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An Assessment of the Biodiversity of New Hampshire with Recommendations for Conservation Action

Scientific Advisory Group
New Hampshire Ecological Reserve System Project

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On the cover: the state-endangered showy lady-slipper orchid (*Cypripedium reginae*).
Photograph by Mike Stevens.

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Executive Summary

Introduction

New Hampshire is home to more than 15,000 species of plants and animals, 100 types of natural communities, and ecosystems as diverse as the Great Bay estuary, the spruce-fir forests of the North Country, the summits of the White Mountains , and the floodplains of the Merrimack and Connecticut Rivers. This rich biological diversity, which includes not only plants and animals but also the habitats and ecological processes that sustain them, is a living legacy that helps keep our air clean, our water pure, our economy strong, and our quality of life high. The biodiversity of New Hampshire, however, is vulnerable to ongoing development and degradation. As we enter the next century, we have a remarkable opportunity to safeguard the species and places that form the ecological fabric of the Granite State.

The New Hampshire Ecological Reserve System Project is a statewide partnership of state natural resource agencies, private conservation organizations, scientists, land managers, landowners, and forest products industry representatives that was formed to address the opportunities for biodiversity conservation in the state. Established by the N.H. Division of Forest and Lands and the N.H. Fish and Game Department, the project functions under the guidance of a 27-person Steering Committee.

As a first step towards fulfilling its mission, the Steering Committee convened a Scientific Advisory Group to 1) assess the current status of biodiversity in New Hampshire at the species, natural community, and landscape levels; 2) examine how well the current system of conservation lands protects the state's biological diversity; and 3) define the scientific principles for design of a system of ecological reserves.

In order to evaluate biodiversity from a variety of perspectives, the Scientific Advisory Group selected the following measures, or indicators, of the status of biodiversity: rare plant species, rare or vulnerable animal species, natural communities (including both rare and common types), subwatersheds with concentrations of unusual physical or geologic characteristics, and core forest areas (a measure of unfragmented forested blocks). In order to assess the effectiveness of current conservation lands, the Scientific Advisory Group determined whether selected features occurred on or off existing conservation lands; the analysis did not include assessments of current management practices or the benefits to biodiversity of sound management on private lands that are not formally protected. Data on subdivision and terrain alteration permits were used to assess the vulnerability of biodiversity across the state.

The analyses conducted by the Scientific Advisory Group are based on existing databases housed at the New Hampshire Natural Heritage Inventory and the Fish and Game Department. It is important to note that these databases are by no means complete and do not represent a comprehensive sampling of the state's biodiversity. Many portions of the state have never been systematically surveyed, and may therefore erroneously appear to have no occurrences of rare species or natural communities. The Scientific Advisory Group, however, strongly believes that the data do reflect real trends in the status of biodiversity and the effectiveness of the current system of conservation lands.

Findings

The biodiversity of New Hampshire is threatened at the species, natural community, and ecosystem level. For example:

- New Hampshire has lost biodiversity at the species, natural community, and ecosystem level. 11 species of animals and 13 species of plants have been extirpated from the state. Of four pine barrens that were originally found in the state, essentially only one remains. Despite extensive reforestation since the 1800s, there is a lack of undisturbed habitats including grasslands, waterbodies and riparian corridors, and mature forest types such as northern hardwoods, oak-pine, and spruce-fir.

- There are 22 plant species, 30 animal species, and 25 natural community types in New Hampshire that are considered globally rare or imperiled.

- We know of exemplary occurrences for fewer than 50% of the natural communities in the state.

- New Hampshire is losing roughly 10,000 acres of open space to development each year.

The intensity and nature of threat varies widely across the state and for different features of biodiversity, with some features relatively secure and others severely and immediately imperiled. Reflecting a pattern common throughout the United States, many of the areas in New Hampshire that contain the greatest concentrations of rare species and natural communities are also the most vulnerable to development and habitat alteration.

Though conservation lands comprise approximately 20% of the land area in New Hampshire, the current system of conservation lands in New Hampshire does not appear to provide comprehensive, long term protection of biodiversity at the species, natural community, or landscape levels. For example, over half of known classified rare natural communities, three-quarters of known rare plants, more than 80% of known rare vertebrate species, and over 90% of known rare invertebrate species have 2 or fewer known occurrences on conservation lands. The precise level of protection for a species or natural community does vary depending on the specific species, community, or ecoregion. *Many species, natural communities, and landscape types are known to be well represented on current conservation lands.*

Recommendations

1. Improve biodiversity conservation strategies on public lands known to harbor concentrations of rare species, natural communities, and landscape features. For many public land managers and their private partners, biodiversity conservation is already a top priority.

2. Begin process of designing and establishing an integrated and comprehensive set of reserves that incorporate principles of reserve design. These reserves would include public conservation lands and lands owned by interested and willing private landowners. Ecological criteria by which to assess the suitability of a potential reserve include:

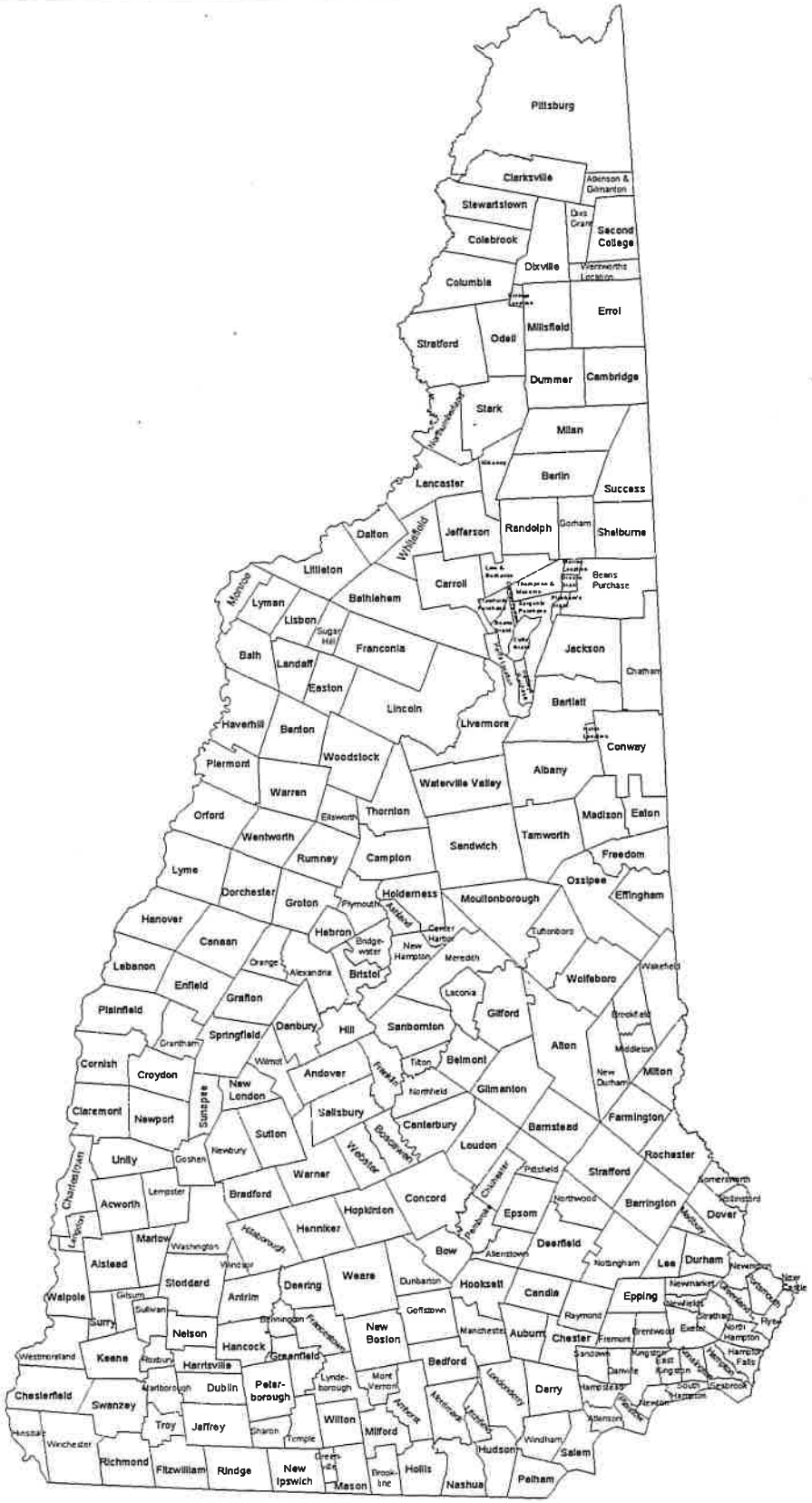
a. presence of globally-rare species and natural communities

b. concentrations of rare species and natural communities
c. areas with high physiographic or natural community diversity
d. large blocks of unfragmented core forest, especially mature forest
e. areas adjacent to existing conservation lands
f. areas that serve as connectors between existing reserves, especially riparian corridors and ridgelines
g. exemplary examples of all natural communities, including common ones, as well as matrix communities
h. exemplary occurrences of disjunct, regionally-centered, or limited species and natural communities.
i. critical wildlife habitats

3. Expand upon current education and training programs for landowners, planners, and natural resource managers by developing on-the-ground understanding of the importance of bioidversity and the strategies needed to protect it.

While the above recommendations are essential to safeguarding the state's biodiversity, we should keep in mind that ecological reserves are just one component of an overall strategy of natural resource and land management. Equally important are existing initiatives and programs to support and encourage good management of, for example, commercial timberlands, wildlife populations, and watersheds.

Figure 1. Municipalities of New Hampshire.



Data Sources:

Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Map generated for the New Hampshire Ecological Reserve System Project, 1998

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Introduction

Biological diversity, or biodiversity as it is commonly called, is a term for the variety of life in all its forms, as well as the processes that maintain it[1]. We often think of biodiversity in terms of individual species, ranging from the rare (peregrine falcon, lynx, Karner blue butterfly, and Robbins' cinquefoil) to the common (American robin, black flies, white-tailed deer, and sugar maple).

The idea of biodiversity, however, includes the places and interactions, such as food chains, flooding, and pollination, that sustain those species. Therefore, scientists also recognize the natural community and landscape, or ecosystem, levels of biodiversity. A natural community is a group of species (plants, animals, bacteria, fungi) that occur together in a particular type of place. Spruce-fir forests and coastal sand dunes are two examples of the 130 types of natural communities found in New Hampshire. The landscape level of biodiversity is used to describe the variety of communities within a larger region. The landscape of New Hampshire can be divided into three broad ecological regions: the White Mountain ecoregion, the Southern New England Coastal Hills and Plain ecoregion, and the New Hampshire-Vermont Uplands region. While the three ecoregions share many of the same species and natural communities, anyone familiar with New Hampshire can think of differences in topography and character between the ecoregions.

Protecting biodiversity requires us to consider all three levels (species, natural community, and landscape) of biodiversity. For example, bald eagles need specific foods (fish) and they also need big white pine trees where they can perch and build their nests. If bald eagles are to thrive, however, they need more than fish and big pines. They also need places or ecosystems that include rivers or lakes with healthy fish populations in areas where the eagles will be buffered from excessive human disturbance.

While the idea of biodiversity may at first seem quite complex, it is simple to show how much we as people depend on biodiversity for economic prosperity, health, and a high quality of life. Here are some of the reasons biodiversity is important:

- We directly depend on biodiversity to perform services and provide raw materials: plants that purify the water we drink and the air we breathe, trees we use for construction materials and paper, insects that pollinate fruit and vegetable crops and eat pests, and bacteria that enrich our soils. Basic ecosystem services are the foundation of our economy and many are provided essentially free of charge.
- Biodiversity is the source of much of modern medicine: for example, aspirin comes from a willow tree and penicillin from a common fruit mold.
- The species and landscapes that are part of New Hampshire's biodiversity attract millions of people who come to hike, hunt, take photographs, ski, and study nature, spending millions of dollars in New Hampshire's local communities in the process. The diversity and beauty of the natural world is part of what makes people proud to live in New Hampshire.

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[1] For a comprehensive overview of New Hampshire's biodiversity, please read *New Hampshire's Living Legacy: The Biodiversity of the Granite State*, available from the N.H. Department of Fish and Game (271-2462).

- One of the strongest arguments for protecting biodiversity, other than the fact that our economy and quality of life depend on it, is that it represents a living legacy that we have inherited and which we will pass on to our children. Many people believe we have an ethical obligation to our children to be good stewards of our ecological inheritance.

Historical background of the Ecological Reserves System project

In September 1994, the Northern Forest Lands Council submitted to the Governors of New Hampshire, Maine, Vermont, and New York its report *Finding Common Ground*, which outlined the Council's recommendations for reinforcing the traditional patterns of land ownership and uses of large forest areas in the Northern Forest. The Northern Forest Lands Council consisted of representatives of local communities, the forest products industry, environmental organizations, and state land and resource management agencies. The Council's recommendations reflected six years of research and public input, the comments of over 1,500 citizens, and were rooted in and advanced a broadly shared vision of the region.

As part of its findings, the Council highlighted the importance of biodiversity conservation:

> *The Council believes that maintaining the region's biodiversity is important in and of itself, but also as a component of stable forest-related economies, forest health, land stewardship, and public understanding.*

To that end, the Council recommended that states "develop a process to conserve and enhance biodiversity across the landscape." The Council provided guidelines for this process, including:

> *(a) Assess the status of biodiversity in each state and the extent to which it is protected under the current system of public and private land conservation;*
>
> *(b) Provide landowners with information about how to conserve biodiversity on their land through both forest management practices and establishment of ecological reserves;*
>
> *(c) Provide financial incentives to landowners for measures taken to conserve and enhance biodiversity; and*
>
> *(d) Use scientific assessment and analysis to create a system of ecological reserves.*

The Council further recommended that areas to be included in an ecological reserve system should be selected according to certain ecological criteria; that selection must be according to the state's open space planning and acquisition plans; that before new ecological reserves are established, the extent of ecological values already protected on public lands and private conservation lands be assessed; and that the state conservation agencies take the lead in carrying out these actions.

In late 1995, as a direct response to the recommendations of the Northern Forest Lands Council, the New Hampshire State Forester, who directs the Division of Forests and Lands, and the Director of the New Hampshire Department of Fish and Game established the Ecological Reserves System Project and appointed a 27-person Steering Committee. The Steering Committee, comprised of representatives of a broad range of interests, was charged with

coordinating all aspects of an Ecological Reserve System planning process that would include all of New Hampshire, not just the Northern Forest portion of the state. The Steering Committee's mission is to:

- *Assess the status of biodiversity in New Hampshire and the extent to which it is protected under the current system of public and private conservation lands.*
- *Provide a science-based blueprint for selection, design, establishment and management of a system of ecological reserves whose primary aim is biodiversity conservation.*
- *Assure a broad range of interests is represented and involved in the planning process through a series of public education and comment sessions.*
- *Disseminate the findings of the NH Scientific Committee on Biodiversity through existing education systems and the development of new outreach programs.*
- *Develop a proposal for presentation to the state legislature and the people of New Hampshire for voluntary designation and funding of ecological reserves.*

The Steering Committee was also charged with avoiding duplication of previous efforts to assess and conserve the natural resources of New Hampshire.[2]

III. Definition and goals of an ecological reserve system

The Committee began its work by drafting a definition of the goals for the Ecological Reserve System:

- *Perpetuate all elements of native biodiversity at all levels - genetic, species, community, and ecosystem - including different stages of succession.*
- *Maintain ecological and evolutionary processes at their natural frequency and spatial scale.*
- *Provide comprehensive representation of physical elements.*
- *Educate people about the benefits of biodiversity conservation*

[2] Please read Appendix I for a listing of important references that complement this report.

Based on these goals, the Steering Committee defined an ecological reserves system in the following way:

> *An ecological reserve system is a collection of lands managed and monitored to protect biodiversity in all its forms. Ecological reserves within the system will vary in size, location, ownership, and protection strategy. The system will be a mix of large and small parcels, some privately owned, others owned by private conservation organizations, and others publicly owned. Private lands will become part of the system only through voluntary landowners.*

An individual ecological reserve is defined by the Steering Committee as an area of land or water that contributes to one or more of the following system goals:

- *sustain or restore certain species, natural communities, physical elements, or ecological processes that are necessary to maintain native biodiversity.*

- *provide areas that serve as benchmarks to assess the impacts of human activities and natural global changes, and to demonstrate the benefits of having healthy and functioning ecosystems.*

- *contribute to the functioning of adjacent ecological reserves.*

Ecological reserves would also provide the people of New Hampshire the opportunity to experience and learn from representative examples of the state's natural ecosystems.

IV. Conducting a biodiversity assessment for New Hampshire

As written above, the first two parts of the Steering Committee's mission are to:

- Assess the status of biodiversity in New Hampshire and the extent to which it is protected under the current system of public and private conservation lands.

- Provide a science-based blueprint for selection, design, establishment and management of a system of ecological reserves whose primary aim is biodiversity conservation.

In early 1996, the Steering Committee commissioned a Scientific Advisory Group (SAG) to conduct the biodiversity assessment, evaluate the current system of conservation lands, and outline the scientific principles that should be incorporated into a blueprint for an ecological reserve system.

Scientific Principles for Design of an Ecological Reserve System

I. Introduction

The Scientific Advisory Group was charged with developing a list of scientifically defensible principles of reserve design (site selection and site design). These principles are used throughout this report to evaluate the effectiveness of the current system of publicly and privately protected conservation lands and to recommend selection and design criteria for new reserves.

A. Definitions

(1) Ecological Reserve System: A complex of areas in a variety of sizes, locations, ownerships and protection, appropriately managed and actively monitored to accomplish the following goals: (a) maintain ecological processes at their natural frequency and spatial scale; (b) perpetuate all elements of native biodiversity at all levels -- genetic, species, community, and ecosystem -- including different stages of succession; (c.) provide comprehensive representation of physical elements; (d) educate people about the benefits of biodiversity conservation.

(2) Ecological Reserve: An area of land and/or water that contributes to one or more of the following goals: (a) sustain or restore certain species, natural communities, physical elements or ecological processes that are necessary to maintain native biodiversity; (b) provide areas that serve as benchmarks to assess the impacts of human activities and natural global changes, and to demonstrate the benefits of having healthy and functioning ecosystems; (c) contribute to the functioning of adjacent ecological reserves.

(3) Principle: An empirical observation or scientific theory drawn from the scientific literature.

(4) Criterion: A specific attribute, based on one or more principles, that is used to evaluate the appropriateness of an area for inclusion in an ecological reserve system.

(5) Site Selection: The process of using criteria to evaluate areas for inclusion in an ecological reserve system.

(6) Site Design: The process of identifying the area and management practices necessary to meet the ecological requirements of the target species or natural communities on the site.

B. Specific assumptions behind the principles

The principles presented below assume that the primary goal of ecological reserves is to protect biological diversity at the gene, species and community levels and to maintain ecological processes at their natural frequency and spatial scale. Thus, such systems and their component reserves are intended to do one of the following:

(1) protect functional examples of rare biological elements (communities, species, genetic forms) and the physical surroundings and ecological processes that maintain them.

(2) protect multiple, functional, and representative examples of different widespread communities and the physical habitats and ecological processes that maintain them.

(3) protect areas with high biodiversity at the community, species or genetic level, and the physical habitats and ecological processes that maintain this diversity.

II. Principles of reserve site selection

A. Spatial variation in the physical environment

Reserves that include a great variety of physical environments (dry upland and wetland areas, different types of bedrock, north and south facing slopes) protect more biodiversity than reserves that are physically homogeneous, as the resource and habitat requirements of more species can be met. Physically diverse areas are especially important for species that require different habitats during different life stages, such as many amphibians.

B. Relation to adjacent lands

(1) Protection of biodiversity is enhanced when a reserve is surrounded by a "buffer zone." Buffer zones are areas adjacent to ecological reserves in which some of the human activities that may be excluded from reserves (i.e., resource extraction) may take place, but where extensive development is prohibited. Buffer zones reduce human impact on the reserve and increase the effective area of the reserve. They do so by (a) reducing negative effects that occur at the reserve edge and (b) providing additional habitat for at least some of the species the reserve protects, thus increasing population sizes and reducing the likelihood of extinction.

(2) Insularization of reserves (separation from nearby habitats of a similar nature) reduces rates of migration to and from reserves. The extent of insularization is influenced by social and economic conditions on adjacent lands, and future insularization of a reserve may be indicated by zoning status and development plans for adjacent lands.

C. Regional processes

(1) A reserve's biodiversity is influenced by cyclic or stochastic local and regional processes such as flooding, fire, drought, and climate change. Many of these processes are essential for maintaining viable populations of certain species as they permit colonization and establishment of new individuals. Community and ecosystem properties (e.g., competitive interactions, nutrient cycling) also respond to these processes. Consequently, reserves that continue to experience these local and regional processes will continue to support particular species, genetic forms, and communities more effectively than other reserves.

(2) Local and regional processes may be affected by human activities in the region and thus the viability of reserves may be affected. For example, if an area requires flooding to maintain a certain community, but a planned impoundment will eliminate such flooding in the future, the area's use as a floodplain reserve may be limited.

D. Current ecological condition

(1) Ecological content: The presence of rare or representative species or natural communities may indicate special or representative physical site conditions that will continue to give rise to regional biodiversity indefinitely, even when the species and communities that currently inhabit the site are no longer present.

(2) Potential for restoration: While sites may not include particular species or communities at the present time, physical and biological conditions at the site may have the potential to support and sustain such species and communities in the future.

III. Principles of Individual Reserve Design

A. Size

(1) A single large reserve protects more biodiversity than a single small reserve, all else being equal.

There are many reasons for this pattern:

(a) A large reserve can support more individual organisms than a small reserve, thus there is a greater chance of finding more species in a large reserve.

(b) In a large reserve, each species has more individuals than it would in a small reserve. As large populations are less prone to extinction than small populations, equilibrial numbers of species will be higher in areas where population sizes are larger.

(c) A large reserve is more likely to be encountered by dispersing organisms than is a small reserve, for it is a larger "target" than a small reserve. Thus, the immigration rate of new species is higher.

(d) A large reserve includes a greater variety of physical conditions (habitats) than small reserves, thus providing conditions and resources required by a greater number of species and perhaps supporting a greater number of community types.

(e) Some species require large areas of contiguous habitat and will not persist in a small reserve. (If reserves are made large enough to protect wide-ranging species, then many other spatially less demanding species will be protected.)

(f) Compared to a small reserve, a large reserve has less edge (perimeter) per unit area. Thus, a larger proportion of a large reserve is free from edge effects. Edge effects refer to an altered state of the reserve edge caused by activities just outside the reserve. These effects may include: a different microclimate, increased levels of noise and pollution, increased effects of domestic animals, and more frequent visitation by humans.

(g) A large reserve is more likely to escape total destruction by catastrophic disturbance than is a small reserve.

(h) In a large reserve, the integrity of ecological processes such as nutrient cycling, energy flow, and predator-prey relations is more likely to be maintained than in a small reserve.

(2) A single large reserve may protect less biodiversity than a group of several small reserves whose total area equals that of the large reserve.

This will occur if:

(a) Each of the small reserves occurs in a different physical environment or different community (greater environmental heterogeneity is included within the group of small reserves than in the single large reserve).

(b) Single large reserves are potentially susceptible to severe damage from physical disturbances or biotic threats (e.g., introduced pathogens). In a group of small reserves, biodiversity persists in some reserves even if one is destroyed. "Don't put all your eggs in one basket" -- even if it is a big basket.

B. Shape

(1) Circular reserves protect more biodiversity than non-circular reserves, all else being equal. Circular reserves have less "edge" (perimeter) per unit area of reserve than elongate reserves. Thus, negative edge effects (see above) are minimized.

(2) Reserves with a non-circular shape may more effective in protecting biodiversity when any of the following are true:

(a) when a non-circular reserve includes a greater variety of physical conditions or communities than a circular reserve.

(b) when the boundary of the non-circular reserve surrounds entire watersheds or entire water bodies such that water contamination or disruption of nutrient cycling are less likely.

(c) when a non-circular reserve by virtue of its configuration may contain more of the biological and physical requirements for the species, community, or ecosystem of concern.

C. Condition / viability

Reserves in which species populations and their interactions are viable and sustainable, and in which ecosystem processes are functional and sustainable or can be mimicked by appropriate management activities, will more effectively protect biodiversity than other reserves. In many cases where a species or natural community is tightly linked to an ecological process such as fire or flooding, the presence of a functioning process is as important as the species or natural community itself. Active management may be needed as a substitute for natural processes that will not occur spontaneously given alterations of the landscape such as fire suppression, dam building, or development.

IV. Principles of reserve system design

A. Size of the reserve system

The greater the total area of the reserve system, the more biological diversity will be protected, all else being equal.

B. Distribution of reserves

(1) The greater the number of different communities represented in the system, the greater the number of species and genetic forms that will be protected.

(2) Certain species, genetic forms, and communities are more vulnerable than others. The greater the number of these elements protected in the reserve system, the greater the total amount of biodiversity protected.

(3) The greater the number of large reserves established in each type of natural community, and for each vulnerable species and genetic form, the greater the likelihood of long-term protection. A single reserve for a particular species or kind of community does not constitute sufficient protection.

(4) Locating reserves so as to maximize migration between them enhances the biodiversity in each reserve as well as in the reserve system as a whole. Immigration can be maximized by:

(a) establishing reserves in clusters.

(b) establishing reserves adjacent to or near lands managed in a way that would permit migration of native organisms (e.g., production forest land, recreational land).

C. Community scale and nesting of reserves

(1) Natural communities may be classified based on their size, extent, and landscape relationships (Anderson 1997).

(a) Matrix communities are the dominant cover types of a region and occur on the scale of hundreds to a million acres in an undeveloped landscape. They are quite variable and are driven by regional scale processes. They are important as coarse filters for wide-ranging animal species such as big herbivores, predators, and forest interior birds. Examples are beech-birch-maple forests, red spruce-balsam fir forests, and oak-pine forests (See Table 1).

(b) Large patch communities may form extensive cover in some areas but are generally associated with a single dominant local process such as hydrology or fire regime. Large patch communities often have distinct animal or plant species associated with them and may serve as resource patches within matrix communities. Examples include red maple swamps, rich northern hardwood forests, and spruce bogs.

(c) Small patch communities are the smallest type of natural community and reflect very specific local physical conditions. Although their boundaries are easy to delineate, they are inextricably linked to the landscapes in which they occur. Thus, they may not be viable over the long term without preservation of the whole system in which they are embedded. Small patch communities harbor a disproportionate number of rare animal and invertebrate species, and include types such as basin marshes and calcareous seeps.

See Table 2 for further descriptions of each community class.

The spatial distribution of each natural community type can be illustrated with an example from the Northern Forest (the Northern Forest portion of New Hampshire falls within the White Mountain Ecoregion). In the Northern Forest Region, 5% of the natural community types are matrix communities, 40% are large patch types, and 55% are small patch communities. Matrix communities, however, cover close to 75% of the remaining natural landscape, large patch types cover 20% of the landscape, and small patch types cover less than 5% of the landscape (Anderson 1997). These data include only terrestrial and freshwater wetland natural communities, and do not include aquatic natural communities.

Each of the three types of community must be conserved at the appropriate scale. Moreover, large and small patch natural community types are best protected when embedded in a reserve of matrix communities.

Table 1. Matrix and Large Patch Natural Communities of New Hampshire.	
The names in bold reflect the natural community type names used in this analysis.	
The names under each bold heading represent the corresponding types in the most current classification.	
In most cases, the current classification has split the previous community types into several types.	
Natural Community	**Patch Type**
Hemlock-spruce-northern hardwood forest	Large/Matrix
Central New England Transitional Forest on Acidic Bedrock or Till	
Hemlock-beech-northern hardwood forest	Large/Matrix
Hemlock-beech-oak-pine forest	Matrix
Northern New England High Elevation Spruce-Fir Forest	
High elevation mountain spruce-fir forest: high elevation balsam fir variant	Large/Matrix
High elevation mountain spruce-fir forest: Typic spruce-fir forest	Matrix
High elevation mountain spruce-fir forest	Matrix
Northern New England Hardwood Forest on Acidic Bedrock or Till	
Hemlock-beech-northern hardwood forest	Large/Matrix
Sugar maple-beech-yellow birch forest	Matrix
Northern hardwood-spruce-fir forest	Matrix
Southern New England Dry Central Hardwood Forest on Acidic Bedrock or Till	
Dry Appalachian oak-hickory forest	Large/Matrix
Southern New England Central Hardwood Forest on Acidic Bedrock or Till	
Mesic Appalachian oak-sugar maple-beech-hemlock forest	Large/Matrix

Table 2. Comparison of attributes for the three types of natural community occurrence patterns DRAFT - M. Anderson, ECS, 6/96/1996

	MATRIX / DOMINANT Communities which form the dominant matrix of an area. Occurrences are generally 100 to - 1 million acres	LARGE PATCH Communities which occur as large patches covering generally 20-1000 acres	SMALL PATCH Communities which typically occur as very small, 1-50 acre patches. They are often an inextricable part of a larger community mosaic
GENERAL EXAMPLES:	terrestrial forests on till, lake sediment, outwash	talus slope/cove forests, summit woodlands basin swamps & seepage forest floodplain & herbaceous marshes bogs & shrub swamps	cliff faces fens & basin marshes alpine associations & rocky outcrops tidal marsh associations riverside seeps
SPECIFIC EXAMPLES:	Spruce-fir forest N-Hardwood forest Yellow birch-spruce transitional forest	N.W.Cedar swamp Black spruce bog Krumholtz Pine/heath woodland Black spruce upland woodland Rich N-hardwood forest	Slender sedge fens Alpine meadows & acidic rocky summits Calcareous cliffs Dry upland W.Cedar forest Talus heaths Red oak summits
APPROXIMATE SIZE (ACRES)	200-1,000,000 Estimate 80% of total landscape	20-1000 Estimate 20% of total landscape	0-100 Estimate <2% of total landscape
THREAT	degradation / fragmentation	various	rarity
CONSERVATION VALUE	Biological Integrity May be common but often threatened by degradation, logging, fragmentation etc. Important as a buffer for the patch types. Important cover and structure for wide ranging fauna. Large examples probably buffer themselves.	Biological Diversity/Integrity Important centers of biodiversity within the matrix communities. Important "matrices" for the small patch types. Important sources of habitat diversity and resource patches for faunal use	Biological Diversity Important for biodiversity protection often with many locally rare species. Needs to be imbedded in an appropriate intact landscape to be viable. May have a very specific set of associated small fauna
% COMMUNITIES	approximately 5 %	approximately 40 %	approximately 55 %

CONSERVATION STRATEGY	Addressing ecoregional threats, sustainable forestry, large scale land management practices etc. EO/portfolio focus should be on large contiguous areas with ecologically /historically sound core areas (eg.old growth), and maximum embedded patch communities. A minimum dynamic area model is useful for understanding matrix dynamics	Appropriate targets for EO approach and inventory, portfolio design and reserve systems. Ideal occurrence would contain many embedded small patch communities and be well buffered by fragments of matrix types. A source/sink metapopulation model is useful construct for understanding small patch dynamics	Appropriate targets for EO based approach. Occurrences should be clustered and nested in matrix/large patch communities or at least larger landscapes. A source/sink metapopulation model is useful construct for understanding small patch dynamics
CONTIGUOUS-NESS	May remain functional in relatively manipulated landscapes, Inclusions of patch communities is typical	Should be as large and unfragmented as possible, Typically have inclusions of both matrix fragments and other large and small patch communities	Viability is dependent on surrounding landscape mosaic, Low tolerance for any internal fragmentation
HABITAT SPECIFICITY	general, climatic, reflects the dominant species	specific, typically reflects a dominant physical factor such as topographic position, hydrology or disturbance	very specific , often dependent on a variety of environmental factors interacting in a very specific way
COMPOSITION VARIABILITY	Composition is structured by competition, Dominance is high and variability is low. These types may be quite similar over wide areas	Intermediate between matrix and small patch types	Composition is structured by environmental stress which limits the dominant competitors, may serve as refugia for rare species or as be highly variable in composition. At the extreme, may be depauperate
INVENTORY, I.D. STRATEGY	Large unfragmented areas, roadless areas, historically avoided areas, RS data, overlaid with high topo/geo diversity to maximize inclusions of patch communities	EO database, heritage inventory, landscape signatures, RS data	EO data base, heritage inventory, landscape analysis

D. Corridors

(1) Natural connections between reserves may enhance biodiversity by facilitating immigration between reserves and increasing effective population sizes.

(2) New corridors between reserves or between reserves and other natural or semi-natural lands may enhance immigration of desirable species but may also permit migration of invasive species, including pathogens. The effectiveness of such corridors must be assessed through autecological study of potentially migrating species and potentially invasive species.

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Key Findings About the Biodiversity of New Hampshire

The organization of this section reflects the research methods of the Scientific Advisory Group. The Scientific Advisory Group organized sub-committees to assess biodiversity at three general levels: animal species diversity, plant species and natural community diversity, and landscape or ecosystem diversity. The fourth section is an assessment of patterns of vulnerability of biodiversity. In the summary findings and recommendation section, we have integrated the results of all four subcommittees and answered the questions originally posed by the Steering Committee.

The methods and supporting data that led to these key findings and recommendations are contained in Appendices I and II.

I. Landscape and ecosystem diversity

- New Hampshire can be divided into three broad ecological regions: the White Mountain Ecoregion, the New Hampshire-Vermont Upland Ecoregion, and the Southern New England Coastal Hills and Plain Ecoregion (See Figure 2). Each of these ecoregions possesses a distinct set of ecological features and threats to biodiversity and will benefit from different sets of conservation strategies. [3]

- 9 subwatersheds have been identified that contain aggregations of unusual landscape or geological diversity features (See Figures 3 and 8). These watersheds are clustered in the following regions: Great Bay and the Seacoast, the Lakes region, the Connecticut River, the White Mountains, and the Connecticut Lakes region.

- There are concentrations of unfragmented and undeveloped areas, referred to hereafter as core forest areas, in the southwestern part of the state, the White Mountains, and the North Country (See Figure 4). Note that the core forest areas do include wetlands.

- While the White Mountain Ecoregion contains much of the unfragmented forest in the state, the concept of core forest areas is relative to the region of the state being considered. In the Southern New England Coastal Hills and Plain Ecoregion, unfragmented lands occur at the scale of hundreds to several thousand acres. In the White Mountain Ecoregion, unfragmented lands occur at the scale of thousands to tens of thousands of acres. The New Hampshire-Vermont Upland Ecoregion contains unfragmented blocks from hundreds to roughly ten thousand acres (this figure is an approximation).

- Core forest areas do not correlate well with physiographically diverse areas. There are several exceptions, such as the White Mountains and the Connecticut Lakes region (See Figures 4 and 8).

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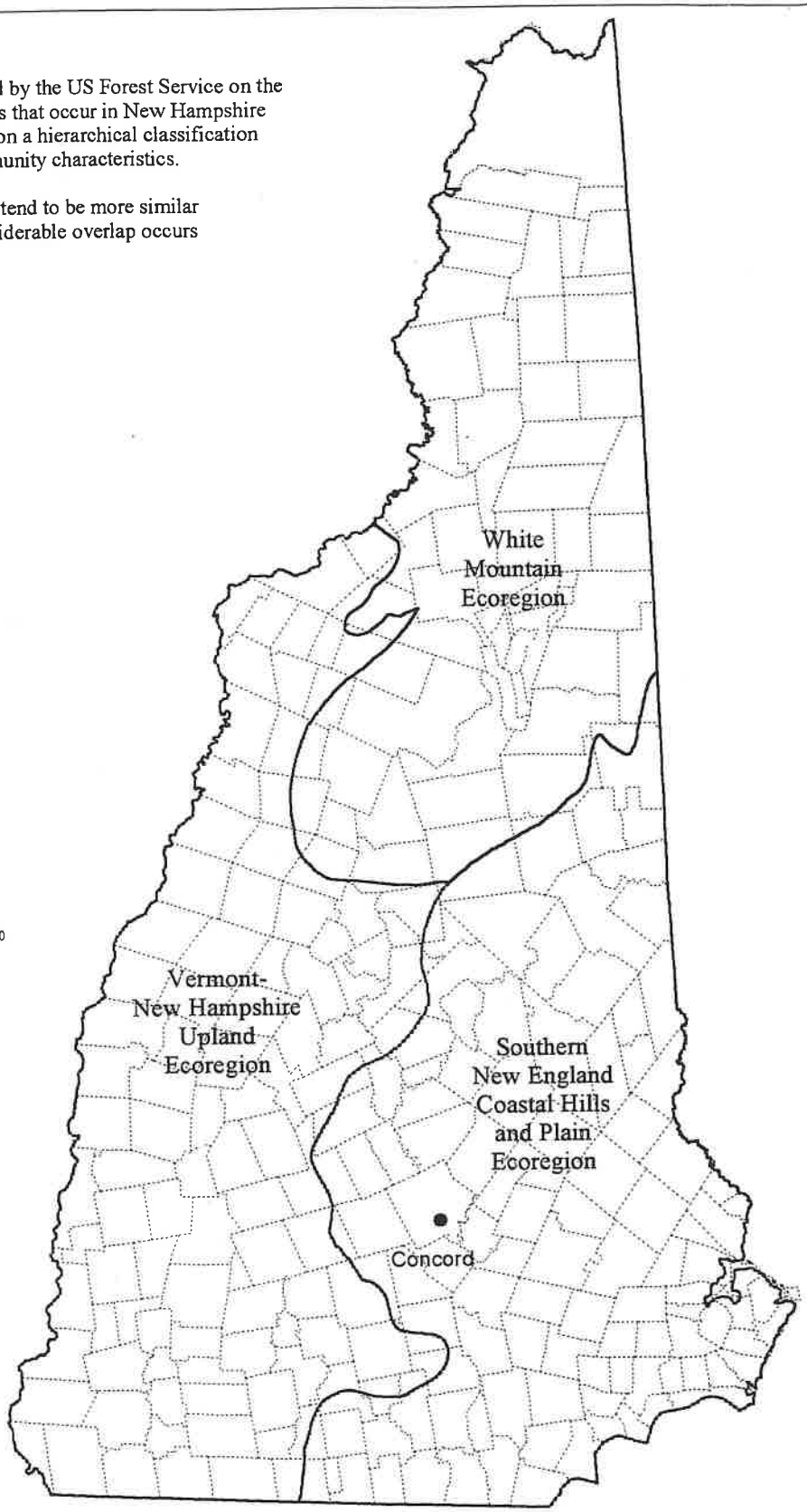
[3] Ecoregions are based on USDA Forest Service National Hierarchical Framework of Ecological Units.

Figure 2. Ecoregions of New Hampshire.

Starting with the ecological units defined by the US Forest Service on the basis of climate and geology, the 13 units that occur in New Hampshire were combined into 3 ecoregions based on a hierarchical classification analysis (TWINSPAN) of natural community characteristics.

Within ecoregions, natural communities tend to be more similar than they are between ecoregions. Considerable overlap occurs near ecoregion boundaries, however.



Data Sources:

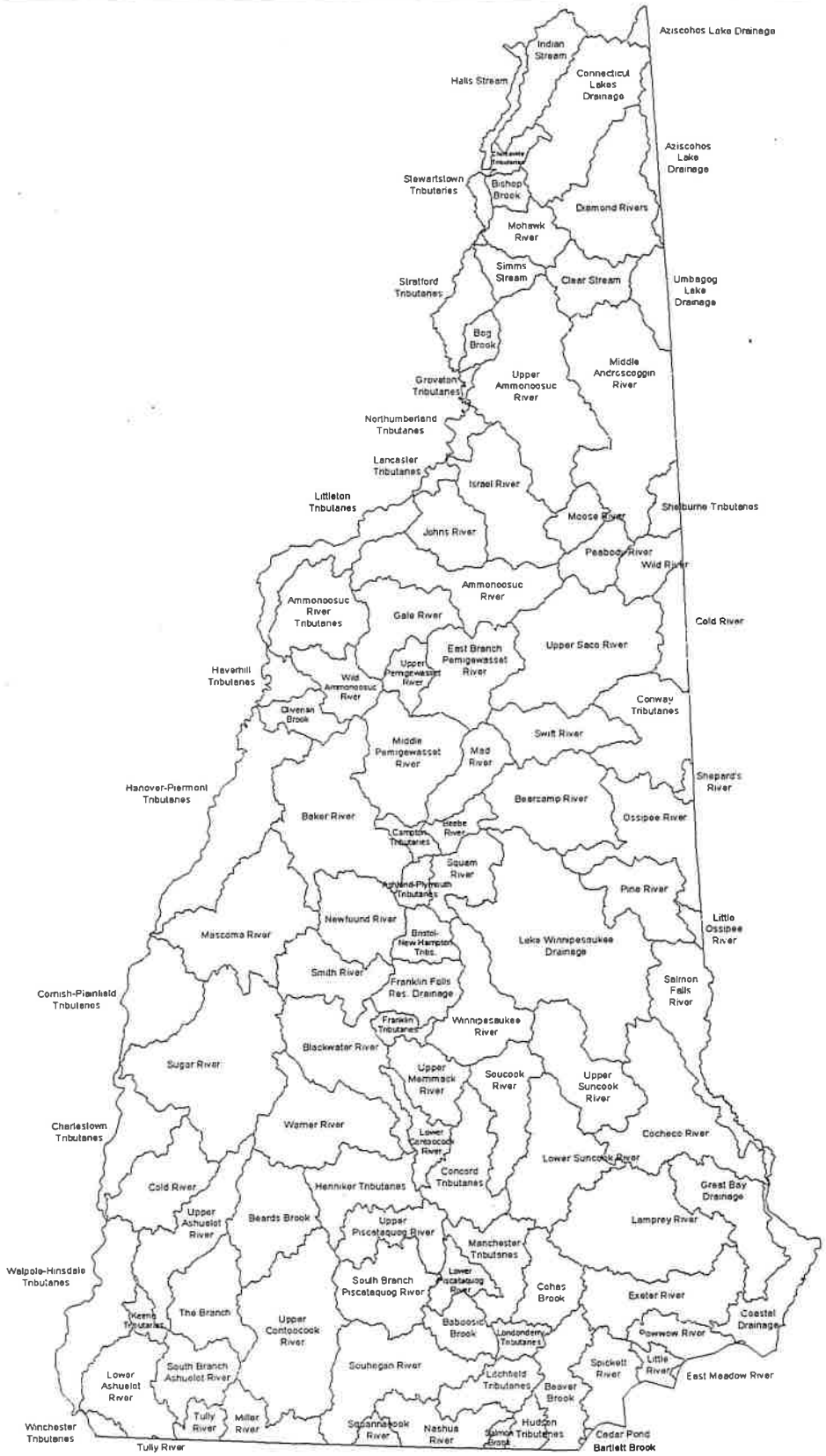
Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Ecoregions derived from the USDA Forest Service National Hierarchical Framework of Ecological Units (1994).

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

Figure 3. Watersheds of New Hampshire.



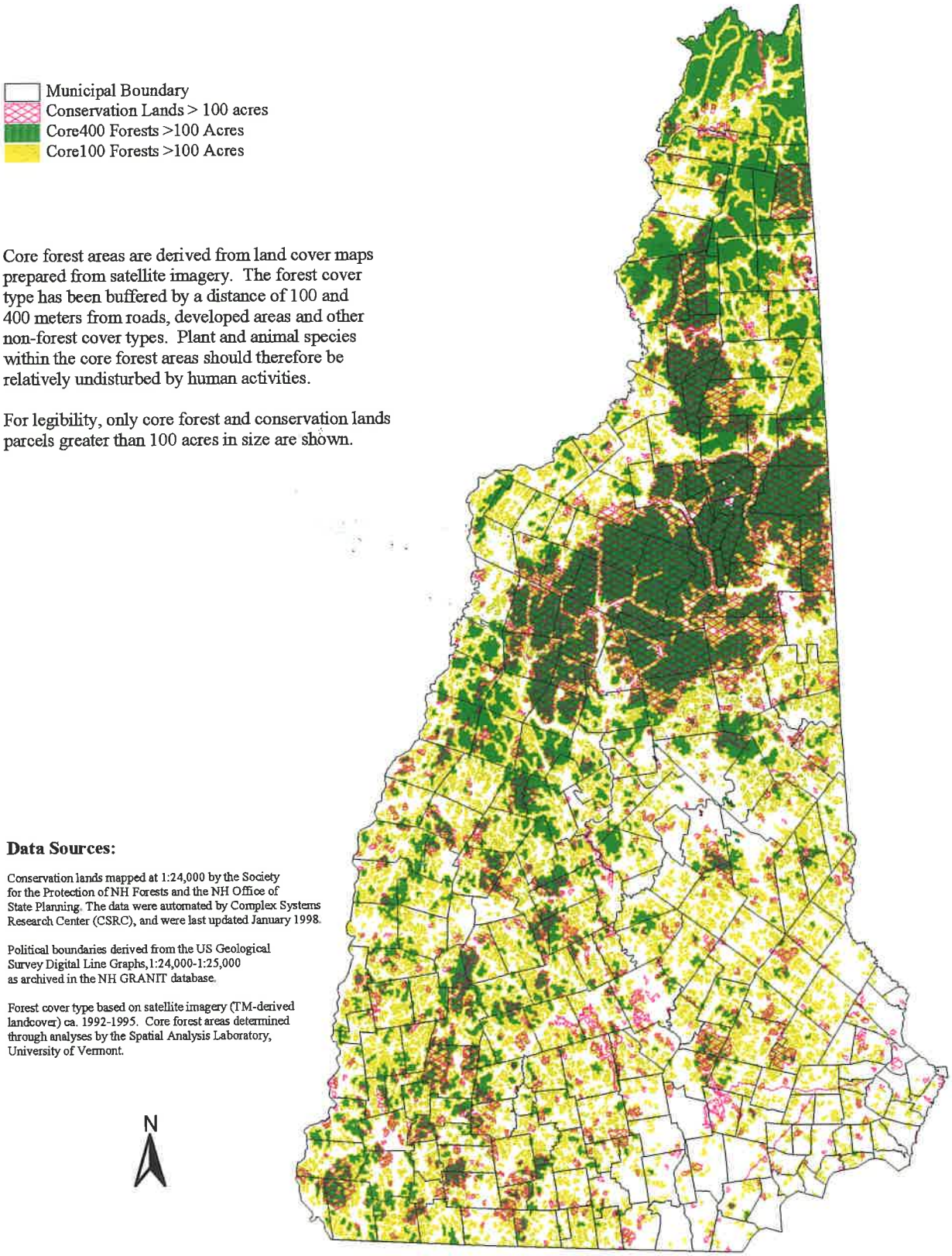
Data Sources:

Surface water boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

Figure 4. Core forest areas relative to conservation lands in New Hampshire.



Core forest areas are derived from land cover maps prepared from satellite imagery. The forest cover type has been buffered by a distance of 100 and 400 meters from roads, developed areas and other non-forest cover types. Plant and animal species within the core forest areas should therefore be relatively undisturbed by human activities.

For legibility, only core forest and conservation lands parcels greater than 100 acres in size are shown.

Data Sources:

Conservation lands mapped at 1:24,000 by the Society for the Protection of NH Forests and the NH Office of State Planning. The data were automated by Complex Systems Research Center (CSRC), and were last updated January 1998.

Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Forest cover type based on satellite imagery (TM-derived landcover) ca. 1992-1995. Core forest areas determined through analyses by the Spatial Analysis Laboratory, University of Vermont.

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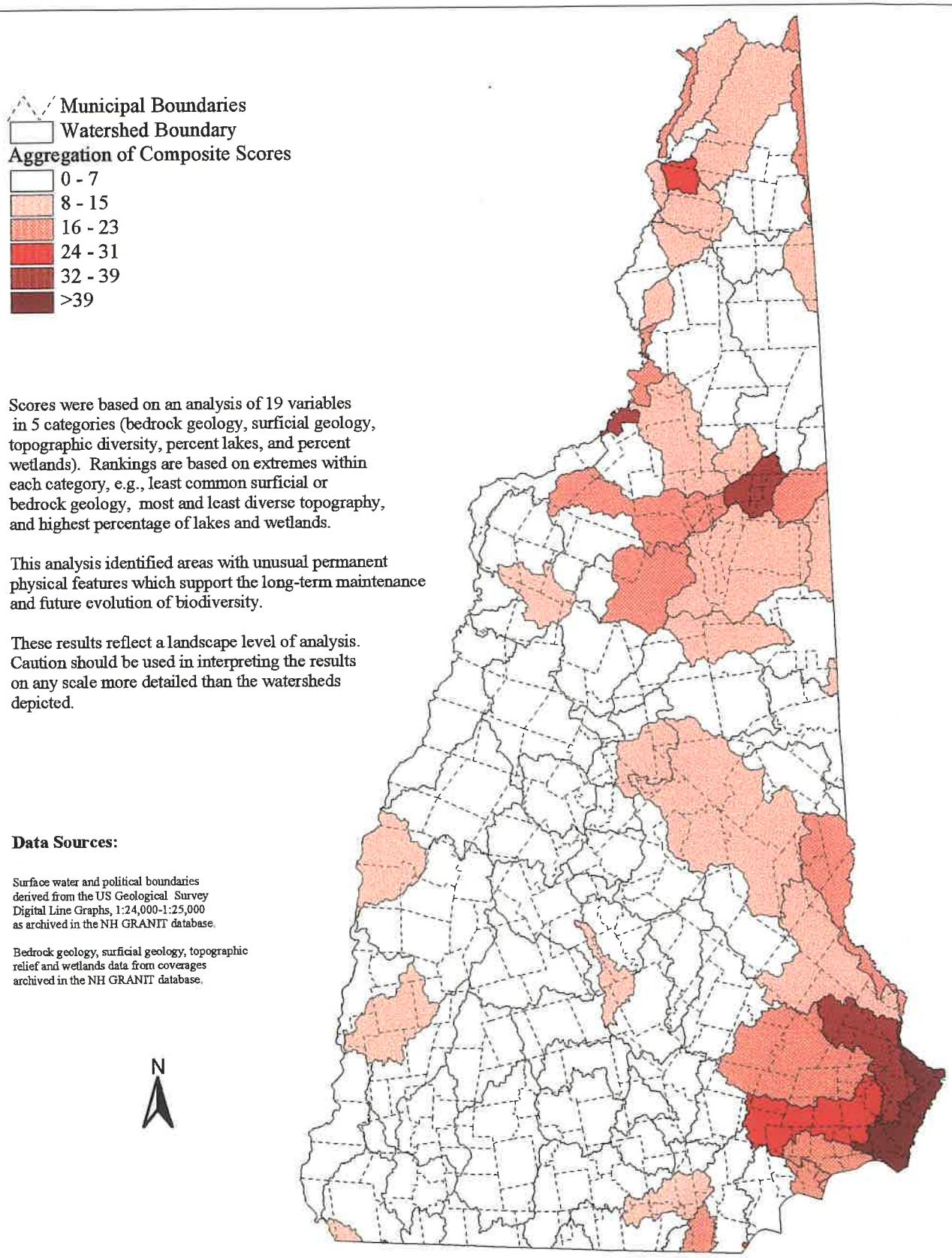
Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

Figure 8. Watersheds in New Hampshire with aggregations of unusually diverse landscape or geological features.



Scores were based on an analysis of 19 variables in 5 categories (bedrock geology, surficial geology, topographic diversity, percent lakes, and percent wetlands). Rankings are based on extremes within each category, e.g., least common surficial or bedrock geology, most and least diverse topography, and highest percentage of lakes and wetlands.

This analysis identified areas with unusual permanent physical features which support the long-term maintenance and future evolution of biodiversity.

These results reflect a landscape level of analysis. Caution should be used in interpreting the results on any scale more detailed than the watersheds depicted.

Data Sources:

Surface water and political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Bedrock geology, surficial geology, topographic relief and wetlands data from coverages archived in the NH GRANIT database.

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

- In general, higher elevation areas are better represented within the current system of conservation lands and within existing core forest. There are very few core forest areas or large protected areas that occur in low-elevation or riparian areas.

- South of the White Mountains, many core forest areas occur in existing conservation lands. North of the White Mountains, many core forest areas also occur within private timber ownerships.

1. Many of the core forest areas were heavily logged or cleared at one time (the Pemigewasset portion of the White Mountains, for example). In a relatively short time span, they have recovered to be some of the state's most significant conservation lands. However, because of the lack of benchmarks by which to measure change, it is difficult to draw conclusions about the recovery of biodiversity in these core forest areas.

2. Large, contiguous core forest areas, whether managed for timber resources or strictly for biodiversity, will not persist without some form of protection from or incentives against development or land-use conversion. Currently, this is most true south of the White Mountains, but will be increasingly true throughout the state in the coming decades. Opportunities may exist in the Monadnock-Sunnapee Region and the North Country for moderate to large core forests given current low development intensity.

II. Animal diversity

- Listed below are select statistics on the status of animals in New Hampshire. They are taken from *New Hampshire's Living Legacy: the Biodiversity of the Granite State.*

Known numbers of vertebrates: 420
- 175 species of nesting birds
- 60 species of land mammals
- 40 species of reptiles and amphibians
- Number federally listed : 5 (least tern, roseate tern, piping plover, peregrine falcon, bald eagle)
- Number state listed: 25

Known insects and non-insect arthropods: 11,000
- Number tracked by the Natural Heritage Inventory: 153
- Number federally listed: 1 (Karner blue butterfly)
- Number state listed: 7

Freshwater mollusks: unknown number of species
- Number federally listed: 1 (dwarf wedge mussel)
- Number state listed: 1

Fish species: 65
- Number estuarine species federally listed: 1 (shortnose sturgeon)
- Number freshwater species state listed: 1 (Sunapee trout)
- Number tracked by the Natural Heritage Inventory: 4

- The animal species have been extirpated from New Hampshire are mountain lion, woodland caribou, Eastern timber wolf wolf, Loggerhead Shrike, Henslow's Sparrow, and Golden Eagle.

- New Hampshire supports populations of 30 globally rare or imperiled animals (See Table 3).

- 82% of known rare vertebrates and 95% of known rare invertebrates in the state have 2 or fewer occurrences on conservation lands (See Table 4). In terms of occurrences (the number of locations of all communities, plants, or animals) 72% of known rare animal occurrences occur OFF the current system of conservation lands. Note that an occurrence of an animal simply denotes a sighting of an animal and does not indicate the presence of suitable habitat or a viable breeding population.

- Through federal and state protection, species such as wild turkey, deer, moose, black bear, and wood duck have recovered to stable population levels.

- 41 bird species, 11 mammal species, 5 amphibian species, 7 reptile species, and 11 invertebrate species have been recommended as priorities in the design of an ecological reserve system (See Table 5). Protection of these species is not enough to protect the diversity of animal life in the Granite State; the list merely highlights the animals most in need of protection. The Ecological Reserves list includes species that, though still well distributed, have experienced notable declines based on anecdotal evidence (for example, northern leopard frogs and black racers). The federal

Table 3. Globally Rare and Imperiled Animals in New Hampshire

Scientific Name	Common Name	Rarity Rank
Acipenser brevirostrum	Shortnose Sturgeon	G3
Acipenser oxyrinchus	Atlantic Sturgeon	G3
Charadrius melodus	Piping Plover	G3
Myotis leibii	Small-Footed Myotis	G3
Myotis sodalis	Indiana Myotis	G2
Acronicta albarufa	Barrens Daggermoth	G3
Alasmidonta heterodon	Dwarf Wedge Mussel	G1
Alasmidonta varicosa	Brook Floater	G3
Calopteryx amata	Superb Jewelwing	G3
Cerma cora	The Cora Moth	G3
Chaetaglaea cerata	A Noctuid Moth	G3
Cicindela ancocisconensis	A Tiger Beetle	G3
Cicindela marginipennis	Cobblestone Tiger Beetle	G2
Cicindela patruela	A Tiger Beetle	G3
Cicindela puritana	Puritan Tiger Beetle	G1
Enallagma laterale	New England Bluet	G3
Enallagma minusculum	Little Bluet	G3
Gomphus abbreviatus	Spine-Crowned Clubtail	G3
Gomphus quadricolor	Rapids Clubtail	G3
Incisalia irus	Frosted Elfin	G3
Incisalia lanoraieensis	Bog Elfin	G3
Itame sp 1	Pine Barrens Itame	G3
Lanthus parvulus	Zorro Clubtail	G3

Animals, continued

Scientific name	Common Name	Rarity Rank
Mitoura hesseli	Hessel's Hairstreak	G3
Ophiogomphus aspersus	Brook Snaketail	G3
Psectraglaea carnosa	Pink Sallow	G3
Stylurus scudderi	Zebra Clubtail	G3
Williamsonia fletcheri	Ebony Boghaunter	G3
Williamsonia lintneri	Banded Bog Skimmer Dragonfly	G2
Zale sp 1	A Noctuid Moth	G3

Table 4a. Percent of recent (1978+) occurrences of rare species and exemplary natural communities on and off existing conservation lands in New Hampshire. Subtotals for public and private conservation lands held in Fee Ownership (FO) and for those with Conservation Easements or other types of protection (CE).

Element	Percent of Occurrences						Total
			Public		Private		
	Off	On	FO	CE	FO	CE	
Natural Communities	46	54	48	2	4	< 1	636
Plant Species	54	46	41	2	3	< 1	1,251
Vertebrate Species	74	26	21	3	2	< 1	266
Invertebrate Species	70	30	23	6	< 1	0	161

Table 4b. Percent of elements with 0-2, 3-9, or 10+ occurrences on conservation lands for all elements with recent (1978+) occurrences in the NH Heritage database.

Element Type	Number of Occurrences on Conservation Land			Total Number of Elements
	<= 2	3-9	10+	
Natural Communities	58%	33%	9%	98
Plant Species	74	20	6	248
Vertebrate Species	82	13	5	40
Invertebrate Species	95	3	2	65

threatened and endangered species lists highlight those species that are globally or regionally rare due to drastic and demonstrated declines while the state lists statewide rarities.

- Many of the rare animal species in the state are habitat specialists, and their rarity is a reflection of the rarity of their habitat.

- The natural community classification, based mostly on plant associations and physical features, is finer-scale and, in general, does not correlate well to animal species habitat associations. The best link that we are aware of is between rare Lepidoptera (butterflies and moths) and the various successional stage of pitch pine barrens. Other, less well-documented links may exist.

- The distributions of many animal species, especially vertebrate species, *do* correlate well with broader grouping of natural community types or habitat types. We need to develop our understanding of species-habitat type relationships.

- There is a lack of undisturbed examples of the following habitats in New Hampshire: mature northern hardwood forest, mature oak-pine forest, mature spruce-fir forest, grasslands, waterbodies, and riparian corridors (NH Forest Resources Plan, Ecological Assessment, 1996).

- We are seriously unaware of the distribution and status of aquatic species.

- A suite of strategies is needed to effectively protect animal species with different patterns of rarity and habitat needs. Some examples of patterns of rarity and needed conservation strategies are listed below.

    1. Jefferson's salamander appears vulnerable due to few known occurrences on conservation land. This species, however, is likely much more common than the number of documented occurrences and is likely to be found at a number of new sites which occur on conservation land. Therefore, the immediate priority is to gather more information about this species' distribution.

    2. The only Bald Eagle nest in the state is found on the Lake Umbagog National Wildlife Refuge. Although the nest site itself is protected, eagle recovery in New Hampshire will depend on more potential nest sites being protected through efforts to provide undeveloped shoreline along the state's major waterbodies.

    3. American Pipits and Peregrine Falcons are two species where the known breeding sites as well as the potential breeding sites are found on conservation land. The vulnerability of these two species is linked to the management of these areas rather than the protection of new ones.

    4. Blanding's turtle appears to have adequate representation on conservation land. This species, however, occurs at very low densities and the New Hampshire population will need to have many more protected sites throughout its range to remain viable.

    5. Pine marten and lynx require large tracts of spruce-fir forest in which they are protected from direct human disturbance. Maintaining viable populations of these species in the state will require not only considering management of large conservation areas but also the connectivity of those large areas to one another, in addition to educating people about the need for protection of these species.

6. Freshwater mussels, such as the brook floater and the federally listed dwarf wedge mussel, depend on high water quality and the presence of certain species of host fish, among other things, during their life cycle. Maintaining adequate habitat for freshwater mussels requires a watershed based, rather than land protection based, conservation strategies.

- Conservation of animal species requires a complex suite of strategies. While some animals are tightly linked to a specific habitat, many animals use a diversity of natural communities during their life cycle. While management improvements on public lands and further habitat protection are critical strategies, education and public awareness are also important. We must learn to accommodate the habitat needs of animal species (for example, piping plovers and pine marten :two rare and vulnerable species with very different distributions and management needs) if they are to endure in New Hampshire.

Table 2. Animals for priority inclusion in the design of an ecological reserve system.

Reptiles and amphibians

Marbled salamander
Jefferson salamander
Northern leopard frog
Fowler's toad
Mink frog
Spotted turtle
Blanding's turtle
Wood turtle
Smooth green racer
Racer
Eastern hognose snake
Timber rattlesnake

Birds

Common Loon
Pie-billed Grebe
American Bittern
Least Bittern
Osprey
Bald Eagle
Northern Harrier
Red-shouldered Hawk
Golden Eagle
Peregrine Falcon
Spruce Grouse
Common Moorhen
Piping Plover
Willet
Upland Sandpiper
Roseate Tern
Common Tern
Arctic Tern
Least Tern
Rufous-sided Towhee
Eastern Meadowlark
Black Guillemot
Common Nighthawk
Whip-poor-will
Three-toed Woodpecker
Horned Lark
Purple Martin
Sedge Wren
Bicknell's Thrush
Water Pipit
Vesper Sparrow
Grasshopper Sparrow
Sharp-tailed Sparrow
Seaside Sparrow
Rusty Blackbird
Cooper's Hawk
Long-eared Owl
Loggerhead Shrike
Golden-winged Warbler
Henslow's Sparrow
Brown Thrasher

Insects

Karner blue butterfly
Cobblestone tiger beetle
Persius dusky wing
Frosted elfin
Pine barrens zanclognatha moth
Banded bog skimmer dragonfly
Pine pinion moth
White Mountain butterfly
White Mountain fritillary

Table 2, continued.

Mammals

Small-footed myotis
Northern long-eared bat
Eastern red bat
Hoary Bat
Silver-haired bat
Eastern pipistrelle
New England cottontail
Northern bog lemming
Pine marten
Lynx
Bobcat

Freshwater mussels

Dwarf wedge mussel
Brook floater

III. Plant and natural community diversity

- Of some 2,000 plant species that are believed to occur in New Hampshire, approximately 1,500 (75%) are considered native. Of these,
  - 383 (25% of the known native flora) are classified as rare by Natural Heritage
  - 288 (19% of the known native flora) are listed as Threatened (144) or Endangered (144) in the NH Native Plant Protection Act (NH RSA 217-A)
  - 4 (0.26% of the known native flora) are federally listed under the Endangered Species Act (3 are endangered, 1 is threatened)

- Of the 383 species tracked by Natural Heritage, one or more viable populations have been reported in the last 20 years for 248 species (65%). The analyses in this report included just those 248 species. Natural Heritage has no records more recent than 1978 for 105 plant species which are known to have once occurred in New Hampshire.

- New Hampshire supports populations if 22 globally endangered plants and occurrences of 25 globally endangered natural communities (See Table 6).

- Based on a statewide classification developed by the Natural Heritage Inventory, 98 natural community types occur in New Hampshire. 24 of these (24%) have been classified as globally rare or imperiled. It should be noted that many of these natural communities occupy a fairly small portion of the landscape. Relatively undisturbed examples of even the most common natural communities in the state are rare.

- Most occurrences of rare plants and natural communities occur off conservation lands, except for high numbers in the White Mountain National Forest (See Figure 5). 58% of the known rare natural community types and 74% of known rare plant species in the state have 2 or fewer known occurrences on conservation lands. In terms of occurrences (the number of locations of all communities, plants, or animals), 46% of known rare community occurrences and 54% of known rare plant species occurrences occur OFF the current system of conservation lands. These estimates imply that all current conservation lands have both characteristics and management practices that maximize biodiversity protection, which is not necessarily the case. These estimates also do not reflect protection of species and natural communities on private lands that are not formally conserved. Finally, there has been no systematic survey of all conservation lands in the state and not all known occurrences have been entered into the databases used in this analysis.

- Protection of natural communities contributes to the protection of plant and animal species , physical features, and ecological processes that constitute the individual parts of the community. This approach protects rare features and helps keep common features common. Natural communities can thus serve as a "coarse filter" framework for conservation. For example, 5 of the natural communities in New Hampshire contain 33% of the rare plant species in the state. The 5 communities are New England calcareous riverside seep, New England alpine community, Southern New England dry rich forest on acidic/circumneutral bedrock or till, Northern New

Table 6. Globally rare and imperiled plant species and natural communities in New Hampshire

Natural Community	Rarity Rank
Atlantic White Cedar Basin Swamp	G3
Inland Beach Strand Community	G1
Inland New England Acidic Pond Shore/Lake Shore Community	G3
NE Alpine Community	G3
NE Boreal Heathland	G3
NE Calcareous Riverside Seep Community	G2
NE Inland Dune Community	G2
NE Moist Subalpine Heathland	G3
NE Subalpine Heath/Krummolz Community	G3
New England Alpine/Subalpine Bog	G3
New England Dry Riverbluff Opening	G1
New England Pitch Pine/Scrub Oak Barrens	G2
New England Riverwash Hudsonia Barren	G2
NNE Acidic Sloping Fen	G3
NNE Calcareous Cliff Community	G3
NNE Calcareous Level Fen	G3
NNE Calcareous Sloping Fen	G3
NNE Cold-Air Talus Forest/Woodland	G3
NNE Riverside Outcrop Community	G2
SNE Basin Marsh	G3
SNE Coastal Dune Community	G3
SNE Cold-Air Talus Forest/Woodland	G3
SNE Maritime Forest on Dunes	G2
SNE Riverside Outcrop Community	G2
SNE Traprock Bald Rocky Summit/Rock Outcrop Community	G2

Table 6, continued.

Plant species Scientific Name	Common Name	Rarity Rank
Arnica lanceolata	Arnica	G3
Betula minor	Small Birch	G3
Calamagrostis lacustris	Pond Reed Bent-Grass	G3
Cardamine longii	Long's Bitter Cress	G3
Carex polymorpha	Many Forms Sedge	G2
Carex wiegandii	Wiegand's Sedge	G3
Cypripedium arietinum	Ram's-Head Lady's Slipper	G3
Diplachne maritima	Salt-Meadow Grass	G3
Eleocharis nitida	Neat Spike Rush	G3
Geum peckii	Mountain Avens	G2
Hieracium robinsonii	Robinson's Hawkweed	G1
Isoetes eatonii	Eaton's Qillwort	G2
Isotria medeoloides	Small Whorled Pogonia	G2
Liatris borealis	Northern Blazing Star	G3
Listera auriculata	Auricled Twayblade	G3
Poa fernaldiana	Wavy Bluegrass	G2
Potentilla robbinsiana	Robbins' Cinquefoil	G1
Prenanthes boottii	Boott's Rattlesnake-Root	G2
Pycnanthemum torrei	Torry's mountain mint	G2
Scirpus ancistrochaetus	Northeastern Bulrush	G3
Scirpus longii	Long's Bulrush	G2
Scleria reticularis	Stone Rush	G3

England rich mesic forest, and Northern New England calcareous sloping fen. A fine filter framework, in which species (usually highly endangered or habitat-specific species) are individually evaluated and conserved, is used to ensure important species do not slip through the coarse filter of communities.

- Because most natural community types are either large patch or small patch types (See Scientific Principles section), conservation of the majority of natural community types can be achieved on a relatively small portion of the landscape. Patch communities, however, may not remain viable over the long term unless they are embedded in a viable matrix community.
- Certain aspects of physical diversity have a disproportionately higher influence on biological diversity. Protection of these physical features, which can include nutrient-rich bedrock outcroppings and floodplain soils, is an important step towards long term protection of the full range of the state's natural community-level diversity.
- The following examples illustrate some of the areas in the state that support concentrations of highly-ranked occurrences of plants, animals, and natural communities. This is not a comprehensive list.

1. Natural communities and rare plants in alpine and subalpine zones of the Presidential Range of the White Mountains.

2. New England Pitch Pine/Scrub Oak Barrens and New England Dry Riverbluff Openings in the Concord area.

3. New England Pitch Pine/Scrub Oak Barrens, New England Hudsonia Riverwash Barrens, and several rare plants including silvering (*Paronychia argyrocoma* var. *albimontana*) and hairy hudsonia (*Hudsonia tomentosa*) in the Ossipee/Conway area and along the Saco River.

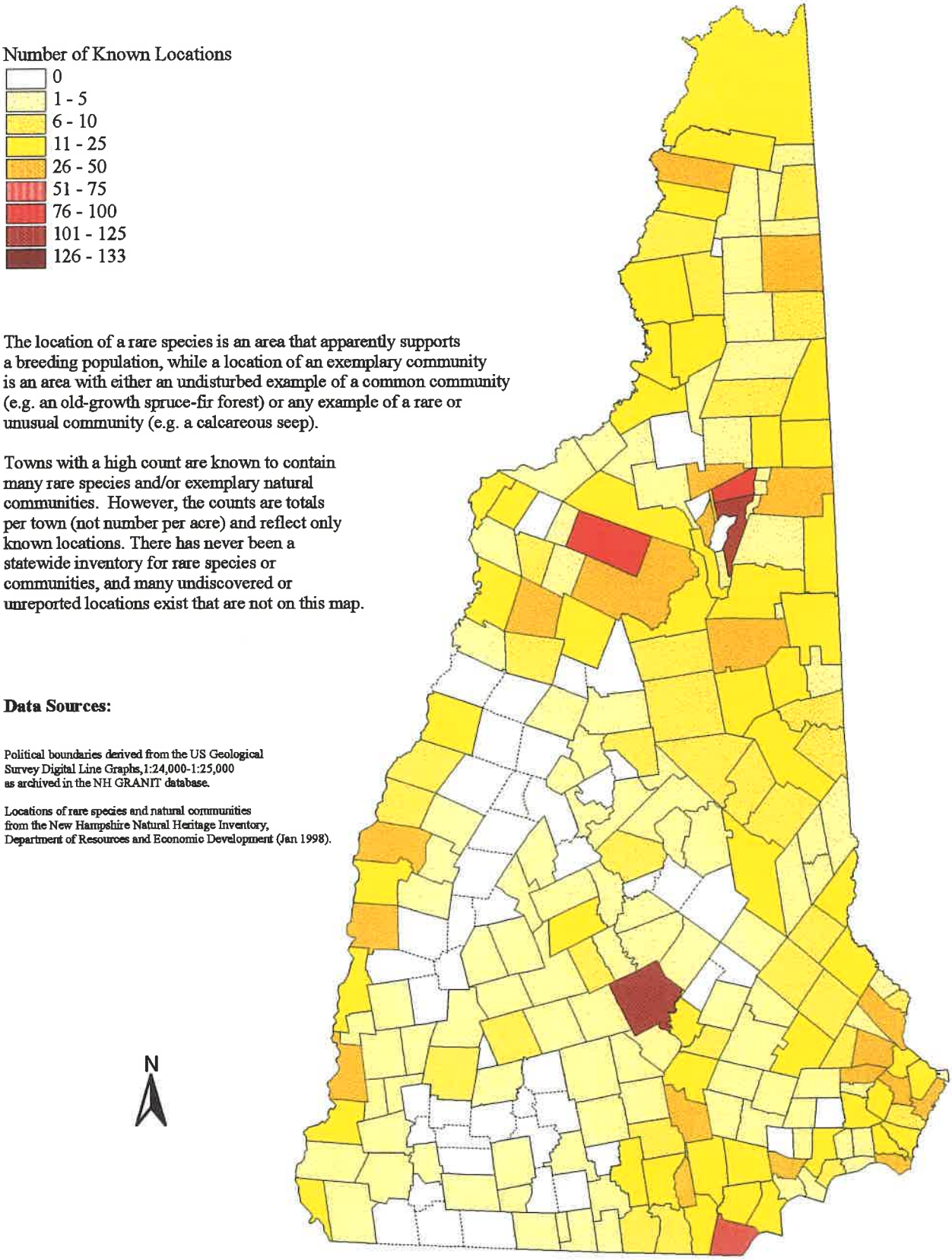
4. Calcareous Riverside Seeps, a Northern New England Calcareous fen, and Northern New England Riverside Outcrop Communities, and dozens of rare plants along the length of the Connecticut River.

5. Inland New England Acidic Pond Shore/Lake Shore Communities, a sclerolepis (*Sclerolepis uniflora*) population, and the state's westernmost population of small whorled pogonia (*Isotria medeoloides*) in central southern New Hampshire.

6. A variety of species in northern Strafford County including a Northern New England Rich Mesic Forest, two rare sedge (*Carex* sp.) species, and several populations of small whorled pogonia.

7. Natural communities such as Atlantic White Cedar-Yellow Birch/Sweet Pepperbush Swamps, Swamp White Oak Floodplain Forests, estuarine and coastal wetlands, and rare species in Great Bay, Seabrook, and the Kingston/Exeter area.

Figure 6. Known locations of rare species and exemplary natural communities in New Hampshire by township.



The location of a rare species is an area that apparently supports a breeding population, while a location of an exemplary community is an area with either an undisturbed example of a common community (e.g. an old-growth spruce-fir forest) or any example of a rare or unusual community (e.g. a calcareous seep).

Towns with a high count are known to contain many rare species and/or exemplary natural communities. However, the counts are totals per town (not number per acre) and reflect only known locations. There has never been a statewide inventory for rare species or communities, and many undiscovered or unreported locations exist that are not on this map.

Data Sources:

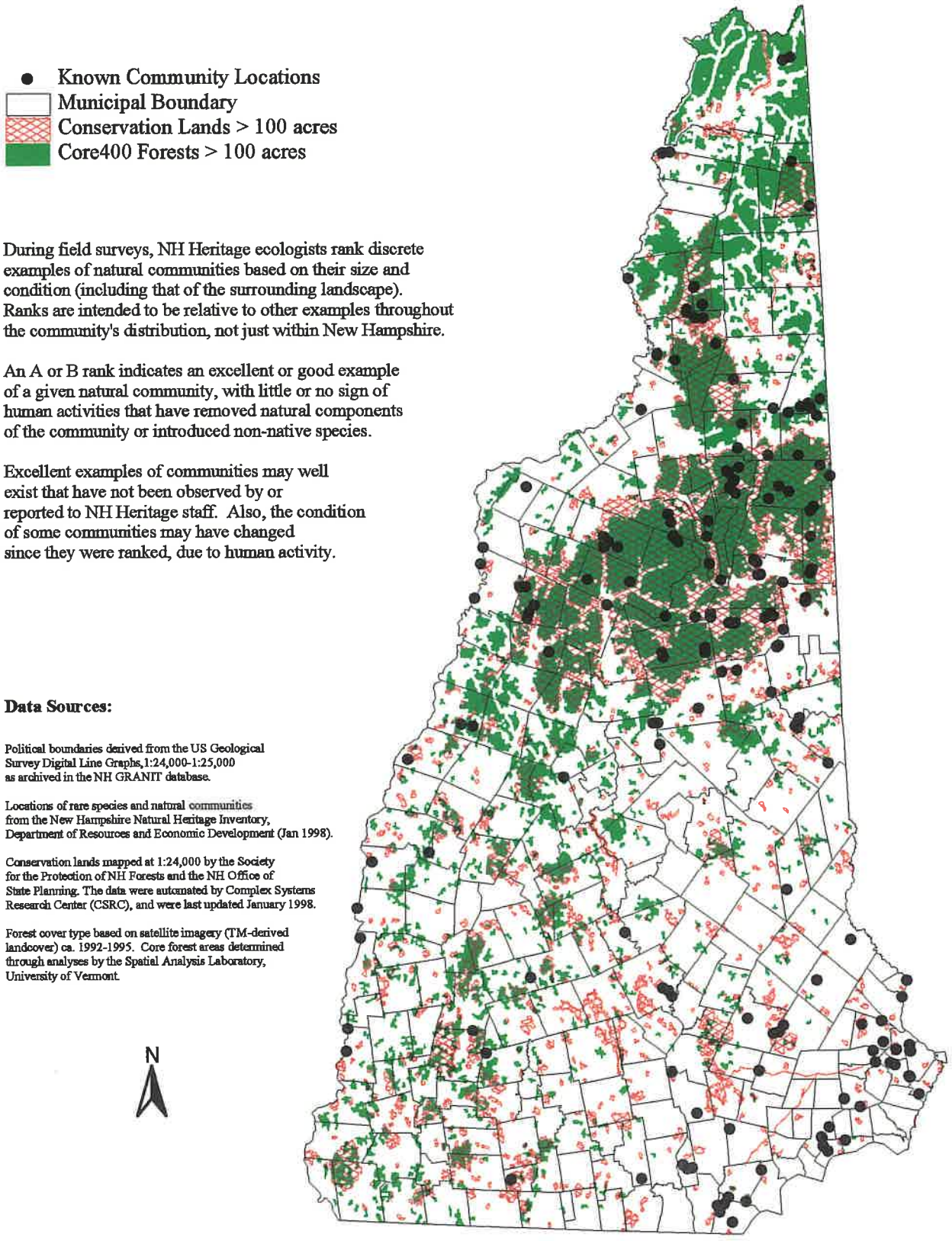
Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Locations of rare species and natural communities from the New Hampshire Natural Heritage Inventory, Department of Resources and Economic Development (Jan 1998).

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

Figure 7. Known locations of A- and B- ranked natural communities in New Hampshire relative to existing conservation lands and core forest areas.



During field surveys, NH Heritage ecologists rank discrete examples of natural communities based on their size and condition (including that of the surrounding landscape). Ranks are intended to be relative to other examples throughout the community's distribution, not just within New Hampshire.

An A or B rank indicates an excellent or good example of a given natural community, with little or no sign of human activities that have removed natural components of the community or introduced non-native species.

Excellent examples of communities may well exist that have not been observed by or reported to NH Heritage staff. Also, the condition of some communities may have changed since they were ranked, due to human activity.

Data Sources:

Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Locations of rare species and natural communities from the New Hampshire Natural Heritage Inventory, Department of Resources and Economic Development (Jan 1998).

Conservation lands mapped at 1:24,000 by the Society for the Protection of NH Forests and the NH Office of State Planning. The data were automated by Complex Systems Research Center (CSRC), and were last updated January 1998.

Forest cover type based on satellite imagery (TM-derived landcover) ca. 1992-1995. Core forest areas determined through analyses by the Spatial Analysis Laboratory, University of Vermont.

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

IV. The vulnerability of biodiversity

- Of the top 10 environmental risks ranked by the New Hampshire Comparative Risk Project, 6 risks (or threats) have a direct impact on biodiversity. The risk is followed by its rank.

    1. Degradation of surface water habitat (1)
    2. Loss of land habitat from development (3)
    3. Physical alteration of water and shoreland habitat (4)
    4. Loss of water habitat (filling, draining) (5)
    5. Acid deposition (on forests, soils, inland waters, and estuaries) (6)
    6. Degradation of forest habitat by fragmentation (10)

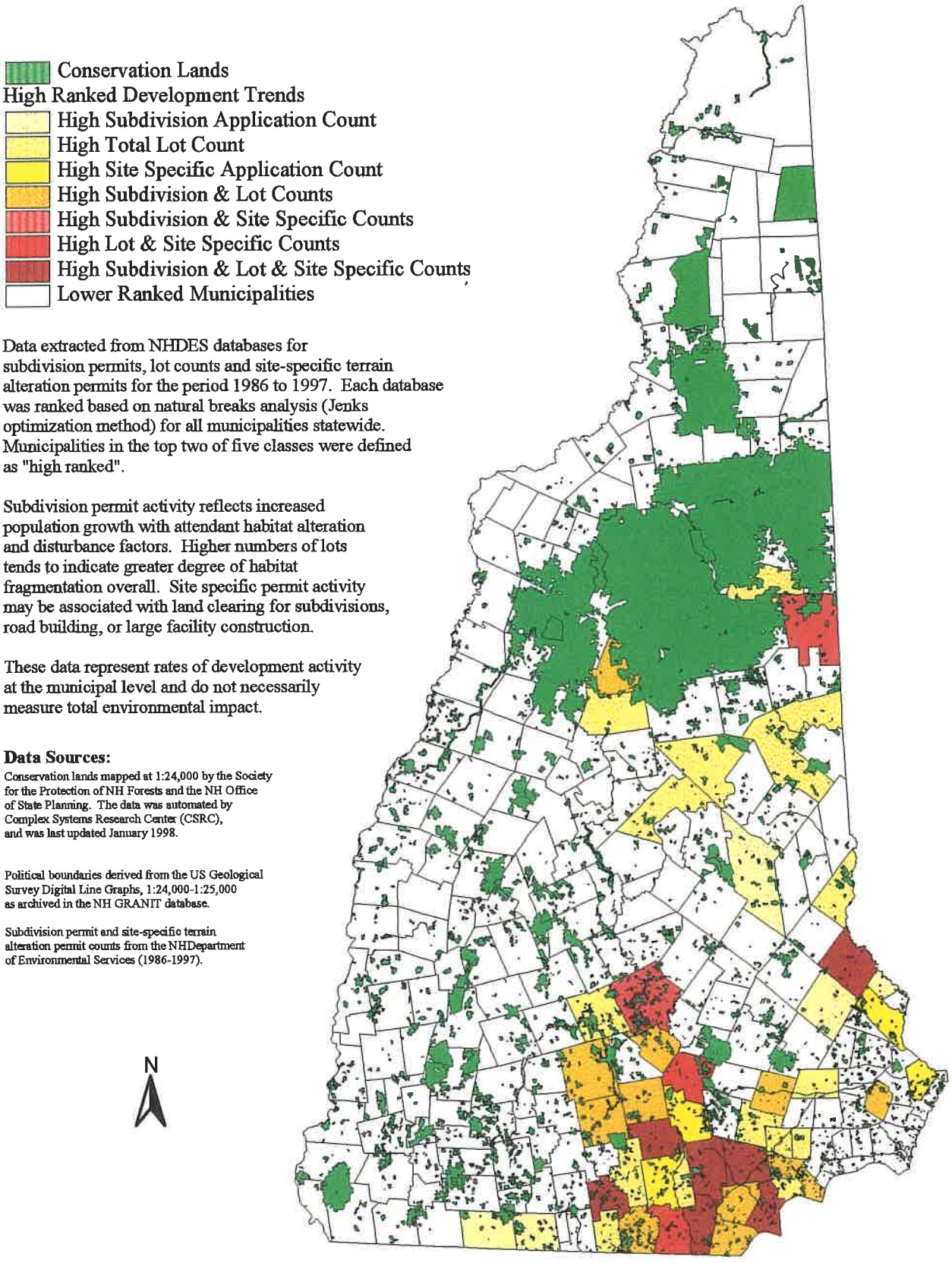
  The predominance of habitat related threats is particularly noteworthy because the Comparative Risk Project examined a broad spectrum of environmental risks to the welfare of people and the natural world and did not start its work with a focus on just habitat or biodiversity related issues.

- All the above threats, except acid deposition, could be partially mitigated by expanding the current system of conservation lands through a combination of managed timberlands, riparian protection corridors, and lands managed strictly for biodiversity.

- The SAG has developed maps that show levels of subdivision permit applications on a township basis (See Figure 9). Subdivision permit activity reflects increased population growth and an increase in direct threats as well as increased recreation levels. These maps reveal several patterns:

    1. The most intense development pressures are in the southern and southeastern parts of the state.
    2. There is moderate to high development pressure along the eastern side of the state as far north as the town of North Conway.
    3. There is relatively low development pressure in the southwestern part of the state and north of the White Mountains.
    4. There are isolated towns with moderate to high development rates throughout the state, often reflecting second home development activity.

Figure 9. Rate of development activity in New Hampshire towns between 1986 and 1997 based on permits administered by the New Hampshire Department of Environmental Services.



Data extracted from NHDES databases for subdivision permits, lot counts and site-specific terrain alteration permits for the period 1986 to 1997. Each database was ranked based on natural breaks analysis (Jenks optimization method) for all municipalities statewide. Municipalities in the top two of five classes were defined as "high ranked".

Subdivision permit activity reflects increased population growth with attendant habitat alteration and disturbance factors. Higher numbers of lots tends to indicate greater degree of habitat fragmentation overall. Site specific permit activity may be associated with land clearing for subdivisions, road building, or large facility construction.

These data represent rates of development activity at the municipal level and do not necessarily measure total environmental impact.

Data Sources:

Conservation lands mapped at 1:24,000 by the Society for the Protection of NH Forests and the NH Office of State Planning. The data was automated by Complex Systems Research Center (CSRC), and was last updated January 1998.

Political boundaries derived from the US Geological Survey Digital Line Graphs, 1:24,000-1:25,000 as archived in the NH GRANIT database.

Subdivision permit and site-specific terrain alteration permit counts from the NHDepartment of Environmental Services (1986-1997).

Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

Summary findings and recommendations

This section summarizes the results and recommendations of the Scientific Advisory Group. The methods and supporting data that led to these key findings and recommendations are contained in Appendices I and II.

What is the status of biodiversity in New Hampshire?

The biodiversity of New Hampshire is threatened at the species, natural community, and ecosystem level. The intensity and nature of threat varies widely across the state and for different features of biodiversity, with some features relatively secure and others severely and immediately imperiled. Reflecting a pattern common throughout the United States, many of the areas in New Hampshire that contain the greatest concentrations of rare species and natural communities are also the most vulnerable to development and habitat alteration.

- New Hampshire has lost and continues to lose features of biodiversity at the species, natural community, and landscape level:

  1. 6 animals that once occurred in New Hampshire or in adjacent waters are globally extinct: labardor duck, sea mink, great auk, passenger pigeon, heath hen, and scrag whale.

  2. At least 5 animals that once occurred in New Hampshire are no longer found in the state: Eastern timber wolf, caribou, mountain lion, lynx, and wolverine.

  3. While it does not appear that we have lost any plants that were once widespread and abundant, we have lost naturally uncommon or rare species. 13 species have been extirpated from the state and there are 75 plant species that have not been sighted since 1978. 4 species that once occurred in New Hampshire have been seen nowehere in New England since 1970. Several tree species, notably elm and chestnut, that were once canopy dominants have been decimated by introduced pests and disease.

  4. Of four pine barrens that were originally found in the state, only one, the Ossipee Pine Barrens, remains. Pitch pine barrens have an astonishing variety of unusual species, so this is a particularly significant loss.

  5. Less than 1% of the New England landscape has remained unaltered by human land use.[4] The New Hampshire Forest Resources Plan reports a lack of undisturbed grassland, forest, and aquatic habitats. There is a lack of mature oak-pine, northern hardwood, and spruce-fir forests.

- There are a number of serious and immediate biodiversity conservation challenges facing us in New Hampshire:

  1. There are 22 globally endangered plants and 30 globally endangered animals in New Hampshire (See Tables 3 and 6).

  2. There are 25 globally endangered natural community types in New Hampshire (See Table 6).

[4] Davis, M. B. 1996. Eastern Old-Growth Forests. Island Press, Washington.

3. There are few exemplary examples of even the most common natural community types throughout the state. We know of exemplary (A-ranked) examples for only 48 natural community types in the state (See Figure 7. For list, consult *Plant and natural community biodiversity* section in Appendix II). Old-growth forests account for less than 1% of the landscape, and there are few mature (100-250 year old) examples of most common forested natural communities.

4. From 1982 to 1992, New Hampshire lost 15,000 net acres of forest land per year [5]. Though the rate of forest loss has likely slowed since the boom of the 1980s, we are likely still losing roughly 10,000 acres per year. While the last 150 years have seen a dramatic reforestation of the state, forest cover peaked around 1980 and is now gradually declining. The seriousness of this trend is that conversion of forest to suburban or urban development, unlike historical land uses such as pasture and agriculture, is essentially irreversible.

5. Ongoing hydrologic alteration of and development along lakeshores, streams and rivers, estuaries, and the Atlantic coastline have led to there being few, if any, undisturbed aquatic ecosystems in the state. We are limited by a severe lack of knowledge about the status of aquatic ecosystems in the state.

- In some respects, New Hampshire is faring much better than many other states. For example:

  1. The state has lost a relatively low number of native species.

  2. Twenty-one percent of the state is in some form of permanent conservation protection (See Table 7).

  4. The White Mountain National Forest harbors globally significant species and natural communities and offers landscape level protection for beech-birch-maple forests and spruce-fir forests, two of the dominant matrix communities in the state. The area of the White Mountain National Forest that is excluded from all resource extraction activities amounts to 7.5% of the total area of the state.

  5. There are significant areas of the state with relatively low human population densities and development rates.

How effective is the current system of conservation lands in the state?

There is general consensus among the Scientific Advisory Group that the current system of conservation lands in New Hampshire does *not* provide comprehensive, long term protection of biodiversity at the species, natural community, or landscape level. The precise level of protection does vary depending on the specific species, community, or ecoregion. *Some species, natural communities, and landscape types <u>are</u> well represented on current conservation lands.*

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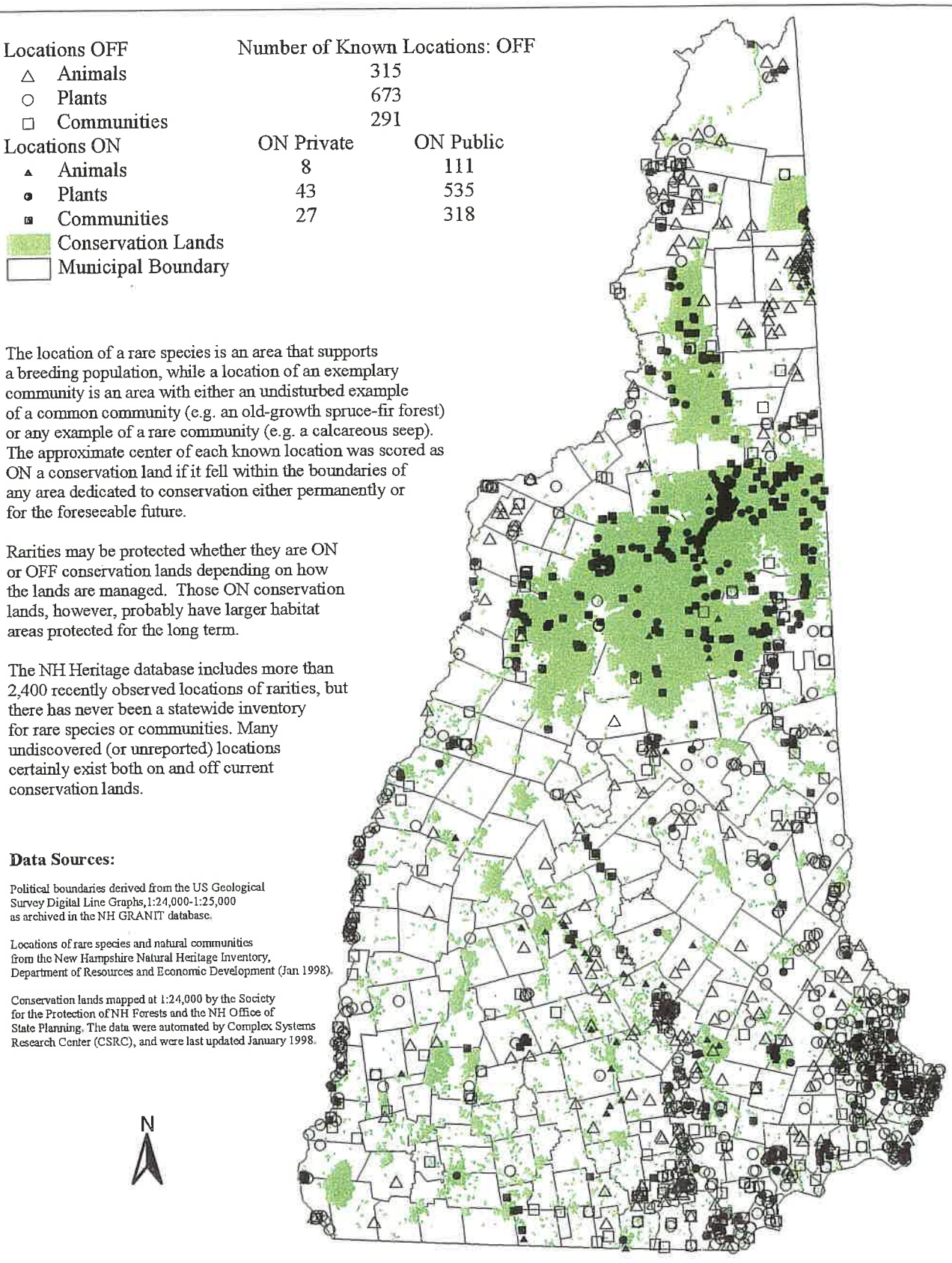
[5] New Hampshire Forest Resources Plan, Human Assessment Report, 1996. See Appendix I for full reference.

Table 7. Conservation Land in New Hampshire			
Total acreage in New Hampshire: 5,796,511			
Figures are approximate and reflect incomplete conservation lands mapping			
Agency or Organization	Acres held	Percent of All Conservation Land	Percent of All NH Land
Federal Government	759,610	60.1	13.1
State of New Hampshire	217,540	17.2	3.8
Local and County Governments	130,693	10.3	2.3
Quasi-public (water districts)	6,562	0.5	0.1
Major Private Organizations (ASNH, SPNHF, TNC)	149,370	11.8	2.6
Total Conservation Land in New Hampshire	**1,263,775**	**100**	**21.9**

Figure 5. Known locations of rare species and exemplary natural communities in New Hampshire that are either ON or OFF existing conservation lands.



Map generated for the New Hampshire Ecological Reserve System Project, 1998

For more information contact the project coordinator at: The Nature Conservancy, 2-1/2 Beacon Street, Suite 6, Concord NH 03301. (603) 224-5853

- Statewide, most known rare species and natural communities are not well-represented within the current system of conservation lands (See Figure 5 and Table 4).

- Existing conservation lands have provided the state's most significant areas for restoration of core forest areas over the last 100 years.

- Nearly eight percent of the state is effectively in reserve status, with most of that area occurring in the portions of the White Mountain National Forest designated as wilderness or excluded from resource extraction activities. The great majority of this area is in high elevation forests either on the National Forest or on State Forests.

- Except in the White Mountain ecoregion, current conservation lands are not well connected to one another and they do not reflect scientific principles for designing biodiversity conservation lands. The isolation and small size of many conservation lands decreases the likelihood of the resident species and natural communities remaining viable over the long term.

- Current biodiversity management strategies on public conservation lands may not be sufficient to sustain species and natural communities. As a corollary, management practices on private lands may be sustaining significant species and natural communities although those lands are not formally protected.

What are the Scientific Advisory Group's recommended strategies for establishing a system of ecological reserves for New Hampshire?

While the following recommendations are essential to safeguarding the state's biodiversity, we should keep in mind that ecological reserves are just one component of an overall strategy of land and natural resource management. Equally important are existing initiatives and programs to support and encourage good management of, for example, commercial timberlands, wildlife populations, and watersheds.

A. Setting Conservation Priorities

1. Emphasize protection of globally rare species and natural communities. Develop a more comprehensive representation of these particularly vulnerable features in a system of conservation areas managed strictly for biodiversity.

2. Protect known concentrations of rare species and natural communities, for example, the 5 natural communities known to harbor 33% of the rare plants in the state and the 6 concentrations of rare species and natural communities listed in the Plant and Natural Community Diversity section.

3. Work to protect exemplary (A and possibly B ranked), viable occurrences of all natural community types, including common natural community types and matrix natural community

types, on existing public lands. These exemplary communities serve the function of benchmarks, especially when they are embedded in a matrix of unfragmented lands.

4. Restore natural communities that currently have no exemplary occurrences.

5. For some species, especially wide-ranging mammals and area-sensitive birds, effective conservation involves protecting unfragmented blocks of common matrix communities. For other species, such as butterflies and moths associated with pine barrens, identification and protection of specific habitat associations are the most effective strategy.

6. The selected priority strategies in each of New Hampshire's 3 ecoregions are:

a. **White Mountain Ecoregion**

Review the effectiveness of management activities on the White Mountain National Forest and on state-owned lands. This ecoregion has large areas that are already protected, including extensive acreage that is excluded from resource extraction activities. Much of the focus can therefore be on refining management activities, working to connect large tracts of conservation land, and protecting isolated rare species and natural communities. Collaborate with private timberland managers and owners to incorporate biodiversity protection into forest management plans.

b. **Vermont-New Hampshire Upland Ecoregion**

Pursue opportunities for establishing landscape-scale conservation areas in the southwestern portion of the state. This region currently has relatively low development pressures and is dominated by different natural communities and physical features than those represented in the White Mountain ecoregion, which contains most of the large contiguous natural areas in the state. Private conservation efforts have already led to the establishment of several significant conservation areas, notably the Peirce Reservation and Andorra Forest, that already partially function as landscape-scale reserves, and which could ultimately be connected to Pillsbury and Mount Sunapee State Parks.

In addition, there is a need to conduct more ecological surveys for rare plants, animals, and natural communities in the region. Little information currently exists on these features.

c. **Southern New England Coastal Hills and Plain Ecoregion**

Pursue significant protection opportunities in the Great Bay/seacoast region and southernmost New Hampshire. In this region, the size of existing matrix communities is much smaller than in other, less-developed portions of the state; however, the region supports a large number of rare species and natural communities. Protecting remaining unfragmented forest blocks and wetland complexes will be crucial to maintaining the viability of the numerous rare species and natural communities in the region and to protecting the few remaining examples of the coastal plain landscape.

B. Evaluating and designing potential ecological reserves

In Section A, we have recommended features and areas that should be priorities for inclusion in an ecological reserve system. In this section, we more broadly define the ecological criteria and approach that should be used in establishing reserves.

1. Begin process of designing and establishing an integrated and comprehensive set of reserves that incorporate principles of reserve design. These reserves would include public conservation lands and lands owned by interested and willing private landowners. In general, these reserves should reflect application of the principles of reserve design. Criteria by which to assess the importance of a potential reserve are:

a. presence of globally-rare species and natural communities
b. concentrations of rare species and natural communities
c. areas with high physiographic or natural community diversity
d. large blocks of core forest, especially mature forest
e. areas adjacent to existing conservation lands
f. areas that serve as connectors between existing reserves, especially riparian corridors and ridgelines
g. exemplary examples of all natural communities, including common ones, as well as matrix communities
h. exemplary occurrences of disjunct, regionally-centered, or limited species and natural communities.
i. critical wildlife habitats

See Table 8 for example of assessment criteria for identification and evaluation of potential ecological reserves. See Figures 10 and 11 for examples of ecological reserve models that integrate biodiversity protection with human activities.

2. The recommended approach to conserving natural communities over the long term is to preserve viable examples of matrix communities which have concentrations of small and large patch community types embedded within them. The recommended size for preserving matrix communities ranges from a recommended minimum size of 5,000 acres to 25,000 acres [6]. Refer to Scientific Principles of Reserve Design section for explanation of the justification and benefits of this approach.

In practice, we will need to think in terms of a sliding scale in the design of ecological reserves. Establishing landscape-level, matrix community reserves at the recommended 25,000 acre level will likely only be feasible in the White Mountain Ecoregion. Opportunities for smaller scale matrix reserves exist in the NH-VT Uplands Ecoregion, as well as in the White Mountain Ecoregion. Protecting relatively small scale matrix communities is possible throughout the state.

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[6] McMahon, J. 1998. An inventory of potential ecological reserves on Maine's public lands and private conservation lands. Maine Forest Biodiversity Project.
Anderson 1997. See bibliography for "Scientific Principles" section for full reference.

Table 8. Ecological Criteria for the Evaluation of Potential Ecological Reserves		
Criteria	**Yes/No**	**Supporting Information**
1. Are there globally-rare species and natural communities?		
(names, number of occurrences, global rank, quality ranks for each occurrence)		
2. Are there concentrations of state-rare species and natural communities?		
(names, number of occurrences, global rank, quality ranks for each occurrence)		
3. Does the area have high physiographic or natural community diversity?		
(Name features and/or natural communities)		
4. Does the area support exemplary examples of natural community types,		
including common or matrix natural community types?		
(Name natural communities and quality rank of occurrences)		
5. Does the area support exemplary occurrences of disjunct, regionally-centered,		
or ecoregionally limited/restricted limited species and natural communities?		
(Name natural communities and quality rank of occurrences)		
6. Does the area support critical wildlife habitat?		
(Name species)		
7. Is the area within or adjacent to a core forest area (especially mature forest)?		
(List size of core forest and dominant matrix natural community types)		
8. Are the rare features of biodiversity well-buffered from human disturbance by matrix natural communities?		
9. Does the area expand on or connect existing conservation lands (riparian corridors are especially important)?		
10. Does the shape of the area minimize the extent of its edge (i.e., a blocky or circular shape)?		

Figure 10. Conceptual example of ecological reserve nested in areas of compatible human use.

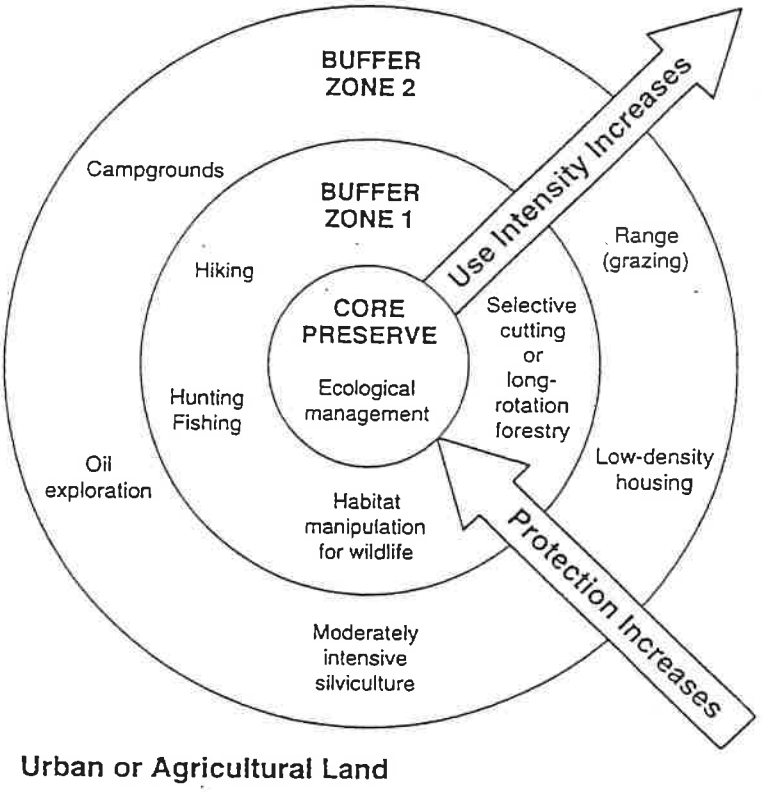

FIGURE 5.6 A multiple-use module (MUM). An inviolate core reserve is surrounded by a gradation of buffer zones, with intensity of human use increasing outward and intensity of protection increasing inward (from Noss 1987a, modified from Harris 1984). Used with permission of the Natural Areas Association.

From: Noss, R.F., and A.Y. Cooperrider.1994. Saving Nature's Legacy. Island Press, Washington.

Figure 11. Conceptual example of ecological reserve nested in areas of compatible human use.

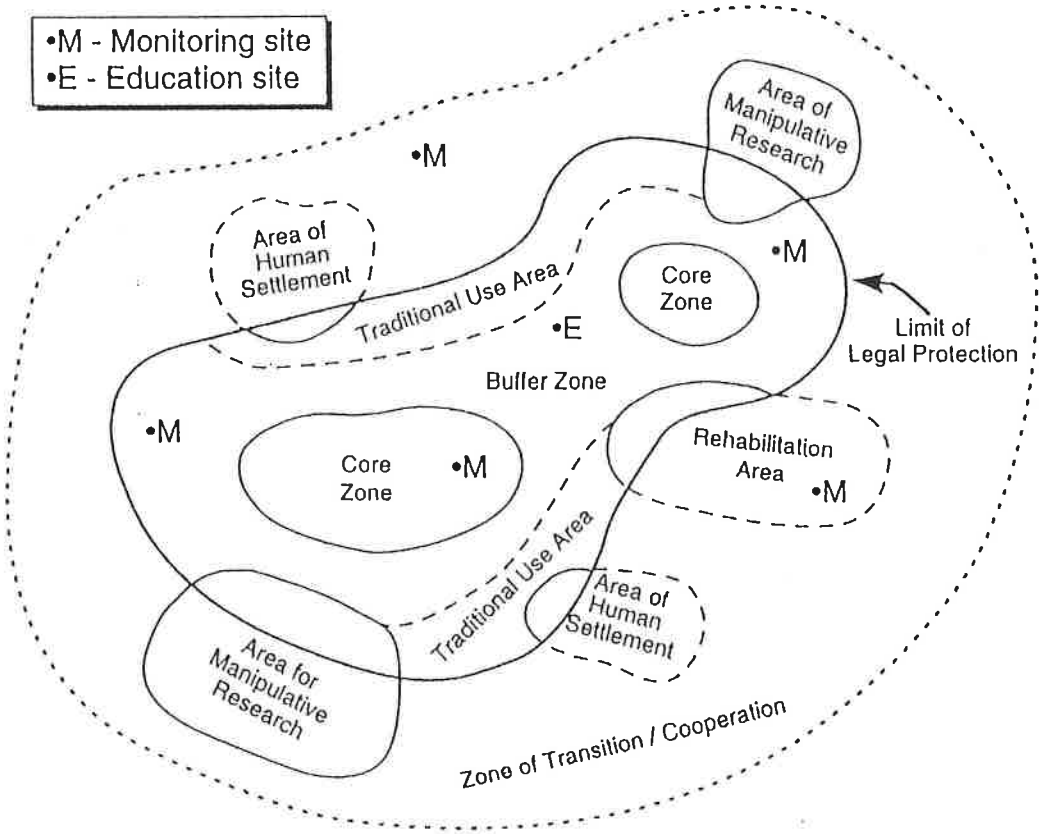

FIGURE 5.5 Conceptual layout of an ideal biosphere reserve (based on Hough 1988).

From: Noss, R.F., and A.Y. Cooperrider.1994. Saving Nature's Legacy. Island Press, Washington.

Finally, there are significant isolated features of biodiversity worthy of inclusion in a reserve system throughout the state.

C. Information Needs

1. Continue developing practical applications of the databases and Geographic Information Systems used to conduct this assessment. Develop a centralized database and set of GIS data layers and develop a webpage that provides access to New Hampshire biodiversity information. Integrate extensive databases on animal species developed and maintained by the Audubon Society of New Hampshire.

2. Encourage expanded inventory work by the New Hampshire Natural Heritage Inventory and the New Hampshire Fish and Game Department's Nongame and Endangered Wildlife Program. Our knowledge of the distribution and status of rare species and all natural communities must be improved.

3. Implement a comprehensive and standardized review of conservation lands that includes complete ecological inventories and assessments of management practices.

4. Develop our understanding of the status and threats to the state's aquatic communities.

5. Develop a monitoring program for tracking the status of known occurrences of priority species and natural communities.

D. Implementation Strategies

The general recommendation from the Scientific Advisory Group is to begin a broad-based, collaborative effort with public lands managers and willing private landowners to design and establish a system of ecological reserves. The establishment of reserves can occur in a variety of ways and under a variety of institutional frameworks. What is important is that we begin to apply our understanding of significant features of biodiversity and the principles of reserve design to on-the-ground land conservation and management efforts.

Some of the specific recommendations are:

1. Work with public lands managers to establish effective biodiversity conservation strategies on public lands known to harbor concentrations of rare species, natural communities, and landscape features. For many public land managers and their private partners, biodiversity conservation is already a top priority. Public conservation lands that contain concentrations of rare features (more than 3 known species) are listed in Appendix III. Identify public lands with biodiversity features that are not currently receiving sufficient management attention.

2. Support private-public land protection partnerships in regions identified by the EPA's Resource Protection Project: Great Bay, the Ossipee region, the White Mountains, the Connecticut River, the Connecticut Lakes region, and Lake Umbagog. The work of the Scientific

Advisory Group confirms the significance of these priority areas. While they are more broadly defined, these areas overlap to some extent with the 6 concentration areas listed in the Plant and Community Diversity section.

3. Support ongoing land protection and watershed management initiatives on major rivers and riparian corridors with known concentrations of rare features, for example, the Connecticut and Merrimack Rivers. Major river corridor protection requires, in addition to land protection, a suite of conservation strategies such as regulatory measures and management agreements with dam owners.

4. Support the work of the Land and Community Heritage Commission. Hold briefings for members of the Commission to highlight the results of this report and the importance protecting ecologically-important lands and the need for an ecological reserve system.

5. Work with Regional Planning Commissions, local conservation commissions, and local groups throughout the state to raise awareness of biodiversity features. Notify towns of biological information available for use in decision-making. See Appendix III for examples of information that can be distributed to towns.

6. Work with private landowners on voluntary registration of important lands.

7. Develop educational programs for private landowners, land managers, and foresters that lead to integration of biodiversity protection into land management plans and timber harvesting plans. These educational programs could be implemented through the existing programs of University of New Hampshire's Cooperative Extension Program, county foresters, forester licensing programs, etc.

Appendix I
Additional Sources of Information

This report builds upon the wide range of existing work on the status and management of bioidversity in New Hampshire. The following documents should be consulted for more general information on the state's biodiversity as well as for information on specific managed areas.

For a primer on the biodiversity of New Hampshire:

> Taylor, J., T. D. Lee, and L. F. McCarthy, eds. 1996. New Hampshire's Living Legacy: The Biodiversity of the Granite State. New Hampshire Fish and Game Department, Nongame and Endangered Wildlife Program, Concord, N. H. *Contact Fish and Game at (603) 271-2462 for a copy of the book.*

For background on the Northern Forest Lands Council recommendations:

> Northern Forest Lands Council. 1994. Finding Common Ground: the Recommendations of the Northern Forest Lands Council. Northern Forest Lands Council. *Contact N. H. Division of Forests and Lands at (603) 271-2214 for a copy of recommendations and technical appendix.*

For statewide forest planning efforts:

> Forest Resources Plan Steering Committee. 1996. New Hampshire Forest Resources Plan. N. H. Division of Forests and Lands, Concord, N.H. *Contact N.H. Division of Forests and Lands at (603) 271-2214 for a copy of the Plan and the Assessment Report.*

For an assessment of environmental risks in New Hampshire:

> NH Comparative Risk Project. 1997. Report on Ranked Environmental Risks in New Hampshire. Concord, NH. Contact (603) 226-1009 for a copy of the report.

For information on rare plants, rare wildlife, and exemplary natural communities:

> Audubon Society of New Hampshire
> 2 Silk Farm Road, Concord, NH 03301. (603) 224-9909.
>
> New Hampshire Natural Heritage Inventory
> Division of Forests and Lands, Department of Resources and Economic Development.
> P. O. Box 1856, Concord, NH 03302. (603) 271-3623.
>
> Non-Game and Endangered Wildlife Program, Fish and Game Department
> Hazen Road, Concord, NH 03301. (603) 271-2462.

For suggested good forestry practices:

> New Hampshire Forest Sustainability Standards Work team. 1997. Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire. Society for the Protection of New Hampshire Forests, Concord, N.H. *Contact the Society for the Protection of New Hampshire Forests at (603) 224-9945 for a copy of the manual.*

For wildlife habitat management information:

Community Habitat Mapping Manual. New Hampshire Fish and Game Department, Nongame and Endangered Species Program. *Contact Fish and Game at (603) 271-2462 for a copy of the book.*

For information on the implications of land conservation on local taxes:

Auger, P. A. 1996. Does Open Space Pay? UNH Cooperative Extension, Durham, NH. *Call (603) 862-0107 for a copy.*

Society for the Protection of NH Forests and NH Wildlife Federation. 1997. The Dollars and Sense of Open Space. Contact the NHWF at (603)224-5953 for informational materials and for scheduling the slide show.

For information on wildlife management, forestry practices, and land management:

Division of Forests and Lands, Department of Resources and Economic Development.
P. O. Box 1856, Concord, NH 03302. (603) 271-2214.

New Hampshire Timberland Owners Association
54 Portsmouth Street, Concord, NH 03301. (603) 224-9699.

Society for the Protection of New Hampshire Forests
54 Portsmouth Street, Concord, NH 03301. (603)224-9945

Audubon Society of New Hampshire
2 Silk Farm Road, Concord, NH 03301. (603) 224-9909.

Non-Game and Endangered Wildlife Program, Fish and Game Department
Hazen Road, Concord, NH 03301. (603) 271-2462.

University of New Hampshire Cooperative Extension. Pettee Hall, 55 College Road. University of New Hampshire. Durham, HN 03824-3599. (603) 862-0107.

For information on private land conservation:

Audubon Society of New Hampshire
3 Silk Farm Road, Concord, NH 03301. (603)224-9909.

The Nature Conservancy
2 1/2 Beacon Street, Suite 6, Concord, NH 03301. (603)224-5853.

Society for the Protection of New Hampshire Forests
54 Portsmouth Street, Concord, NH 03301. (603)224-9945.

For information on public lands management plans:

Division of Forests and Lands, Department of Resources and Economic Development
P. O. Box 1856, Concord, NH 03302. (603) 271-2214.

Fish and Game Department
Hazen Road, Concord, NH. (603) 271-2462.

White Mountain National Forest
719 Main Street, Laconia, NH 03246. (603) 528-8796.

Appendix II

Supporting Materials for Scientific Advisory Group Findings and Recommendations

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Methods

In order to evaluate biodiversity from a variety of perspectives, the Scientific Advisory Group selected the following measures, or indicators, of the status of biodiversity: rare plant species, rare or vulnerable animal species, natural communities (including both rare and common types), subwatersheds with concentrations of unusual physical or geologic characteristics, and core forest areas (a measure of unfragmented forested blocks).

The analyses conducted by the Scientific Advisory Group are based on existing databases housed at the New Hampshire Natural Heritage Inventory and the Fish and Game Department. It is important to note that these databases are by no means complete and do not represent a comprehensive sampling of the state's biodiversity. Many portions of the state have never been systematically surveyed, and may therefore erroneously appear to have no occurrences of rare species or natural communities. The Scientific Advisory Group, however, the data do reflect real trends in the status of biodiversity and the effectiveness of the current system of conservation lands.

Animals

The status and distribution of animal species was assessed through the use of databases at the Fish and Game Department and the Natural Heritage Inventory and coordinated by John Kanter of the Fish and Game Department's Nongame and Endangered Wildlife Program. The driving goal for animals was to develop a list of species that should be considered as priorities for inclusion in the design of a system of ecological reserves. Jim Taylor of the University of New Hampshire developed a matrix to select a list of species that demonstrated a level of vulnerability that requires conservation (see attached species matrices). Because distribution and population trend information is poorly known for many species, experts were assembled as a way to assess species population conditions and vulnerability. The knowledge of these experts was used extensively to formulate the species list.

The criteria for inclusion in the list include:

- species that are on the state threatened and endangered lists
- species with the unofficial designation of special concern
- species ranked as critically imperiled by the Natural Heritage Inventory
- species recommended by programs such as Partners in Flight
- species recommended through consensus professional judgment

While our understanding of some groups of animals, such as terrestrial vertebrates, is quite good, much more work needs to be done to assess the status of invertebrates and fish. Even among terrestrial vertebrates, some groups like bats remain poorly understood.

As emphasized above, it is important to note that the databases used for this analysis are incomplete. Not only do the databases not reflect al the bioidversity of New Hampshire, they may in some instances not even contain all the known occurrences of priority species. Therefore, developing an integrated database for animals and an effective method of assimilating new data is of paramount importance.

Plants and natural communities

The analyses of plants and natural communities were conducted by the Natural Heritage Inventory ("NHI") using the Biological and Conservation Database (BCD). NHI maintains records and tracks the status of 383 plant species and over 100 natural community types. NHI has current records (at least one observed occurrence in the last 20 years) for 248 plant species and 98 natural community types. All 248 plant species and 98 natural communities were identified by experts as high-priority targets for conservation efforts. Plants and natural community types were then evaluated from a variety of perspectives, such as state and global rarity and number of exemplary occurrences, in order to provide more detailed information as to their patterns of rarity and sensitivity.

In understanding the use of BCD as an analysis tool, one should keep in mind that there has never been a systematic statewide inventory of plants and natural communities. The results of the BCD analyses, therefore, are biased towards the regions and types of habitats that Heritage ecologists and others have been able to inventory. Also, NHI has traditionally focused on rare natural communities; therefore, our knowledge of exemplary examples of common community types is not as thorough as we would like.

Landscape and geologic diversity

This work was guided conceptually by members of the Scientific Advisory Group, with the technical work conducted largely at the University of Vermont's Spatial Analysis Lab under the direction of David Capen.

A. Significant subwatersheds

Based on data from the GRANIT watershed coverage delineated at the 1:24 000 scale by the NH Department of Environmental Services, New Hampshire was divided into 113 watershed units. Fifteen measures of physical and geologic diversity were grouped into 5 categories: wetlands, lakes, topographic diversity, parent soil materials, and bedrock geology. Each watershed was then scored on a 1-10 basis (with 10 being the highest score) for abundance and rarity. The watershed units with the highest 5 values (6-10) per variable were considered in the final analysis.

62 watershed units scored 6-10 for at least one variable. To simply illustrate the highest scoring watershed units, 5 map composites were created, one for each category of variables. The map composites provide a visual summary of the 5 categories. In essence, then the watersheds that score highly for several variables may be areas of unusual concentrations of physical or geologic features. Subwatersheds in areas with obviously significant landscape characteristics, such as the Great Bay Estuary and the Presidential Range of the White Mountains, are shown. Watersheds with more subtle characteristics that are still important in terms of influencing biodiversity (for example, areas with pockets of enriched bedrock that are not mapped on current bedrock geology maps) may not have been highlighted by this analysis.

B. Core forest areas

Landsat TM (thematic mapper) imagery for 1992-93 was used to develop a land-cover/land-use (LCLU) map for the state of New Hampshire. The map was developed in the

University of Vermont's Spatial Analysis Laboratory as part of the Gap Analysis Project, and was designed to be compatible with a similar product for Vermont. To maintain high accuracy, only 6 classes of land cover/land use were delineated: forest, developed land, other non-forested land (agriculture, fallow, etc.), wetlands, surface water, and roads. Four of these classes were interpreted from TM imagery-- forest, developed, surface water, and other non-forest. The other categories were "burned into" the map from existing sources of data. Roads were taken from 1:100,000 U.S. Geological Survey digital line graphs (DLGs) using road classes 1-5, which define roads maintained year-round. Wetlands were from a LULC map developed by the Complex Systems Research Center at the University of New Hampshire. The final map was a raster coverage with 26 meter by 26 meter resolution.

An assessment of the accuracy of the map was done by using land-cover data derived from aerial videography flown across New Hampshire in 1995 and 1996. We used 1007 point locations (697 for forest, 51 for developed land, 57 for surface water, and 202 for the "other' category). User's accuracy of the classification was 92.3% for forest, 94.8% for developed land, 93.3% for surface water, and 85% for other.

Core forest was delineated and mapped by establishing buffers along edges of non-forest categories that reflect categories of human alteration of the landscape: roads, developed land, and "other." We did not buffer the borders of surface waters and wetlands. It was necessary to "mask" for high-elevation, open land, and to consider these land types as forest so they were not buffered. Two different buffers were used to produce two separate maps of core forest: a 400-meter edge buffer and a 100-meter edge buffer. The 400-meter buffer, if applied to a square parcel of unbroken forest land, would require more than 64 hectares (158 acres) in order to have core forest; the 100-meter buffer requires more than 4 hectares (9.88 acres).

Assessment of existing conservation lands

Conservation lands have been mapped and classified at 1:24 000 by the Society for the Protection of New Hampshire Forests using data from 1990-1995 and by the NH Office of State Planning using 1992 data. The map of conservation lands I currently being updated, and the version used was current as of January 1, 1998.

We overlaid point locations for each known occurrence of a species or natural community on a map of conservation lands in New Hampshire. Point locations are from the NH Natural Heritage Inventory. They are for the center of the occurrence (communities, in particular, may extend well beyond the point location) and are mapped to the nearest second of latitude and longitude.

Each occurrence whose point location was within the boundary of any conservation land was classified as being "on" conservation land. The lands were further classified based on the type of agency (private or public) primarily responsible for the land and the type of protection (fee ownership, easements, etc.).

To characterize how well protected each element is, we counted the total number of occurrences on conservation land for that element. We then assigned each element to one of three

groups that are intended to describe how well protected an element currently is. In the absence of a detailed analysis for each element of how many occurrences are needed to ensure its survival, we used a goal of 10 protected occurrences as a reasonable first approximation. For example, the U.S. Fish and Wildlife Service Recovery plan for Jesup's milk-vetch (*Astragalus robbinsii* var. *jesupii*), one of the rarest plants in New Hampshire, sets a preliminary target of 10 viable occurrences to ensure the long-term survival of the species. The categories we used are:

Number of protected occurrences	How well is the element protected?
0-2	Poorly, if at all
3-9	Possibly well
10+	Quite well

Note that for the rarest elements in New Hampshire, there may only be 2-3 occurrences total anywhere in the state. So "poorly protected" does not necessarily mean that setting aside more conservation land would improve matters.

Also, just because an occurrence fall on conservation land does not mean that it is well protected under current management practices. Conversely, occurrences on private lands may be well protected under current management practices even though the land is not formally conserved.

Vulnerability of biodiversity

An assessment of the status of biodiversity in New Hampshire and the effectiveness of the current system of conservation lands must be viewed, at least in part, from the perspective of the vulnerability of biodiversity to development and irreversible land uses. In order to generate this perspective, the Scientific Advisory Group conducted an analysis of development trends in the state, on a township basis. This was not intended to be a comprehensive analysis of patterns of development and intensive land use, but a first pass using easily available data from the NH Department of Environmental Services (NH DES).

The three NH DES datasets that were used are:

1. Subdivision permit applications received. These applications are submitted for septic system approval for subdivisions; this category includes many small subdivisions. This dataset does not include the number of applications generally approved; however, NH DES confirms that many if not most of the permits are approved. 13, 121 records were used.

2. Numbers of lots for subdivision permit applications approved. These are the lot counts associated with approved subdivision applications. This dataset complements and expands on the subdivision permit dataset by yielding estimates of the total number of lots being created. 57,278 records were used.

3. Site specific or terrain alteration permits approved and pending. These are permits issued for large scale land disturbances such as subdivision roads, gravel pits, golf courses, etc. 3800 records were used.

All data fall within the period of 1986-1997, and were sorted by municipality.

The datasets were joined to New Hampshire political boundary GIS coverages obtained from GRANIT, and maps were then generated for each NH DES dataset. As can be seen in the map keys, classification of the data in each map involves larger ranges in the higher numbers to help highlight those municipalities in which more intense change has occurred over the 10 year review period.

Because the municipalities exhibiting higher numbers varied from dataset to dataset, a composite map overlaying all three datasets was also produced in order to better illustrate the aggregate intensity of land use change in the state. Derivative datasets were first created from each dataset by using a statistical modeling technique (Jenk's optimization) that reveals the "natural breaks" or significant numerical changes in groups of records. Five classes of data were generated for each dataset using this grouping method, but only the top two classes were selected for the derivative datasets. Subsequently, the three derivative datasets were merged and reclassified according to which of the three measures (subdivisions, lot counts, and site specific permits) were overlapping within a municipality. The composite map is in the key findings section.

The four maps produced in this analysis are striking in terms of the correlation that appears in southeastern New Hampshire, especially in the urbanized corridor extending from Concord south to Nashua and including the southern tier towns. Also, several Lakes Region and White Mountain Region towns appear to have experienced relatively intense land use change.

However, there may be several inconsistencies or subtleties in the datasets which give the impression of intensity where none exists. For example, the data on subdivisions is for applications received by NH DES, but not necessarily approved. The data on approvals are not yet available, so the actual number of subdivisions may be significantly lower than the data suggest. Nevertheless, the number of applications received does indicate the relative level of land use change intensity in a municipality occurring over the ten year period, and can be used as a comparative measure statewide.

Another, perhaps more important issue lies with the data available on the number of lots associated with subdivision applications that have been approved by NH DES. The lot counts are not in question, but the many of the larger numbers in the dataset are associated with condominium developments or possibly apartment buildings. Similarly, some of the records in the central and northern portions of the state appear to include campgrounds and trailer park sites. Thus, there is a question of what defines a lot, especially if very little land area is involved. Still, the numbers can be used to illustrate the range of development intensity around the state.

Last, the site specific permit data should also be used carefully because larger developments are already accounted for in the subdivision and lot count datasets probably also required these permits during road building and facility construction. Thus, there could be some triple counting biasing the aggregated dataset that inflates the actual level of development activity.

Synthesis of the data into a Geographic Information System (GIS)

Data on animals, plants, natural communities, subwatersheds, core forests, and conservation lands were aggregated into a single GIS, housed temporarily at the University of Vermont's Spatial Analysis Laboratory. Maps, such as Map 4, were then produced that depicted either single layers of data or multiple, integrated layers of data. Maps based on the assessment of the vulnerability of biodiversity were produced at the Society for the Protection of New Hampshire Forests; these data will be included in the overall GIS.

The goal of the Project scientists is to develop a single GIS that provides researchers, planners, and land managers with access to the information in an efficient manner. Much more work needs to be done to improve these datasets: we need to update the datasets that were used for the analysis and we need to incorporate additional existing data sets such as those maintained by the Audubon Society of New Hampshire. Finally, we need to establish a webpage that facilitates use of these data.

Endangered and Threatened WILDLIFE OF NEW HAMPSHIRE

Endangered wildlife are those native species whose prospects for survival in New Hampshire are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to ensure continued existence as a viable component of the state's wildlife community.

Threatened wildlife are those species which may become endangered if conditions surrounding them begin, or continue, to deteriorate.

— MAMMALS —

Endangered	*Threatened*
Canada lynx, *Lynx canadensis*	pine marten, *Martes americana*
small-footed bat, *Myotis leibii*	

— BIRDS —

Endangered	*Threatened*
pied-billed grebe, *Podilymbus podiceps*	common loon, *Gavia immer*
common tern, *Sterna hirundo*	least tern, *Sterna antillarum*
*piping plover, *Charadrius melodus*	arctic tern, *Sterna paradisaea*
upland sandpiper, *Bartramia longicauda*	*roseate tern, *Sterna dougallii*
*bald eagle, *Haliaeetus leucocephalus*	Cooper's hawk, *Accipter cooperii*
golden eagle, *Aquila chrysaetos*	northern harrier, *Circus cyaneus*
*peregrine falcon, *Falco peregrinus*	osprey, *Pandion haliaetus*
sedge wren, *Cistothorus platensis*	common nighthawk, *Chordeiles minor*
loggerhead shrike, *Lanius ludovicianus*	purple martin, *Progne subis*
Henslow's sparrow, *Ammodramus henslowii*	

— FISH —

Endangered	*Threatened*
Sunapee trout, *Salvelinus alpinus*	(none currently listed)
*shortnose sturgeon, *Acipenser brevirostrum*	

— REPTILES —

Endangered	*Threatened*
timber rattlesnake, *Crotalus horridus*	(none currently listed)

*** federally threatened or endangered**

— AMPHIBIANS —

Endangered	*Threatened*
(none currently listed)	(none currently listed)

— INVERTEBRATES —

Endangered	*Threatened*
* dwarf wedge mussel, *Alasmidonta heterodon* brook floater, *Alasmidonta varicosa* frosted elfin butterfly, *Incisalia irus* * Karner blue butterfly, *Lycaeides melissa samuelis* Persius duskywing skipper, *Erynnis persius* banded bog skimmer, *Williamsonia lintneri*	pine pinion moth, *Lithophane lepida lepida* pine barrens zanclognatha moth, *Zanclognatha martha* cobblestone tiger beetle, *Cicindela marginipennis*

*** federally threatened or endangered**

History of Endangered Wildlife Protection in New Hampshire

1973 - The Endangered Species Act, a federal law, was passed. It protects wildlife and plant species in danger of nationwide extinction.

1979 - The New Hampshire Endangered Species Conservation Act was passed, giving New Hampshire Fish and Game Department the authority to protect wildlife in danger of becoming extinct in New Hampshire.

1980 - The first list of New Hampshire threatened and endangered wildlife was created

1987 - The threatened and endangered wildlife list was revised. This list, effective 6/29/87, remains in effect.

The list of New Hampshire's endangered and threatened wildlife is maintained by the New Hampshire Fish & Game Department. The list is used to determine protection and management actions necessary to ensure the survival of the state's endangered and threatened wildlife. State and federal agencies and numerous New Hampshire nonprofit conservation organizations work cooperatively to protect and manage the state's wildlife. The Fish & Game Department has legal authority regarding all wildlife, game, nongame and endangered or threatened species.

This work is made possible through voluntary contributions to the Nongame and Endangered Wildlife Program. Donations to this program are matched by state dollars. A small amount of federal money, available only for federally listed species, also assists wildlife. With your help we are able to protect New Hampshire's wildlife.

For more information about the Nongame and Endangered Wildlife Program, to report a sighting of threatened or endangered wildlife, or to make a contribution contact:

Nongame & Endangered Wildlife Program
New Hampshire Fish & Game Department
2 Hazen Drive, Concord, NH 03301

or call **(603) 271-2462.**

(11/94)

NEW HAMPSHIRE NATURAL HERITAGE INVENTORY
DRED - DIVISION OF FORESTS & LANDS
PO BOX 1856 -- 172 PEMBROKE ROAD, CONCORD, NH 03302-1856
(603) 271-3623

Animal Tracking List

Including species listed as threatened or endangered under the NH Endangered Species Conservation Act of 1979

This list is maintained in cooperation with the

Nongame & Endangered Wildlife Program
New Hampshire Fish & Game Department
2 Hazen Drive, Concord, NH 03301
(603) 271-2462

June 1998

A Quick Overview of the NH Natural Heritage Inventory's Purpose and Policies

The Natural Heritage Inventory is mandated by the Native Plant Protection Act of 1987 (NH RSA 217-A) to determine protective measures and requirements necessary for the survival of native plant species in the state, to investigate the condition and degree of rarity of plant species, and to distribute information regarding the condition and protection of these species and their habitats.

The Natural Heritage Inventory provides information to facilitate informed land-use decision-making. We are not a regulatory agency; instead, we work with landowners and land managers to help them protect the State's natural heritage and meet their land-use needs.

The Natural Heritage Inventory has three facets:

Inventory involves identifying new occurrences of sensitive species and classifying New Hampshire's biodiversity. We currently study more than 600 plant and animal species and 120 natural communities. Surveys for rarities on private lands are conducted only with landowner permission.

Tracking is the management of occurrence data. Our database currently contains information about more than 4,000 plant, animal, and natural community occurrences in New Hampshire.

Interpretation is the communication of Natural Heritage Inventory information. Our goal is to cooperate with public and private land managers to help them *protect* rare species populations and exemplary natural communities.

The Nongame & Endangered Wildlife Program of the NH Fish & Game Department coordinates protection efforts for the state's wildlife that are not hunted, fished, or trapped. The Nongame Program works closely with the NH Natural Heritage Inventory to maintain a database of rare and imperiled wildlife populations throughout the state. Locational information about rare animals in the Natural Heritage Inventory database compliments a habitat-based database for all of New Hampshire's wildlife that is managed by the NH Fish & Game Department.

Animals Tracked by the Nongame Program and the NH Natural Heritage Inventory

The following list is our current assessment of the status of the state's rarest and most imperiled animal species. The Nongame Program has developed the list in cooperation with researchers, conservation organizations such as the Audubon Society of New Hampshire, knowledgeable amateur biologists, and the NH Natural Heritage Inventory. We obtained wildlife locations from sources including museum specimens, personal contacts, the scientific literature, and through extensive field research. It is important for readers to remember that this list is dynamic -- as new discoveries are made or populations are lost, species may be added to or removed from the list.

For each species, we have provided the following information:

Common Name — Common names are provided for all species that have them. Many insect species, particularly moths, do not have common names, so general terms such as "A Noctuid Moth" are used.

Scientific Name — Scientific names are standardized with the scientific names used by other Natural Heritage programs throughout the United States, Canada, the Caribbean, Latin America, and South America.

Global & State Ranks — When considering the rarity of a species, it is important to consider the status of a species both in New Hampshire and across its total range. The degree of rarity within New Hampshire is noted with a "State Rank" and throughout its range with a "Global Rank." Ranks are on a scale of 1 to 5, with a 1 indicating critical imperilment, a 3 indicating that the species is uncommon, and a 5 indicating that the species is stable and common. Some species, such as the dwarf wedgemussel *(Alasmidonta heterodon)*, are critically imperiled both globally and in New Hampshire. Other species, such as the upland sandpiper *(Bartramia longicauda)*, are very rare in New Hampshire (S1) but quite common in other parts of their range (G5).

The rankings for wildlife are based more on the degree of imperilment than on the number of occurrences in the state, although abundance certainly plays a role in assessing a species' long-term viability in New Hampshire. Some species, such as the fish crow *(Corvus ossifragus)* have only a few occurrences in New Hampshire but, since they are expanding northward into the state, they are not considered imperilled. Blandings turtles *(Emydoidea blandingii)*, on the other hand, appear to be distributed fairly broadly across the state, but populations are extremely small and vulnerable to habitat loss, so they are considered at risk.

In this technical list, we have noted the full global and state ranks. The codes are defined on pages 3 and 4.

Listing

A portion of New Hampshire's rare animals are listed as "threatened" or "endangered" under the NH Endangered Species Conservation Act of 1979 (NH RSA 212-A). Five of these species are also listed under the federal Endangered Species Act of 1973 (42 USCA §§ 4321-4370c). Listing represents a political recognition of rarity, so some species that are biologically rare (as indicated by the State and Global Ranks) may not be listed as "threatened" or "endangered." Under the NH Endangered Species Conservation Act, "endangered" species are those in danger of being extirpated from the state, while "threatened" species face the possibility of becoming "endangered."

Known Locations

There has not been a comprehensive search of the state for rare species, so we are frequently finding or learning about previously unknown populations. Further, many populations have not been checked since they were originally found, sometimes more than 50 years ago, so we do not know the status of these populations. We have therefore separated Known Locations into two sub-categories: those last seen prior to 1978, and those reported on or after 1978. This distinction helps show the state of our knowledge about a given species and the need for additional research.

You Can Help!

Our biologists can only cover so much ground, so we are constantly seeking information from other sources. Knowledgeable recommendations for adding or removing species from the list of "endangered" and "threatened" species are always welcomed. Further, locational information about any of the species we track will help make our database more complete and therefore more useful for land-use planning. A form for reporting rare animal species that you find is attached to the back of this list. It is the policy of the NH Natural Heritage Inventory not to survey on private property without landowner permission, so please respect your neighbor's privacy. Thank you!

If you have any questions or need additional information, please do not hesitate to contact us.

Address: Nongame Program/NHF&G
2 Hazen Drive
Concord, NH 03301

Telephone: (603) 271-2462
Fax: (603) 271-1438

Address: Natural Heritage Inventory/DRED
PO Box 1856
Concord, NH 03302-1856

Telephone: (603) 271-3623
Fax: (603) 271-2629

Explanation of Global and State Rank Codes

Ranks describe rarity both throughout a species' range (globally, or "G" rank) and within New Hampshire (statewide, or "S" rank). The rarity of sub-species and varieties is indicated with a taxon ("T") rank. For example, a G5T1 rank shows that the species is globally secure (G5) but the sub-species is critically imperiled (T1).

Code	*Examples*		*Description*
1	G1	S1	Critically imperiled because extreme rarity (generally one to five occurrences) or some factor of its biology makes it particularly vulnerable to extinction.
2	G2	S2	Imperiled because rarity (generally six to 20 occurrences) or other factors demonstrably make it very vulnerable to extinction.
3	G3	S3	Either very rare and local throughout its range (generally 21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction because of other factors.
4	G4	S4	Widespread and apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5	G5	S5	Demonstrably widespread and secure, although the species may be quite rare in parts of its range, particularly at the periphery.
U	GU	SU	Status uncertain, but possibly in peril. More information needed.
H	GH	SH	Known only from historical records, but may be rediscovered. A G5 SH species is widespread throughout its range (G5), but considered historical in New Hampshire (SH).
X	GX	SX	Believed to be extinct. May be rediscovered, but evidence indicates that this is less likely than for historical species. A G5 SX species is widespread throughout its range (G5), but extirpated from New Hampshire (SX).
E		SE	An exotic that is established in the state, but may be native in nearby regions.

The following modifiers indicate that there is some question about a species' rank.

Code	*Examples*		*Description*
Q	G5Q	GHQ	Questions or problems may exist with the species' or sub-species' taxonomy, so more information is needed.
?	G3?	S3?	The rank is uncertain due to insufficient information at the state or global level, so more inventories are needed. When no rank has been proposed the rank may be "G5T?" or "S?"

The following modifiers indicate when the breeding status of a migratory species is considered separately from individuals passing through or not breeding within the New Hampshire. These modifiers are only attached to state ranks.

Code	*Example*	*Description*
B	SHB	Indicates the breeding status in New Hampshire of a migratory species.
N	S1N	Indicates the non-breeding status in New Hampshire of a migratory species. These species are typically over-wintering birds with regular aggregation areas that could be conservation targets.
Z	SZN	Indicates that non-breeding occurrences of a species are not tracked by the NH Natural Heritage Inventory. These species are typically birds that over-winter sporadically in New Hampshire.

Breeding-status modifiers may be used alone or in combinations. For example:

S3B,SZN	Breeding occurrences are uncommon (S3B), and over-wintering birds are not tracked (SZN).
SHB,SZN	Only historical records of breeding are known (SHB), and over-wintering birds are not tracked (SZN).
S3B	Breeding occurrences are uncommon (S3B), and the species does not over-winter in New Hampshire.
SUB,S1N	The breeding status of the species is unknown (SUB), and any wintering site is critically imperiled or extremely rare (S1N) regardless of breeding status.

When ranks are somewhat uncertain or the species' status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The species may be globally secure (G5), but appears to be at some risk (G4).
G5T2T3	The species is globally secure (G5), but the sub-species is somewhat imperiled (T2T3).
G4?Q	The species appears to be relatively secure (G4), but more information is needed to confirm this (?). Further, there are questions or problems with the species' taxonomy (Q).
G3G4Q S1S2	The species is globally uncommon (G3G4), and there are questions about its taxonomy (Q). In New Hampshire, the species is very imperiled (S1S2).

New Hampshire Natural Heritage Inventory

Rare Animal Species in New Hampshire

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Invertebrates - Mollusks						
Brook Floater (Alasmidonta varicosa)	G3	S1?	-	E	3	27
Dwarf Wedge Mussel (Alasmidonta heterodon)	G1	S1	E	E	7	12
Eastern Pondmussel (Ligumia nasuta)	G4G5	S1	-	-	1	3
Invertebrates - Insects						
-- (Agrotis stigmosa)	G4	SU	-	-	-	1
-- (Anomogyna perquiritata)	G5	S2S3	-	-	3	-
-- (Apantesis carlotta)	G4	SU	-	-	-	1
-- (Catocala sp 1)	G5	S1S2	-	-	-	2
-- (Papaipema lysimachiae)	G4	S?	-	-	-	2
-- (Xanthorhoe algidata)	G?	S2S3	-	-	-	2
A Geometrid Moth (Euchlaena madusaria)	G5	S1	-	-	-	2
A Geometrid Moth (Eumacaria latiferrugata)	G4G5	S2S4	-	-	-	3
A Geometrid Moth (Itame subcessaria)	G4?	SH	-	-	1	-
A Geometrid Moth (Metarranthis apiciaria)	GU	SH	-	-	1	1
A Geometrid Moth (Xanthorhoe ramaria)	G5	S2S3	-	-	1	-
A Moth (Grammia quenseli)	G5	S2	-	-	1	2
A Moth (Gynaephora rossii)	G5	S2	-	-	2	-
A Moth (Hepialus hyperboreus)	G5	S1S3	-	-	1	-
A Noctuid Moth (Acronicta lanceolaria)	G4	S3	-	-	-	1
A Noctuid Moth (Anarta melanopa)	G5	S?	-	-	3	6
A Noctuid Moth (Andropolia contacta)	G5	SH	-	-	1	-
A Noctuid Moth (Anepia capsularis)	G5	SH	-	-	1	-
A Noctuid Moth (Anomogyna fabulosa)	G4	S2	-	-	1	1
A Noctuid Moth (Anomogyna homogena)	G4	S2?	-	-	1	-
A Noctuid Moth (Anomogyna imperita)	G5	S2S3	-	-	-	1
A Noctuid Moth (Anomogyna rhaetica)	G4	S1S2	-	-	-	1
A Noctuid Moth (Anomogyna speciosa)	G5	S2S3	-	-	1	-
A Noctuid Moth (Apharetra purpurea)	G4	S2	-	-	-	4
A Noctuid Moth (Chaetaglaea cerata)	G3G4	S2S3	-	-	4	1
A Noctuid Moth (Chytonix sensilis)	G4	S1S2	-	-	2	1
A Noctuid Moth (Cucullia speyeri)	G4	S3	-	-	-	1
A Noctuid Moth (Eucoptocnemis fimbriaris)	G4	SH	-	-	2	-
A Noctuid Moth (Euxoa dissona)	G5	S2	-	-	1	-
A Noctuid Moth (Euxoa pleuritica)	G4	S1	-	-	2	1
A Noctuid Moth (Idia diminuendis)	G4G5	S2S4	-	-	3	-
A Noctuid Moth (Lasionycta leucocycla hampa)	G5T1T3	S2	-	-	-	1
A Noctuid Moth (Lasionycta subdita)	GU	S1S2	-	-	2	-
A Noctuid Moth (Lemmeria digitalis)	G4G5	SH	-	-	1	-
A Noctuid Moth (Lithophane thaxteri)	G4	SU	-	-	-	3
A Noctuid Moth (Pachnobia okakensis)	G4	SH	-	-	1	-
A Noctuid Moth (Pachnobia scropulana)	G4	SH	-	-	1	-
A Noctuid Moth (Platyperigea meralis)	G4	S1	-	-	-	2
A Noctuid Moth (Sphinx canadensis)	G4	SH	-	-	1	-

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
A Noctuid Moth (Sphinx eremitus)	G4	SH	-	-	1	-
A Noctuid Moth (Sympistis funesta)	G5	S2	-	-	1	1
A Noctuid Moth (Sympistis melaleuca)	G5	S1	-	-	-	1
A Noctuid Moth (Trichosilia manifesta)	G4	SH	-	-	2	-
A Noctuid Moth (Zale curema)	G4	S2	-	-	-	1
A Noctuid Moth (Zale obliqua)	G5	S2	-	-	-	1
A Noctuid Moth (Zale sp 1)	G3Q	S1	-	-	-	1
Appalachian Brown (Satyrodes appalachia)	G5	S1?	-	-	-	1
Aureolaria Seed Borer (Rhodoecia aurantiago)	G4	SU	-	-	1	-
Banded Bog Skimmer Dragonfly (Williamsonia lintneri)	G2	S1	-	E	-	4
Barrens Chaetaglaea (Chaetaglaea tremula)	G5	S?	-	-	-	1
Barrens Xylotype (Xylotype capax)	G4	S2	-	-	1	4
Blueberry Gray (Glena cognataria)	G4G5	S3?	-	-	-	2
Bog Elfin (Incisalia lanoraieensis)	G3	SH	-	-	1	-
Broad-Lined Catopyrrha (Catopyrrha coloraria)	G4	S1	-	-	1	-
Cobblestone Tiger Beetle (Cicindela marginipennis)	G2G3	S1	-	T	-	4
Cobweb Skipper (Hesperia metea)	G4G5	S3	-	-	-	5
Columbine Duskywing (Erynnis lucilius)	G4	SH	-	-	3	1
Dusted Skipper (Atrytonopsis hianna)	G4G5	S3?	-	-	-	2
Edwards' Hairstreak (Satyrium edwardsii)	G4	S3	-	-	-	2
Fen Ant (Lasius minutis)	G?	S1	-	-	-	1
Frosted Elfin (Incisalia irus)	G3G4	S1	-	E	2	5
Gooseberry Spanworm (Itame ribearia)	G4	SX	-	-	1	-
Graceful Clearwing (Hemaris gracilis)	G4	S2S3	-	-	5	3
Hackberry Butterfly (Asterocampa celtis)	G5	S2?	-	-	-	1
Henry's Elfin (Incisalia henrici)	G5	S2S3	-	-	-	1
Hessel's Hairstreak (Mitoura hesseli)	G3G4	SH	-	-	1	-
Hoary Comma (Polygonia gracilis)	G5	S1	-	-	1	3
Horace's Dusky Wing (Erynnis horatius)	G5	SU	-	-	-	1
Karner Blue Butterfly (Lycaeides melissa samuelis)	G5T2	S1	E	E	4	3
New Jersey Tea Span Worm (Apodrepanulatrix liberaria)	G4	S1S2	-	T	1	3
Noctuid Moth (Zale submediana)	G4	S3	-	-	-	2
Persius Dusky Wing (Erynnis persius persius)	G4T2T3	S1	-	E	3	2
Phyllira Tiger Moth (Grammia phyllira)	G4	S1	-	-	3	1
Pine Barrens Itame (Itame sp 1)	G3	S1S2	-	-	-	1
Pine Barrens Zanclognatha Moth (Zanclognatha martha)	G4	S1	-	T	-	4
Pine Devil (Citheronia sepulcralis)	G4	SX	-	-	3	-
Pine Pinion Moth (Lithophane lepida lepida)	G4T3T4	S1S2	-	T	-	1
Pinion Moth (Xylena thoracica)	G4	S2	-	-	1	2
Pink Sallow (Psectraglaea carnosa)	G3	SH	-	-	4	-
Sleepy Duskywing (Erynnis brizo brizo)	G5T5	S2	-	-	-	3
Southern Pine Sphinx (Lapara coniferarum)	G5	S1S2	-	-	-	2
Southern Variable Dart Moth (Anomogyna elimata)	G5	S3S4	-	-	-	1
Spiny Oakworm (Anisota stigma)	G5	SH	-	-	2	-
The Cora Moth (Cerma cora)	G3G4	S1S2	-	-	1	1
The Tawny Emperor (Asterocampa clyton)	G5	SZB	-	-	-	1
Twilight Moth (Lycia rachelae)	G4	S2	-	-	-	1
White Mountain Butterfly (Oeneis melissa semidea)	G5T2	S2	-	-	1	1
White Mountain Fritillary (Boloria titania montinus)	G5T2	S2	-	-	-	3

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Wild Indigo Dusky Wing (Erynnis baptisiae)	G5	S1	-	-	-	1
Vertebrates - Fish						
American Brook Lamprey (Lampetra appendix)	G4	S2	-	-	1	-
Banded Sunfish (Enneacanthus obesus)	G5	S3	-	-	8	-
Finescale Dace (Phoxinus neogaeus)	G5	S2	-	-	4	-
Lake Whitefish (Coregonus clupeaformis)	G5	S3	-	-	5	3
Round Whitefish (Prosopium cylindraceum)	G5	S3	-	-	-	3
Vertebrates - Amphibians						
Fowler's Toad (Bufo fowleri)	G5	S3	-	-	2	-
Jefferson Salamander (Ambystoma jeffersonianum)	G5	S2S3	-	-	-	1
Marbled Salamander (Ambystoma opacum)	G5	S1	-	-	2	-
Slimy Salamander (Plethodon glutinosus)	G5	SH	-	-	1	-
Vertebrates - Reptiles						
Blanding's Turtle (Emydoidea blandingii)	G4	S3	-	-	14	26
Eastern Box Turtle (Terrapene carolina)	G5	SE?	-	-	1	2
Eastern Hognose Snake (Heterodon platirhinos)	G5	S3	-	-	6	8
Spotted Turtle (Clemmys guttata)	G5	S3	-	-	4	22
Timber Rattlesnake (Crotalus horridus)	G5	S1	-	E	7	4
Wood Turtle (Clemmys insculpta)	G4	S3	-	-	-	6
Vertebrates - Birds						
American Bittern (Botaurus lentiginosus)	G4	S3B	-	-	-	2
Bald Eagle (Haliaeetus leucocephalus)	G4	S1	T	E	-	10
Black-Backed Woodpecker (Picoides arcticus)	G5	S3S4	-	-	-	7
Black-Crowned Night-Heron (Nycticorax nycticorax)	G5	SHB,SZN	-	-	-	1
Brown Thrasher (Toxostoma rufum)	G5	S3	-	-	-	1
Cerulean Warbler (Dendroica cerulea)	G4	S3B	-	-	-	1
Common Loon (Gavia immer)	G5	S3B,SZN	-	T	-	2
Common Moorhen (Gallinula chloropus)	G5	S2	-	-	-	4
Common Nighthawk (Chordeiles minor)	G5	S2B	-	T	-	1
Common Tern (Sterna hirundo)	G5	S1	-	E	-	5
Cooper's Hawk (Accipiter cooperii)	G5	S2B,SZN	-	T	-	2
Fish Crow (Corvus ossifragus)	G5	S3	-	-	-	3
Golden-Winged Warbler (Vermivora chrysoptera)	G4	S2B	-	-	-	2
Grasshopper Sparrow (Ammodramus savannarum)	G5	S1B	-	-	-	3
Great Blue Heron (rookery) (Ardea herodias)	G5	S4B,SZN	-	-	-	34
Henslow's Sparrow (Ammodramus henslowii)	G4	SHB	-	E	-	1
Horned Lark (Eremophila alpestris)	G5	S3B	-	-	-	1
Least Bittern (Ixobrychus exilis)	G5	S1	-	-	-	2
Northern Harrier (Circus cyaneus)	G5	S2B,SZN	-	T	-	25
Osprey (Pandion haliaetus)	G5	S2B,SZN	-	T	-	33
Peregrine Falcon (Falco peregrinus anatum)	G4T4	S1	E	E	8	13
Pied-Billed Grebe (Podilymbus podiceps)	G5	S1B,SZN	-	E	1	10
Piping Plover (Charadrius melodus)	G3	S1	T	E	-	1
Purple Martin (Progne subis)	G5	S1B	-	T	1	10
Ring-Necked Duck (Aythya collaris)	G5	S3B,SZN	-	-	1	7
Sedge Wren (Cistothorus platensis)	G5	S1	-	E	-	1
Three-Toed Woodpecker (Picoides tridactylus)	G5	S1	-	-	1	2

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Upland Sandpiper (Bartramia longicauda)	G5	S1	-	E	-	5
Water Pipit (Anthus rubescens)	G5	S1B,SZN	-	-	-	1
Vertebrates - Mammals						
Eastern Pipistrelle (Pipistrellus subflavus)	G5	S1N,SUB	-	-	-	2
Marten (Martes americana)	G5	S2	-	T	-	3
Northern Bog Lemming (Synaptomys borealis)	G4	SH	-	-	2	-
Small-Footed Myotis (Myotis leibii)	G3	S1	-	E	-	1
Vertebrates - Bat Hibernacula						
Abandoned Mine (Bat hibernaculum)	G5	S1	-	-	-	7

Rank Prefix:

G = Global Rank
S = State Rank
T = Global or State rank for a subspecies or variety.

Rank Suffix:

1 = Critically imperiled due to rarity or vulnerability
2 = Imperiled
3 = Rare / uncommon
4 = Widespread but with cause for long-term concern
5 = Widespread, abundant, and secure
E = Exotic
RF = Reported falsely
Z = Zero occurrences
H = Occurred historically, not known to have beeen extirpated
X = Extirpated
?/U = Not ranked / Unknown
Q = Questionable taxonomy

Listing Codes:

T = Threatened
E = Endangered

DRAFT

Table PC.9. Number of known occurrences on conservation lands for animal species.

Number OFF	Number of occurrences ON conservation land		
	0-2	3-9	10+
No one knows	Jefferson salamander Northern leopard frog Fowler's toad Wood turtle Rusty blackbird Salt marsh sharp-tailed sparrow Seaside sparrow Sedge wren Common moorhen American bittern Least bittern Common nighthawk Horned lark Eastern pipistrelle Pine marten New england cottontail		
10+	Dwarf wedge mussel Brook floater Purple martin Eastern hognose snake		
3-9	Marbled salamander Karner blue butterfly Cobblestone tiger beetle Persius dusky wing Frosted elfin Pine barrens zanclognatha moth Banded bog skimmer dragonfly Timber rattlesnake Black guillemot Common tern Upland sandpiper Grasshopper sparrow		
0-2	Pine pinion moth Water pipit Least tern Piping plover Bald eagle Three-toed woodpecker Small-footed myotis Northern bog lemming	Spotted turtle Pied-billed grebe Willet Vesper sparrow Common loon Northern harrier	Blanding's turtle Osprey Peregrine falcon

Example animal species maps and descriptions

maps using GIS for each one. Appendix will eventually include all state listed wildlife and species of special management concern

Species Information Sheet Outline y

ENDANGERED SPECIES

Species: **bald eagle** (Haliaeetus leucocephalus)

Geographic Area - Regional Occurrence in the State: statewide
Priority Conservation Zones. Shoreline of Great Bay, Merrimack River from Concord to Massachusetts Border, Androscoggin River, Connecticut River. Area of Lake Winnipesaukee and Winnipesaukee River

Habitat Associations:
Breeding: islands and shores of large lakes, rivers, bays

Winter: Same as above, however, ice free areas created by tail-waters of dams, rapids, power stations and tidal fluctuations are critical to providing feeding areas.
During night and periods of inclement weather, Eagles roost in large white pines areas.

Probability of Occurrence at Undocumented locations:
Breeding: Low
Wintering: Moderate

Protection Strategies:

Adopt state shoreland protection standards.

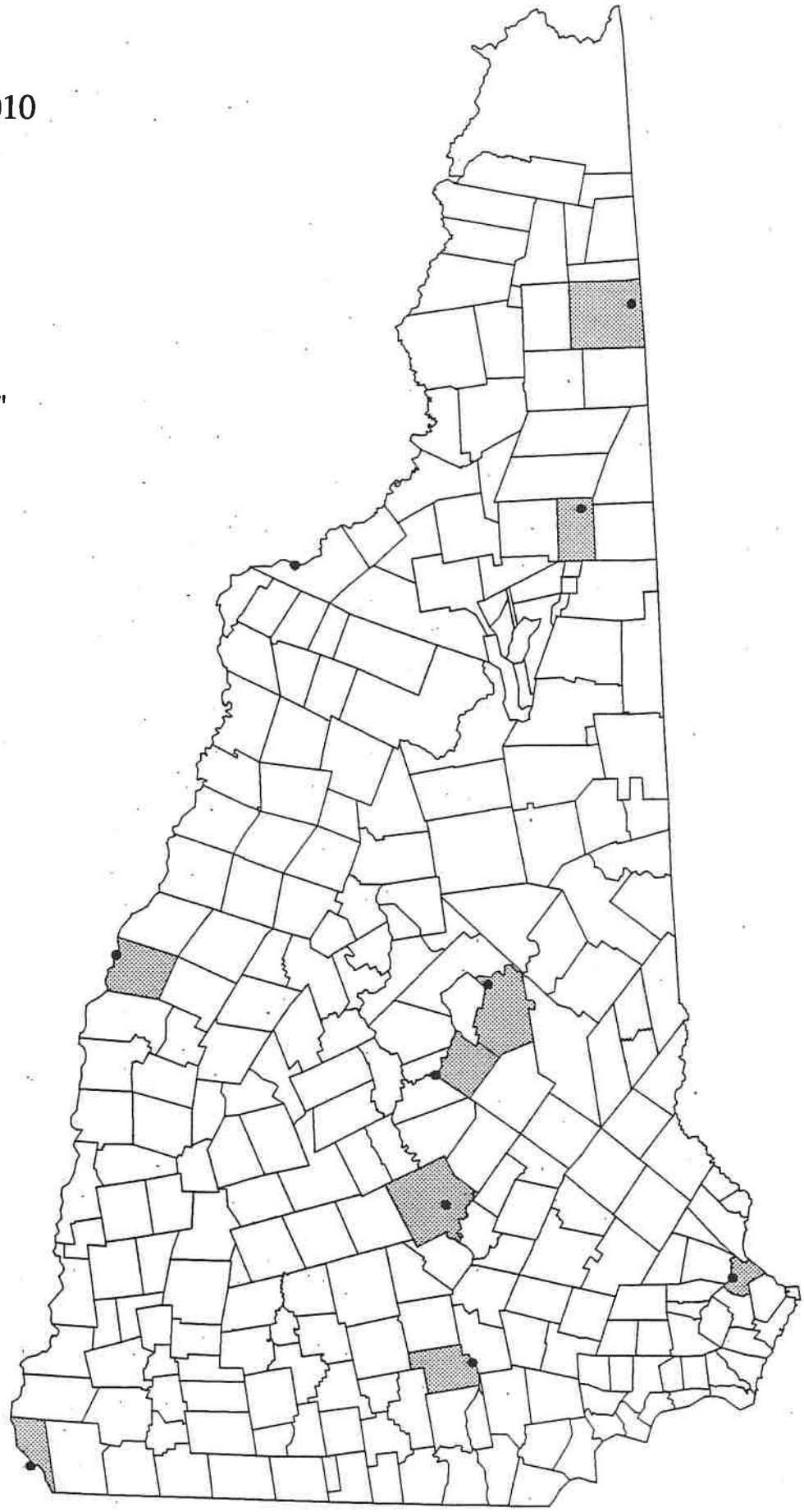
Further provide recommendations (restrictions) on tree removal within 250' zone. All standing dead trees should also be left. Treat all trees within 250' feet of shore as potential. Target areas that remain ice free during winter. Restrict winter recreational activity from known areas of high use.

Where to go for more Information? Audubon Society of NH, NH Fish and Game Department, and the US Fish and Wildlife Service have been working together with volunteers since 1980 to track numbers and identify important locations.

Bald Eagle

Elcode: ABNKC10010

Point locations from
database "ERS_ADOT"



Species Information Sheet Outline

Species: . **spotted turtle** (Clemmys guttata)

Geographic Area - Regional Occurrence in the State: Strafford, Rockingham, Hillsborough and Southern Merrimack County.

Habitat Associations: A variety of wetlands including woodland streams, wet meadows, beaver ponds bog holes, small ponds, marshes, swamps and brackish tidal creeks. Preference for a series of small shallow wetlands???? check and reference Joyal

Probability of Occurrence at Undocumented locations: high

Protection Strategy:
Avoid upgrading or adding road systems that will bisect wetland complexes.

Provide natural buffers around stream and river systems where they connect wetland complexes.

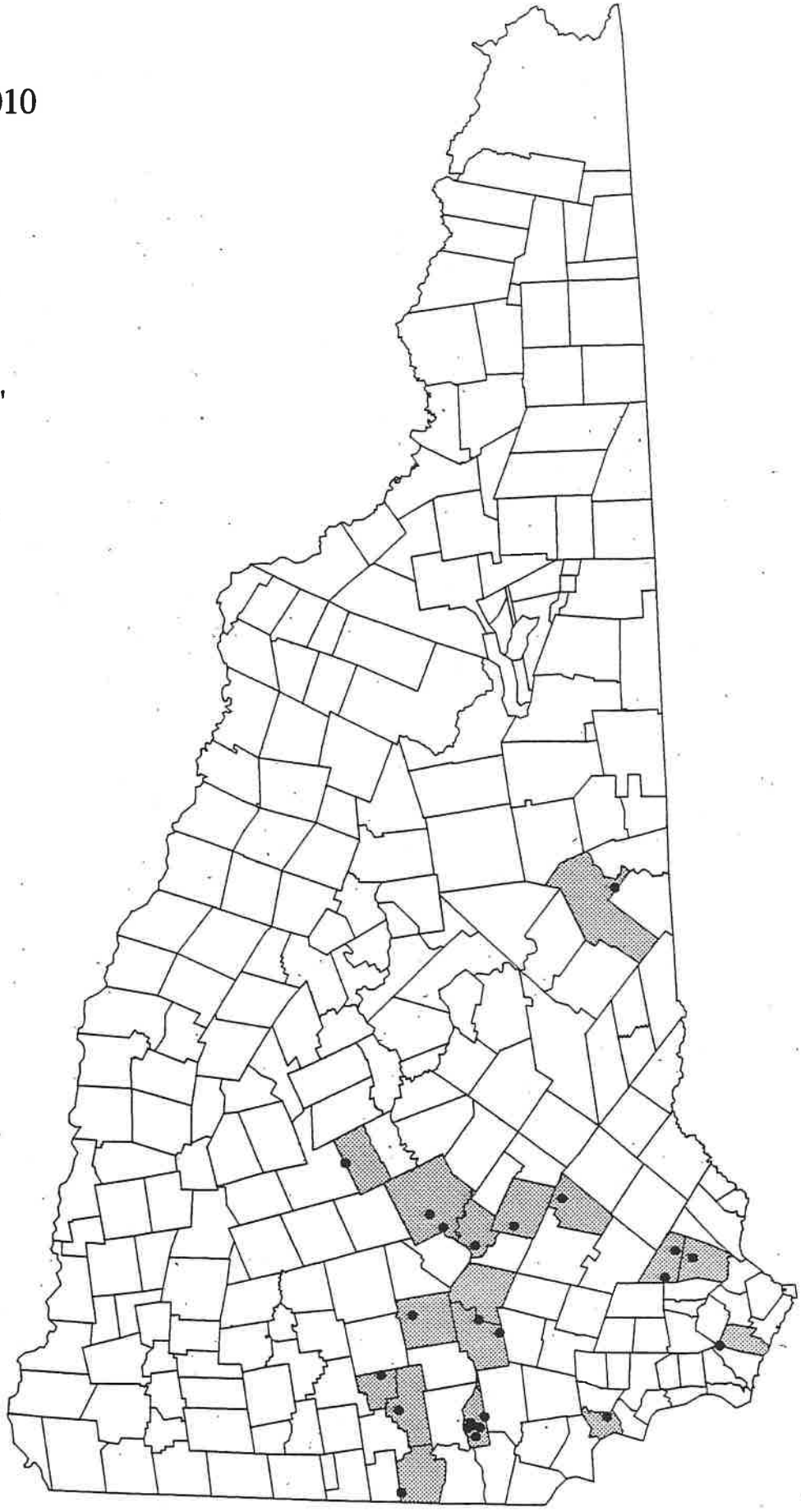
Educate students in the community about importance of leaving turtles in the wild and the legal protection provided to them by state law.

3

Spotted Turtle

Elcode: ARAAD02010

Point locations from
database "ERS_ADOT"



Species Information Sheet Outline y

ENDANGERED SPECIES

Species: **brook floater** (Alasmidonta varicosa)

Geographic Area - Brook Floater is known to occur in the following rivers: Exeter, Lamprey, Suncook Merrimack, Piscataquog, Sugar.

Conservation zones: Above Rivers

Habitat Associations: rapid and riffle areas on rocky, sandy, or gravel shoals of freshwater rivers

Probability of Occurrence at Undocumented locations: moderate

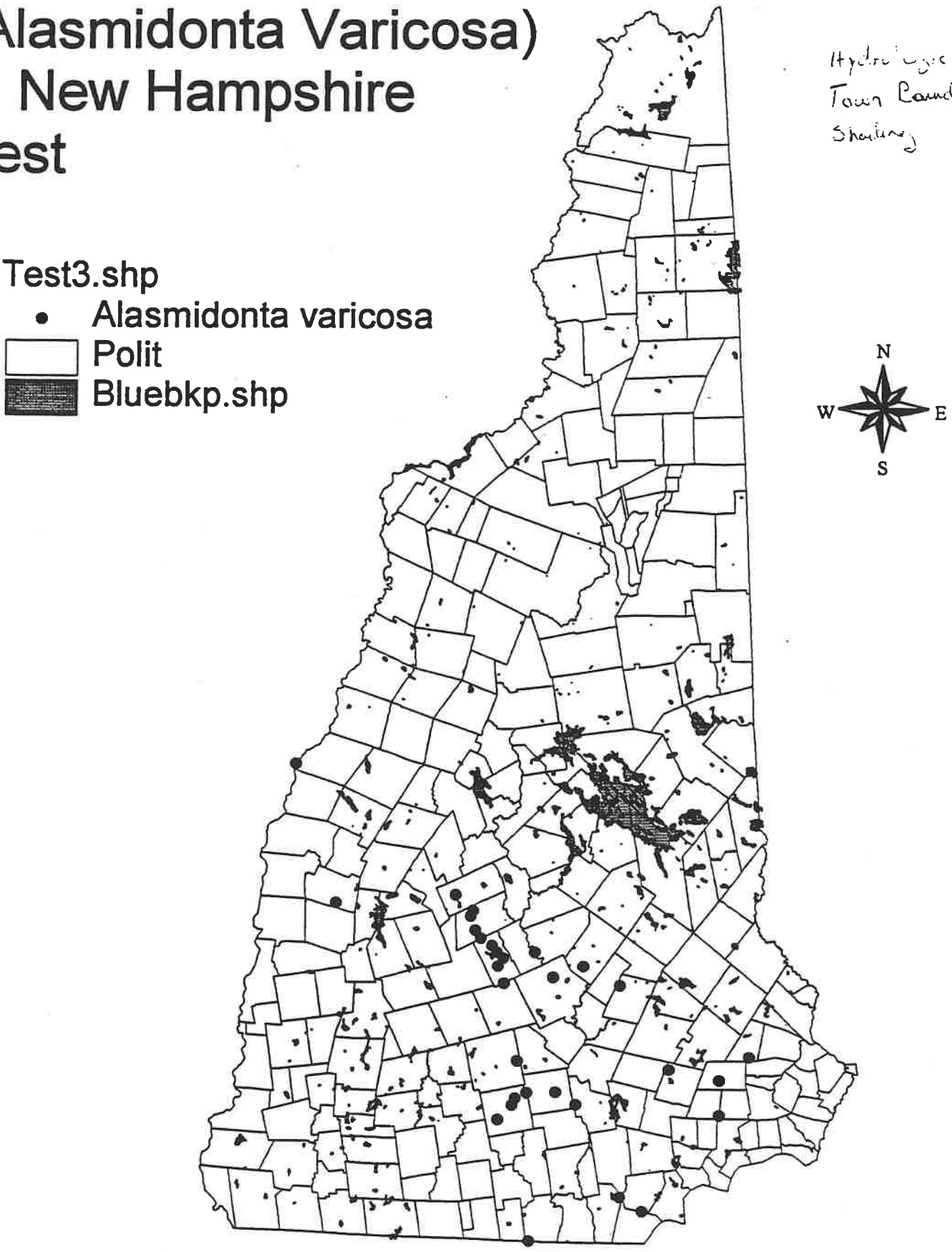
Protection Strategy: Little is known about the environmental and habitat factors that affect this species. The following assumptions and correlated protection strategies provide protection guidelines

1) All measures to protect water quality protect habitat conditions for these mussels

2) Any bank or instream work such as bridge replacement or stabilization in the immediate area or upstream can negatively impact the local population. When bridge replacement or bank work is planned a more detailed inventory should be undertaken to determine the extent of the population and impacts from the project. Lists of qualified biologists are available at NH Fish and Game Department.

3) Protective buffers, either through easements or regulations, provide the most long-term strategy for maintaining mussel populations. Effectiveness of buffers increases with width but minimum standards for water quality (see buffers document) are likely sufficient.

Brook Floater (Alasmidonta Varicosa) in New Hampshire Test



Species and Genetic Diversity Matrix — Codes, Definitions, and Explanations
9/96 draft

** = Indicates that species should be considered as a priority for inclusion in Ecological Reserve System.
D = Information useful in design of ecological reserves that include this species.
Blank field = descriptive characteristic.
* = Matrix should be annotated to provide more complete information.

Expert Caveat: This flags, at the outset, whether or not a particular species should be included or excluded (regardless of later indicators) due to extenuating circumstances. An example would be an "N" for fish crow. This species is "rare" in NH but is expanded its range into the state and should therefore not be a species of concern in the Ecological Reserve System.

Demography: ↑ = increasing; ↓ = decreasing; ↔ = stable.

Reproductive Rate: A "low reproductive rate" could be noted for a species having one or more of the following qualities: long pre-reproductive period, small brood size, or low reproductive success.

Gene Flow: Note that a species with low gene flow may also be flagged as having a disjunct distribution.

Physical Feature Requirements: Refers to whether a species is found in association only with certain physical site conditions, such as pH, salinity, temperature, etc.

Threats: Should be taken into consideration under the "Expert Caveat" column.

Key indicators of species of concern or priority:

- Species that are endemic, have disjunct populations, or are at the edges of their ranges.
- Species whose populations are in decline rangewide or in NH, or whose sizes or numbers are much lower than historically.
- Species that are globally rare or are rare in NH.
- Species with low reproductive rates.

Categories that primarily provide descriptive information:

- Associations with disturbance frequency and type.
- Subsections in which species occur.

Species and Genetic Diversity Matrix—Part 1
9/96 draft

SPECIES	Subsp. (Y/N)	Expert Caveat (Y/N)	DEMOGRAPHY																					
			Rangewide Trend									Statewide Trend									Rarity			
			# Populations			Pop. Size			# Relative to Historic #s			# Populations			Pop. Size			# Relative to Historic #s						
			↑	↓	↔	↑	↓	↔	↑	↓	↔	↑	↓	↔	↑	↓	↔	↑	↓	↔	Global Rank	State Rank	Fed Status	State Status
	D			**			**			**			**			**			**		** (G1-G3)	** (S1-S3)	** (T/E)	** (T/E)

Species and Genetic Diversity Matrix—Part 2
9/96 draft

SPECIES	DISTRIBUTION									POPULATION DYNAMICS					
	Rangewide						Statewide		Subsections (List each in which species occurs.)	Reproductive Rate		Gene Flow b/w Populations		Response to Humans	
	Endemic	Edge of Range	Disjunct	Central	Quality of NH Pops. Relative to Rangewide		Continuous	Discontinuous		Low	High	Low	High	Tolerant	Intolerant
					High	Low									
	**	**	**		**			**	D	**		**			**

Species and Genetic Diversity Matrix—Part 3
9/96 draft

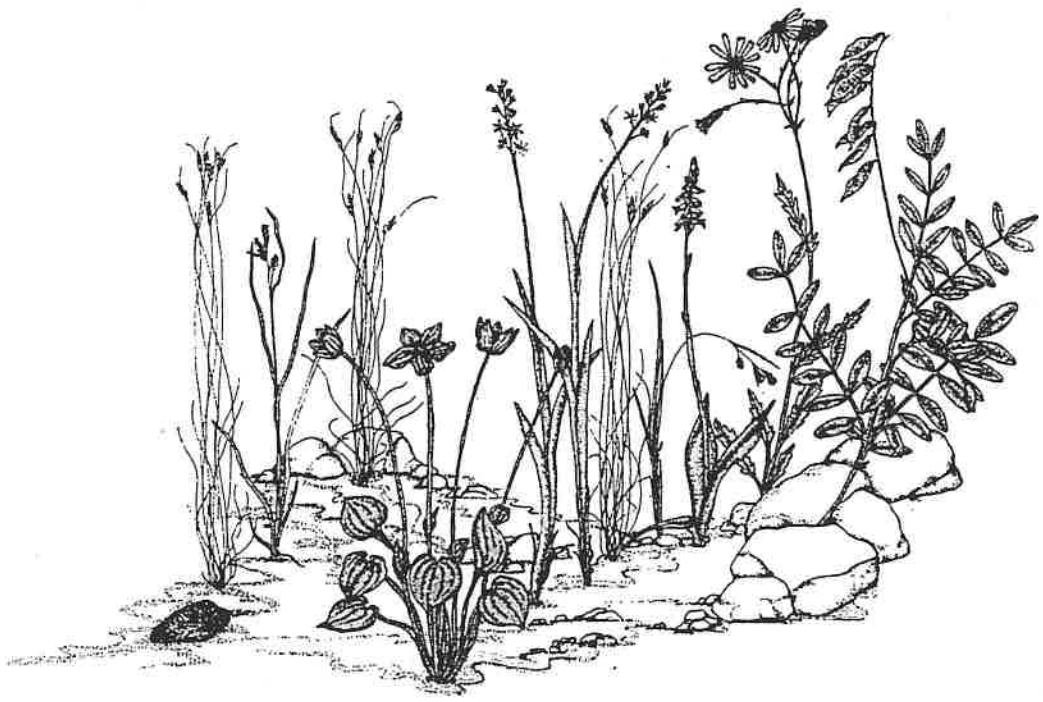
SPECIES	HABITAT REQUIREMENTS													THREATS*	
	Disturbance		Natural Biotic Relationships*		Physical Feature Requirements*		Life Cycle Requirements*		Tolerance of Phys Conditions*		Nat. Comm. Relationships*		Home Range Requirements *	Low	High
	Freq.	Type	Narrow	Broad	Narrow	Broad	1 Stage	>1 Stage	Narrow	Broad	Few	Many			
	D	D	**		**			D	**		**		D	D	D

NEW HAMPSHIRE NATURAL HERITAGE INVENTORY
DRED - DIVISION OF FORESTS & LANDS
PO BOX 1856 -- 172 PEMBROKE ROAD, CONCORD, NH 03302-1856
(603) 271-3623

Plant Tracking List

Including species listed as threatened or endangered under the NH Native Plant Protection Act of 1987

Technical Copy



June 1998

Cover illustration of a riverside seep by
Caren Caljouw

The NH Natural Heritage Inventory is a small state program in the Division of Forests & Lands. Our mission is to find, track, and facilitate the protection of New Hampshire's rare plants and exemplary natural communities (which are essentially different types of forests, wetlands, grasslands, etc.). We currently study more than 600 plant and animal species and 120 natural communities. Our database contains information about more than 4,000 plant, animal, and natural community occurrences throughout the state.

Plants Tracked by the NH Natural Heritage Inventory

The following list is our current assessment of the status of the state's rarest and most imperiled plant species. We have developed the list in cooperation with researchers, conservation organizations such as The Nature Conservancy, and knowledgeable amateur botanists. We obtained plant locations from sources including herbarium specimens (some dating from the late 1800s), personal contacts, the scientific literature, and through extensive field research. It is important for readers to remember that this list is dynamic -- as new discoveries are made or populations are lost, species may be added to or removed from the list.

For each species, we have provided the following information:

Common Name — Readers should remember that common names vary across the range of the plant. For example, "wild lupine" *(Lupinus perennis)* in New Hampshire is called "wild blue lupine" in New York and "sundial lupine" in other parts of its range; the name also commonly leads to confusion with garden lupine *(Lupinus polyphyllus)* which is not native to New Hampshire but grows wild in some areas.

Scientific Name — Scientific names are standardized with the scientific names used by other Natural Heritage programs throughout the United States, Canada, the Caribbean, Latin America, and South America. The primary reference used is Kartesz, J.T. and R. Kartesz. 1980. *A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland.* vol. 2 - The Biota of North America. The University of North Carolina Press, Chapel Hill, NC.

Global & State Ranks — When considering the rarity of a species, it is important to consider the status of a species both in New Hampshire and across its total range. The degree of rarity within New Hampshire is noted with a "State Rank" and throughout its range with a "Global Rank." Ranks are on a scale of 1 to 5, with a 1 indicating critical imperilment, a 3 indicating that the species is uncommon, and a 5 indicating that the species is stable and common. Some species, such as Jesup's milk-vetch *(Astragalus robbinsii* var. *jesupi)*, are critically imperiled both globally and in New Hampshire. This species has three known populations on the planet, all on a 16-mile stretch of the Connecticut River. Other species, such as small yellow lady's-slipper *(Cypripedium parviflorum)*, are very rare in New Hampshire (S1) but quite common in other parts of their range (G5).

In this technical list, we have noted the full global and state ranks, whereas on the general plant list we have rounded the codes. The codes are defined on page 3.

Listing

Most of New Hampshire's rare plants are listed as "threatened" or "endangered" under the NH Native Plant Protection Act of 1987 (NH RSA 217-A). Four of these species are also listed under the federal Endangered Species Act of 1973 (42 USCA §§ 4321-4370c). Listing represents a political recognition of rarity, so some species that are biologically rare (as indicated by the State and Global Ranks) may not be listed as "threatened" or "endangered." Under the NH Native Plant Protection Act, "endangered" species are those in danger of being extirpated from the state, while "threatened" species face the possibility of becoming "endangered."

Known Locations

There has not been a comprehensive search of the state for rare species, so we are frequently finding or learning about previously unknown populations. Further, many populations have not been checked since they were originally found, sometimes more than 50 years ago, so we do not know the status of these populations. We have therefore separated Known Locations into two sub-categories: those last seen prior to 1978, and those reported on or after 1978. This distinction helps show the state of our knowledge about a given species and the need for additional research.

In addition to recognizing "endangered" and "threatened" plant species, the NH Native Plant Protection Act identifies 11 plants as "special concern." These species are not rare in New Hampshire, but their showy nature makes them vulnerable to over-collection. The NH Natural Heritage Inventory does not track these species, nor do we seek locational data for them:

Grass pink	*Calopogon tuberous*	White fringed orchis	*Platanthera blephariglottis*
Flowering dogwood	*Cornus florida*	Large purple fringed orchid	*Platanthera grandifolia*
Pink lady's slipper	*Cypripedium acaule*	Rose pogonia	*Pogonia ophioglossoides*
Dutchman's breeches	*Dicentra cucullaria*	Lapland rosebay	*Rhododendron lapponicum*
Trailing arbutus	*Epigaea repens*	Pitcher plant	*Sarracenia purpurea*
Mountain laurel	*Kalmia latifolia*		

You Can Help!

Our biologists can only cover so much ground, so we are constantly seeking information from other sources. Knowledgeable recommendations for adding or removing species from the list of "endangered" and "threatened" species are always welcomed. Further, locational information about any of the species we track will help make our database more complete and therefore more useful for land-use planning. A form for reporting rare plant species that you find is attached to the back of this list. It is the policy of our agency not to survey on private property without landowner permission, so please respect your neighbor's privacy. Thank you!

If you have any questions or need additional information, please do not hesitate to contact us.

Address: NHNHI/DRED
PO Box 1856
Concord, NH 03302-1856

Telephone: (603) 271-3623

Fax: (603) 271-2629

Explanation of Global and State Rank Codes

Ranks describe rarity both throughout a species' range (globally, or "G" rank) and within New Hampshire (statewide, or "S" rank). The rarity of sub-species and varieties is indicated with a taxon ("T") rank. For example, a G5T1 rank shows that the species is globally secure (G5) but the sub-species is critically imperiled (T1).

Code	*Examples*	*Description*
1	G1 S1	Critically imperiled because extreme rarity (generally one to five occurrences) or some factor of its biology makes it particularly vulnerable to extinction.
2	G2 S2	Imperiled because rarity (generally six to 20 occurrences) or other factors demonstrably make it very vulnerable to extinction.
3	G3 S3	Either very rare and local throughout its range (generally 21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction because of other factors.
4	G4 S4	Widespread and apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5	G5 S5	Demonstrably widespread and secure, although the species may be quite rare in parts of its range, particularly at the periphery.
U	GU SU	Status uncertain, but possibly in peril. More information needed.
H	GH SH	Known only from historical records, but may be rediscovered. A G5 SH species is widespread throughout its range (G5), but considered historical in New Hampshire (SH).
X	GX SX	Believed to be extinct. May be rediscovered, but evidence indicates that this is less likely than for historical species. A G5 SX species is widespread throughout its range (G5), but extirpated from New Hampshire (SX).

Modifiers are used as follows.

Code	*Examples*	*Description*
Q	G5Q GHQ	Questions or problems may exist with the species' or sub-species' taxonomy, so more information is needed.
?	G3? S3?	The rank is uncertain due to insufficient information at the state or global level, so more inventories are needed. When no rank has been proposed the global rank may be "G?" or "G5T?"

When ranks are somewhat uncertain or the species' status appears to fall between two ranks, the ranks may be combined. For example:

G4G5	The species may be globally secure (G5), but appears to be at some risk (G4).
G5T2T3	The species is globally secure (G5), but the sub-species is somewhat imperiled (T2T3).
G4?Q	The species appears to be relatively secure (G4), but more information is needed to confirm this (?). Further, there are questions or problems with the species' taxonomy (Q).
G3G4Q S1S2	The species is globally uncommon (G3G4), and there are questions about its taxonomy (Q). In New Hampshire, the species is very imperiled (S1S2).

A Quick Overview of the NH Natural Heritage Inventory's Purpose and Policies

The Natural Heritage Inventory is mandated by the Native Plant Protection Act of 1987 (NH RSA 217-A) to determine protective measures and requirements necessary for the survival of native plant species in the state, to investigate the condition and degree of rarity of plant species, and to distribute information regarding the condition and protection of these species and their habitats.

The Natural Heritage Inventory provides information to facilitate informed land-use decision-making. We are not a regulatory agency; instead, we work with landowners and land managers to help them protect the State's natural heritage and meet their land-use needs.

The Natural Heritage Inventory has three facets:

Inventory involves identifying new occurrences of sensitive species and classifying New Hampshire's biodiversity. We currently study more than 600 plant and animal species and 120 natural communities. Surveys for rarities on private lands are conducted only with landowner permission.

Tracking is the management of occurrence data. Our database currently contains information about more than 4,000 plant, animal, and natural community occurrences in New Hampshire.

Interpretation is the communication of Natural Heritage Inventory information. Our goal is to cooperate with public and private land managers to help them *protect* rare species populations and exemplary natural communities.

New Hampshire Natural Heritage Inventory

Rare Plant Species in New Hampshire

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Acalypha virginica (Three-Seeded Mercury)	G5	SH	-	T	5	-
Acer nigrum (Black Maple)	G5Q	S1	-	T	3	7
Adlumia fungosa (Climbing Fumitory)	G4	S1	-	T	11	4
Agalinis maritima (Salt-Marsh Gerardia)	G5	S2	-	T	2	16
Agrostis borealis (Boreal Bentgrass)	G5	S3	-	-	17	6
Allium canadense (Wild Garlic)	G5	S1	-	E	2	3
Allium schoenoprasum var sibiricum (Siberian Chives)	G5T5	S2	-	T	4	3
Ammophila breviligulata (Beach Grass)	G5	S3	-	-	2	16
Amphicarpaea bracteata var comosa (Hog-Peanut)	G5T?	S2	-	T	4	-
Anemone cylindrica (Long-Fruited Anemone)	G5	SH	-	-	10	-
Anemonella thalictroides (Rue Anemone)	G5	S1S2	-	T	-	5
Arabis canadensis (Sickle-Pod)	G5	S2	-	T	1	6
Arabis hirsuta var pycnocarpa (Hairy Rock-Cress)	G5T5	S1	-	E	2	1
Arabis laevigata (Smooth Rock-Cress)	G5	S1	-	-	5	-
Arabis missouriensis (Missouri Rock-Cress)	G4?Q	S1S2	-	T	6	4
Arctostaphylos alpina (Alpine Bearberry)	G5	S1	-	T	4	6
Arethusa bulbosa (Arethusa)	G4	S1	-	E	12	8
Arisaema dracontium (Green Dragon)	G5	S1	-	E	-	2
Aristida longespica var geniculata (Spiked Needlegrass)	G5T?	S2	-	E	3	1
Aristida tuberculosa (Sea-Beach Needlegrass)	G5	S1	-	E	-	3
Arnica lanceolata (Arnica)	G3	S1	-	T	3	4
Artemisia campestris ssp caudata (Tall Wormwood)	G5T4	S2	-	T	-	8
Asclepias amplexicaulis (Blunt-Leaved Milkweed)	G5	S1	-	T	6	6
Asclepias purpurascens (Purple Milkweed)	G4G5	SH	-	-	4	-
Asclepias quadrifolia (Four-Leaved Milkweed)	G5	S1	-	T	5	5
Asclepias tuberosa (Butterfly-Weed)	G5	S1	-	E	7	-
Aster ciliolatus (Ciliated Aster)	G5	SH	-	T	9	-
Aster crenifolius var arcuans (Leafy-Bracted Aster)	G5QT5Q	SH	-	E	3	-
Aster patens var patens (Skydrop Aster)	G5T5	S2	-	T	5	5
Aster ptarmicoides (Snowy Aster)	G5	S1	-	E	-	2
Aster tenuifolius (Large Salt Marsh Aster)	G5	S1	-	E	-	4
Astragalus alpinus var brunetianus (Alpine Milk-Vetch)	G5T2T3	SX	-	-	1	-
Astragalus robbinsii var jesupii (Jesups' Milk-Vetch)	G5T1	S1	E	E	-	3
Aureolaria pedicularia var intercedens (Fern-Leaved Foxglove)	G5T?	S1	-	E	-	3
Aureolaria virginica (Downy False-Foxglove)	G5	S2	-	T	8	3
Barbarea orthoceras (American Winter-Cress)	G5	SH	-	E	1	-
Betula glandulosa (Dwarf Birch)	G5	S1	-	T	-	11
Betula minor (Small Birch)	G3G4Q	S1S2	-	-	9	12
Betula nigra (River Birch)	G5	S2	-	T	2	10
Betula pumila (Swamp Birch)	G5	S1	-	E	-	1
Bidens discoidea (Small Bidens)	G5	S3	-	E	3	6

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Bidens laevis (Smooth Bidens)	G5	SH	-	-	1	-
Bromus kalmii (Kalm's Brome-Grass)	G5	SH	-	E	3	-
Bromus pubescens (Hairy Brome-Grass)	G5Q	S1	-	T	3	1
Calamagrostis cinnoides (Cinna-Like Reed Bent-Grass)	G5	S1	-	-	4	1
Calamagrostis lacustris (Pond Reed Bent-Grass)	G3Q	S1	-	T	1	6
Calamagrostis nubila (Cloudy Reed Bent-Grass)	GHQ	SX	-	-	1	-
Calamagrostis pickeringii (Pickering's Reed Bent-Grass)	G4	S2S3	-	T	8	10
Calamagrostis stricta var inexpansa (Neglected Reed Bent-Grass)	G5T5	SU	-	E	6	1
Calypso bulbosa (Fairy Slipper)	G5	SX	-	E	2	-
Campanula uliginosa (Greater Marsh-Bellflower)	G5	SH	-	-	5	1
Camptosorus rhizophyllus (Walking-Fern Spleenwort)	G5	S1	-	E	5	1
Cardamine bellidifolia (Alpine Bitter-Cress)	G5	S1	-	E	7	2
Cardamine bulbosa (Bulbous Bitter-Cress)	G5	S1	-	E	2	3
Cardamine longii (Long's Bitter Cress)	G3Q	SH	-	T	1	-
Cardamine pratensis var palustris (Cuckoo Flower)	G5T5	S1	-	E	-	1
Carex aestivalis (Summer Sedge)	G4	SH	-	-	2	-
Carex amphibola var rigida (Ambiguous Sedge)	G5T5	S2	-	T	3	1
Carex atratiformis (Black Sedge)	G5	S1	-	-	3	-
Carex aurea (Golden-Fruited Sedge)	G5	S2	-	T	5	2
Carex baileyi (Bailey's Sedge)	G4	S1S2	-	T	4	2
Carex bebbii (Bebb's Sedge)	G5	S2S3	-	T	7	2
Carex bigelowii (Bigelow's Sedge)	G5	S3	-	-	9	16
Carex bullata (Inflated Sedge)	G5	S1	-	E	3	2
Carex buxbaumii (Buxbaum's Sedge)	G5	SH	-	E	1	-
Carex capillaris ssp capillaris (Hair-Like Sedge)	G5T?	S1	-	T	2	1
Carex capitata ssp arctogena (Head-Like Sedge)	G5T4?	S1	-	T	4	2
Carex castanea (Chestnut Sedge)	G5	S1	-	E	1	2
Carex cristatella (Small Crested Sedge)	G5	S2	-	-	8	4
Carex cumulata (Piled-Up Sedge)	G4?	S2	-	T	6	2
Carex diandra (Lesser Panicled Sedge)	G5	S1	-	E	4	2
Carex eburnea (Ebony Sedge)	G5	S1	-	E	-	1
Carex exilis (Meagre Sedge)	G5	S1	-	T	5	-
Carex flaccosperma var glaucodea (Flaccid Sedge)	G5T5	SH	-	E	1	-
Carex garberi var bifaria (Garber's Sedge)	G4T3Q	S1	-	E	-	5
Carex gracilescens (Slender Sedge)	G5?	S2	-	-	1	-
Carex granularis var haleana (Granular Sedge)	G5T4	S1	-	E	2	2
Carex polymorpha (Many Forms Sedge)	G2G3	S1	-	T	1	1
Carex retroflexa (Reflexed Sedge)	G5	SH	-	T	5	-
Carex scirpoidea (Scirpus-Like Sedge)	G5	S1	-	T	5	6
Carex seorsa (Separated Sedge)	G4	S1	-	E	1	1
Carex sparganioides (Bur Sedge)	G5	S1	-	E	3	-
Carex trichocarpa (Hairy-Fruited Sedge)	G4	S1	-	-	-	2
Carex umbellata (Hidden Sedge)	G5	SU	-	E	12	-
Carex wiegandii (Wiegand's Sedge)	G3	S1S2	-	T	6	2

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Cassia hebecarpa (Wild Senna)	G5	SH	-	E	10	-
Cassia nictitans (Wild Sensitive Senna)	G5	SH	-	E	1	-
Cassiope hypnoides (Moss Bell-Heather)	G5	S2	-	T	6	6
Castilleja coccinea (Scarlet Painted-Cup)	G5	SX	-	-	2	-
Castilleja septentrionalis (Pale Painted-Cup)	G5	S1	-	T	7	3
Celtis occidentalis (Hackberry)	G5	S2	-	T	3	10
Cenchrus longispinus (Burgrass)	G5	S2S3	-	T	6	4
Chamaecyparis thyoides (Atlantic White Cedar)	G4	S3	-	-	12	30
Chenopodium boscianum (Bosc's Pigweed)	G?	S2	-	E	4	1
Chenopodium rubrum (Coast-Blite Goosefoot)	G5	S2	-	T	4	2
Cirsium horridulum (Yellow Thistle)	G5	S1	-	E	1	2
Collinsonia canadensis (Canada Horse-Balm)	G5	SH	-	-	2	-
Conopholis americana (Squaw-Root)	G5	S3	-	T	7	6
Convolvulus spithamaeus (Low Bindweed)	G4G5	S2	-	T	7	-
Corallorrhiza odontorhiza (Autumn Coral-Root)	G5	S1	-	E	1	3
Corydalis aurea (Golden Corydalis)	G5	SX	-	-	2	-
Crotalaria sagittalis (Arrow-Headed Rattle-Box)	G5	SH	-	E	1	-
Cryptogramma stelleri (Slender Cliff-Brake)	G5	S1	-	T	-	6
Cuscuta pentagona (Five-Angled Dodder)	G5	SH	-	E	1	-
Cynoglossum boreale (Hound's-Tongue)	G4Q	S1	-	E	5	1
Cyperus aristatus (Incurved Umbrella-Sedge)	G5	S2	-	T	5	1
Cyperus grayi (Gray's Umbrella-Sedge)	G5	S1	-	E	-	2
Cyperus houghtonii (Houghton's Umbrella-Sedge)	G4?	S1	-	T	4	1
Cypripedium arietinum (Ram's-Head Lady's-Slipper)	G3	S1	-	E	13	2
Cypripedium parviflorum (Small Yellow Lady's-Slipper)	G5	S1	-	E	8	2
Cypripedium pubescens (Large Yellow Lady's-Slipper)	G5	S2	-	T	10	9
Cypripedium reginae (Showy Lady's-Slipper)	G4	S1	-	E	1	6
Dentaria laciniata (Cutleaf Toothwort)	G5	S1	-	E	4	2
Dentaria maxima (Large Toothwort)	G5Q	SH	-	-	1	-
Deschampsia atropurpurea (Mountain Hairgrass)	G5	S2	-	-	6	5
Desmodium cuspidatum (Toothed Tick-Trefoil)	G5	SH	-	-	3	-
Desmodium marilandicum (Maryland Tick-Trefoil)	G5	S1	-	E	3	1
Desmodium rigidum (Stiff Tick-Trefoil)	G?Q	SH	-	E	2	-
Desmodium rotundifolium (Prostrate Tick-Trefoil)	G5	S2	-	T	3	6
Diapensia lapponica (Lapland Diapensia)	G5	S3	-	T	11	18
Dicentra canadensis (Squirrel-Corn)	G5	S2S3	-	T	11	15
Digitaria filiformis (Slender Crab-Grass)	G5	SH	-	-	4	-
Diplachne maritima (Salt-Meadow Grass)	G3G4	SH	-	-	1	-
Diplazium pycnocarpon (Narrow-Leaved Spleenwort)	G5	S1	-	E	3	1
Draba lanceolata (Lance-Leaved Draba)	G3G5	S1	-	E	-	1
Dryopteris fragrans (Fragrant Fern)	G5	S1	-	T	4	8
Dryopteris goldiana (Goldie's Fern)	G4	S2	-	T	12	10
Eleocharis erythropoda (Bald Spike-Rush)	G5	SH	-	-	3	-
Eleocharis halophila (Salt-Loving Spike-Rush)	G4	S1	-	T	2	10
Eleocharis nitida (Neat Spike-Rush)	G3G4	SH	-	-	3	-

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Eleocharis parvula (Small Spike-Rush)	G5	S1S2	-	T	4	15
Eleocharis pauciflora var fernaldii (Few-Flowered Spike-Rush)	G5T?Q	S1	-	E	4	3
Eleocharis tuberculosa (Tubercled Spike-Rush)	G5	SH	-	E	3	-
Empetrum atropurpureum (Purple Crowberry)	G5	S2	-	T	12	18
Epilobium alpinum (Alpine Willow-Herb)	G?Q	S1	-	-	1	2
Epilobium ciliatum (Ciliated Willow-Herb)	G5	S2	-	T	22	1
Epilobium hornemannii (Hornemann Willow-Herb)	G5	S2	-	T	9	12
Equisetum palustre (Marsh Horsetail)	G5	S1	-	T	8	3
Equisetum pratense (Meadow Horsetail)	G5	S2	-	T	14	3
Equisetum variegatum (Variegated Horsetail)	G5	S2	-	-	8	12
Eragrostis frankii (Frank's Love-Grass)	G5	SH	-	-	2	-
Eragrostis hypnoides (Moss Love-Grass)	G5	SH	-	-	1	-
Eriophorum angustifolium (Narrow-Leaved Cotton-Grass)	G5	S1	-	E	-	1
Eupatorium fistulosum (Tubular Thoroughwort)	G5?	SH	-	E	5	-
Eupatorium pubescens (Hairy Boneset)	G5T5	S1	-	E	-	1
Eupatorium sessilifolium (Upland Boneset)	G5	S1	-	E	1	1
Euphrasia oakesii (Oakes' Eyebright)	G4	S1	-	E	4	1
Festuca octoflora var tenella (Slender 8-Flowered Fescue)	G5T?	S2	-	E	2	1
Festuca rubra var prolifera (Proliferous Fescue)	G5T4	S1	-	E	1	1
Galearis spectabilis (Showy Orchis)	G5	S2	-	T	4	5
Galium labradoricum (Labrador Bedstraw)	G5	S1	-	E	2	-
Galium obtusum var obtusum (Large Marsh Bedstraw)	G5T4	S2	-	E	2	-
Galium pilosum (Hairy Bedstraw)	G5	S2	-	E	1	4
Gaylussacia dumosa var bigeloviana (Huckleberry)	G5T4T5	S2	-	T	4	6
Gentiana andrewsii (Andrews' Gentian)	G4	S1	-	T	6	2
Gentiana crinita (Fringed Gentian)	G4	S2	-	T	18	9
Gentiana quinquefolia (Stiff Gentian)	G5	SH	-	-	6	-
Geocaulon lividum (Northern Comandra)	G5	S2	-	T	6	2
Geranium carolinianum var carolinianum (Carolina Cranesbill)	G5T5	SH	-	E	2	-
Geranium carolinianum var confertiflorum (Cranesbill)	G5T5?	SH	-	E	3	-
Geum peckii (Mountain Avens)	G2	S2	-	T	9	28
Glyceria acutiflora (Sharp Flowered Manna-Grass)	G5	S1	-	E	6	1
Gnaphalium supinum (Mt. Cudweed)	G5	S1	-	E	3	1
Hackelia deflexa var americana (Beggar's-Lice)	G5TU	S1	-	E	1	-
Hackelia virginiana (Woodland Hound's-Tongue)	G5	S2	-	T	13	4
Halenia deflexa (Spurred Gentian)	G5	S1	-	E	2	3
Hemicarpha micrantha (Small-Flowered Hemicarpa)	G4	SH	-	-	3	-
Heteranthera dubia (Water-Stargrass)	G5	S1	-	E	2	1
Hieracium robinsonii (Robinson's Hawkweed)	G1G2	S1	-	E	-	1
Hieracium umbellatum (Umbelled Hawkweed)	G5?	SH	-	E	1	-
Hierochloe alpina (Alpine Sweet Grass)	G5	S2	-	-	8	8
Hippuris vulgaris (Common Mare's-Tail)	G5	S3	-	T	7	-
Honckenya peploides ssp robusta (Sea-Chickweed)	G5T4	S1	-	E	-	1
Houstonia longifolia (Long-Leaved Bluets)	G4G5	SH	-	-	1	-
Hudsonia ericoides (Golden-Heather)	G4	S1S2	-	T	2	10

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Hudsonia tomentosa (Hairy Hudsonia)	G5	S1	-	T	2	15
Hydrophyllum virginianum (Northern Waterleaf)	G5	S2	-	T	5	9
Hypericum pyramidatum (Great St. John's-Wort)	G4	S1S2	-	T	3	4
Hypoxis hirsuta (Hairy Stargrass)	G5	S2	-	T	8	5
Iris prismatica (Slender Blue Flag)	G4G5	S2	-	T	4	9
Isoetes eatonii (Eaton's Quillwort)	G2Q	SH	-	-	8	-
Isoetes engelmannii (Engelmann's Quillwort)	G4	S1	-	-	16	1
Isoetes macrospora (Large-Spored Quillwort)	G5	S1	-	T	4	1
Isoetes riparia (River Bank Quillwort)	G4	SH	-	T	14	-
Isotria medeoloides (Small Whorled Pogonia)	G2G3	S2	T	E	7	49
Isotria verticillata (Large Whorled Pogonia)	G5	S1	-	E	3	1
Iva frutescens ssp oraria (Marsh Elder)	G5T5	S2	-	T	3	6
Juncus platyphyllus (Flat-Leaved Rush)	G4G5	SH	-	-	1	-
Juncus secundus (One-Sided Rush)	G5?	SH	-	E	6	-
Juniperus horizontalis (Creeping Juniper)	G5	S1	-	E	-	2
Lechea tenuifolia (Slender Pinweed)	G5	SH	-	E	2	-
Lemna trisulca (Star-Duckweed)	G5	S2	-	-	2	3
Lemna valdiviana (Duckweed)	G5	S2	-	E	1	-
Lespedeza procumbens (Trailing Bush-Clover)	G5	SH	-	E	2	-
Lespedeza virginica (Slender Bush-Clover)	G5	S1	-	T	2	4
Liatris borealis (Northern Blazing Star)	G3Q	S1	-	E	8	5
Lilaeopsis chinensis (Eastern Lilaeopsis)	G5	S2	-	T	-	6
Lilium superbum (Turk's-Cap Lily)	G5	S1	-	E	-	1
Limosella australis (Mudwort)	G4G5	S1	-	E	-	2
Lindernia anagallidea (False Pimpernel)	G5	S1S2	-	E	-	2
Liparis loeselii (Loesel's Twayblade)	G5	S2	-	T	16	6
Listera auriculata (Auricled Twayblade)	G3	S1	-	E	4	3
Listera convallarioides (Lily-Leaved Twayblade)	G5	S2	-	T	10	5
Listera cordata (Heart-Leaved Twayblade)	G5	S2	-	T	13	8
Lobelia kalmii (Kalm's Lobelia)	G5	S2	-	T	5	10
Loiseleuria procumbens (Alpine Azalea)	G5	S2	-	T	1	11
Lupinus perennis (Wild Lupine)	G5	S1	-	T	11	26
Luzula confusa (Northern Woodrush)	G5	S1	-	E	4	-
Luzula spicata (Spiked Woodrush)	G5	S3	-	T	13	6
Lycopus rubellus (Gypsywort)	G5	SH	-	-	1	-
Lygodium palmatum (Climbing Fern)	G4	SX	-	-	3	-
Lysimachia thyrsiflora (Tufted Loosestrife)	G5	S2	-	T	1	5
Malaxis monophyllos var brachypoda (White Adder's-Mouth)	G5T4	S1	-	E	2	1
Malaxis unifolia (Green Adder's-Mouth)	G5	S2	-	T	42	10
Megalodonta beckii (Water Marigold)	G4G5	S2	-	-	8	4
Menispermum canadense (Yellow Parilla)	G5	S1	-	-	-	1
Mikania scandens (Climbing Hempweed)	G5	S2	-	T	4	6
Milium effusum (Millet-Grass)	G5	S2S3	-	T	19	18
Mimulus moschatus (Muskflower)	G4G5	S1	-	E	-	3
Minuartia glabra (Smooth Sandwort)	G4	S1S2	-	T	2	5

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Minuartia stricta (Rock Sandwort)	G5	S1	-	E	1	3
Muhlenbergia sobolifera (Sprout Muhlenbergia)	G5	S1	-	T	4	2
Muhlenbergia tenuiflora (Slender-Flowered Muhlenbergia)	G5	SH	-	-	3	-
Myriophyllum farwellii (Farwell's Milfoil)	G5	SH	-	T	10	-
Nuphar advena (Spatter-Dock)	G5	S1	-	-	1	1
Nuphar microphyllum (Tiny Cow-Lily)	G5	S1	-	-	1	-
Oryzopsis canadensis (Canadian Mountain-Rice)	G5	SH	-	E	2	-
Osmorhiza chilensis (Mountain Sweet-Cicely)	G5	SH	-	E	15	-
Oxyria digyna (Mountain Sorrel)	G5	S1	-	T	3	3
Panax quinquefolius (Ginseng)	G4	S2	-	T	15	20
Panicum longifolium (Long-Leaved Panic-Grass)	G4	SH	-	-	1	-
Panicum philadelphicum (Philadelphia Panic-Grass)	G5	S2	-	E	8	-
Parietaria pensylvanica (Pellitory)	G5	SX	-	-	1	-
Parnassia glauca (Grass-of-Parnassus)	G5	S2	-	T	-	6
Paronychia argyrocoma var albimontana (Silverling)	G4T3Q	S3	-	T	5	17
Paronychia canadensis (Smooth-Forked Chickweed)	G5	S1	-	T	-	7
Petasites frigidus var palmatus (Sweet Coltsfoot)	G5T5	S1	-	E	4	2
Phleum alpinum (Alpine Timothy)	G5	S2	-	T	2	3
Phyllodoce caerulea (Mountain-Heath)	G5	S2	-	T	1	10
Physostegia virginiana (Lion's-Head)	G5	S1S2	-	-	-	5
Pinguicula vulgaris (Common Butterwort)	G5	S1	-	E	2	2
Pinus banksiana (Jack Pine)	G5	S1S2	-	T	7	1
Platanthera flava var herbiola (Pale Green Orchis)	G4T4Q	S2	-	T	-	8
Poa fernaldiana (Wavy Bluegrass)	G2G3	S2S3	-	E	12	6
Poa glauca (White Bluegrass)	G5	S2S3	-	T	7	-
Poa pratensis ssp alpigena (Alpine Meadow Grass)	G?T?	SH	-	E	5	-
Polygala cruciata var aquilonia (Cross Polygala)	G5T4	SH	-	-	3	-
Polygonatum biflorum var commutatum (Giant Solomon's Seal)	G5T4?	S1	-	E	-	1
Polygonum douglasii (Douglas' Knotweed)	G5	S1	-	T	6	4
Polygonum erectum (Erect Knotweed)	G5	SH	-	E	3	-
Polygonum exsertum (Exserted Knotweed)	G4G5	S2	-	T	-	13
Polygonum prolificum (Prolific Knotweed)	G4?	S2	-	T	6	3
Polygonum robustius (Robust Knotweed)	G4G5	S2	-	T	4	2
Polygonum tenue (Slender Knotweed)	G5	SH	-	E	3	-
Polygonum viviparum (Viviparous Knotweed)	G5	S1	-	T	1	2
Potamogeton alpinus (Thin-Leaved Alpine Pondweed)	G5	S2	-	T	7	-
Potamogeton filiformis var alpinus (Northern Slender Pondweed)	G5T5	S1	-	E	2	-
Potamogeton foliosus (Leafy Pondweed)	G5	S1	-	E	4	1
Potamogeton lateralis (New England Pondweed)	GUQ	S1S2	-	-	-	1
Potamogeton nodosus (Knotty Pondweed)	G5	S2	-	-	11	7
Potamogeton pectinatus (Sago Pondweed)	G5	S2	-	T	7	-
Potamogeton praelongus (White-Stem Pondweed)	G5	SH	-	-	1	-
Potamogeton pusillus var gemmiparus (Budding Pondweed)	G5T3T4	S2	-	T	5	1
Potamogeton vaseyi (Vasey Pondweed)	G4	S2	-	T	8	1
Potamogeton zosteriformis (Flatstem Pondweed)	G5	S2	-	T	10	-

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Potentilla robbinsiana (Robbins' Cinquefoil)	G1	S1	E	E	-	2
Prenanthes boottii (Boott's Rattlesnake-Root)	G2	S1	-	T	1	4
Prenanthes serpentaria (Gall-of-the-Earth)	G5	SH	-	-	3	-
Proserpinaca pectinata (Mermaid-Weed)	G5	S1	-	E	2	1
Prunus americana (American Plum)	G5	S2	-	T	6	-
Puccinellia paupercula var alaskana (Alaskan Goose-Grass)	G4?T?	S3	-	E	-	1
Pycnanthemum incanum (Hoary Mt. Mint)	G5	S1	-	E	1	4
Pycnanthemum torrei (Torry's Mountain Mint)	G2	SH	-	E	1	-
Pycnanthemum virginianum (Virginian Mt. Mint)	G5	S1	-	E	2	1
Pyrola asarifolia (Pink Wintergreen)	G5	S2	-	E	7	2
Quercus macrocarpa (Mossy-Cup Oak)	G5	S1	-	-	1	1
Ranunculus ambigens (Water-Plantain)	G4	SH	-	E	2	1
Ranunculus fascicularis (Early Buttercup)	G5	S1	-	E	-	2
Rhinanthus crista-galli (Yellow Rattle)	G4	SU	-	-	2	1
Rhododendron lapponicum (Lapland Rosebay)	G5	S2	-	-	-	7
Rhododendron maximum (Giant Rhododendron)	G5	S2	-	-	10	4
Rhododendron rhodiflorum (Pink Azalea)	G5	SH	-	E	2	-
Rhododendron viscosum (Swamp Azalea)	G5	S3	-	T	4	37
Rhynchospora capillacea (Hair-Like Beak-Rush)	G5	S1	-	E	1	1
Rosa acicularis (Prickly Rose)	G5	SH	-	E	2	-
Rubus chamaemorus (Baked Apple Berry)	G5	S1S2	-	E	3	6
Rubus cuneifolius (Wedge Sand Blackberry)	G5	S1	-	E	-	1
Rumex pallidus (White Dock)	G4	SH	-	E	1	-
Sagittaria cuneata (Wapato)	G5	SH	-	T	10	-
Salicornia bigelovii (Dwarf Glasswort)	G5Q	S2	-	T	7	10
Salicornia virginica (Perennial Glasswort)	G5	S1	-	T	1	3
Salix argyrocarpa (Silver Willow)	G4	S1	-	T	-	5
Salix cordata var abrasa (Heart Shaped Willow)	G5	S1	-	-	1	1
Salix herbacea (Dwarf Willow)	G5	S1S2	-	T	1	5
Salix pellita (Satin Willow)	G5	SH	-	T	17	-
Salix planifolia (Tea-Leaved Willow)	G5	S2	-	T	1	9
Salix uva-ursi (Bearberry Willow)	G5	S2S3	-	-	-	17
Samolus parviflorus (False Water Pimpernell)	G5	S1	-	T	-	6
Sanicula canadensis (Short-Styled Sanicle)	G5	SH	-	-	1	-
Sanicula gregaria (Gregarious Black Snakeroot)	G4	S2	-	T	6	2
Sanicula trifoliata (Three-Leaved Black Snakeroot)	G4	S2	-	T	8	4
Saxifraga aizoon var neogaea (Livelong Saxifrage)	G5T?	S1	-	E	-	2
Saxifraga cernua (Nodding Saxifrage)	G4	S1	-	E	-	1
Saxifraga rivularis (Alpine Brook Saxifrage)	G5?	S1	-	E	2	2
Scirpus ancistrochaetus (Northeastern Bulrush)	G3	S1	E	E	-	8
Scirpus longii (Long's Bulrush)	G2	S1	-	-	-	1
Scirpus pendulus (Lined Bulrush)	G5	S2	-	T	4	1
Scirpus polyphyllus (Many Leaved Bulrush)	G5	SU	-	E	3	-
Scirpus robustus (Stout Bulrush)	G5	S3	-	T	-	16
Sclerolepis uniflora (Sclerolepis)	G4	S1	-	E	-	1

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +
Senecio obovatus (Round-Leaved Ragwort)	G5	S1	-	-	-	1
Senecic pauperculus (Dwarf Ragwort)	G5	S2	-	T	5	8
Sericocarpus linifolius (White-Topped Aster)	G5	S1	-	T	3	3
Sibbaldia procumbens (Sibbaldia)	G5	S1	-	E	-	1
Silene acaulis var exscapa (Moss Campion)	G5T?	S1	-	T	6	2
Solidago calcicola (Rock Goldenrod)	G4G5	SH	-	-	4	-
Solidago cutleri (Cutler's Goldenrod)	G4Q	S3	-	T	-	9
Solidago odora (Sweet Goldenrod)	G5	S2	-	T	1	11
Solidago patula (Square-Stem Goldenrod)	G5	SH	-	-	1	-
Solidago purshii (Pursh's Goldenrod)	G5	S1	-	T	5	7
Sparganium androcladum (Branching Bur-Reed)	G4G5	SH	-	-	2	-
Sparganium eurycarpum (Large Bur-Reed)	G5	S2	-	T	-	16
Sphenopholis obtusata (Blunt Sphenopholis)	G5	SH	-	E	1	-
Spiranthes casei (Case's Lady's-Tresses)	G4	S1	-	E	1	2
Spiranthes lucida (Shining Lady's-Tresses)	G5	S1	-	T	-	6
Sporobolus cryptandrus (Sand Drop-Seed)	G5	S2	-	T	-	9
Sporobolus neglectus (Small Drop-Seed)	G5	S1	-	E	-	1
Staphylea trifolia (Bladdernut)	G5	S2S3	-	T	1	4
Tephrosia virginiana (Goat's-Rue)	G5	S1	-	E	5	1
Teucrium canadense var virginicum (Canadian Germander)	G5TU	SH	-	E	5	-
Tillaea aquatica (Pygmy Weed)	G5	S1	-	E	1	1
Tofieldia glutinosa (Sticky False Asphodel)	G5	S1	-	T	-	4
Triosteum aurantiacum (Orange Horse-Gentian)	G5	S1	-	E	1	2
Triphora trianthophora (Three-Birds Orchid)	G4	S2	-	T	11	9
Triplasis purpurea (Sand Grass)	G4G5	SH	-	-	1	-
Trisetum melicoides (Bristle Grass)	G4	SH	-	-	1	-
Uvularia grandiflora (Large-Flowered Bellwort)	G5	S1	-	E	2	3
Uvularia perfoliata (Perfoliate Bellwort)	G5	S1	-	E	-	2
Vaccinium boreale (Alpine Blueberry)	G4	S3	-	-	4	11
Valeriana uliginosa (Marsh Valerian)	G4Q	S1	-	E	-	1
Veronica wormskjoldii (Alpine Speedwell)	G4G5	S1	-	E	1	2
Viburnum rafinesquianum (Downy Arrow-Wood)	G5	S1	-	E	1	5
Viola affinis (Pale Early Violet)	G5	S2	-	E	4	-
Viola labradorica (Labrador Violet)	G5	S1S2	-	-	1	-
Viola nephrophylla (Kidney-Leaved Violet)	G5	S2	-	T	8	-
Viola palmata (Palmate Violet)	G5	SU	-	E	2	-
Viola palustris (Alpine Marsh Violet)	G5	S2	-	T	2	4
Viola pedata var linearíloba (Bird's-Foot Violet)	G5	S2	-	T	5	6
Waldsteinia fragarioides (Barren Strawberry)	G5	S1	-	T	6	2
Woodsia glabella (Smooth Woodsia)	G5	S1	-	E	2	2
Woodsia obtusa (Blunt-Lobe Woodsia)	G5	S2	-	T	3	5
Woodwardia areolata (Netted Chain-Fern)	G5	SH	-	E	2	-
Zanthoxylum americanum (Northern Prickley Ash)	G5	S1	-	E	1	-

Name	Rank		Listing		Known Locations	
	Global	State	Federal	State	<1978	1978 +

Rank Prefix:

G = Global Rank
S = State Rank
T = Global or State rank for a subspecies or variety.

Rank Suffix:

1 = Critically imperiled due to rarity or vulnerability
2 = Imperiled
3 = Rare / uncommon
4 = Widespread but with cause for long-term concern
5 = Widespread, abundant, and secure

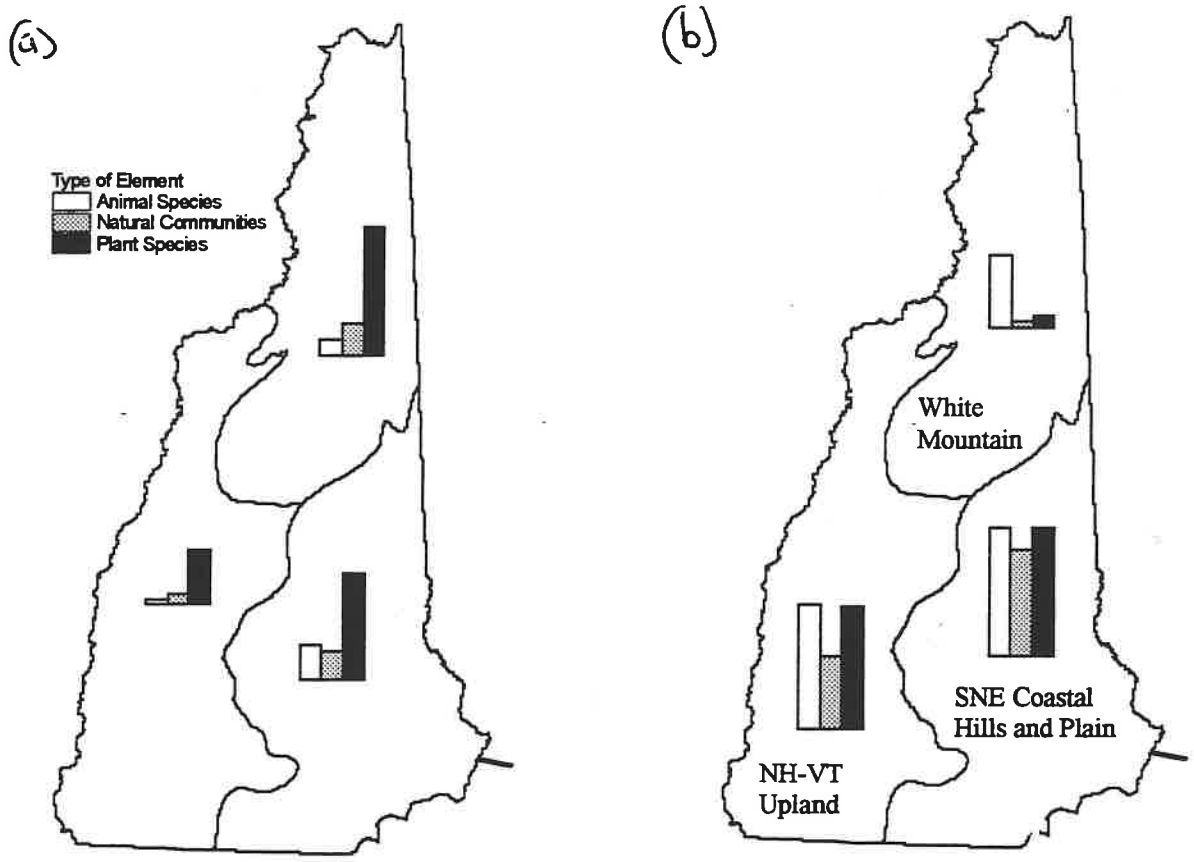
H = Occurred historically, not known to have beeen extirpated
X = Extirpated

?/U = Not ranked / Unknown
Q = Questionable taxonomy

Listing Codes:

T = Threatened
E = Endangered

Figure PC.1 Distribution of rare species and exemplary natural communities in New Hampshire, by ecoregion.



Number per 1,000 acres

Percent of Occurrences NOT on Conservation Land

Ecoregion	Element	No. per 1000 acres	Percent NOT on conservation land
White Mountain	Animal Species	0.9	51.6
	Natural Communities	1.5	18.3
	Plant Species	5.5	21.6
NH-Vermont Upland	Animal Species	0.4	78.8
	Natural Communities	0.6	52.2
	Plant Species	2.5	78.0
S. New England Coastal Hills and Plain	Animal Species	1.6	80.6
	Natural Communities	1.3	70.0
	Plant Species	4.6	81.1

Table PC.1. Conservation status of rare plant species currently known to occur in New Hampshire.

Globally*	Regionally* (New England)	New Hampshire*	Number of Species
Imperiled	Imperiled	Imperiled	8
Rare or Uncommon	Imperiled	Imperiled	8
Common	Imperiled	Imperiled	62
		Rare or Uncommon	5
	Rare or uncommon	Imperiled	153
		Rare or uncommon	9
Status Unknown	--	--	3
		Total Species:	**248**

* Imperiled = 20 or fewer known occurrences, and/or highly vulnerable to extinction.
Rare or Uncommon = 20-100 known occurrences, and/or vulnerable to extinction.

Table PC.2. Conservation status of exemplary natural communities currently known to occur in New Hampshire.

Globally*	Ecoregional Distribution**	New Hampshire*	Number of Communities
Imperiled	Restricted	Imperiled	9
Rare or Uncommon	Restricted	Imperiled	15
Common	Restricted	Imperiled	1
		Rare or Uncommon	1
	Limited or Widespread	Imperiled	2
		Rare or uncommon	0
Status Unknown	--	--	70
		Total Communities:	**98**

* Imperiled = 20 or fewer known occurrences, and/or highly vulnerable to extinction.
Rare or Uncommon = 20-100 known occurrences, and/or vulnerable to extinction.
** Restricted = occurs in only one ecoregion
Limited or Widespread = occurs in two or more ecoregions

Ranking index attribute values for rare plant species. Though plants are listed in descending order of cumulative points assigned, this list does not represent an importance ranking.

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Carex polymorpha	G2	1	S1	1		2	2	2	2	2
Hieracium robinsonii	G1	1	S1	1	1	2	2	2	2	2
Potentilla robbinsiana	G1	1	S1	1	2	2	2	2	2	2
Scirpus longii	G2	1	S1	0		2	2	2	1	2
Astragalus robbinsii var jesupii	T1	1	S1	0		2	2	2	1	2
Listera auriculata	G3	1	S1	1	1	1	2	2	2	2
Prenanthes boottii	G2	1	S1	3	4	2	2	2	2	1
Poa fernaldiana	G2	1	S2	1	6	2	2	2	2	1
Scirpus ancistrochaetus	G3	1	S1	2		1	2	2	2	2
Isotria medeoloides	G2	1	S2	2	9	2	2	2	2	1
Carex wiegandii	G3	1	S1	0	2	1	2	2	1	2
Arnica lanceolata	G3	1	S1	1	4	1	2	2	2	1
Geum peckii	G2	1	S2	4	28	2	2	2	2	0
Cynoglossum boreale	G4	1	S1	0	1	0	2	2	1	2
Cypripedium arietinum	G3	1	S1			1	2	2	0	2
Carex garberi var bifaria	T3	1	S1			1	2	2	0	2

Liatris borealis	G3	1	S1			1	2	2	0	2
Betula minor	G3	1	S1	1	12	1	2	2	2	0
Valeriana uliginosa	G4	2	S1	1		0	1	2	2	2
Sclerolepis uniflora	G4	2	S1	1		0	1	2	2	2
Euphrasia oakesii	G4	2	S1	1	1	0	1	2	2	2
Aster ptarmicoides	G5	2	S1	1	1	0	1	2	2	2
Carex capitata ssp arctogena	T4	2	S1	1	2	0	1	2	2	2
Polygonum viviparum	G5	2	S1	1	2	0	1	2	2	2
Cardamine bellidifolia	G5	2	S1	2	2	0	1	2	2	2
Pinguicula vulgaris	G5	2	S1	2	2	0	1	2	2	2
Mimulus moschatus	G4	2	S1	1	1	0	1	2	2	2
Calamagrostis lacustris	G3	2	S1	1	4	1	1	2	2	1
Betula pumila	G5	3	S1	1	1	0	1	2	2	2
Juniperus horizontalis	G5	3	S1	1	1	0	1	2	2	2
Viburnum rafinesquianum	G5	3	S1	2		0	1	2	2	2
Lupinus perennis	G5	3	S1	1	2	0	1	2	2	2
Cyperus houghtonii	G4	2	S1	0		0	1	2	1	2
Rubus cuneifolius	G5	2	S1	0		0	1	2	1	2
Gentiana andrewsii	G4	2	S1	0		0	1	2	1	2
Aristida tuberculosa	G5	2	S1	0	1	0	1	2	1	2

Carex trichocarpa	G4	2	S1	0	1	0	1	2	1	2
Saxifraga rivularis	G5	2	S1	0	2	0	1	2	1	2
Geocaulon lividum	G5	2	S2	0	2	0	1	2	1	2
Epilobium alpinum	G?	2	S1	0	2	0	1	2	1	2
Saxifraga aizoon var neogaea	T?	2	S1	0	2	0	1	2	1	2

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Eleocharis pauciflora var fernaldii	T?	2	S1	0	2	0	1	2	1	2
Oxyria digyna	G5	2	S1	1	3	0	1	2	2	1
Polygonum douglasii	G5	2	S1	0	2	0	1	2	1	2
Salix herbacea	G5	2	S1	2	5	0	1	2	2	1
Minuartia glabra	G4	2	S1	1	5	0	1	2	2	1
Carex scirpoidea	G5	2	S1	3	5	0	1	2	2	1
Arctostaphylos alpina	G5	2	S1	1	6	0	1	2	2	1
Triphora trianthophora	G4	2	S2	3	3	0	1	2	2	1
Salix planifolia	G5	2	S2	1	9	0	1	2	2	1
Betula nigra	G5	2	S2	2	3	0	1	2	2	1
Calamagrostis pickeringii	G4	2	S2	3	9	0	1	2	2	1
Camptosorus rhizophyllus	G5	6	S1	1		0	0	2	2	2
Cyperus aristatus	G5	6	S2	1		0	0	2	2	2
Heteranthera dubia	G5	6	S1	1		0	0	2	2	2
Eriophorum angustifolium	G5	6	S1	1	1	0	0	2	2	2
Isotria verticillata	G5	6	S1	1	1	0	0	2	2	2
Triosteum aurantiacum	G5	6	S1	1		0	0	2	2	2
Limosella australis	G4	6	S1	1	1	0	0	2	2	2
Sanicula trifoliata	G4	6	S2	1	1	0	0	2	2	2

Cardamine bulbosa	G5	6	S1	1	1	0	0	2	2	2
Minuartia stricta	G5	6	S1	1	2	0	0	2	2	2
Pycnanthemum incanum	G5	6	S1	1		0	0	2	2	2
Aster tenuifolius	G5	6	S1	1		0	0	2	2	2
Staphylea trifolia	G5	6	S2	1		0	0	2	2	2
Lysimachia thyrsiflora	G5	6	S2	1	1	0	0	2	2	2
Galium pilosum	G5	6	S2	1	2	0	0	2	2	2
Megalodonta beckii	G4	6	S2	1	2	0	0	2	2	2
Rhododendron maximum	G5	6	S2	2	2	0	0	2	2	2
Eleocharis halophila	G4	6	S1	1	1	0	0	2	2	2
Aster patens var patens	T5	6	S2	2	1	0	0	2	2	2
Cypripedium reginae	G4	6	S1	3		0	0	2	2	2
Desmodium rotundifolium	G5	6	S2	1	1	0	0	2	2	2
Parnassia glauca	G5	6	S2	1	1	0	0	2	2	2
Asclepias amplexicaulis	G5	6	S1	1	1	0	0	2	2	2
Lilaeopsis chinensis	G5	6	S2	4	1	0	0	2	2	2
Gaylussacia dumosa var bigeloviana	T4	6	S2	1	1	0	0	2	2	2
Arabis canadensis	G5	6	S2	2	2	0	0	2	2	2
Samolus parviflorus	G5	6	S1	2	2	0	0	2	2	2
Iva frutescens ssp oraria	T5	6	S2	2	2	0	0	2	2	2

Cryptogramma stelleri	G5	6	S1	1	2	0	0	2	2	2
Platanthera flava var herbiola	T4	6	S2	1		0	0	2	2	2
Senecio pauperculus	G5	6	S2	2	2	0	0	2	2	2
Gentiana crinita	G4	6	S2	1	2	0	0	2	2	2

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Iris prismatica	G4	6	S2	1	1	0	0	2	2	2
Hudsonia ericoides	G4	6	S1	1		0	0	2	2	2
Agalinis maritima	G5	6	S2	1	2	0	0	2	2	2
Ranunculus ambigens	G4	2	S1			0	1	2	0	2
Sporobolus neglectus	G5	2	S1			0	1	2	0	2
Rhynchospora capillacea	G5	2	S1			0	1	2	0	2
Cardamine pratensis var palustris	T5	2	S1			0	1	2	0	2
Sibbaldia procumbens	G5	2	S1		1	0	1	2	0	2
Draba lanceolata	G4	2	S1		1	0	1	2	0	2
Carex capillaris ssp capillaris	T?	2	S1		1	0	1	2	0	2
Saxifraga cernua	G4	2	S1		1	0	1	2	0	2
Gnaphalium supinum	G5	2	S1		1	0	1	2	0	2
Veronica wormskjoldii	G4	2	S1		2	0	1	2	0	2
Silene acaulis var exscapa	T?	2	S1		2	0	1	2	0	2
Castilleja septentrionalis	G5	2	S1	0	3	0	1	2	1	1
Phleum alpinum	G5	2	S2	0	3	0	1	2	1	1
Viola palustris	G5	2	S2	0	4	0	1	2	1	1
Deschampsia atropurpurea	G5	2	S2	0	5	0	1	2	1	1
Salix argyrocarpa	G4	2	S1	0	5	0	1	2	1	1

Cassiope hypnoides	G5	2	S2	0	6	0	1	2	1	1
Luzula spicata	G5	2	S3	1	6	0	1	1	2	1
Agrostis borealis	G5	2	S3	1	6	0	1	1	2	1
Rhododendron lapponicum	G5	2	S2	0	7	0	1	2	1	1
Hierochloe alpina	G5	2	S2	0	8	0	1	2	1	1
Phyllodoce caerulea	G5	2	S2	1	10	0	1	2	2	0
Betula glandulosa	G5	2	S1	1	11	0	1	2	2	0
Loiseleuria procumbens	G5	2	S2	2	11	0	1	2	2	0
Epilobium hornemannii	G5	2	S2	5	12	0	1	2	2	0
Paronychia argyrocoma var albimontana	T3	2	S3	4	11	1	1	1	2	0
Corallorhiza odontorhiza	G5	3	S1			0	1	2	0	2
Tofieldia glutinosa	G5	3	S1			0	1	2	0	2
Scirpus pendulus	G5	6	S2	0		0	0	2	1	2
Quercus macrocarpa	G5	6	S1	0		0	0	2	1	2
Potamogeton foliosus	G5	6	S1	0		0	0	2	1	2
Potamogeton lateralis	GU	6	S1	0		0	0	2	1	2
Chenopodium rubrum	G5	6	S2	0		0	0	2	1	2
Honckenya peploides ssp robusta	T4	6	S1	0		0	0	2	1	2
Eupatorium sessilifolium	G5	6	S1	0		0	0	2	1	2
Carex seorsa	G4	6	S1	0		0	0	2	1	2

Eupatorium pubescens	T5	6	S1	0		0	0	2	1	2
Menispermum canadense	G5	6	S1	0	1	0	0	2	1	2
Pinus banksiana	G5	6	S1	0	1	0	0	2	1	2
Proserpinaca pectinata	G5	6	S1	0	1	0	0	2	1	2

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Bromus pubescens	G5	6	S1	0	1	0	0	2	1	2
Cyperus grayi	G5	6	S1	0	1	0	0	2	1	2
Festuca rubra var prolifera	T4	6	S1	0	1	0	0	2	1	2
Carex bebbii	G5	6	S2	0		0	0	2	1	2
Lindernia anagallidea	G5	6	S1	0		0	0	2	1	2
Carex aurea	G5	6	S2	0		0	0	2	1	2
Polygonum robustius	G4	6	S2	0		0	0	2	1	2
Petasites frigidus var palmatus	T5	6	S1	0	1	0	0	2	1	2
Carex diandra	G5	6	S1	0	1	0	0	2	1	2
Sanicula gregaria	G4	6	S2	0	1	0	0	2	1	2
Ranunculus fascicularis	G5	6	S1	0	1	0	0	2	1	2
Waldsteinia fragarioides	G5	6	S1	0	1	0	0	2	1	2
Dentaria laciniata	G5	6	S1	0	2	0	0	2	1	2
Equisetum pratense	G5	6	S2	0		0	0	2	1	2
Polygonum prolificum	G4	6	S2	0		0	0	2	1	2
Salicornia virginica	G5	6	S1	0		0	0	2	1	2
Lemna trisulca	G5	6	S2	0		0	0	2	1	2
Aureolaria virginica	G5	6	S2	0		0	0	2	1	2
Carex cristatella	G5	6	S2	0		0	0	2	1	2

Uvularia grandiflora	G5	6	S1	0	1	0	0	2	1	2
Allium canadense	G5	6	S1	0	1	0	0	2	1	2
Equisetum palustre	G5	6	S1	0	1	0	0	2	1	2
Cenchrus longispinus	G5	6	S2	0		0	0	2	1	2
Hackelia virginiana	G5	6	S2	0	1	0	0	2	1	2
Hypericum pyramidatum	G4	6	S1	0	1	0	0	2	1	2
Asclepias quadrifolia	G5	6	S1	0		0	0	2	1	2
Physostegia virginiana	G5	6	S1	0		0	0	2	1	2
Woodsia obtusa	G5	6	S2	0	1	0	0	2	1	2
Hypoxis hirsuta	G5	6	S2	0	1	0	0	2	1	2
Mikania scandens	G5	6	S2	0	1	0	0	2	1	2
Anemonella thalictroides	G5	6	S1	0	2	0	0	2	1	2
Listera convallarioides	G5	6	S2	1	5	0	0	2	2	1
Liparis loeselii	G5	6	S2	0	1	0	0	2	1	2
Rubus chamaemorus	G5	6	S1	1	4	0	0	2	2	1
Potamogeton nodosus	G5	6	S2	0		0	0	2	1	2
Arethusa bulbosa	G4	6	S1	0		0	0	2	1	2
Acer nigrum	G5	6	S1	0	1	0	0	2	1	2
Salicornia bigelovii	G5	6	S2	0	1	0	0	2	1	2
Hydrophyllum virginianum	G5	6	S2	0	1	0	0	2	1	2

Dryopteris fragrans	G5	6	S1	3	5	0	0	2	2	1
Lobelia kalmii	G5	6	S2	0	1	0	0	2	1	2
Dryopteris goldiana	G4	6	S2	3	4	0	0	2	2	1
Solidago odora	G5	6	S2	0	1	0	0	2	1	2

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Eleocharis parvula	G5	6	S1	1	5	0	0	2	2	1
Polygonum exsertum	G4	6	S2	3	4	0	0	2	2	1
Hudsonia tomentosa	G5	6	S1	4	4	0	0	2	2	1
Dicentra canadensis	G5	6	S2	3	7	0	0	2	2	1
Panax quinquefolius	G4	6	S2	2	9	0	0	2	2	1
Vaccinium boreale	G4	1	S3	0	11	0	2	1	1	0
Calamagrostis stricta var inexpansa	T5	2	SU	0	1	0	1	0	1	2
Solidago cutleri	G4	2	S3	0	9	0	1	1	1	1
Salix uva-ursi	G5	2	S2	0	17	0	1	2	1	0
Calamagrostis cinnoides	G5	6	S1			0	0	2	0	2
Malaxis monophyllos var brachypoda	T4	6	S1			0	0	2	0	2
Isoetes engelmannii	G4	6	SH	1		0	0	0	2	2
Aristida longespica var geniculata	T?	6	S2			0	0	2	0	2
Polygonatum biflorum var commutatum	T4	6	S1			0	0	2	0	2
Lilium superbum	G5	6	S1			0	0	2	0	2
Diplazium pycnocarpon	G5	6	S1			0	0	2	0	2
Carex amphibola var rigida	T5	6	S2			0	0	2	0	2
Desmodium marilandicum	G5	6	S1			0	0	2	0	2
Senecio obovatus	G5	6	S1			0	0	2	0	2

Tephrosia virginiana	G5	6	S1		0	0	2	0	2
Pycnanthemum virginianum	G5	6	S1		0	0	2	0	2
Arabis hirsuta var pycnocarpa	T5	6	S1		0	0	2	0	2
Carex eburnea	G5	6	S1	1	0	0	2	0	2
Glyceria acutiflora	G5	6	S1	1	0	0	2	0	2
Tillaea aquatica	G5	6	S1	1	0	0	2	0	2
Epilobium ciliatum	G5	6	S2	1	0	0	2	0	2
Festuca octoflora var tenella	T?	6	S2	1	0	0	2	0	2
Glaux maritima	G5	6	S1	1	0	0	2	0	2
Carex castanea	G5	6	S1		0	0	2	0	2
Carex baileyi	G4	6	S1		0	0	2	0	2
Muhlenbergia sobolifera	G5	6	S1		0	0	2	0	2
Carex bullata	G5	6	S1		0	0	2	0	2
Carex granularis var haleana	T4	6	S1		0	0	2	0	2
Aureolaria pedicularia var intercedens	T?	6	S1	1	0	0	2	0	2
Carex cumulata	G4	6	S2	1	0	0	2	0	2
Arisaema dracontium	G5	6	S1	1	0	0	2	0	2
Pyrola asarifolia	G5	6	S2	1	0	0	2	0	2
Woodsia glabella	G5	6	S1	1	0	0	2	0	2
Uvularia perfoliata	G5	6	S1	1	0	0	2	0	2

Sericocarpus linifolius	G5	6	S1		0	0	2	0	2
Halenia deflexa	G5	6	S1		0	0	2	0	2
Allium schoenoprasum var sibiricum	T5	6	S2	1	0	0	2	0	2
Adlumia fungosa	G4	6	S1	1	0	0	2	0	2

	Attribute Values					Points Assigned				
Scientific Name	**GRnk**	**Div**	**SRnk**	**nA**	**nOn**	**gr**	**div**	**sr**	**a**	**on**
Lespedeza virginica	G5	6	S1		1	0	0	2	0	2
Galearis spectabilis	G5	6	S2	0	3	0	0	2	1	1
Spiranthes lucida	G5	6	S1			0	0	2	0	2
Bidens discoidea	G5	6	S3	0	1	0	0	1	1	2
Solidago purshii	G5	6	S1	0	3	0	0	2	1	1
Celtis occidentalis	G5	6	S2	0	3	0	0	2	1	1
Artemisia campestris ssp caudata	T4	6	S2	0	4	0	0	2	1	1
Listera cordata	G5	6	S2	0	8	0	0	2	1	1
Sporobolus cryptandrus	G5	6	S2	0	4	0	0	2	1	1
Malaxis unifolia	G5	6	S2	0	6	0	0	2	1	1
Equisetum variegatum	G5	6	S2	0	3	0	0	2	1	1
Sparganium eurycarpum	G5	6	S2	0	3	0	0	2	1	1
Scirpus robustus	G5	6	S3	4	3	0	0	1	2	1
Milium effusum	G5	6	S2	5	14	0	0	2	2	0
Empetrum atropurpureum	G5	6	S2	2	18	0	0	2	2	0
Rhododendron viscosum	G5	6	S3	1	4	0	0	1	2	1
Conopholis americana	G5	6	S3	0	3	0	0	1	1	1
Viola pedata var linearíloba	G5	6	S2		3	0	0	2	0	1
Paronychia canadensis	G5	6	S1		3	0	0	2	0	1

Ammophila breviligulata	G5	6	S3	0	6	0	0	1	1	1
Carex bigelowii	G5	6	S3	6	16	0	0	1	2	0
Diapensia lapponica	G5	6	S3	3	18	0	0	1	2	0
Chamaecyparis thyoides	G4	6	S3	2	12	0	0	1	2	0

Attribute:	Prefix	Suffix
GRnk = Global rarity rank	G = Global	1 = Critically imperiled (<= 5 occurrences)
	S = State	2 = Imperiled (6-20 occurrences)
SRnk = State rarity rank	T = Taxon	3 = Rare or uncommon (21-100 occurrences)
		4, 5 = Widespread and abundant
		? = Uncertain
Div = Regional rarity rank (NEPCoP Division)		1 = Globally rare
		2 = Regionally rare (< 20 current occurrences within New England)
		3 = Locally rare (one or more occurrences with biolgoical, ecological, or genetic significance)
		6 = Not on the NEPCoP list (common somewhere in New England)

nA = Number of "A"-ranked occurrences in New Hampshire

nOn = Number of occurrences on conservation land in New Hampshire

Ranking index attribute values for natural communities. Though natural communities are listed in descending order of total points assigned, the list does not imply an importance ranking.

Community Name	Attribute Values					Points Assigned				
	Grnk	Reg	Srnk	nA	nOn	gr	Reg	sr	a	on
NE Inland Dune Community	G2	R	S1	1	1	2	2	2	2	2
NNE Riverside Outcrop Community	G2	R	S1	2	1	2	2	2	2	2
New England Riverwash Hudsonia Barren	G2	R	S1	1	1	2	2	2	2	2
New England Dry Riverbluff Opening	G1	R	S1	1	2	2	2	2	2	2
New England Pitch Pine/Scrub Oak Barrens	G2	R,L	S1	3	2	2	2	2	2	2
Inland Beach Strand Community	G1	L	S1	1	1	2	1	2	2	2
NE Subalpine Heath/Krummolz Community	G3	R	S1	3		1	2	2	2	2
NE Boreal Heathland	G3	R	S1	3	3	1	2	2	2	2
NE Moist Subalpine Heathland	G3	R	S1	2		1	2	2	2	2
NE Calcareous Riverside Seep Community	G2	R	S1		1	2	2	2	1	2
SNE Riverside Outcrop Community	G2	L	S1		0	2	1	2	1	2
NNE Calcareous Cliff Community	G3	L	S1	4	2	1	1	2	2	2
SNE Basin Marsh	G3	L	S1	1	2	1	1	2	2	2
Inland New England Acidic Pond Shore/Lake Shore Community 2	G3	L	S1	2		4	1	1	2	2
NNE Basin Marsh		R	S1	1		0	2	2	2	2
CNE Dry Transitional Forest on Sandy/Gravelly Soils		R	S1	1	0	0	2	2	2	2
NNE Circumneutral Talus Forest/Woodland		R	S2	1	1	0	2	2	2	2

NNE Cold-Air Talus Forest/Woodland	G3	R	S1	5		1	2	2	2	1
New England Alpine/Subalpine Bog	G3	R,L	S1	3	6	1	2	2	2	1
SNE Maritime Forest on Dunes	G2	L	S1			2	1	2	0	2
NNE Lowland Spruce/Fir Forest		L	S2	1		0	1	2	2	2
SNE Calcareous Seepage Swamp		L	S1	1	0	0	1	2	2	2
SNE Circumneutral Rocky Summit/Rock Outcrop Community		L	S1	2	1	0	1	2	2	2
SNE Circumneutral Talus Forest/Woodland		L	S1	2	3	0	1	2	2	2
Blackgum/Red Maple Basin Swamp	*	L	S1	3	4	0	1	2	2	2
SNE Acidic Level Fen		L	S2	3	3	0	1	2	2	2
SNE Dry Rich Forest on Acidic/Circumneutral Bedrock or Till	G5	L	S1	4	3	0	1	2	2	2
NNE Calcareous Seepage Swamp	G4	L	S2	1	4	0	1	2	2	2
SNE Dry Central Hardwood Forest on Acidic Bedrock or Till		L	S2	1	3	0	1	2	2	2
SNE Coastal Salt Pond Marsh	G4	R	S1			0	2	2	1	2
SNE Coastal Dune Community	G3	R	S1			1	2	2	0	2
NNE Acidic Sloping Fen	G3	R	S1		1	1	2	2	0	2
NE Alpine Community	G3	R	S1	5		1	2	2	2	0
NNE Calcareous Sloping Fen	G3		S1		0	1	0	2	1	2
Atlantic White Cedar Basin Swamp	G3		S1	9	10	1	0	2	2	1
NNE Riverside Meadow		L	S1			0	1	2	1	2
SNE Acidic Talus Forest/Woodland		L	S2			0	1	2	1	2

NE Acidic Riverside Seep Community	*	L	S1		2	0	1	2	1	2

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Community Name	Attribute Values					Points Assigned				
	Grnk	Reg	Srnk	nA	nOn	gr	Reg	sr	a	on
SNE Lake Sediment/River Terrace Forest		L	S2		3	0	1	2	1	2
NNE Lake Sediment/River Terrace Forest		L	S2	2	6	0	1	2	2	1
Red Pine Forest/Woodland	G?	L	S2	6	8	0	1	2	2	1
SNE Level Bog		L	S1	5	6	0	1	2	2	1
SNE Coastal Interdunal Marsh/Swale		R	S1			0	2	2	0	2
Gulf of Maine Brackish Tidal Marsh		R	S2		2	0	2	2	0	2
Gulf of Maine Salt Marsh	G5	R	S3	3	4	0	2	0	2	2
SNE Acidic Rocky Summit/Rock Outcrop Community		R,L	S3	5	5	0	2	0	2	2
SNE Cold-Air Talus Forest/Woodland	G3		S1			1	0	2	0	2
NNE Calcareous Level Fen	G3		S1		0	1	0	2	0	2
NNE Calcareous Rocky Summit/Rock Outcrop Community		L	S1			0	1	2	0	2
SNE Red Maple Alluvial Swamp		L	S4	1	0	0	1	0	2	2
SNE Mesic Central Hardwood Forest on Acidic Bedrock or Till		L	S3	2	3	0	1	0	2	2
NNE Level Bog		L	S2	4	12	0	1	2	2	0
Hemlock Forest		L,W	S3	1		0	1	0	2	2
SNE High-Energy Riverbank Community		L,W	S?	1	1	0	1	0	2	2
SNE Basin Swamp		L,W	S3	2	1	0	1	0	2	2
NNE High-Energy Riverbank Community		R,W	S?	6	8	0	2	0	2	1
SNE Stream Bottom Forest		W	S2		2	0	0	2	1	2

Circumneutral Northern Hardwood Seepage Forest	GU		S2			0	0	2	0	2
SNE Circumneutral Cliff Community		L	S3		0	0	1	0	1	2
NNE Acidic Cliff Community		L	S5	3		0	1	0	2	1
NNE Circumneutral Cliff Community		L	S3	3	7	0	1	0	2	1
NNE Acidic Rocky Summit/Rock Outcrop Community		R	S3	10	14	0	2	0	2	0
NNE High Elevation Spruce-Fir Forest		R,L	S4	12		0	2	0	2	0
NNE Rich Mesic Forest		R,L	S3	8	22	0	2	0	2	0
SNE Dry Oak/Pine Forest on Sandy/Gravelly Soils		W	S2		0	0	0	2	0	2
CNE Dry Transitional Forest on Acidic Bedrock or Till		W	S3	1	5	0	0	0	2	2
NNE Acidic Seepage Swamp		W	S3	2	4	0	0	0	2	2
SNE Acidic Seepage Swamp		W	S3	3	3	0	0	0	2	2
NNE Red Maple Alluvial Swamp		L	S4			0	1	0	0	2
SNE Coastal Rocky Headland Community		L	SU		0	0	1	0	0	2
NNE Acidic Level Fen		L	S3	5	15	0	1	0	2	0
NNE Mesic Hardwood Forest on Acidic Bedrock or Till		L,W	S4	7	23	0	1	0	2	0
CNE Mesic Transitional Forest on Acidic Bedrock or Till		W	S5	4	7	0	0	0	2	1
NNE Basin Swamp		L,W	S3		6	0	1	0	0	1
Coastal/Southern Shallow Emergent Marsh		W	SU		0	0	0	0	0	2

Community Name	Attribute Values Grnk Reg Srnk nA nOn	Points Assigned gr Reg sr a on

Attribute:	Prefix	Suffix
GRnk = Global rarity rank	G = Global	1 = Critically imperiled (<= 5 occurrences)
	S = State	2 = Imperiled (6-20 occurrences)
SRnk = State rarity rank	T = Taxon	3 = Rare or uncommon (21-100 occurrences)
		4, 5 = Widespread and abundant
		? = Uncertain
Reg = Regional rarity rank		R = Restricted to one ecoregion
		L = Limited (typically in one region but also occurs in a few adjacent
		W = Widespread (typical of one region but also occurs in most other

nA = Number of "A"-ranked occurrences in New Hampshire

nOn = Number of occurrences on conservation land in New Hampshire

Excellent (A-ranked) examples of Natural Communities

78 NCS types

Community Name	# of A-ranked occurrences on or off conservation lands: ON	OFF
New England Dry Riverbluff Opening		1
New England Riverwash Hudsonia Barren		1
SNE Basin Swamp		1
SNE High-Energy Riverbank Community		1
Inland Beach Strand Community		1
SNE Calcareous Seepage Swamp		1
SNE Dry Central Hardwood Forest on Acidic Bedrock or Till		1
CNE Dry Transitional Forest on Sandy/Gravelly Soils		1
Blackgum/Red Maple Basin Swamp		2
New England Alpine/Subalpine Bog		2
New England Pitch Pine/Scrub Oak Barrens		3
SNE Acidic Seepage Swamp		3
SNE Dry Rich Forest on Acidic/Circumneutral Bedrock or Till		4
Gulf of Maine Salt Marsh	1	
SNE Circumneutral Talus Forest/Woodland	1	
SNE Circumneutral Rocky Summit/Rock Outcrop Community	1	
SNE Level Bog	1	
SNE Acidic Level Fen	1	
SNE Mesic Central Hardwood Forest on Acidic Bedrock or Till	1	
NE Alpine/Subalpine Pond	1	
SNE Basin Marsh	1	
NNE Lowland Spruce/Fir Forest	1	
Clear Softwater Lake/Pond	1	
NE Inland Dune Community	1	
NNE High-Energy Riverbank Community	1	1
CNE Mesic Transitional Forest on Acidic Bedrock or Till	1	1
Inland New England Acidic Pond Shore/Lake Shore Community	1	1
NNE Riverside Outcrop Community	1	1
SNE Rich Mesic Forest	1	2
SNE Acidic Rocky Summit/Rock Outcrop Community	1	2
NNE Circumneutral Cliff Community	1	2
NNE Rich Mesic Forest	1	4
NNE Acidic Seepage Swamp	2	
NNE Acidic Cliff Community	2	
NE Boreal Heathland	2	1
NNE Calcareous Cliff Community	2	2
NNE Level Bog	3	
NE Subalpine Heath/Krummolz Community	3	
Red Pine Forest/Woodland	3	1
Atlantic White Cedar Basin Swamp	3	1
NNE Mesic Hardwood Forest on Acidic Bedrock or Till	3	1
NNE Acidic Level Fen	4	
SNE Floodplain Forest	4	3
NNE Cold-Air Talus Forest/Woodland	5	
NE Alpine Community	5	
NNE Acidic Talus Forest/Woodland	5	
NNE Acidic Rocky Summit/Rock Outcrop Community	5	2
NNE High Elevation Spruce-Fir Forest	10	
	81	47

Jan 1998

Table X. Relative sensitivity of upland and fresh water wetland communities to human induced impacts, proportion of rare community type, and potential for rare plants. H=high; M=medium; L=low sensitivity.

COMMUNITY CLASS	Soil Type	Erosion/mech-anical disturb. sensitivity (logging or rec. vehicles)	Access/slope/ hydrologic limitations	Relative sensitivity to hiking or climbing	Relative poten. for *nutrient loss* to leaching from disturbance	Relative sensitivity to local *nutrient inputs*	Proportion of rare community type in group	Potential for rare plants
Mesic acidic upland forests (steep)	Coarse to mod. fine tills & terrace soils	M-H	M-H	L	M	L	L	L-M
Mesic acidic upland forests (low-moderate slopes)	Coarse to mod. fine till & terrace flats	L	L-M	L	L	L	L	L
Mesic enriched forests	Loams: fine till, colluvium, river terraces	M-H	L-M	L-M	H	L	H	H
Dry upland forests	Shallow till/sand/grvl	L	L	L	L	M?	M-H	L-M
Dry woodlands (rocky ridges, summits, sandplains)	Shallow till, bedrock, sand/grvl	L-M	L-H	M-H	L	L?	H	H
Acidic talus slopes	Rocky talus, colluv.	M	M-H	M-H	M	L	L	L-M
Enriched talus slopes	Rocky talus, colluv.	M-H	M-H	M-H	M-H	L	H	H
Cliffs	Soil in rock cracks	L	H	H	L	L	M	H
Alpine - sedge meadow	Organic	M-H	H	M	L	M-H	H	M-H
Alpine - heath/ krummholz, heath/meadows, barrens, cliffs & wetlands	Organic/coarse mineral	H	H	H	L	M-H	H	H
Acidic basin swamps	Peat	M-H	H	L-M	L-M	M	M	L-M
Streamside & enriched swamps	Muck and peat	M-H	H	L-M	M-H	L-M	M-H	M-H
Floodplain forests	Mineral(silt/sand)	M	H	L-M	H	L-M	H	M
Vernal pools, seeps, basin marshes, sandy pondshores	Variable (organic, till, sand outwash)	H	H	H	L	H	H	H
Bogs and fens	Peat	M-H	H	M-H	L	H	H	M-H
Marshes and shrub thickets	Muck or mineral	M	H	L-M	M	L-M	L-M	L-M
Riverbank communities	Mineral and shallow organic turfs	H	H	M	L?	M-H	M-H	M-H

Sperduto, Daniel. 1997. The Natural Communities of New Hampshire: A Guide and Classification. DRAFT as of November 21, 1997.

The link between physical diversity and community and plant diversity

Dan Sperduto - 6/1/98

Natural communities are groups of organisms that occur together in the landscape where a particular set of physical and biological factors coincide. They can be identified by both the set of physical and biological factors and by groups of indicator species that characterize the community. Although physical diversity varies enormously across the landscape and can be classified in an infinite number of ways, certain aspects of physical diversity have a disproportionately high influence on biota. The primary physical factors that affect all organisms are listed in Table 1. If one or more of these factors changes significantly from one area to another in the landscape, it will likely be reflected by a change in species composition and consequently community type. Since certain groups of physical factors tend to recur together in the landscape, community types tend to recur as well.

Climate and is a dominant physical influence that affects vegetation and soil development over large geographic areas. There are major climate differences in New Hampshire along both latitudinal (N-S) and elevational (high-low elevation) gradients. Climate controls the amount of energy and water that are available to all organisms. Within the umbrella of this influence, local factors that affect vegetation include landforms, bedrock, surficial deposits, soils and nutrients that derive from them, water, disturbance, and humans.

Bedrock and landforms left with the passage of the glaciers shape the land we see today. At a finer scale, the surficial deposits that derive from the bedrock, and the soils that develop from them over time, impose a great influence on plants and the animals associated with them. Two primary aspects of their influence are the mineral composition of the bedrock source material and the nature of the resulting surficial deposits. Bedrock, and the soils that develop from it, is the ultimate source of most of the mineral nutrients plants need to grow and are the long-term storage pools for most nutrients. The mineral composition (or **mineralogy**) of bedrock varies greatly in terms of the amount and rate of nutrient release, the texture of sediments that develop from it, and, in turn, the plants and communities that occur there. Soils are often formed from sediments and rocks transported from off-site, and frequently consist of material from more than one type of bedrock. The soil at any one site will reflect the bedrock at that same site to varying degrees, depending on the proportion of the sediments in the soil that the local bedrock contributed.

Disturbance is a critical factor that affects all communities to one degree or another. It may affect single individuals or many organisms across entire communities, and may be of physical or biological origin. Natural disturbances include felling of trees by wind (windthrow) or beavers, herbivory by mammals, insects or other organisms, flooding, ice-scour, and fire. Human disturbances include harvesting, development, motorized vehicles, and other activities. These and other factors remove living vegetation, modify conditions of a site, and usually influence the course of succession and the outcome of competition.

Other **biological factors** (other than disturbance agents) that act independently of or in combination with physical features include competition among species, succession, and the establishment or extinction of species from a particular area over time.

All of these factors combine in different ways to produce different community types that occupy different sized patches in the landscape, depending on the distribution of the most influential factors. Plants are sensitive indicators of physical environments, and are most strongly influenced by major differences in those physical features that control plant growth - nutrients, water, climate, and disturbance. For instance, "boreal calcareous fen" communities occur at only a few, small locations in NH where there is a combination of the right physical features: a boreal climate, and a relatively constant groundwater seepage that flows through calcium rich bedrock and soil, and lack of streambank over flow allows peat to accumulate. This combination of physical features is identifiable by a specific group of plants that reflect these factors, such as showy lady's slippers. Whether the bedrock is dolomite, limestone, or calcium-rich

schist may not be important to the organisms here, but the presence of abundant calcium is. However, if one physical factor changes considerably, for instance, the bedrock source material is granite or mica shcist rather than limestone or dolomite, the groundwater will be acidic, and the community might be a "boreal acidic fen", indicated by plants such as the northern bog orchid. If the particular combination of conditions is rare, such as found in boreal calcareous fens, the community and its organisms will also likely be rare; if the combination is more frequent in the landscape, such as found in boreal acidic fens, the community will be more common.

Communities and the physical features they reflect occur form complex mosaics or patterns in the landscape because the physical and biological factors that control organisms change in their intensity and distribution from one geographic area to another, and from one geographic scale to another. This complexity can be unravelled to some extent by looking at different communities and landscape features according to the dominant *patterns* and dominant *processes* at different geographic scales. Although there is a great diversity of community types in New Hampshire, they can be grouped according to the landscape features and ecological processes that dominate them. These functional groups of communities, or ecosystems, are shown in Table 2. It is important to note that these broad "ecosystems" can be sub-divided further, particularly according to differences in climate and soil nutrient levels as indicated by vegetation differences. Several different ways of looking at physical diversity at the landscape or regional level are also indicated in this table and how they differ.

Physical features used in the ERS-SAG landscape diversity effort cover large, landscape level areas, and the unusual watershed units identified correspond to where extreme combinations of these features occur. The watershed units that contain these extreme features may not contain the entire geographic area of the physical feature(s) that makes it unusual; in addition, the unusual physical features of the watershed (e.g. a particular bedrock group) may or may not affect biota, depending on the degree to which it has actually influenced surface conditions within that watershed, and the extent to which other local factors have masked or overriden its potential influence.

Table 1. Physical factors that influence organisms and communities, with emphasis on vegetation. The characteristics, abundance, intensity, and/or spatial and temporal availability of these factors shape what groups of species will survive in any given area.

REGIONAL/LANDSCAPE SCALE

1) **Climate** - expressed latitudinally and elevationally
2) **Surficial deposits, landforms, and soils**

LOCAL

1) **Soils**: Mineralogy, soil development, soil fertility, and abundance of limiting nutrients
2) **Water**: Annual and seasonal availability etc (hydrology/drainage)
3) **Light**: Dependant on climate limitations, type of vegetation cover, and frequency and time since disturbance.
3) **Disturbance**: Flooding, windthrow, fire, etc.

Table 2. Several different ways of looking at physical and community diversity at the landscape level result when different geographic scales or units are used or when different aspects of geographic patterns are emphasized (e.g. the general size of community vs. proportion of a land unit). Functional groups of communities ("ecosystem" types) that are indicated in the local-scale portion of this table share certain dominant ecological processes (common landforms, soil types, and disturbance regimes). It is important to note that these broad ecosystems can be sub-divided further according to differences in climate and soil nutrient levels, among other factors.

LANDSCAPE SCALE

1) **Ecoregions** (subsections) and **Land Type Associations** : These are nested bio-physical land units in the landscape that emphasize different major combinations of soils and climate (expressed latitudinally and elevationally). The distribution of natural communties have beem identified according to the Ecoregions and LTAs they occur in, and can be further described according to whether they are *restricted* to a single ecoregion, *limited* to one or two other ecoregions, or *widespread* across many.

2) **Matrix, Large and Small patch communities**: These units emphasize how different community types tend to occupy different size ranges in the landscape, and that different patch sizes share certain ecological functions, processes, and other characteristics. Matrix communities cover 100's to more than 1000 acres and correspond primarily to upland glacial till soils that dominate the NH's landscape. Core Forest areas from ERS SAG identified large patches of matrix forest in the state.

3) **Watersheds with extremes of certain large-area physical features**: These units emphasize watershed units (of arbitrary size) that have a high or low proportion of certain large-scale features. Different ranges of elevations and concentrations of wetlands, broad soil types and broad bedrock groups were identified by the landscape diversity exercise (ERS-SAG).

LOCAL SCALE

I) Wetlands - *areas where water is near or at the surface for most or a part of the year*

Stream side swamps - streambank overflow regular.

Basin or depression swamps - streambank overflow minor; stagnant conditions prevail (forested peat lands).

Groundwater swamps - groundwater flow and seepage are important.

Floodplain forests - Temporary flooding along rivers.

Open peatlands - Bogs and fens where relatively stagnant conditions lead to peat development.

Stream side Marshes- wet, Stream side wetlands with minor peat accumulation.

Basin marshes - big vernal pools with vegetation and no inlets or outlets.

Pond and lake shores - wetland sites affected by wave action.

Seeps - Forest, cliff, riverside and other kinds of seeps. Small areas where groundwater emerges from the ground.

Aquatic-bed - Dominated by submersed and floating leaved plants.

Uplands: *areas where water is not near or at the surface for most or a part of the year*

Forests on glacial till - major groupings of till include shallow to deep, and compact to loose.

Talus slopes - forests, woodlands and open areas on jumbles of rock below cliffs.

River terraces and lake-bed sediments: forests on fine to coarse sediments deposited by rivers or at the bottom of glacial lakes.

Outwash/ice-contact deposits - forests and barrens formed on fine to coarse sediments deposited near or at the margin of melting glaciers.

Colluvial soils and other enriched conditions - nutrient rich forests found where down slope movement of soil and organic matter concentrates and collects in drainages and bases of slopes.

Rocky ridges and alpine tundra - dry, shallow soil and bedrock areas along ridgelines with open woodlands and barren areas; alpine tundra at high elevations.

Cliffs - steep rock faces.

Temp. flooded rivershores, riverbanks, and riverbluffs - Open sand, gravel, cobble bars, stable and eroding riverbanks and bluffs that are temporarily but violently flooded.

Dunes - forests and open areas on stabilized or actively shifting sands.

Estuarine and Aquatic systems separate

A Preliminary Model for Classifying Aquatic Communities in Lakes

by James F. Haney

I. Introduction:

New Hampshire is unusual in its abundance and diversity of lakes and streams. Within these aquatic ecosystems there is a great diversity in the types of plant and animal communities. Despite the conspicuous nature of these water bodies and their importance to the inhabitants of the State, there is has been little progress made toward documenting their biodiversity for the purpose of protecting their natural aquatic communities. Existing classification schemes for lakes and streams do not adequately address the problem of identifying these aquatic communities. This problem is not unique to New Hampshire or to the Northeast and hopefully there will emerge a unified system that can be applied to all geographical regions.

Because of the fundamental differences in the structure and function of lake and stream ecosystems, it is not feasible to use a single model to identify the aquatic communities in both systems. Here, we present a method for classifying lakes that identifies their biotic communities based on physical, chemical and biological features of each system. It also attempts to incorporate our present knowledge of ecological processes that regulate community structure. To make the model most functional, most of the model parameters selected were those for which there is information in existing data bases, such as from NH Lakes Lay Monitoring Program, NH Department of Environmental Services and NH Fish and Game.

Often the productivity and integrity of aquatic ecosystems depends on populations of less conspicuous organisms, such as the invertebrates and microscopic plants in lakes. To protect biodiversity in our lakes it is important to include these communities. The model presented is preliminary and should be viewed as a starting point. Its predictions can be used, along with information on the frequency and location of lakes, to help target those systems that are in need of protection. It is important that predictions of the model be verified so that the classification can be further refined. Finally, it is hoped that the model will also serve as a guide to developing a standardized methodology for collection and analysis of vertebrate and invertebrate organisms. Support is needed for a concerted effort to further develop and refine this classification system.

II. Assumptions of the Model:

(1) Measures of biodiversity in aquatic communities should include invertebrate and invertebrate animals, as well as both microphytic and macrophytic plants.

(2) There is presently inadequate information concerning the aquatic communities in New Hampshire lakes and ponds, especially for invertebrate/microphytic communities and aquatic vertebrates other than sport fish.

(3) Aquatic communities are shaped by both physical and biological factors. Such parameters can be used as surrogates for identifying types of communities.

III. Approach:

Much recent evidence suggests aquatic communities are determined by both "bottom-up" (physical/chemical) as well as "top-down" (predator-prey) forces. Thus, as a starting point (stage 1), lakes would be classified according to functional communities (aggregate communities) predicted from bottom-up and top-down lake features (surrogate parameters). A subset of lakes would then be selected for field inventories to verify the model predictions. Using these data the classification scheme will then be refined. Where several surrogate parameters are applied to a single lake, it will be necessary to define the hierarchical effects or these factors on communities, such as a deep, acidic, high altitude lake.

IV. Examples of surrogate parameter data available for most New Hampshire Lakes

A. Bottom-up (physical/chemcial) forces

1. Basin morphometry
    a. maximum depth
    b. relative depth
    c. Elevation
    d. high elevation
    e. low elevation

3. Nutrients
    a. total phosphorus concentration in the epilimnion
    b. nitrogen: phosphorus ratio

4. Water Chemistry
    a. alkalinity
    b. calcium concentration
    c. pH
    d. silica concentration
    e. hypolimnetic oxygen
    f. dissolved humics (water color)

5. Hydraulic retention time

B. Top-down (biological) forces

1.Fish species
    a. warm-water species
    b. cold-water species
    c. fishless waters

2. Other dominant predators
    a. spotted newts
    b. invertebrates, e.g. *Chaoborus* (phantom midge larvae)

V. Examples of surrogate parameters and predicted communities

Surrogate Parameter	Force or Action	Aggregate Communities
1. Shallow depth	Stratification: None	Shallow, polymictic communities
Deep	Stratification: yes	Metalimnetic communities
Very deep/protected	Stratification: extreme (meromixis)	Meromictic communities
2. High Elevation	Short growing season/ low temperature	High altitude alpine and arctic communities
	Low frequency of immigration	Endemic/undisturbed/ relic communities
Low Elevation (coastal lakes/ponds)	High salt concentration	Saline communities
3. Nutrients	Extremely low phosphorus concentration	Oligotrophic communities
	High silica	Diatom communities
	Low nitrogen: phosphorus ratio	Cyanobacterial communities
4. Water chemistry		
	High alkalinity/calcium concentration	Hard water communities
	Low pH due to atmospheric ppt.	Acidophillic lake species
		"Fishless" communities
	Dystrophic acidity	Bog communities
	Oxygen: summer anoxia in hypolimnion	Photochemotrophs Chemical refugium communities
	Oxygen: perennial anoxia in monimolimnion	Anaerobic microbial communities Metazoan meromictic communities
	Oxygen: regular winter anoxia	Low oxygen tolerant communities
5. Fish species	Predation by warm water fish species	Warm-water communities (e.g. warm water fish, small Cladocera and rotifers)
	Predation by cold water fish species	Cold water communities (e.g. salmonid fish, copepod and large cladoceran zooplankton)
	Fishless	Invertebrate-predator dominated communities (e.g. *Chaoborus americanus*)

VI. Targeting of Lakes:

An overview of the lakes in New Hampshire based on physical and chemical features can provide a useful means of identifying lakes and lake communities that are rare and diverse. The following example is used to illustrate this process. As seen in Figure 1, based on a sample of nearly 600 lakes (> 10 acres), the average maximum depth of New Hampshire lakes is about 9 meters or 30 feet (median depth = 6.7 meters). There are only 18 lakes deeper than 30 meters (100 feet) and less than a dozen of those have a surface area less than 1000 hectares (2500 acres). Similarly, there are 12 lakes in New Hampshire at elevations above 2000 feet (Figure 2). Most of these are relatively shallow, with only three of these high elevation lakes are more than 10 meters deep. One of these lakes is in the White Mountains and two are in the most northern part of the state. Since deep lakes stratify in the summer, they generally have greater numbers of microhabitats with corresponding greater biodiversity in the open water. Due to their isolation, these lakes may have less disturbed native communities, unique species or relic species remaining from past glacial periods. One can conclude that deep, high elevation lakes are rare in New Hampshire. They also have a high likelihood of having diverse or unique aquatic communities. The next step is to test these predictions. Careful sampling must be conducted in these lakes to determine the species living in the lake and the present chemical conditions. One can also use this approach, to assess the frequency of lakes on the basis of chemical features such as alkalinity (Figure 3) and biological conditions such as chlorophyll *a* concentration (Figure 4). An up-to-date data base is especially important for the chemical and biological conditions as these conditions are likely to show considerable variation with time.

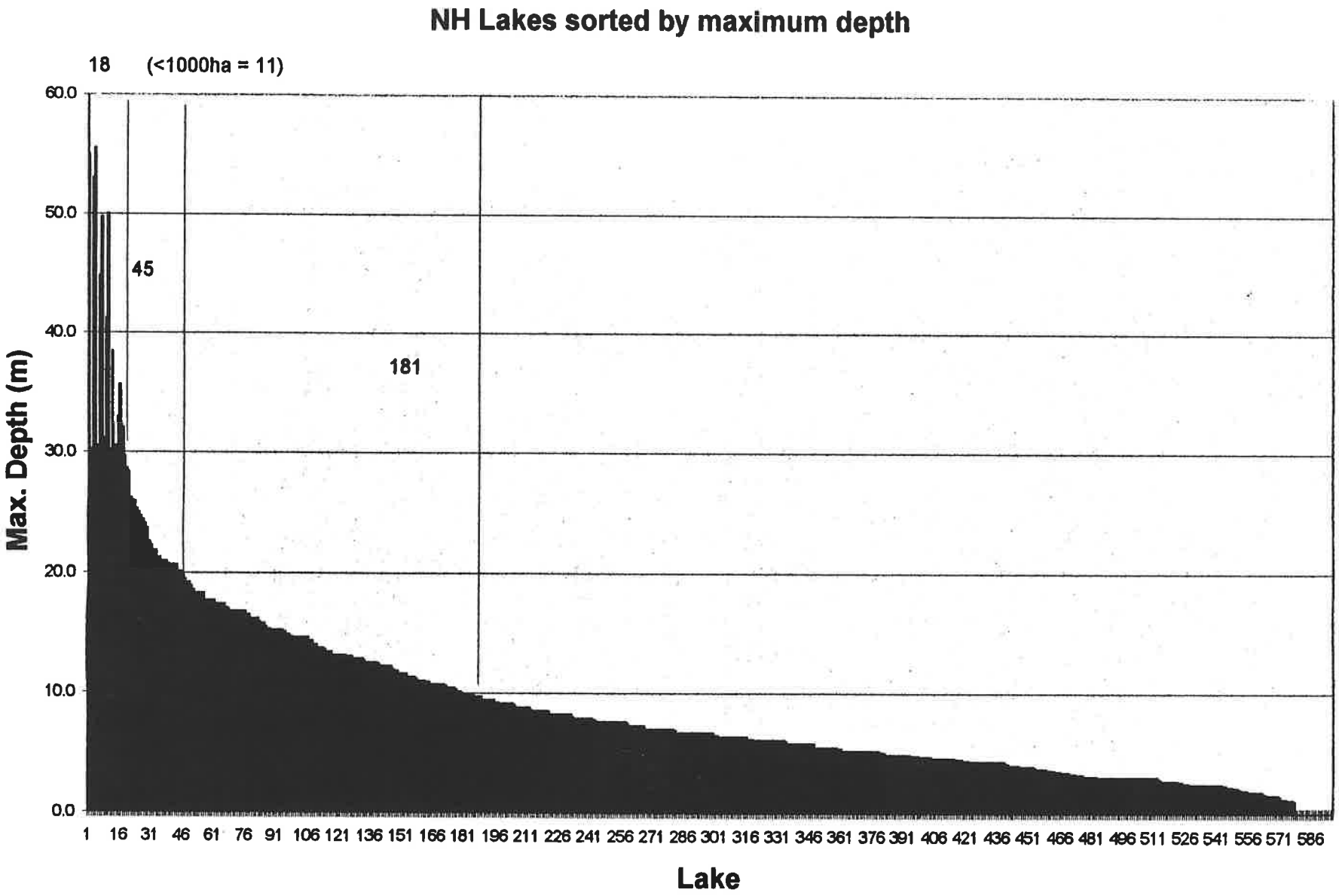

NH Lakes sorted by maximum depth
18
(<1000ha = 11)
45
181
Max. Depth (m)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1 16 31 46 61 76 91 106 121 136 151 166 181 196 211 226 241 256 271 286 301 316 331 346 361 376 391 406 421 436 451 466 481 496 511 526 541 556 571 586
Lake

Figure 1.

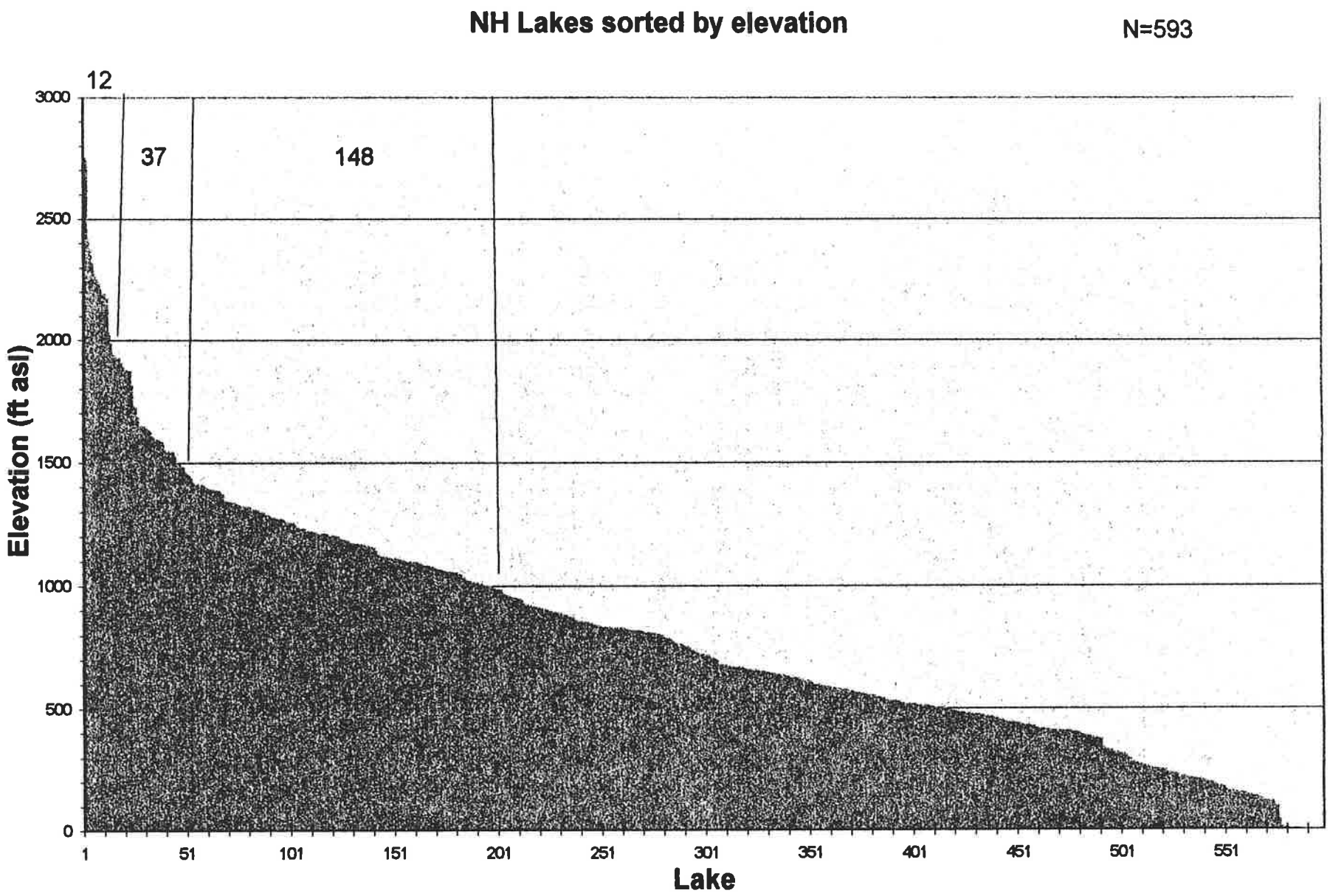

NH Lakes sorted by elevation
N=593
12
37
148
3000
2500
2000
1500
1000
500
0
Elevation (ft asl)
1
51
101
151
201
251
301
351
401
451
501
551
Lake

Figure 2.

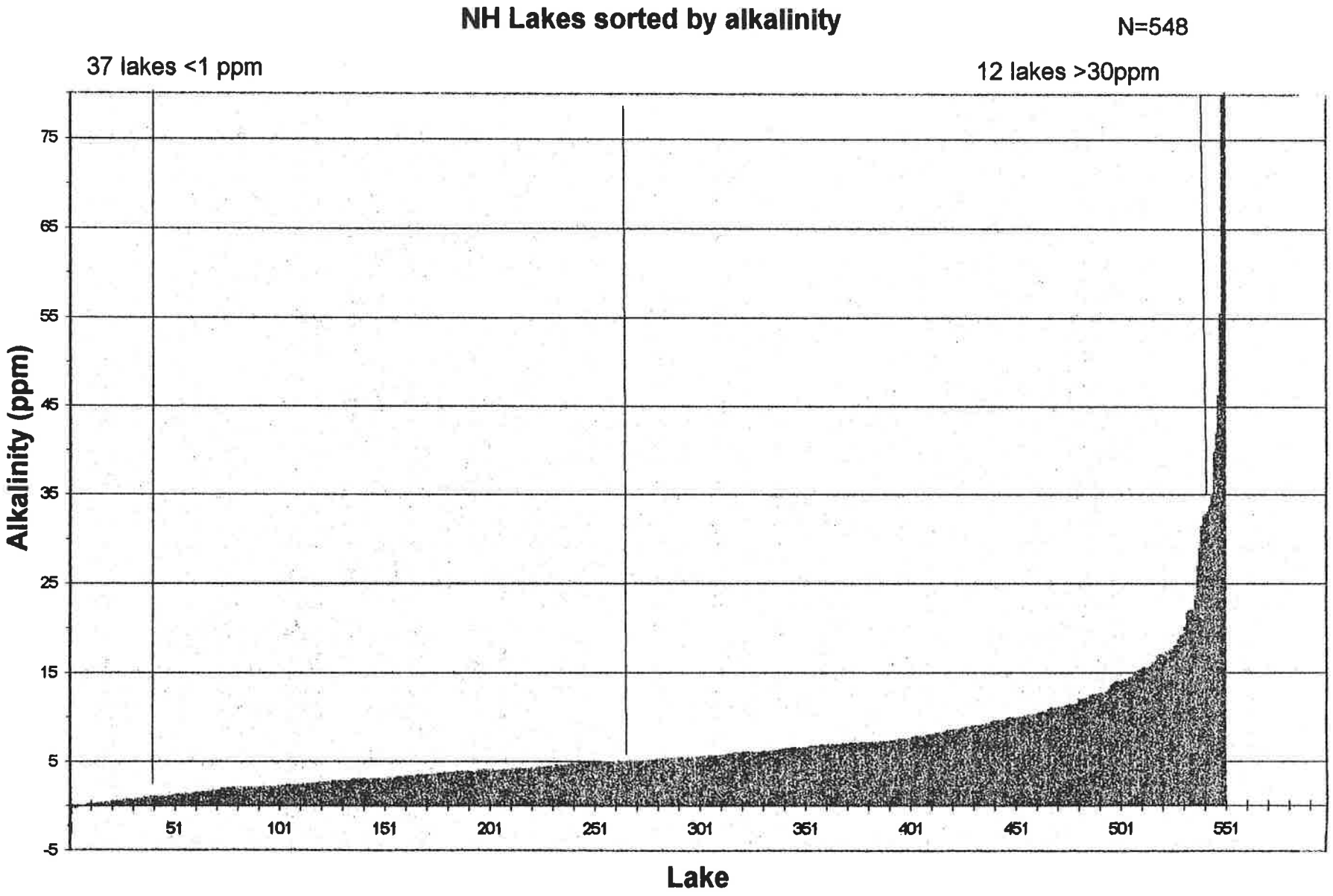

NH Lakes sorted by alkalinity
N=548
37 lakes <1 ppm
12 lakes >30ppm
Alkalinity (ppm)
75
65
55
45
35
25
15
5
-5
51
101
151
201
251
301
351
401
451
501
551
Lake

Figure 3.

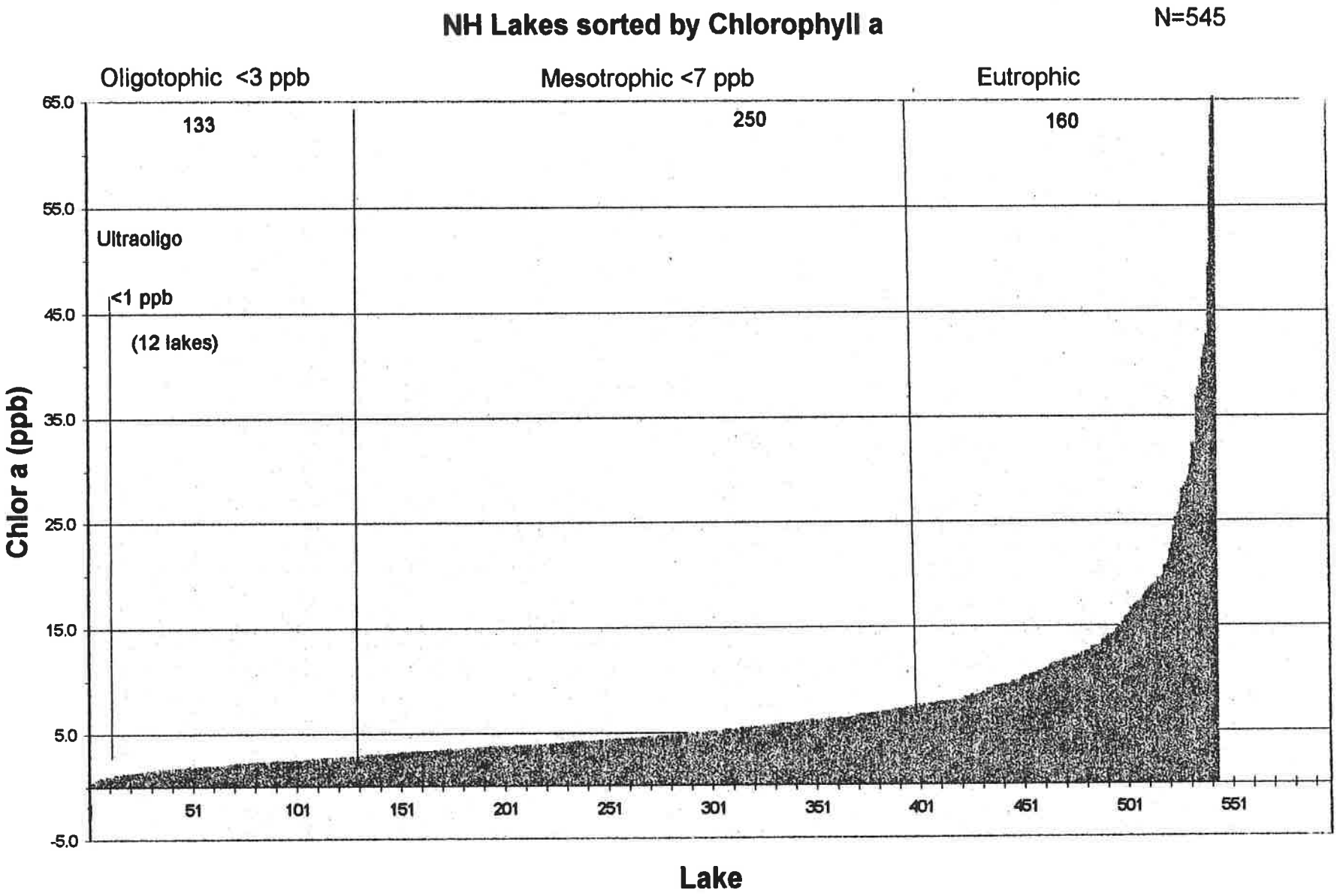

NH Lakes sorted by Chlorophyll a
N=545
Oligotophic <3 ppb
Mesotrophic <7 ppb
Eutrophic
133
250
160
Ultraoligo
<1 ppb
(12 lakes)
Chlor a (ppb)
65.0
55.0
45.0
35.0
25.0
15.0
5.0
-5.0
51
101
151
201
251
301
351
401
451
501
551
Lake

Figure 4.

LANDSCAPE AND GEOLOGICAL DIVERSITY

GOAL: To identify subwatersheds that represent the diversity of permanent or enduring features of New Hampshire's biodiversity.

APPROACH: Identify regions of the state that reflected extremes: (1) least common lithology; (2) least common surficial geology; (3) highest and lowest elevations; (4) most diverse and least diverse topography; and (5) highest percentages of lakes or wetlands.

Lithology

Felsic and quartzose	48%
High grade peltic	26%
Calc-silicate	7%
Low-grade peltic	6%
Poor feltic	5%
Sulfidic	4%
Mafic and metamorphic	2%
Carbonate-bearing	2%

Surficial Geology

Glacial till-2	37%
Glacial till	32%
Bedrock	8%
Alluvial	1%
Lacustrine	1%

Topographic

Maximum elevation
Minimum elevation
Local maxima/area (highest and lowest)

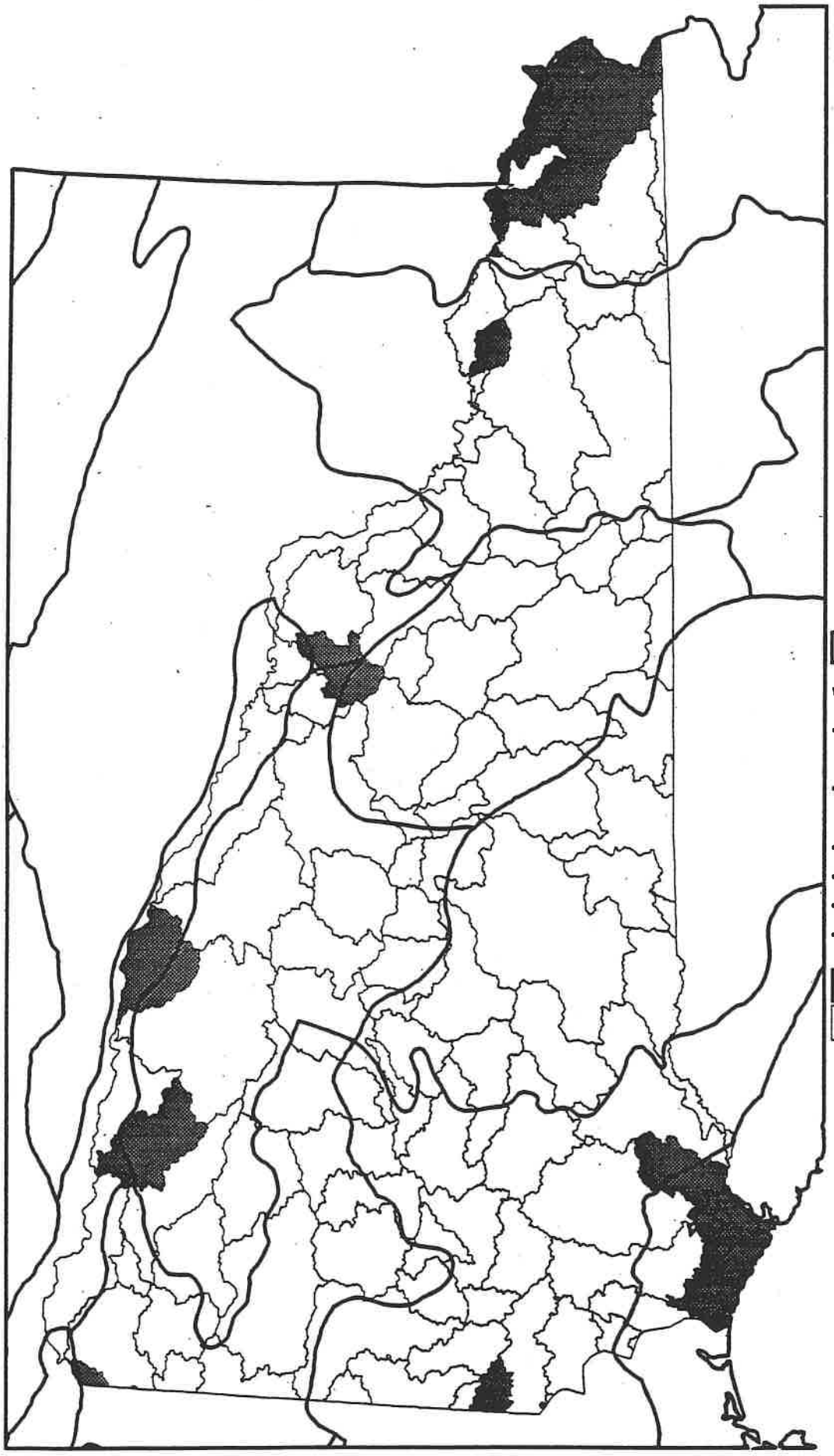
Lakes

No. of lakes (highest and lowest)
Lakes as percent of watershed (highest and lowest)

Wetlands

Wetlands as percent of watershed (highest and lowest)

SCORING SYSTEM: Ranked top five watersheds for each variable and scored 10, 9, 8, 7, 6. Summed scores within and across categories.



NH Ecol. Reserve
Composite of High Scorin
Subwatersheds:
select bedrock geology
variables scored by
abundance

Source:
USGS 1:250K scale

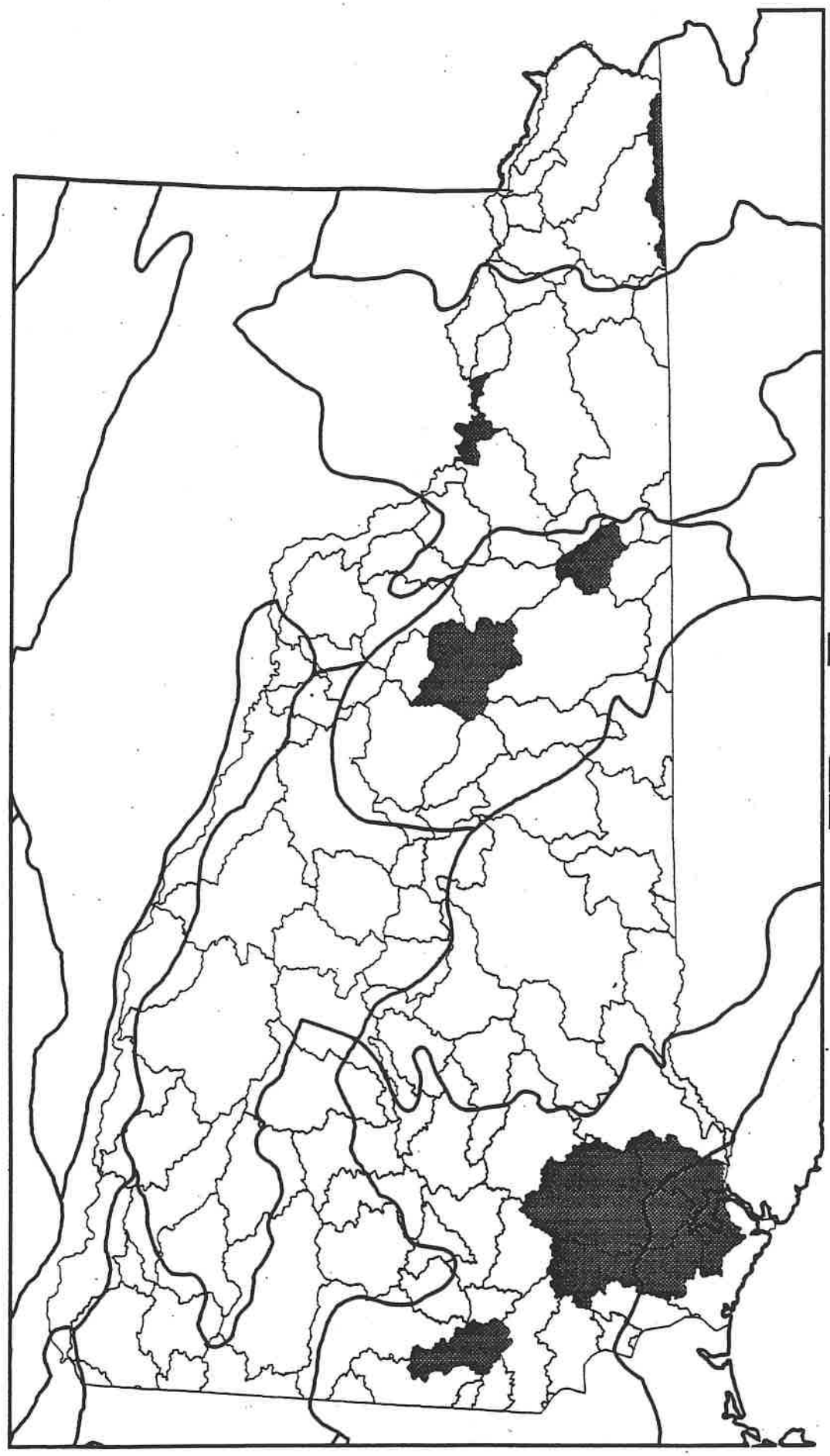
Bailey's Ecoregions

WS % of:
-mafic and metamorphic
equivalents
-intermediate to quartz-
poor felsic
-low-grade peltic
-sulfidic metasedimentary
-carbonate-bearing
-calc-silicate

(8-10 scores)
0

10 0 10 Miles

N
W E
S



NH Ecol. Reserve
Composite of High Scoring Subwatersheds:
alluvial, lacustrine, & shallow bedrock parent soils

Source:
D. Publicover

Bailey's Ecoregions

WS alluvial, lacustrine, & shallow bedrock parent soils

(8-10 scores)

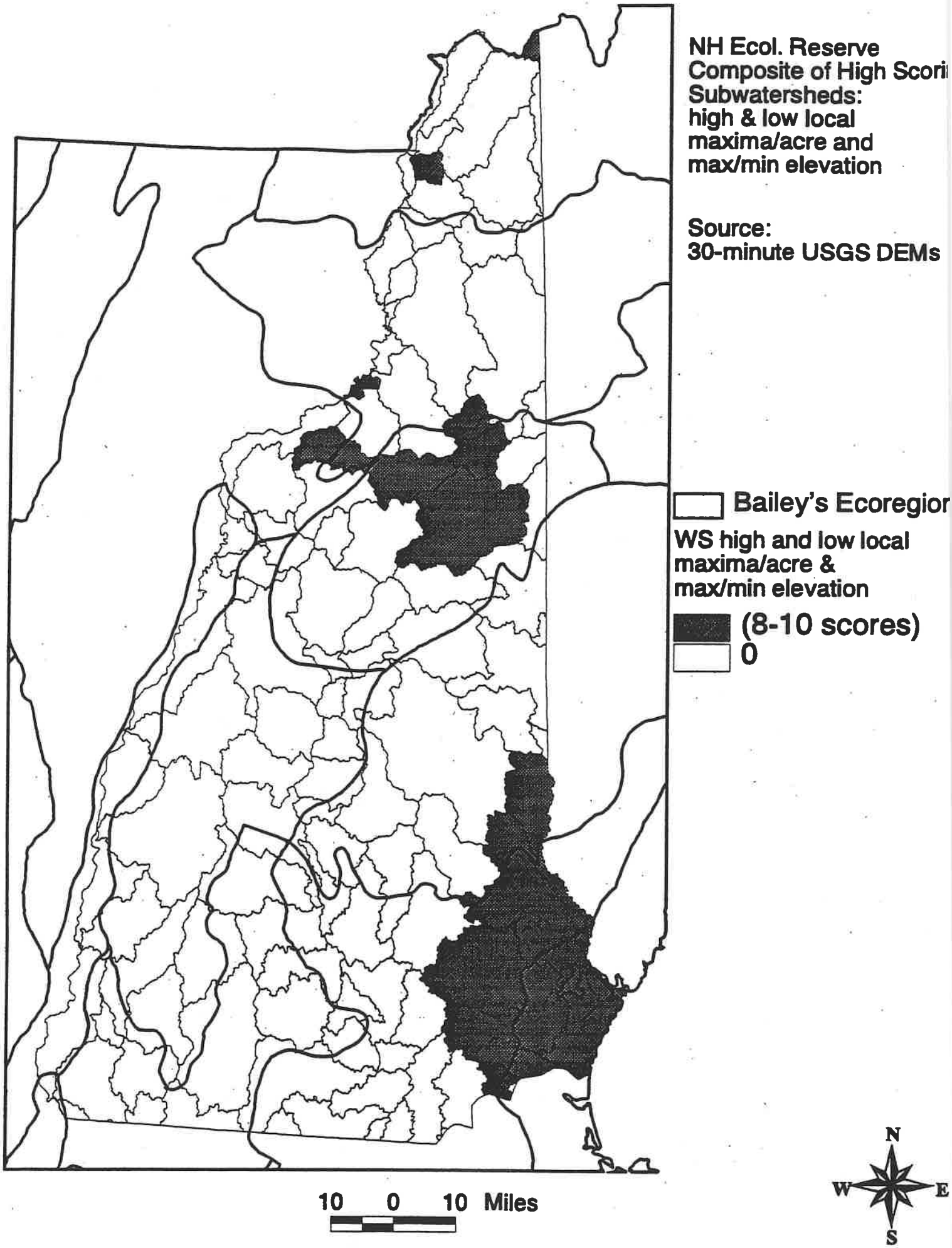
0

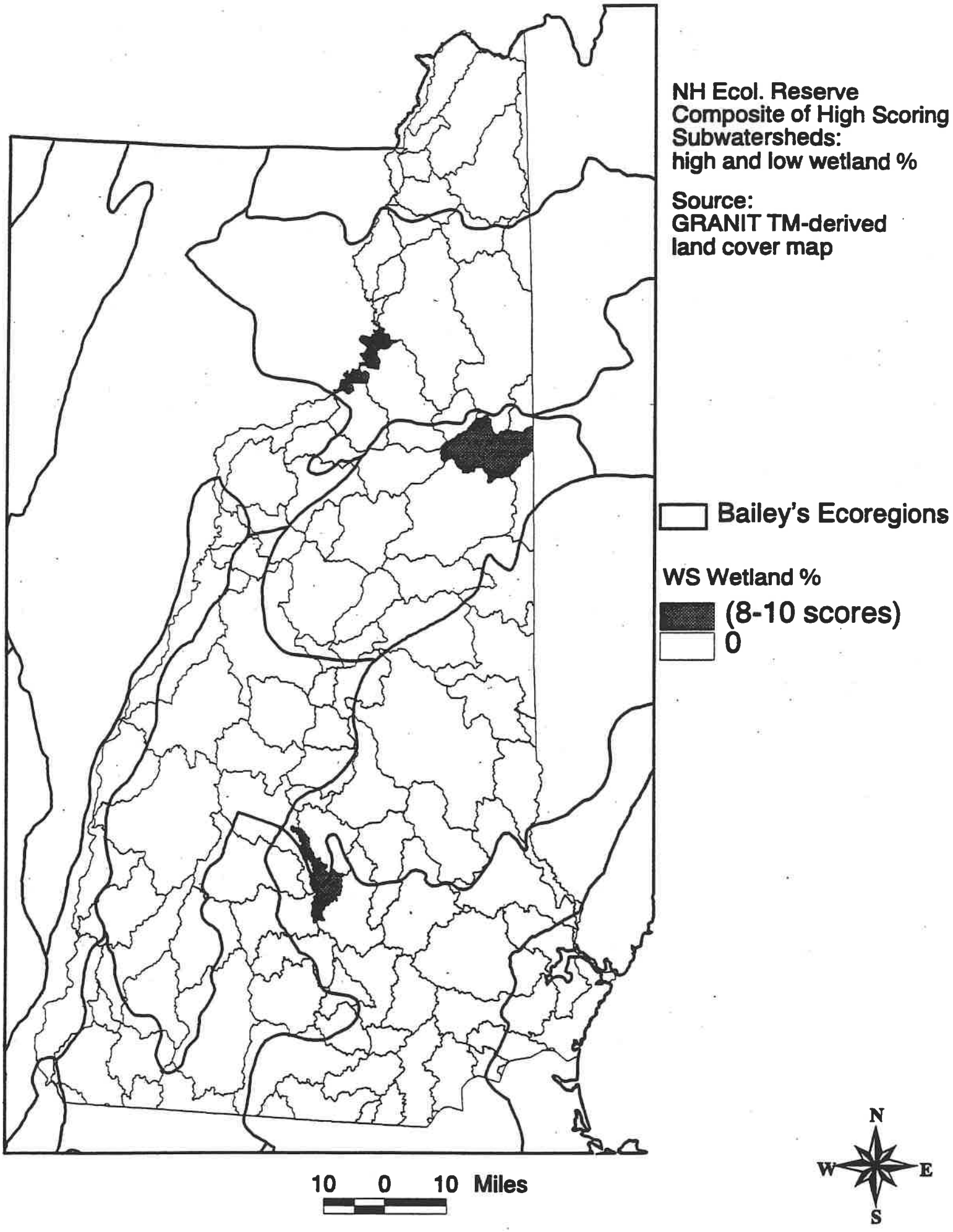
10 0 10 Miles

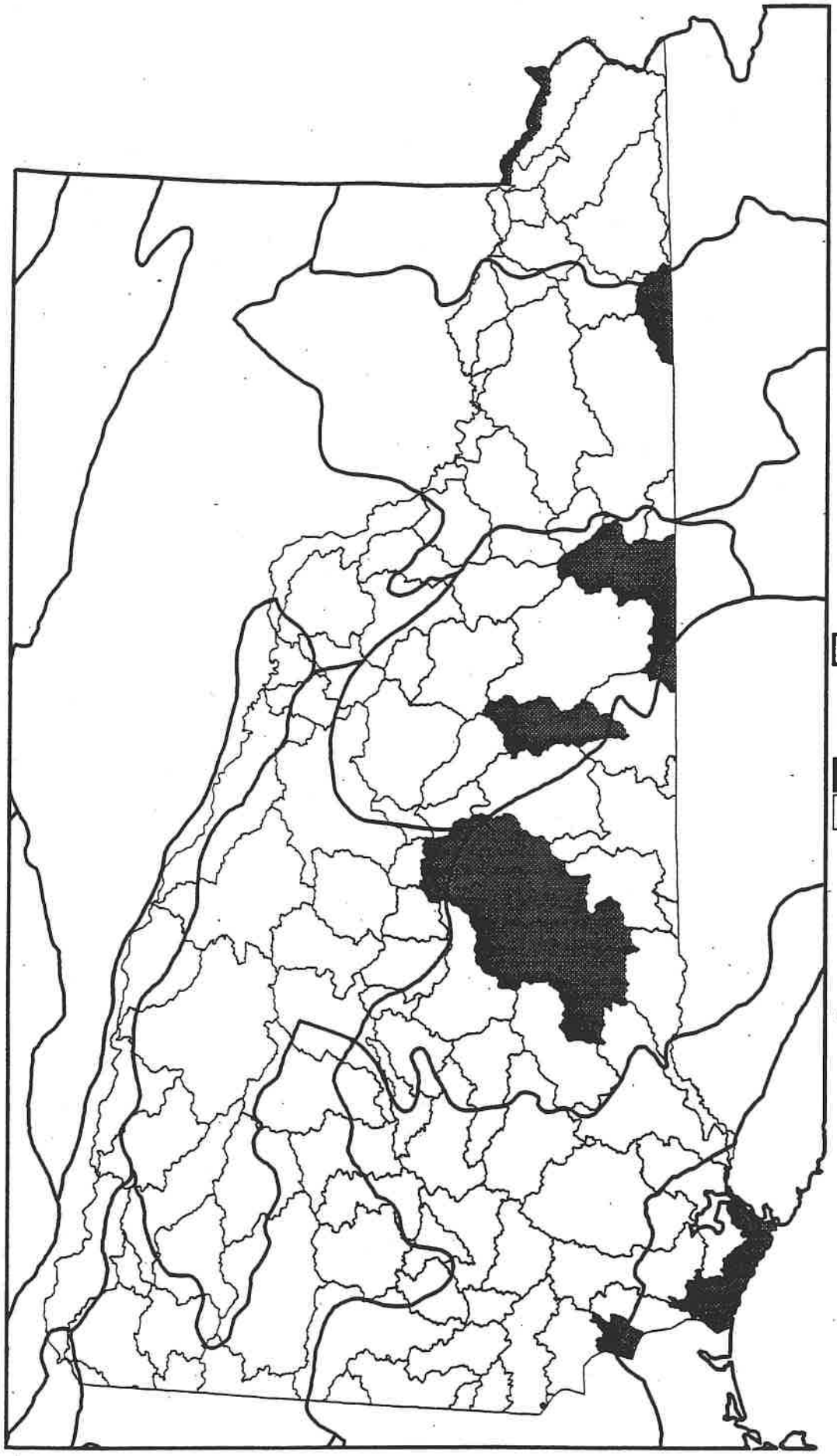
N

W E

S


NH Ecol. Reserve
Composite of High Scori
Subwatersheds:
high & low local
maxima/acre and
max/min elevation
Source:
30-minute USGS DEMs
Bailey's Ecoregior
WS high and low local
maxima/acre &
max/min elevation
(8-10 scores)
0
10 0 10 Miles
N
W
E
S


NH Ecol. Reserve
Composite of High Scoring
Subwatersheds:
high and low wetland %
Source:
GRANIT TM-derived
land cover map
Bailey's Ecoregions
WS Wetland %
(8-10 scores)
0
10 0 10 Miles
N
W
E
S



NH Ecol. Reserve
Composite of High
Scoring Subwatersheds:
high and low
for #lakes/acre &
lake %

Source:
USGS DLG's as archived
in GRANIT

Bailey's Ecoregions

WS #Lakes/acre & Lake %

(8-10 scores)

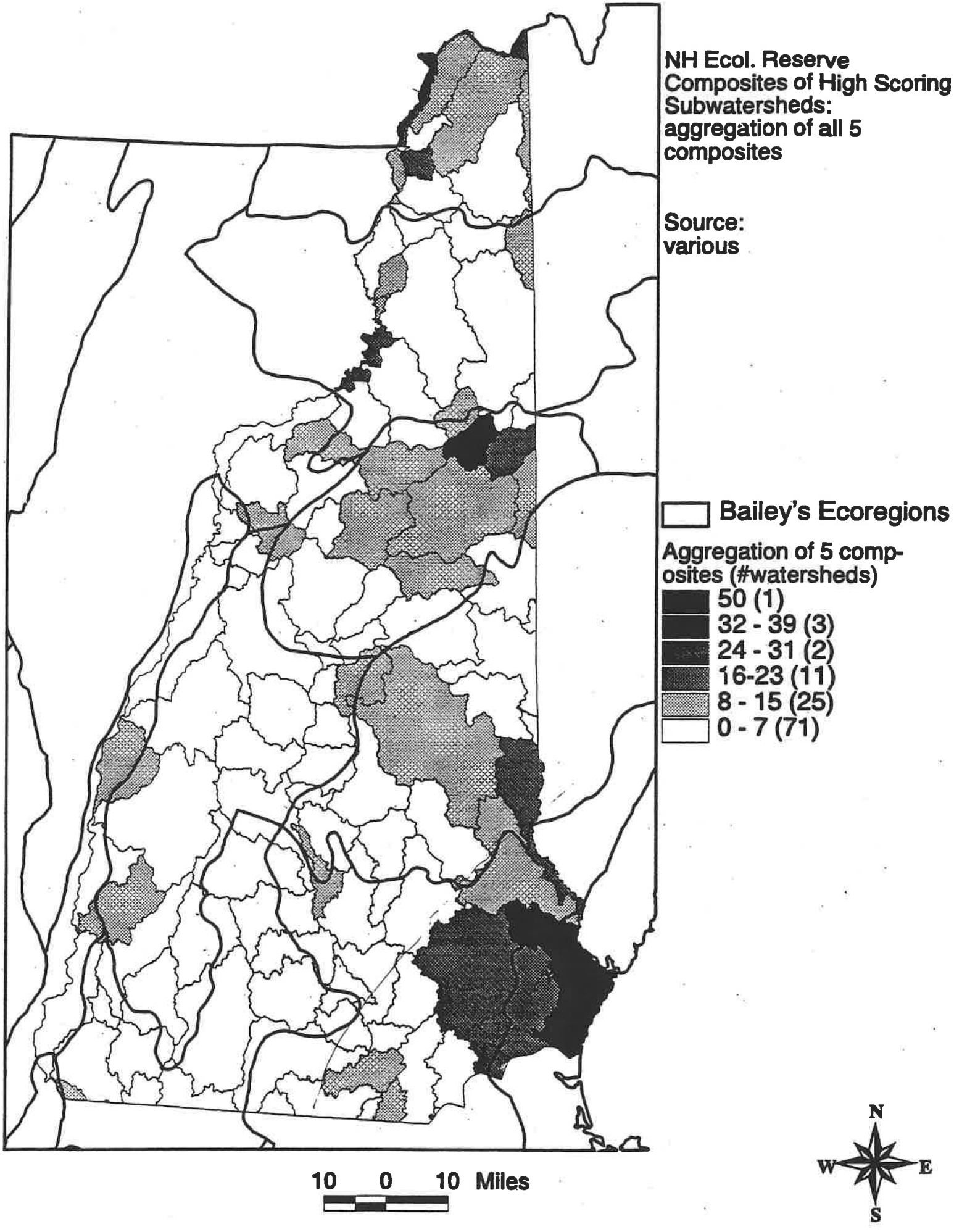
0

10 0 10 Miles

N

W E

S


NH Ecol. Reserve
Composites of High Scoring
Subwatersheds:
aggregation of all 5
composites
Source:
various
Bailey's Ecoregions
Aggregation of 5 comp-
osites (#watersheds)
50 (1)
32 - 39 (3)
24 - 31 (2)
16-23 (11)
8 - 15 (25)
0 - 7 (71)
10 0 10 Miles
N
W
E
S

E1

Table XX. Percent of each subwatershed in core forest area, for both 100 meter and 400 meter road buffer widths.		
Watershed Name	**100 meter buffer**	**400 meter buffer**
Ammonoosuc River Tributaries	41.6	9.1
Ammonoosuc River	61	35.2
Ashland-Plymouth Tributaries	48.2	16
Aziscohos Lake Drainage	85	60.3
Baboosic Brook	28.2	2
Baker River	69.1	37.4
Bartlett Brook	27.5	0
Bearcamp River	62.2	29.4
Beards Brook	59.3	19.5
Beaver Brook	12.4	0.6
Beebe River	72.1	35.3
Bishop Brook	45.3	8.1
Blackwater River	58	21.5
Bog Brook	69.6	39.9
Bristol-New Hampton Tribs.	45.2	8.2
Campton Tributaries	62.2	30.7
Cedar Pond	56.1	0
Charlestown Tributaries	47.8	10.3
Clarksville Tributaries	58.2	17.5
Clear Stream	78.3	50.6
Coastal Drainage	11.5	0.3
Cocheco River	28.3	1.2
Cohas Brook	26.6	3.2
Cold River	49.3	7.6
Cold River	74.2	42.4
Concord Tributaries	28.5	3.3
Connecticut Lakes Drainage	66.1	32.7
Conway Tributaries	44.9	13
Cornish-Plainfield Tributaries	47.8	10.9
Diamond Rivers	81.5	54.9
East Branch Pemigewasset Rive	93.7	84.9
East Meadow River	10.1	0
Exeter River	22.6	0.6
Franklin Falls Res. Drainage	51.3	16.8
Franklin Tributaries	41.2	7.7
Gale River	62.5	33.8
Great Bay Drainage	16.5	0.2
Groveton Tributaries	34.9	12.2
Halls Stream	74.7	45.7
Hanover-Piermont Tributaries	56	23.7
Haverhill Tributaries	31.5	4.5
Henniker Tributaries	43.4	8.2
Hudson Tributaries	12.5	0
Indian Stream	82.8	57.3
Israel River	63.2	42.2
Johns River	39.3	9.5
Keene Tributaries	44.9	15.3

Lake Winnipesaukee Drainage	31.8	6.3
Lamprey River	34.1	1.9
Lancaster Tributaries	48	14.2
Litchfield Tributaries	16.9	0.6
Little Ossipee River	24	0.4
Little River	16.9	0.7
Littleton Tributaries	50.1	12.7
Londonderry Tributaries	14.3	0.3
Lower Ashuelot River	60.7	20.2
Lower Contoocook River	43.8	4.8
Lower Piscataquog River	26.7	2.2
Lower Suncook River	39.7	5
Mad River	74.3	52.6
Manchester Tributaries	21.3	1.4
Mascoma River	53.9	16.4
Middle Androscoggin River	64.2	27.4
Middle Pemigewasset River	73.1	46.4
Miller River	44.4	7.1
Mohawk River	40.4	13.2
Moose River	73.4	47.8
Nashua River	29.7	2.6
Newfound River	59.8	28.8
Northumberland Tributaries	50.1	12.3
Oliverian Brook	62.1	33.4
Ossipee River	44.6	11.6
Peabody River	82.8	64.5
Pine River	45.7	9.2
Powwow River	24	0.8
Salmon Brook	4.2	0
Salmon Falls River	35.2	4.2
Shelburne Tributaries	77.4	49.5
Shepards River	59.1	6.9
Simms Stream	70.7	43.5
Smith River	57.5	18.1
Soucook River	38.1	4
Souhegan River	35.8	5.3
South Branch Ashuelot River	51.3	12.6
South Branch Piscataquog River	41.8	4.5
Spickett River	15.5	0.6
Squam River	40.7	11.7
Squannacook River	45.9	3.4
Stewartstown Tributaries	48	7.1
Stratford Tributaries	73.1	48.2
Sugar River	47.2	12.9
Swift River	72	41.6
The Branch	53.8	14.8
Tully River	54.7	10.3
Umbagog Lake Drainage	48.8	18
Upper Ammonoosuc River	77	51.4
Upper Ashuelot River	60.6	19.4
Upper Contoocook River	44.4	8.4

Upper Merrimack River	41	7.9
Upper Pemigewasset River	85.6	70.5
Upper Piscataquog River	42.6	4
Upper Saco River	79.6	57.4
Upper Suncook River	42.5	6.2
Walpole-Hinsdale Tributaries	40.6	9.3
Warner River	51.2	12.4
Wild Ammonoosuc River	69.9	41.5
Wild River	95.5	88.6
Winchester Tributaries	45.7	3.5
Winnipesaukee River	29	2