PEER REVIEW

How Much is Enough? Distribution and Protection Status Of Habitats in the Adirondacks

By MICHALE J. GLENNON and RAYMOND P. CURRAN

Abstract

One of the most enduring debates in the Adirondacks concerns how much protected land we need in the Park, and the balance of human needs versus environmental protection. Using some newly available resources, we provide information to contribute to the discussion. The recently completed Northeast Terrestrial Habitat Classification System and associated map provides a consistent habitat classification system across the entire northeast (West Virginia to Maine), and a freely available digital map that can be used in GIS analyses. We used this map to examine habitat types and their distribution within the Adirondacks, as well as their relationship to terrestrial Adirondack vertebrate species, especially those that are of conservation concern. To our knowledge, this is the first time such a large number of states and jurisdictions have chosen to create a common language of habitat types, it is the first time we can examine habitats on large scales as opposed to land cover, and it is the first time we can visualize these habitats and ask questions about their distributions. We hope it will help to address some of the important questions often raised.

Key words: *habitat classification, conservation priorities, land protection strategy, responsibility species, Species of Greatest Conservation Need*

Introduction

The Adirondack Park has been a controversial experiment since its inception and will remain so. This contentious history is well documented in many places including Schneider (1998), Terrie (1997), Porter et al. (2009) and others. The question of how much land should be protected via State acquisition or easement is a persistent argument and recent articles in local outlets consistently draw numerous comments on both sides (Beamish 2010, Martineau 2012, Nelson 2012). As our friend Dr. Ross Whaley reminds us, "Adirondackers would rather fight than win." Often these discussions are largely philosophical and important, and this effort will not change them, nor should it. We did, however, set out to try to add some information to the debate from a wildlife ecology perspective.

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Recent habitat classification and mapping conducted by The Nature Conservancy and others has made available comprehensive information on the types, locations and extent of habitats across the Adirondacks and beyond. The Northeast Habitat Classification and Mapping project (Ferree and Anderson 2013) grew out of a 2006 workshop of the Northeast Association of Fish and Wildlife Agencies, at which the importance of development of consistent regional habitat maps was highlighted as a top priority for the northeast region. A major component of the project was the development of a terrestrial habitat classification that could be used to provide a standardized and consistent habitat and ecosystem classification at multiple scales across states and to offer managers a tool for understanding regional biodiversity patterns. The resulting Northeast Terrestrial Habitat Classification System (NETHCS) was created by a team of staff from NatureServe, with a steering committee consisting of representatives from each of the 13 states that make up the USFWS eastern region (ME, NH, VT, MA, RI, CT, NY, NJ, PA, DE, MD, DC, WV, VA) and mapped by The Nature Conservancy's Eastern Conservation Science office. It is a continuous, 30 meter raster coverage that maps upland and wetland wildlife habitats/ecological systems for the Northeast. The ecological systems represented in the map are mosaics of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients, in a pattern that repeats itself across landscapes.

Prior large-scale regional mapping efforts have been conducted including the National Land Cover Database (NLCD; http://www.mrlc.gov), the GAP Analysis project (http://gapanalysis.usgs.gov), and the LANDFIRE project (http://www.landfire.gov) but have focused primarily on land cover rather than habitat. The NLCD is a Landsat-based, 30-m resolution land cover database for the United States and provides spatial reference and descriptive data for characteristics of the land surface (Homer et al. 2012). It is seamless and nationwide and maps 16 different land cover types. It is, however, created from satellite imagery and therefore limited in resolution and the most recent version is 2006. The National Gap Analysis Program (GAP) is part of the U.S. Geological Survey and initially attempted to map terrestrial habitat in

each state as part of an assessment of terrestrial vertebrate species richness. However, each state completed their mapping efforts independently with classification systems, techniques, and quality varying considerably between states. These maps were based on the same satellite imagery used to create the 1990s NLCD and are therefore also out-of-date. Other regions of the country have undertaken and completed high quality regional GAP mapping efforts, but no such dataset currently exists for the Northeast. LANDFIRE is another national-level mapping effort and is an interagency vegetation, fire, and fuel characteristics mapping program sponsored by the US Department of the Interior and the USDA Forest Service. Its data products are numerous and include existing vegetation type which is mapped using decision tree models, field data, Landsat imagery, elevation, and biophysical gradient data. Both LANDFIRE and more recent versions of National GAP use Natureserve's Ecological Systems classification and the revised US National Vegetation Classification (USNVC; Federal Geographic Data Committee 2008) which are better suited to mapping habitat but because of their national scope are, however, limited in their applicability for smaller-scale regional assessments. The NETHCS and associated map provide a consistent set of habitat types and are meant to provide a common base for characterizing wildlife habitats across states, to facilitate interstate communication about habitats, and to promote an understanding of terrestrial and aquatic biodiversity patterns across the region (Ferree and Anderson 2013).

We used the NETHCS map to examine the distribution of habitat types within the administratively defined land use categories of the Adirondack Park. Using simple GIS methods, we tabulated the areas of each of the habitat types within all of the land use categories of the Park and examined their protection status. In order to determine their potential importance for wildlife, we compiled a list of vertebrates for the Adirondack Park and used ecology and life history information from NatureServe to link species to habitat types. Our primary goals were to determine: (1) what is the distribution of habitat types within the Adirondacks relative to land ownership, and (2) what does the distribution of these habitat types mean for vertebrates? Understanding where habitats are distributed in the Park is a critical step in ensuring the protection of the natural resources and biological diversity this landscape supports, a goal of the management agencies that oversee public and private lands both.

Methods

Mapping

The NETHCS map was created by the Eastern Science office of The Nature Conservancy and is publicly available at conservationgateway.org. The final report for the classification and mapping project can be downloaded along with the GIS datasets and describes the full project which included: (1) development of a terrestrial habitat classification to be used to standardize the delineation and quantification of habitat across state

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boundaries to evaluate specific habitat types in a regional context; (2) development of an aquatic habitat classification and map of stream data; (3) development of a dataset showing lands that are conserved—those in federal, state, local, or private ownership with some degree of habitat protection. The project was undertaken with the support of the Northeast Association of Fish and Wildlife Agencies (NEAFWA) as part of its Regional Conservation Needs assessment and grant program. Project tasks and deliverables were contracted to NatureServe with a subcontract to The Nature Conservancy.

NETHCS was developed as a standardized set of habitats that would be consistent with other regional classification and mapping efforts. It is based on the ecological systems classification created by NatureServe, with additional classes for developed and highly altered lands (Ferree and Anderson 2013). Habitat Systems are intended for use at multiple scales and for supplementing finer-scale approaches that may be used by individual states for specific projects. The range of habitat types includes extensive (1000s of ha) types as well as small-patch systems of only a hectare or two. There are a total of 120 Habitat Systems in the entire region, grouped into 35 "macrogroups," which are broader-scale units tied to the National Vegetation Classification Standard (Ferree and Anderson 2013). Within the Adirondack Park, there are 42 of habitat types represented within 17 macrogroups (Table 1). Ferree and Anderson (2013) provide an extensive description of the process of creating the habitat classification as well as its relationship to other regional habitat classifications systems. The habitat types are described extensively in Anderson et al. (2013).

The primary steps of the mapping process within each ecological region were: (1) compile datasets of environmental variables for the region (topography and elevation, geology, climate, land cover, etc.), (2) develop a list of ecological systems, then use the literature and expert review to determine their distribution, scale, landscape pattern, and ecological character, (3) compile plot samples of terrestrial habitats from Natural Heritage Programs, Forest Inventory Analysis points, and other sources and crosswalk and tag all samples to the appropriate ecological system, (4) develop distribution models for the matrix-forming forest habitats using a classification and regression tree analysis of classified plot samples on the environmental variables compiled in step 1, (5) transfer the matrix forests information onto the landscape using landform-based units, (6) develop distribution models for the upland patch systems (barrens, glades, cliffs, etc.) and wetland patch systems (swamps, marshes, bogs, etc.) using plot samples and relevant biophysical variables, and (7) assemble all models into one ecoregion-wide map and develop legend (Ferree and Anderson 2013).

Table 1. *Macrogroup-level terrestrial habitats of the Adirondacks and the proportion of the Park they represent. Each macrogroup consists of one or more habitat types, as described by Anderson et al. (2013).*

Macrogroup	%	Description
Alpine	< 1	Areas near or above treeline
Boreal Upland Forest	11	Wooded uplands characterized by black spruce or jack pine; sometimes by red spruce without temperate elements
Central Hardwood Swamp	< 1	Wooded non-floodplain wetlands characterized by conifers (other than Atlantic white cedar and pitch pine) and deciduous hardwoods
Central Oak-Pine	< 1	Wooded uplands of the central and northeastern US oak-hickory region
Cliff and Talus	1	Vertical or near-vertical cliffs and the talus slopes associated with them (and the occasional talus areas developing without adjacent cliffs)
Emergent Marsh	1	Freshwater marshes in more-or-less permanent water with non-persistent vegetation
Glade and Savannah	< 1	Upland areas with sparse trees and a grassy understory; usually over rock, sometimes sand
Northeastern Floodplain Forest	< 1	Wooded floodplain wetlands of the northeast.
Northern Hardwood and Conifer	68	Wooded uplands of the north-temperate northeast, characterized by northern hardwoods, pines, hemlock, or red spruce
Northern Peatland	1	Raised bogs, and boreal-flavor bogs and fens in the glaciated northeast
Northern Swamp	10	Wooded non-floodplain wetlands of the northeast.
Outcrop and Summit Scrub	1	Upland areas with a mixture of shrubs, herbs, and sometimes stunted trees, associated with rock outcrops and summits
Wet Meadow/Shrub Marsh	2	Freshwater marshes and wet meadows with persistent vegetation of shrubs, sedges, and wetland forbs
Ruderal Shrubland and Grassland	< 1	Upland shrubby, grassy, or mixed cover areas created or maintained in areas that would naturally revert to forest over time
Agriculture	1	Lands currently being used for crop production or pasture
Developed	2	Recreational and urban/suburban grassland areas, sometimes with inclusions of other cover; parks, airports, golf courses, residential, commercial, industrial areas, strip mines, gravel pits, etc.

GIS Analysis

The NETHCS map was downloaded from www.conserveonline.org (now offline, the dataset must now be downloaded from conservationgateway.org) with its associated metadata and accompanying documents. It is available as a raster coverage for use in GIS applications; we imported it into ArcMap 10 for all calculations. We summarized the NETHCS habitat data both across the Park as a whole and within the 14 Adirondack Park Land Use and Development Plan Map (LCCD) categories. The LCCD database is a digital rendition of the Adirondack Park Land Use and Development Plan Map, which is prepared based upon the definitions found in New York State Executive Law, the Adirondack Park Agency Act, and in the Adirondack Park State Land Master Plan. We obtained the most up-to-date (as of March 2012) LCCD map data available from the Adirondack Park Agency. Habitats were summarized on public lands, on private, unprotected lands, and on private lands with conservation easements in place within the LCCD categories. We obtained easement information from a GIS shapefile provided to us by the Adirondack Nature Conservancy and Land Trust containing boundaries of conservation easements for the Adirondack Park including those held by The Nature Conservancy, the Adirondack Land Trust, the Lake George Land Conservancy, and the State of New York. This dataset did not include other private easements. We used the Tabulate Area function for all summaries.

To calculate an average patch size for each habitat type, we first reclassified the NETHCS raster to the 17 macrogroup classes using Reclassify in Spatial Analyst. We next converted the simplified NETHCS raster dataset to a polygon file using the Raster to Polygon conversion tool. In the process of converting raster data to polygons, each group of continuous cells with the same values becomes a polygon. Using the attribute table for the newly created polygon dataset, we used the Add Field option in the attribute table to create a new field called area, and the Calculate function within the table to calculate areas of each patch, from which we obtained statistics on mean patch size for each of the macrogroup habitats.

Our summaries were computed on the original habitat classes provided by the NETHCS map but were also condensed to a macrogroup level for the results presented here. We used these summaries to classify the macogroups into 3 categories: (1) well-protected—habitats for which approximately two-thirds or more is protected on State land or conservation easement, (2) underprotected—habitats for which approximately two-thirds or more is located on private lands without easements, and (3) equivalent—habitats which are distributed in relatively similar proportions on protected (state, easement) and unprotected lands.

Vertebrates and Habitats

We compiled a list of terrestrial vertebrates for the Adirondack Park from 2 sources. We adopted the lists provided on the Adirondack Flora and Fauna website of the State University of New York Adirondack Ecological Center (AEC) web page (http://www.esf.edu/aec/adks/florafauna.htm). This site provides complete vertebrate lists for mammals, amphibians, and reptiles. The mammal list comes from Saunders (1988) and the herptile information from Saunders (1989). We crosschecked the herptile list with the distribution data compiled by the New York State Amphibian and Reptile Atlas project to ensure that the Saunders (1989) list can still be considered a current list. No such atlas exists for mammals in the state against which we might do the same confirmation. The bird list provided on this site is not a comprehensive list but is a list of birds occurring on the AEC property or in the vicinity. In the interest of being comprehensive, we used the New York State Breeding Bird atlas data to create a list of Adirondack birds by extracting information on species documented in blocks within the Adirondack Park (New York State Department of Environmental Conservation, McGowan and Corwin 2008).

With our resulting list of Adirondack vertebrates (N = 283), we used the Ecology and Life History information available through the NatureServe Explorer to document potential terrestrial habitats for all vertebrates. NatureServe is a nonprofit conservation organization with a mission of providing the scientific basis for conservation action and represents an international network of biological inventories known as natural heritage programs or conservation data centers operating in all 50 US states, Canada, Latin America, and the Caribbean. NatureServe Explorer (http://www.natureserve.org/explorer) is a product of NatureServe and its natural heritage member programs and provides conservation status, taxonomy, distribution, and life history information for more than 70,000 plants, animals, and ecological communities in the U.S. and Canada. The Ecology and Life History information for each species includes a list of estuarine, riverine, lacustrine, palustrine, and terrestrial habitats with which each species is associated. We compiled this information for each species and cross-walked it to the macrogroup level habitat classes provided by NETHCS (Table 2). This process is an imperfect one because the habitats of the two systems are not the same, but we chose to make use of the NatureServe information because it represents a consistent set of habitats against which all vertebrates are considered. Crosswalking to the finer scale habitat types of the NETHCS rather than the macrogroup level would require extensive literature review and probably a fair amount of personal judgment, which we sought to avoid. The macrogroups and the terrestrial habitats provided by NatureServe are sufficiently broad so as to be comparable, and we provide the crosswalk we used so that these methods are transparent.

Upon compiling the terrestrial habitat information for each species and

Table 2. *Crosswalk used to translate NatureServe terrestrial habitats to NETHCS macrogroups. Categories are not mutually exclusive; some NatureServe habitats were appropriate to more than one macrogroup.*

Macrogroup Name	NatureServe Terrestrial Habitats Assigned to this Macrogroup
Alpine	Alpine
Boreal Upland Forest	Forest-Conifer, Woodland-Conifer
Central Hardwood Swamp	Forested Wetland
Central Oak-Pine	Forest-Hardwood, Woodland-Hardwood
Cliff and Talus	Cliff, Bare Rock/Talus/Scree
Emergent Marsh	Herbaceous Wetland
Glade and Savannah	Savannah
Northeastern Floodplain Forest	Forested Wetland, Riparian
Northern Hardwood and Conifer	Forest-Conifer, Woodland-Conifer, Forest-Hardwood, Woodland-Hardwood, Forest-Mixed, Woodland-Mixed
Northern Peatland	Bog/Fen, Herbaceous Wetland, Scrub/Shrub Wetland
Northern Swamp	Forested Wetland
Outcrop and Summit Scrub	Alpine, Cliff, Tundra, Bare Rock/Talus/Scree
Wet Meadow/Shrub Marsh	Shrubland/Chaparral, Herbaceous Wetland, Scrub/Shrub Wetland
Ruderal Shrubland and Grassland	Grassland/Herbaceous, Old Field, Shrubland/Chaparral
Agriculture	Cropland/Hedgerow, Suburban/Orchard
Developed	Suburban/Orchard, Urban/Edificarian

translating it into the macrogroups each species would potentially make use of, we tabulated numbers of species at the class level and across all vertebrates to determine which macrogroup types were potentially used by which groups, and in what numbers. It is important to note that these species-macrogroup links represent potential habitat only. This information should not be interpreted to suggest that all areas of a particular habitat type would necessarily be used by a given species. In the absence of empirical data and finer-scale information, we can only identify the habitat categories that would *potentially* be used by a given species. For some habitat generalists, this may translate closely to all available habitats, but for specialists who may require fine-scale habitat features that are difficult to map at such scales (e.g., vernal pools), the presence of those features would determine specifically where within these habitat categories a particular species might be found.

Species of Conservation Concern

We also tabulated information on potential habitat for species of conservation concern, using 2 indices. We identified Species of Greatest Conservation Need (SGCN), which are species considered by the New York State Department of Environmental Conservation to be rare, imperiled and those for which status has not been established (http://www.dec.ny.gov/animals/9406.html). SGCN are used by every state in the US and its territories for the purpose of developing state wildlife action plans and soliciting funds for conservation from the federal Wildlife Conservation and Restoration and State Wildlife Grants Programs. SGCN for New York include: (1) species on the current federal list of endangered and threatened species that occur in the state, (2) species that are currently state-listed as endangered, threatened, or special concern, (3) species with 20 or fewer elemental occurrences in the New York Natural Heritage Program database, and (4) estuarine and marine species of greatest conservation need as determined by NYSDEC Bureau of Marine Resources staff. New York currently has 537 species on its SGCN list, 74 of which are terrestrial vertebrates that occur in the Adirondacks.

In addition to SGCN, we also compiled information on the conservation status of species using the state ranks as provided through NatureServe Explorer. Conservation status information is provided for each species or ecological community based on a 1 to 5 scale and is assessed at global, national, and state/provincial scales. We used the state S ranks for each species, with ranks corresponding to the following categories: (1) S1 – critically imperiled, (2) S2 – imperiled, (3) S3 – vulnerable, (4) S4 – apparently secure, (5) S5 – secure. The ranks provided by NatureServe Explorer correspond to the New York State Natural Heritage S ranks; the full methodology for how species are categorized is described in Faber-Langendoen et al. (2012).

Results

Habitat Types

The Adirondacks contains 42 different habitat types which can be condensed into 17 macogroups (Table 1). Of the broader macrogroups, the Adirondacks are comprised primarily of Northern Hardwood and Conifer Forest at 68%. The next largest habitat types in the Adirondacks are Boreal Upland Forest (11%) and Northern Swamp (10%).

Our smallest habitat is Glade and Savannah (mapped only on Valcour Island in a habitat type called Great Lakes Alvar), and numerous other types make up very small proportions of the Adirondack landscape (Table 1).

Protection Status

The Adirondack Park consists of approximately 5.4 million acres of terrestrial habitat (the rest is water) within 14 land use categories designated by the Adirondack Park Agency Act. Our largest categories are Wilderness (21% of Park) and Wild Forest (24%) within the state lands and Rural Use (19%) and Resource Management (28%) on privately owned lands. All other land use categories make up 5% or less of the Adirondack landscape. Of the private lands, approximately 792,000 acres are under conservation easement while 2.1 million acres remain in private ownership, most of which is in Rural Use and Resource Management. There are approximately 856,000 acres of undeveloped land without easements in Rural Use and 873,000 acres in Resource Management.

Tabulation of habitat types reveals an uneven distribution of habitats within land use categories and protection levels (Tables 3 and 4). Several habitat types are disproportionately represented on state lands including: Alpine, Boreal Upland Forest, Cliff and Talus, and Glade and Savannah. Contrastingly, Central Hardwood Swamp, Central Oak-Pine, Northeastern Floodplain Forest, and Ruderal Shrubland and Grassland are disproportionately represented on private lands. Five habitats can be considered well-protected, 6 are under-protected, and 5 are roughly equivalent (Table 3). Average patch sizes among them range from 2 acres in Emergent Marsh to 85 acres in Northern Hardwood and Conifer Forest (Table 3). Rural Use and Resource Management harbor large proportions of those habitat types that are underprotected (Table 4).

Relationship to Vertebrates

We considered the relationship of habitats to terrestrial vertebrates only at the macrogroup level. The Adirondack Park has 54 mammal species, 16 reptiles, 19 amphibians, and 194 birds. Among the macrogroups, there are several which have the potential of very high importance for these species including Northeastern Floodplain Forest, Central Oak-Pine, Wet Meadow/Shrub Marsh, Boreal Upland Forest, and Ruderal Shrubland and Grassland (Figure 1). Each of these five types represent less than 15% of the Adirondack landscape but provide potential habitat for more 50% of its vertebrates. For species we can consider to be rare or of concern, similar patterns are evident (Figure 1).

Combining information on habitats of importance to vertebrates and protection status reveals the importance of private land in the Adirondacks for providing habitat for significant numbers of species. Several habitat types are potentially used by large numbers of vertebrates and are, at the same time, located disproportionately on unprotected land use types. Generally, those habitats that are highly protected represent potential habitat for relatively low numbers of species and vice versa (Figure 1).

Table 3. *Adirondack Park habitats by total acreage, average patch size, and protection status (%)*

Macrogroup	Total (ac)	Ave. Patch Size (ac)	NYS Forest Preserve	Conservation Easement	Private, No Easement
			Well-protected		
Alpine	285	4.7	100	0	0
Boreal Upland Forest	604,461	19.5	67	11	22
Cliff and Talus	54,624	6.6	63	11	27
Glade and Savannah	57	2.1	100	0	0
Outcrop and Summit Scrub	55,681	5.6	72	12	16
			Underprotected		
Central Hardwood Swamp	2,970	2.3	5	3	92
Central Oak-Pine	27,317	7.4	16	8	76
Northeastern Floodplain Forest	6,565	4.7	30	4	66
Ruderal Shrubland and Grassland	3,360	2.3	4	0	96
			Equivalent		
Emergent Marsh	42,787	2.0	47	16	37
Northern Hardwood and Conifer	3,718,981	84.7	44	15	41
Northern Peatland	69,914	10.2	42	27	31
Northern Swamp	550,105	3.2	46	15	39
Wet Meadow/Shrub Marsh	129,343	5.7	45	18	37

Table 4. *Distribution of Adirondack Park habitats by land use category[1] (%)*

Macrogroup	Hamlet	Moderate Intensity	Low Intensity	Rural Use	Resource Mgmt.	Wilder-ness	Wild Forest	Canoe	Primitive
Alpine	0.0	0.0	0.0	0.0	0.0	97.1	0.0	0.0	0.0
Boreal Upland Forest	0.7	1.2	2.9	7.9	20.3	41.7	22.9	0.4	1.1
Cliff and Talus	0.1	0.5	1.2	10.6	24.9	34.9	25.0	0.2	1.5
Glade and Savannah	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Outcrop and Summit Scrub	0.1	0.2	0.6	4.8	22.5	44.6	25.5	0.3	0.9
Central Hardwood Swamp	2.0	8.4	8.1	20.1	52.0	0.0	1.9	0.0	0.0
Central Oak-Pine	2.3	6.1	23.4	28.6	23.4	3.4	11.6	0.0	0.1
Northeastern Floodplain Forest	1.7	2.5	11.4	27.3	26.9	5.4	23.1	0.0	0.2
Ruderal Shrubland and Grassland	1.2	6.0	18.7	64.5	5.4	0.0	0.2	0.0	0.0
Emergent Marsh	1.0	1.2	4.1	15.3	30.4	20.2	25.7	0.3	0.7
Northern Hardwood and Conifer	0.5	1.4	4.7	20.4	28.6	18.8	23.9	0.3	0.7
Northern Peatland	0.6	0.7	1.3	9.7	45.9	11.8	25.0	0.5	4.3
Northern Swamp	1.0	2.4	5.6	17.5	27.1	16.1	28.2	0.2	1.2
Wet Meadow/Shrub Marsh	0.9	1.4	3.2	15.2	34.4	19.4	23.4	0.1	1.0

[1] Private and State land designations as defined by the Adirondack Park Agency Act (New York State Executive Law, Article 27) and the Adirondack Park State Land Master Plan (Adirondack Park Agency 1987). Some proportions do not total 100% as minor land use categories (e.g., Pending Classification, Intensive Use) are not shown. Agriculture and Developed macrogroups are also not shown.

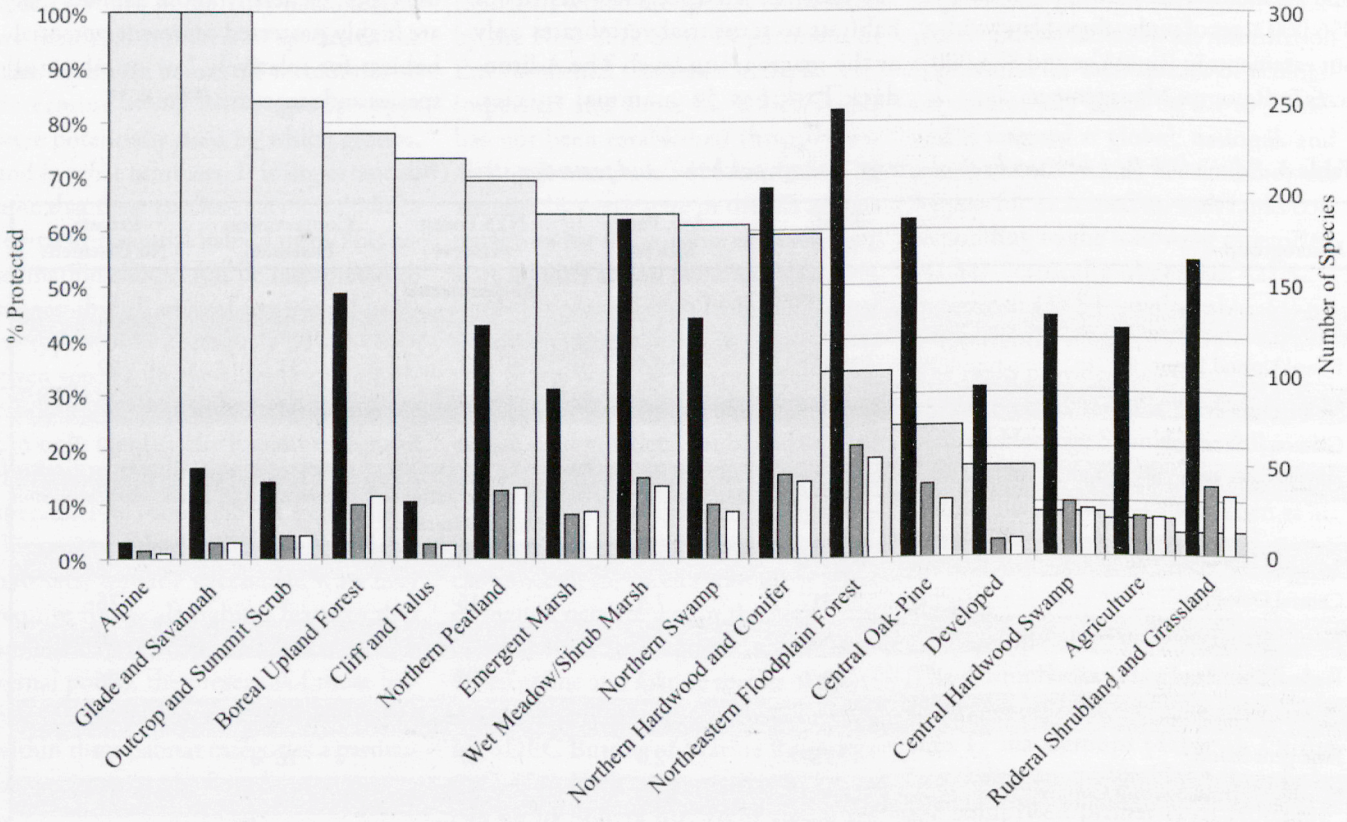

Figure 1. *Macrogroups by proportion protected (NYS Forest Preserve or Conservation Easement; wide gray bars) and total numbers of vertebrates (black), Species of Greatest Conservation Need (dark gray), and imperiled or vulnerable species (NatureServe Rank S1, S2, or S3; white) for which they are potential habitat.*

Discussion

The primary goals of this research were to determine the distribution of habitat types within the Adirondacks relative to land ownership, and what the distribution of those habitat types means for vertebrates. We have demonstrated that the public and private lands in the Adirondacks are not functionally equivalent and that it cannot be assumed that adequate habitat is available for all species entirely on state-owned lands. There are several habitat types that we found to be disproportionately distributed on state lands, and some disproportionately distributed on private lands. From a habitat perspective, the public and private lands in the Adirondacks are not necessarily protecting the same features.

We group the habitat types into a few broad categories for the purposes of considering their distribution, protection status, and the species for whom they may be critical. We also discuss potential threats and suggest opportunities for mitigating them. We place them into 6 major categories including: rocky habitats, boreal habitats, swamp habitats, rare woodland habitats, human-maintained habitats, and matrix habitat.

Rocky habitats of the Adirondacks comprise a number of specific types including alpine, cliff and talus, outcrop and summit scrub, and glade and savannah. These habitats are a small percentage of our overall landscape (< 1%), of small average patch size (2–7 acres), and well represented on state and easement lands. These habitats comprise some very rare ecological communities including the alpine zone of the Adirondacks, known to harbor some of the rarest plants in the state (Slack and Bell 2007), and mountaintop areas that are the homes of icons such as the Bicknell's thrush (*Catharus bicknelli*). Peregrine falcon (*Falco peregrinus*), raven (*Corvus corax*), and several other bird and mammal species are known to use these habitats, but very few reside there. They are unique places but habitat for a relative few among the vertebrates. Recreation in montane environments has the potential to impact strongly these fragile communities. Continued support for Summit Stewards and Forest Rangers, coupled with education of visitors and users of the Park will help to protect them.

Boreal habitats in the Adirondacks are found primarily in 2 macrogroups: Northern Peatland and Boreal Upland Forest. These are also a small percentage of the Adirondack landscape (1–11%) and of intermediate patch size (10–20 acres), but fairly well represented on state and easement lands. These types are critical because they provide habitat for 40–60% of the species of conservation concern and habitat for most of the *responsibility* species in the Adirondacks. Responsibility species are those species found nowhere else in the state and hence, species for which their future in NY depends on what occurs in the Adirondack Park. These habitats are likely to be highly threatened by climate change because they are decidedly northern, adapted to cool, wet summers and cold winters, nutrient poor, and maintained in some places by northern processes like ice buildup on river shores (Jenkins 2010). The icons of this habitat include most of the species that untold numbers of birders travel to the Adirondacks expressly in search of—spruce grouse (*Falcipennis canadensis*), gray jay (*Perisoreus canadensis*), rusty blackbird (*Euphagus carolinus*), olive-sided flycatcher (*Contopus cooperi*)—as well as northern mammals like moose (*Alces alces*) and marten (*Martes americana*). Naturally patchy and fragmented, these boreal habitats are intermixed with more temperate forest types and scattered throughout the Adirondack landscape. Many of our large and spectacular boreal wetland complexes are represented on state and easement lands, but the interaction of small and large patches throughout the boreal regions of the Adirondacks has been shown to be critical to the maintenance of avian communities in these habitats (Glennon 2014). Buffering the smaller, more isolated habitats from potential negative impacts will help to provide protection for the connective tissue that makes the boreal landscape function.

From a habitat perspective, the public and private lands in the Adirondacks are not necessarily protecting the same features.

Swamp habitats in the Adirondacks include Emergent Marsh, Wet Meadow/Shrub Marsh, and Northern Swamp. Like most habitats, they are small in patch size (2–6 acres) and a tiny component of the overall acreage of the Park (1–10%). These habitats fall into an intermediate category in terms of protection, with roughly equal amounts on state and private lands. They are potential habitat for 30–60% of SGCN in NY and are homes for well-known Adirondackers like the great blue heron (*Ardea herodias*), snapping turtle (*Chelydra serpentina*), green frog (*Lithobates clamitans*), and the mink (*Neovison vison*). Adirondack children know them as the best places to explore by canoe, good for trying to reach lily pads and the frogs upon them, or for counting painted turtles lined up precariously on a log. They are probably threatened most not by the activities that occur within them, but those that occur adjacent to them. Roads next to marshes will inevitably be places where turtles and frogs must risk their lives to get to adjacent upland habitats that they need. Run-off from adjacent land use including transportation, residential development, and agriculture, can potentially have severe negative impacts in these places (Mitsch and Gosselink 1986). Buffering them as much as possible from these impacts, both through land use planning and through careful stewardship, will be beneficial.

The Adirondack Park contains a handful of rare woodland habitats of which most humans are probably

unaware and which are very small and exist primarily on the fringes of the Park. These include Central Hardwood Swamp, Central Oak-Pine, and Northeastern Floodplain Forest communities and they occur primarily in the eastern and southeastern regions of the Adirondacks. They are also very disproportionately represented on private land. They are <1% of the landscape and exist in very small patches (2–7 acres), making any sort of land protection strategy for them highly challenging. They are, at the same time, of critical importance to wildlife. Floodplain forests, in particular, are used as habitat by enormous numbers of species and provide critical corridors for dispersal and migration (Mitsch and Gosselink 1986). Oak communities, similarly, provide a vital food source for many species because of the tremendous nutrients provided by acorns (McShea and Healy 2002). Kingfisher (*Megaceryle alcyon*), wood duck (*Aix sponsa*), painted turtle (*Chrysemys picta*), spring peeper (*Pseudacris crucifer*), spotted salamander (*Ambystoma maculatum*), Northern flying squirrel (*Glaucomys sabrinus*), black bear (*Ursus americanus*), river otter (*Lontra canadensis*), little brown bat (*Myotis lucifugus*)—these are just a few of the species that might be found in some of these habitat types. Greater protection for the wildlife value of these habitats may be possible most simply just by increasing the general awareness of their existence and paying particular attention to them in any small or large-scale planning efforts. Protection of small patches of oak-pine or central hardwood swamp may be possible through careful planning but will absolutely require the attention of private landowners. Northeastern Floodplain Forest, in particular, is a habitat we should pay attention to and in which we should strive to prevent degradation.

There are several human-maintained habitats in the Adirondacks that provide homes for species we would otherwise probably not have, or not have in the abundance that we now do. These include Agriculture, Developed lands, and Ruderal Shrubland and Grassland. Like all other habitats previously mentioned, they are small in acreage relative to the Park (1–2% of landscape) and small in patch size (2–7 acres). They are primarily in private ownership. These habitats are used by significant numbers of SGCN, especially Ruderal Shrubland and Grassland—an important habitat for several species of birds in particular. They exist specifically because of human maintenance and would not support the species that they do if not maintained. As such, protection via state acquisition would be nonsensical. If, however, we wish to keep the species for which these habitats provide a home, striving to minimize the negative impacts of our activities in these places will be vitally important. We know from past work in the Adirondacks that human infrastructure and associated activities change wildlife communities in multiple ways (Glennon and Porter 2005, Glennon and Porter 2007, Glennon and Kretser 2013, Glennon et al. 2014). Certain sensitive species like forest interior birds will probably not make extensive use of these habitats. More generalist and cosmopolitan species will thrive within them and in most places. There is a third group, however, for which these habitats are probably the places we are most likely to find them in the Park. In these places there is a subtle balance between providing homes for these species, but protecting them from other species we also tend to bring along. Humans may unwittingly create ecological traps for these animals, particularly birds, by attracting them to otherwise uncommon nesting or feeding habitats while simultaneously increasing their vulnerability to potential predators like raccoons (*Procyon lotor*), blue jays (*Cyanocitta cristata*), and domestic cats (*Felis catus*). For these species—brown thrasher (*Toxostoma rufum*), indigo bunting (*Passerina cyanea*), meadow vole (*Microtus pennsylvanicus*), prairie warbler (*Setophaga discolor*), for example—maintaining their habitats and minimizing negative impacts from disturbance, competition, and predation will be critical.

Last in the habitat types of the Adirondacks is our matrix—Northern Hardwood and Conifer Forest. The majority of the Adirondack landscape (68%) consists of forest types which are contained within the Northern Hardwood and Conifer macrogroup. This habitat is large and extensive, dwarfing all others and representing the basic fabric of the Park. The average patch size is large (84 acres) and these forests are very well represented on both public and private lands. Because most of the Adirondacks are of this type, most Adirondack vertebrates will find a home here, including approximately 60% of New York's SGCN. This is the primary habitat type in which all other habitats are embedded and home for numerous northern forest species including moose, white-tailed deer (*Odocoileus virginianus*), black bear, fisher (*Martes pennanti*), snowshoe hare (*Lepus americanus*), small-footed bat (*Myotis leibii*), grey fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), red-backed vole (*Myodes gapperi*), porcupine (*Erethizon dorsatum*), American toad (*Anaxyrus americanus*), black-throated blue warbler (*Setophaga caerulescens*), Eastern screech owl (*Megascops asio*), hermit thrush (*Catharus guttatus*), sharp-shinned hawk (*Accipiter striatus*), winter wren (*Troglodytes hiemalis*), and yellow-bellied sapsucker (*Sphyrapicus varius*). Matrix communities form extensive cover, encompassing hundreds to millions of acres and a variety of successional stages. They exist under a broad range of environmental conditions, are driven by regional-scale processes, and are critical habitat for wide-ranging fauna (Anderson et al. 1999). Fragmentation, rather than habitat loss, is considered to be the principle threat to most species in these and other matrix forests in the temperate zone (Wilcove et al. 1986). Efforts to prevent further fragmentation of this habitat will help to protect the vast array of diversity

therein. Conservation design in the context of new development is one of the most powerful ways we can do this (Arendt 1996, Reed et al. 2014).

Examination of Adirondack habitats in terms of their acreage, distribution, protection status, and importance for vertebrates yields several conclusions. First, and perhaps most importantly, the public and private lands in the Adirondacks do not protect the same features. As far as terrestrial vertebrates are concerned, they are not on equal footing and not acceptable in a 1:1 swap. Some habitat types—Northern Hardwood and Conifer, Northern Peatland, Northern Swamp, Wet Meadow/Shrub Marsh, Emergent Marsh—are well-represented on state and private lands. Several, however, are represented very disproportionately on state lands—e.g., Alpine, Cliff and Talus, Boreal Upland Forest—and others found in much higher proportions on private lands without easements—e.g., Central Hardwood Swamp, Central Oak-Pine, Northeastern Floodplain Forest. There is a large diversity of habitat types within this Park and those found on both public and private lands are used by our vertebrates.

Second, private lands are critical to our Adirondack biodiversity. In general, larger numbers of vertebrates make use of habitats that are found more prevalently on private land than those on public land. If we are to maintain the species associated with communities such as Central Hardwood Swamp and Northeastern Floodplain forest, private lands must be taken into account. These patterns are evident at larger scales also. As Knight (1999) highlighted, nearly half of all species threatened with extinction occur on private lands, and nearly all threatened species have at least part of their distribution on private lands. The diversity of land use and management activities in the Adirondacks, combined with the patchwork pattern of ownerships in which these activities occur have created a landscape of great biological diversity and global ecological significance. The private lands are very much a part of what makes the whole and must be considered carefully in long-range planning for protection of biodiversity.

Last, we must circle back to our original question and ask, do we have enough? In the context of our vertebrate diversity, for some species we may, while for some we probably do not. For several reasons, however, we suggest that perhaps it is time for a new question. Protection in the sense that we have used it here connotes only legal protection, and not necessarily functional protection. Our state lands are visited by millions each year and human recreation is known to have a multitude of impacts on wildlife (Leung and Marion 2000). Contrastingly, private ownership does not necessarily convey a lack of protection. We do not know the activities occurring on all of the lands in which they are found, nor do we know the extent to which landowners are aware of them. Lands in some single-family ownerships are probably subject to far less recreational pressure than some of our Forest Preserve lands. It is difficult, therefore, to assume that state acquisitions and easements nudge us in one direction or another towards "enough" from an ecological standpoint. Moreover, we have demonstrated that significant numbers of vertebrates in the Adirondacks make use of habitats that are created and maintained by humans, habitats whose characteristics could not be maintained if placed in state ownership. Similarly, several of our natural and critically important habitat types (e.g., Northeastern Floodplain Forest, Central Oak-Pine) exist primarily on the fringes of the park in patches of handfuls of acres. Their distribution and patch size will make land protection a challenging strategy for safeguarding them. Last but far from least is the issue of climate change, whose potential impacts on the Adirondacks outweigh any of the threats we have discussed. It has and will continue to result in range shifts, phenological advances and mismatches, extinctions, rearrangements and the creation of no-analog communities (Parmesan 2006, Williams and Jackson 2007). Maintaining Adirondack biodiversity in a climate change world will require strategies we've not yet conceived of and make it even harder to ask—and answer—how much is enough. Instead, we suggest a new question, and that is: How can we be good stewards of the critical habitat resources on *both* public and private lands in the park? These are resources we know will be needed by future inhabitants of the Park, both human and wild.

Literature Cited

Anderson, M., M. Clark, C.E. Ferree, A. Jospe, A. Olivero Sheldon, and K.J. Weaver. 2013. Northeast Habitat Guides: A companion to the terrestrial and aquatic habitat maps. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/HabitatGuide.

Anderson, M., P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reid, R. Schneider, B. Vickery, and A. Weakley. 1999. Guidelines for representing ecological communities in ecoregional conservation plans. The Nature Conservancy. 74pp.

Arendt, R. 1996. Conservation design for subdivisions: A practical guide to creating open space networks. Island Press. 160pp.

Beamish, D. 2010. That old broken record. Editorial, Adirondack Explorer. Available at: http://www.adirondackexplorer.org/editorials/that-old-broken-record.

Faber-Langendoen, D., T. Keeler-Wolf, D. Meidinger, C. Josse, A. Weakley, D. Tart, G. Navarro, B. Hoagland, S. Ponomarenko, J.P. Saucier, G. Fults, and E. Helmer. 2012. Classification and description of world formation types. Part I (Introduction) and Part II (Description of formation types). Hierarchy Revisions Working Group, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey, Reston, VA, and NatureServe, Arlington, VA.

Federal Geographic Data Committee. Vegetation subcommittee. 2008. National Vegetation Classification Standard, Version 2. FGDC-STD-005-2008 (Version 2). Available at: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/

Ferree, C., and M.G. Anderson. 2013. A map of terrestrial habitats of the Northeastern United States: Methods and Approach. The

Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Glennon, M.J. 2014. Dynamics of boreal birds at the edge of their range in the Adirondack Park, NY. Northeastern Naturalist 21(1): NENHC-51-NENHC-71.

Glennon, M.J., and H.E. Kretser. 2013. Size of the ecological effect zone associated with exurban development in the Adirondack Park, NY. Landscape and Urban Planning 112:10–17.

Glennon, M.J., H.E. Kretser, and J.A. Hilty. 2014. Identifying common patterns in diverse systems: Effects of exurban development on birds of the Adirondack Park and the Greater Yellowstone Ecosystem, USA. Environmental Management, published online 25 November 2014. DOI 10.1007/s00267-014-040509.

Glennon, M.J., and W.F. Porter. 2005. Effects of land use management on biotic integrity: an investigation of bird communities. Biological Conservation 126:499–511.

Glennon, M.J., and W.F. Porter. 2007. Impacts of land-use management on small mammals in the Adirondack Park, New York. Northeastern Naturalist 14(3):323–342.

Homer, C.H., J.A. Fry, and C.A. Barnes. 2012. The National Land Cover Database, U.S. Geological Survey Fact Sheet 2012-3020, 4pp.

Jenkins, J. 2010. Climate change in the Adirondacks: the path to sustainability. Comstock Publishing Associates, Cornell University Press, Ithaca, NY. 183pp.

Knight, R.L. 1999. Private lands: the neglected geography. Conservation Biology 13(2):223–224.

Leung, Y.F., and J.L. Marion. 2000. Recreation impacts and management in wilderness: A state-of-knowledge review. USDA Forest Service Proceedings RMRS-P-15-Vol. 5.

Martineau, K. 2012. What makes this a park? The Adirondack Almanac, December 26, 2012. Available at: http://www.adirondackalmanack.com/2012/12/adirondack-development-what-makes-this-a-park.html.

McGowan, K.J., and K. Corwin. 2008. The Second Atlas of Breeding Birds in New York State. Comstock Publishing Associates, Cornell University Press, Ithaca, NY. 688pp.

McShea, W. J., and Healy, W. H. 2002. Oak Forest Ecosystems: Ecology and Management for Wildlife. John Hopkins University Press, Baltimore, MD.

Mitsch, W.J., and J. G. Gosselink. 1986. Wetlands. Van Nostrand Reinhold, New York, NY. 539pp.

Nelson, P. 2012. How Much Wilderness is Enough? The Adirondack Almanac, October 6, 2012. Available at: http://www.adirondackalmanack.com/2012/10/lost-brook-dispatches-how-much-wilderness-is-enough.html.

Parmesan, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology and Systematics 37:637–669.

Porter, W.F., J.D. Erickson, and R. Whaley, Eds. 2009. The Great Experiment in Conservation: Voices from the Adirondack Park. Syracuse University Press, Syracuse, NY. 606pp.

Reed, S.E., J.A. Hilty, and D.M. Theobald. 2014. Guidelines and incentives for conservation development in local land-use regulations. Conservation Biology 28:258–268.

Saunders, D.A. 1988. Adirondack Mammals. State University of New York, College of Environmental Science and Forestry, Syracuse, NY. 216pp.

Saunders, D.A. 1989. Adirondack Amphibians and Reptiles. Adirondack Ecological Center Special Report No. 31, 8pp.

Schneider, P. 1998. The Adirondacks: A History of America's First Wilderness. Henry Holt and Company, New York, NY. 384pp.

Slack, N.G., and A.W. Bell. 2007. Adirondack Alpine Summits: An Ecological Field Guide. Adirondack Mountain Club, Lake George, NY. 80pp.

Terrie, P. 1997. Contested Terrain: A New History of Nature and People in the Adirondacks. Syracuse University Press, Syracuse, NY. 256pp.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pages 237–256 in M. Soulé, Ed., Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, MA. 584pp.

Williams, J.W., and S.T. Jackson. 2007. Novel climates, no-analog communities, and ecological surprises. Frontiers in Ecology and the Environment 5(9):475–482.

KEN RIMANY

Autumn at Jenny Lake