.	Wetlands of open water 10 acres or greater with some PEM.
	Sedge Wren	Moist meadows, pastures, hayfields with dense sedges and grasses.	PEM wetlands and fields in with hydric A or B soils
	Upland Sandpiper	Extensive grasslands 150 acres or more with low vegetation	Grasslands or similar open land of 150 acres or greater or clusters that add up to this amount
	Osprey	Breeds in vicinity of coastal and fresh water with suitable fishing habitat.	Beaver flowages and/or heron rookeries greater than 10ha (24 acres)and 100 foot buffer within 5 miles of Great Bay and lakes greater than 100 acres. Known nest sites with 300' buffer.

	Grasshopper Sparrow	Short sparse grasslands with some bare patches; weedy grasslands	Open land 30 acres or more with excessively well drained soils
	Red-shouldered Hawk	Mature forested wetlands, especially decidous	500 acre unfragmented blocks of deciduous or mixed wood with a mix of wetland and forest. Known nest sites with 300' buffer.
	American Bittern	Large cattail or other tall emergent freshwater wetlands.	Emergent wetlands greater than 3 acres.
	Least Bittern	Freshwater wetlands with tall, dense vegetation	Emergent wetlands greater than 3 acres.
	Common Moorhen	Extensive palustrine marshes with dense vegetation and interspersed pools and channels. Shallow ponds with extensive palustrine fringes.	Emergent wetlands greater than 3 acres.
	Sora	Emergent palustrine marsh with dense vegetation and open water channels.	Emergent wetlands greater than 3 acres.
	American Woodcock	Upland forest edges meeting areas of aspen or birch saplings, alders (scrub/shrub swamp), overgrown fields, burned or recently logged areas, and wetlands.	Areas with a mix of field/barrens, shrub-shrub wetland or moisit soils and second growth forest
	Whip-poor-will	Dry, open woodland, early successional forest, adjacent to large clearings or brushy field edges	well-drained and excessively well-drained soils associated with open land or early successional habitat
	Golden-winged Warbler	Old fields and pastures, dense scrubby thickets and grey birch stands Iin second growth forests.	early successional habitat
	Blue-winged Warbler	Overgrown farm fields, thickets, second growth woods, often near water.	early successional habitat
Mammals	*New England Cottontail*	Early successional habitats with grassy areas and dense ground cover. Old fields with dense understory, shrublands, power line corridors, and saltmarshes.	early successional habitat, powerlines, rights of ways, old agric. Land > than 12 acres
	Bobcat	Mixed decidous-coniferous hardwood forests with dense understories; wetland edges; outcrops	500+ acres with steep slopes and wetlands (PEM/PSS) or early successional habitat component
	Data Sources:		
	Dr. Kim Babbitt		
	Dr. John Litvaitis		
	David Carroll		
	Doug Grout		
	Chris Martin		
	Dr. Barry Wicklow		
	Maine GAP Analysis		
	MA Priority Sites and Proposed Reserves..		
	New England Wildlife		