WILDLIFE ACTION PLAN MAP ANALYSIS INFORMATION
New Hampshire Fish and Game Department: March 2010

Contents:

DETERMINING ECOLOGICAL CONDITION

Habitat condition was analyzed to develop statewide and regional rankings that identify the highest condition habitat relative to all polygons of a given habitat type in the state. The goal is to provide regional planners and conservation professionals with a tool to help identify the most ecologically intact wildlife habitat areas.

Using the 16 habitat types mapped in the NH Wildlife Habitat Land Cover dataset, plus streams and rivers and lakes and ponds, NHFG biologists developed condition filters to analyze which habitat patches are in the best relative ecological condition in the state. These filters are composed of GIS data that indicate to what degree a particular patch of habitat has good biological diversity (particularly in terms of rare species), is connected to other similar patches in the landscape, and is negatively impacted by humans. There is a different filter for each habitat, but each filter includes biological, landscape, and human impact factors. These three types of data are combined into BIO, LAND and HUMAN scores and are shown in the attribute fields.

Each habitat type has different factors that may affect its condition, but there are some commonalities in each of the groupings. Biological factors included data such as rare species richness for animals, plants and exemplary natural communities, as well as vertebrate species richness and other biological factors. Landscape factors include area of habitat patch, proximity to the nearest similar habitat patch, diversity of ecological land units (TNC data on ecological potential which is similar to potential natural community diversity) within the patch, and other factors depending on the habitat type. Human impacts include data such as road density,

wetlands permits, population density, pollution indices, dams and other similar factors. Pages 3-8 outline the data used for each habitat type; the metadata for each habitat layer provide additional details.

A set of available statewide data was collected for each of these three groups, with each individual score being on a 1-100 scale. Within each group, the scores for each data set were evenly weighted (expect for the aquatic features). The score for each group was then weighted evenly to come up with a single condition score (COND). This score is a relative score, based on all polygons of a given habitat types that occur in NH. Habitat patches were assessed as full polygons except the five matrix forest types, which were assessed in raster format, in 30m pixels (see below).

Surface waters were assessed a little differently than terrestrial habitats. Streams and rivers were assessed in watershed units developed by the US Geological Survey, using the HUC 12 level. The condition filter developed had some factors unevenly weighted, but otherwise the process was the same as the other habitats. See the metadata for details.

In 2010, a significant improvement in the accuracy of scoring the relative condition of forest habitats was accomplished by evaluating all forests as a seamless matrix instead of by individual polygons. This assigns a condition score to each 30 meter pixel (0.22 acre) in the forest habitat data. Using the same thresholds as the 2005 analysis, pixels scoring Highest Ranked Habitat by Ecological Condition are selected for each of the forest types. Pixels must be clustered into a patch of at least 100 acres to rank as highest in the state or biological region. In this method, only the portion of a forest patch meeting the condition threshold is assigned the highest rank rather than the entire polygon.

Each of the 16 terrestrial habitat layers include the overall condition score and the three sub-scores (BIO, LAND, HUMAN) for each habitat polygon. Aquatics condition scores are in a separate dataset. Not all of the underlying data scores are included with the released GIS data due to propriety issues.

RANKING HABITATS

Within each habitat type, the patches were ranked into one of four categories based on percentage of that habitat by area. The four rankings are; **Highest Ranked in the State by Ecological Condition**., **Highest Ranked in the Biological Region by Ecological Condition, Supporting Landscapes, and Not top ranked (all the rest).** The percentages are listed in the table on page 8. The top ranked habitats were assigned **Highest Ranked in the State by Ecological Condition**. Coastal and alpine habitats are so rare that all patches are included in this ranking.

Since NH is so ecologically diverse, the habitats were then ranked within their ecoregional subsection. Ecoregional subsections reflect broad regional patterns of geomorphology, stratigraphy, geologic origin, topography, regional climate, and dominant associations of potential natural vegetation. The Nature Conservancy has identified 9 ecoregions in New Hampshire. These were used to rank habitats as **Highest Ranked in the Biological Region by**

Ecological Condition. The Nature Conservancy also developed watershed groupings, Developed like the ecoregional subsections but with abiotic features that influence aquatic biology and were used for wetland habitats and watersheds.

The condition of a habitat patch will deteriorate if the surrounding landscape is degraded. A third ranking, **Supporting Landscapes**, consists of the upland part of the watershed for surface waters, some very intact forest blocks, some known locations of exemplary natural communities, and additional forest areas as scored through the condition analysis.

In order to capture occurrences of specialist species with imperiled populations, a select set of wildlife Element Occurrences (areas known to support populations of rare species) from the Natural Heritage Bureau database was used either to elevate underlying habitat polygons to the highest rank in NH or to buffer locations within an already high ranked matrix forest. The same was done for significant ecological features identified by NH Natural Heritage Bureau but, elevating them to Supporting Landscape level. Both additions are incorporated in the WAPTIERS data layer. A description of the species, plants and natural communities add-ins begins on page 9.

For more details on this work, see the metadata for each habitat layer and the WAPTIERS layer.

ATTRIBUTES USED IN CONDITION FILTERS FOR SPECIFIC HABITATS

The following factors were quantified and combined to create a single score for each habitat polygon. These scores were used to rank habitat polygons or sections of forests. Habitats are listed alphabetically.

ALPINE

Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area (hectares)
Proximity index (proximity of similar habitat patches)
Variety of ecological land units (ELU30 = elevation, substrate, landform)(TNC)
Density of hiking trails in the unit (km/km2)
Average total deposition of mercury (wet + dry) by land cover type (Miller et al, 2005)
Average deposition index, rate of cation depletion per ha/per year (Miller et al, 2005)

APPALACHIAN OAK PINE FOREST – see Matrix Forests

COASTAL ISLANDS AND DUNES

Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)

Average elevation (meters)
Vegetated (Y=yes or U=unknown)
Total size of island or unit (hectares)
Number of other islands within ½ kilometer
Average distance to mainland (meters)
Percent of island/unit that is wetland-NWI
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Percent already developed (2001 NH Land Cover from GRANIT)
Distance to nearest aquaculture operation (meters)
Average general shoreline sensitivity index value from ESI shoreline data

CLIFF
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area (hectares)
Proximity index (proximity of similar habitat patches)
Recreational rock climbing (Y=yes, U=undetermined)
Distance to nearest hiking trail (meters)
Distance to nearest road (meters)

FLOODPLAIN FOREST
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area of buffer in hectares
% of 1-km buffer around complex that is wetland
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Percent of floodplain forest drainage area that is impounded
Distance to nearest dam (meters)

GRASSLANDS
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area (hectares)
Proximity index (proximity of similar habitat patches)
Percent wetland (National Wetlands Inventory)
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Housing unit density in 2000 (houses per square mile)

MARSH AND SHRUB WETLAND COMPLEXES
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Number of marsh polygons in the complex
Area of largest marsh in the complex (hectares)
Number of dominant NWI vegetation classes in the complex
Road density within 250m of the complex
Distance to nearest road (meters)
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape

MATRIX FORESTS: Appalachian Oak Pine Forest, High Elevation Spruce Forest, Hemlock Hardwood Pine Forest, Lowland Spruce Forest, and Northern Hardwood Conifer Forest
Percent of predicted matrix forest polygon consistent with validated current forest cover types (Miller et al., 2005).
Vertebrate species richness (VT/NH GAP Analysis), maximum in 1 km radius
Richness of rare animal occurrences in 1 km radius, with occurrence records buffered by species dispersal distances
Richness of rare plant occurrences in predicted matrix forest polygons Richness of rare and exemplary natural communities in 1km radius
Richness of ecological land units (substrate, landform) in 1 km radius
Density of matrix (by forest type) in a 5km circle
Size of contiguous forest block within which forest habitat patch is located
Wildlife Connectivity Model, average landscape permeability for 16 species
Road density in the (km road/km2)
Population density in 2000 (people per square mile)
Housing units density in 2000 (houses per square mile)
Average total deposition of mercury (wet + dry) by land cover type (Miller et al, 2005)
Average deposition index, rate of cation depletion per ha/per year (Miller et al, 2005)

HIGH ELEVATION SPRUCE FOREST – see Matrix Forests

HEMLOCK HARDWOOD PINE FOREST – see Matrix Forests

LAKES AND PONDS
water bodies managed for wild trout
water bodies containing lake trout populations
Value based on rarity of fish species of concern present
NHB tracked species count (mussels, eagle, osprey, wood turtle, Cobblestone tiger beetle)
% watershed area in wetlands
% watershed area in open water
Road density in the area/unit (km/km2)

Developed & developable land incl. constrained areas (percent of total land area)
Percent of land area in agriculture
Change in population density 1990 to 2000

LOWLAND SPRUCE FOREST – see Matrix Forests

NORTHERN HARDWOOD CONIFER FOREST – see Matrix Forests

PEATLAND COMPLEXES
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area of buffer in hectares
Percent of 250m buffer of complex that is forest, water or wetland
Distance to nearest human impact
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape

PINE BARRENS
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Percent of area classified by NHB as current pitch pine habitat
Area (hectares)
Proximity index (proximity of similar habitat patches)
Variety of ecological land units (ELU30 = elevation, substrate, landform)
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Population density in 2000 (persons per square mile)
Housing units density in 2000 (houses per square mile)
Average deposition index, rate of cation depletion per ha/per year (Miller et al, 2005)

RIDGE/TALUS SLOPES
Species richness of rare animals within their dispersal distances from the polygon (2008)
Species richness of rare animals within polygon (2008)
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Area (hectares)
Proximity index (proximity of similar habitat patches)
Variety of ecological land units (ELU30 = elevation, substrate, landform)
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Density of hiking trails in the unit (km/km2)
Distance to nearest hiking trail (meters)

Average total deposition of mercury (wet + dry) by land cover type (Miller et al, 2005)
Average deposition index, rate of cation depletion per ha/per year (Miller et al, 2005)

RIVERS AND STREAMS (not updated in 2010, except for Element Occurrence add-ins)
count of anadromous fish species
waterbodies managed for wild trout
waterbodies containing lake trout populations
Status of Eastern brook trout (EBT Joint Venture)
NHB tracked species count (mussels, eagle, osprey, wood turtle, Cobblestone tiger beetle)
Value based on rarity of fish species of concern present
Area of surface water in the unit (hectares)
Length of rivers in kilometers
Area of wetlands in hectares
Road density in the area/unit (km/km2)
Percent of land area that is agriculture
River kilometers not impounded / total river kilometers
Developed & developable land incl. constrained areas (percent of total land area)
Change in population density 1990 to 2000
Percent in conservation

SALT MARSH
Species richness of rare plants in polygon (2008)
Richness of rare and exemplary natural communities in polygon (2008)
Species richness of selected animal species occurrences in polygon (2008)
Species richness of selected animal species occurrences within 1km area (hectares) (2008)
Proximity index (proximity of similar habitat patches)
Distance to nearest salt marsh area > 20 hectares in size (m)
Hectares of saltmarsh within one kilometer
Mean IFES score (Integrated Fragmentation Effects Surface; The Nature Conservancy; Zankel, 2005) – affect of fragmentation on the landscape
Density of all DOT roads (km/km2)
Percent of polygon with invasive plants present
Percent impervious surface

HUC_12 SUBWATERSHEDS (not updated in 2010)
(*the only habitat for which the condition filters were NOT equally weighted, see metadata*)
Count of water bodies within the HUC_12 with wild trout occurrence(s)
Count of water bodies within the HUC_12 managed for lake trout
Eastern Brook Trout Joint Venture Status
Count of occurrences in HUC_12 for: Blanding's, Spotted and Wood Turtles; Common Loon, Bald Eagle, Osprey, Northern Leopard Frog, Cobblestone Tiger Beetle
Count of fish species element occurrences in the HUC_12, incl. 2005 Wildlife Sitings records
Presence of anadromous fish in any 1 or more water bodies within the HUC_12
Hectares of surface water in the HUC_12 (NH)
Total river kilometers in the HUC_12 (2006 IDSLINES 1:100,000 NHD from NHDES)
Total free-flowing river kilometers in the HUC_12 (2006 IDSLINES from NHDES)

Total hectares of palustrine wetland and estuarine marsh in the HUC_12 (NH)
Road Density in the HUC_12 (km/km2 by land area)
Percent of HUC_12 in agriculture or disturbed land cover (2001 NHLC)

RANKING LEVELS FOR EACH HABITAT TYPE AND ADDED PRIORITY FEATURES

Tier 1 = Habitats of Highest Relative Rank by Ecological Condition in New Hampshire
Tier 2 = Habitats of Highest Relative Rank by Ecological Condition in Biological Region
Tier 3 = Supporting Landscapes

Note that these designations are mutually exclusive. Habitat already ranked as Tier 1 counts towards the percentages for Tier 2, but only those not already Tier 1 will be designated as Tier 2. This is also the same for Tier 3.

HABITAT	TIER	% USED FOR EACH RANK
High-Elevation Spruce-fir	1	Top 15% in NH by area
	2	Top 100%
Lowland Spruce-fir	1	Top 15% in NH by area
	2	Top 15% in Subsection by area
	3	Top 30% in Subsection by area
Northern Harwood-Conifer	1	Top 15% in NH by area
	2	Top 15% in Subsection by area
	3	Top 30% in Subsection by area
Appalachian Oak-Pine	1	Top 15% in NH by area
	2	Top 15% in Subsection by area
	3	Top 30% in Subsection by area
Hemlock-Hardwood-Pine	1	Top 15% in NH by area
	2	Top 15% in Subsection by area
	3	Top 30% in Subsection by area
Pine Barrens	1	Top 10% in NH by area
	2	Top 50% in Subsection by area
Rocky Ridges/Talus Slopes	1	Top 10% in NH by area
	2	Top 50% in Subsection by area
Cliffs	1	Top 10% in NH by number of polygons
	2	Top 50% in Subsection by number of polygons
Grassland (may include agricultural fields, pasture lands, airports, golf courses, and other open lands)	1	Top 10% in NH by area. Condition only includes grasslands greater than 25 acres in size.
	2	Top 50% in Subsection by area
Wet Meadow/Shrub Wetland	1	Top 10% in NH by area
	2	Top 50% in Watershed Group by area

Peatland	1	Top 10% in NH by area
	2	Top 50% in Watershed Group by area
Floodplain Forest	1	Top 10% in NH by area
	2	100% in Watershed Group
Watersheds (HUC12s)	1	Top 15% in Watershed Group by area (entire HUC12 watershed)
	2	Top 30% in Watershed Group by area (only 100m buffer of water bodies in these HUC12)
Lakes/Ponds	1	TNC's Top 10 most intact lakes, by lake class (including a 200m buffer of these lakes)
Salt marsh	1	100%
Coastal Islands	1	100%
Dunes	1	100%
Alpine	1	100%
TNC top forest blocks	3	TNC forest blocks top-ranked in ELU Group and/or Ecoregion Subsection
Animal occurrences	1-3	Occurrences of selected endangered, threatened or special concern species. See below
Ecological features (NHB)	1-3	High Priority natural communities as ranked by NHNHB. See notes.

OCCURRENCES USED TO ELEVATE HABITAT RANK

Data for rare species and exemplary natural communities used in these analyses were subset as follows:

- For animals: restricted to endangered, threatened, special concern and S1-S2 species with precise location information (precision = "seconds") that were observed within the last 20 years
- For plants: restricted to populations with precise location information (precision = "seconds") that were observed within the last 20 years
- For natural communities: restricted to those observed within the last 40 years

For important background information on NH Natural Heritage Bureau data, see *Important Background Information for Interpreting Species Richness Counts based on NH Natural Heritage Bureau Data.*

Selected Rare Wildlife

Animal occurrence records were extracted from the NH Natural Heritage Bureau database and overlaid on the WAP habitat polygons. Only geographically precise data recorded within the last 20 years were used. For some species, known core populations, population models or reproductive data were used to refine locations to core populations. Except where noted, the presence of these species elevated the habitat patch to Tier 1: Highest Ranking by Ecological Condition in New Hampshire. Species whose populations were already well covered by the basic condition rankings were not included.

Criteria used to select species:

- Endangered or threatened in NH
- Limited populations known or likely to occur
- Isolated or restricted in NH
- Point specific sensitive information
- Provides critical habitat for state's population which his not already highly ranked

Selected Element Occurrences (EO) (1988-to-2009 and excluding "general" precision) and core populations included:

Birds:

Peregrine nest EOs (natural sites), Bald eagle nesting and wintering habitat (buffered), common nighthawk (non-urban EOs), pied-billed grebe, sedge wren, and American three-toed woodpecker elevated pertinent habitats.

Common loon productive nests (productivity .48 or greater) elevated Lakes and Ponds.

Northern harrier, upland sandpiper, grasshopper sparrow EOs were used to elevate Grasslands habitat.

Piping plover, roseate tern, common tern, least tern occur on tier 1 dunes or coastal islands.

(There are no breeding records of golden eagle in NH.)

Mammals:

New England cottontail: used a refined model delineating core population areas.

Known bat hibernacula with portions of forest block, and small-footed bat EOs, buffered.

American marten occur on high-elevation spruce-fir (already ranked minimum tier 2).

(There are no breeding records of Canada lynx or Eastern wolf in NH).

Reptiles and Amphibians:

Supporting habitat of sensitive snake EOs.

Eastern hognose snake and black racer (with 1km buffer).

Marbled salamander (with 0.3 km buffer)

Blanding's turtle core areas elevated to Tier 3, wetlands within core areas ranked tier 1.

Spotted turtle EOs elevated marsh and peatland complexes.

Invertebrates:

Karner blue butterfly, persius duskywing skipper, pine pinion moth, frosted elfin were used to elevate PINE BARREN habitat.

Special concern pine barrens Lepidoptera elevated selected PINE BARRENS to tier 3

Ringed boghaunter (500m buffer)

(All White mountain fritillary and White mountain arctic EOs are within tier 1 Alpine habitat.)

Aquatic Species:

Cobblestone tiger beetle, American brook lamprey and bridle shiner EOs were used to elevate AQUATIC habitat. Listed fish and mussels elevated stream and 100m buffer to 1 km up and downstream, stopping at dams for mussels. Shortnose sturgeon EOs >20 years old so were not used.

The EO features listed above were used to elevate the underlying non-matrix forest habitat polygons to Tier 1 or are added as separate polygons encompassing multiple habitat types to Tier 1. If the EO only overlapped a matrix forest habitat, then a buffer was applied to the EO and elevated to Tier 1.

Selected Rare Plants And Natural Communities

Natural communities are recurring assemblages of plants and animals found in particular physical environments. Three characteristics distinguish natural communities: 1) plant species composition, 2) vegetation structure (e.g., forest, shrubland, or grassland), and 3) a specific combination of physical conditions (e.g., water, light, nutrient levels, and climate).

Exemplary natural communities are the best remaining examples of New Hampshire's natural community types. Exemplary status is assigned based on a combination of the rarity of the natural community type and the quality rank of a given occurrence. Quality ranks are a measure of the ecological integrity of a community relative to other examples of that particular type based on size, ecological condition, and landscape context. The NH Natural Heritage Bureau (NHNHB) provided spatial data identifying NHNHB-priority sites not covered by habitat polygons meeting "highest quality" tiers based on condition filters. NHNHB developed a simple method to identify high priority natural communities based on element rarity and occurrence condition. All natural community and natural community system EOs that met the following criteria were considered "high" priority for conservation (see NHNHB for details):

1) High quality: Any "A" ranked element occurrence, regardless of rarity.
2) Rare elements: Any "B" ranked element occurrence for rare (S1 or S2) community types.

Natural Communities were restricted to those documented during the last 20 years. All identified Natural Communities and systems were then intersected with associated WAP habitat polygons and used to elevate the rank of a previously unranked polygon from "no rank" to "Tier 3", regardless of its condition score. Where these overlapped a matrix forest, the feature was buffered before scoring it and adding it to the WAPTIERS data layer. Certain areas were identified by NHB as of exceptional ecological value based on an assemblage of EOs, and these were elevated to Tier 1. Natural community-WAP habitat associations were based on Appendix C of the Wildlife Action Plan.

DATA SOURCES FOR CONDITION ANALYSIS

Please refer to WAP spatial data notes (metadata folder) for complete source information.

1.) Rare animal, rare plant and natural communities attributes assigned by NH Natural Heritage Bureau (October 2009).

2.) Digital data describing atmospheric deposition of mercury were provided by Ecosystems Research Group, Ltd using the methods described in Miller et al. (2005). Digital data describing the risk of calcium and other base cation depletion and limitation in forested ecosystems provided by Ecosystems Research Group, Ltd. using methods described in Miller (2005).

3.) Wind power spatial data were provided by Massachusetts Technology Collaborative (2003). Developed by TrueWind Solutions, LLC under contract to AWS Scientific, Inc. as part of a

project jointly funded by the Connecticut Clean Energy Fund, Mass. Technology Collaborative, and Northeast Utilities System.
4.) Integrated Fragmentation Effects Surface spatial data provided by The Nature Conservancy, NH (2005).
5.) Draft vertebrate distributions in 1993 VT/NH Gap Analysis (report 2001). University of Vermont (2005).
6.) Dams and drawdown spatial data provided by NH Dept. of Environmental Services (2005).
7.) Wetland permits 2000-2004 spatial data provided by NHDES Wetlands Bureau (2005).
8.) Hiking trails spatial data provided by Appalachian Mountain Club, 2005.
9.) Timber harvest identified from 1992 and 1998 USGS orthophotos, data provided by Univ. of Vermont, 2005.
10.) NHDOT roads spatial data obtained from GRANIT (www.granit.sr.unh.edu) at Complex Systems Research Center, University of New Hampshire. Accessed January 2009.