Lower New England – Northern Piedmont Ecoregional Conservation Plan; First Iteration Edited

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Executive Summary

None written.

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Introduction

Ecoregional Planning in the Nature Conservancy

The Nature Conservancy's mission is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The increasing rate of extinction in recent years has led to the realization that conserving rare and threatened species and natural communities *per se* is insufficient to effectively protect biodiversity. In broadening the scope of its work, the Conservancy has shifted towards protecting landscapes on an ecoregional scale.

Planning by ecoregions, or areas that are unified in climate, topography, geology, and vegetation, is more sensible ecologically than planning within political boundaries such as states or provinces. Ecoregional planning methods improve on the traditional approach of protecting rare species and terrestrial communities by expanding to include common ecosystems that are representative of each ecoregion. Protection of good examples of these representative ecosystems can serve as a "coarse filter," protecting a broad diversity of both common and rare species. The methods chapters in this report explain and elaborate on the concepts introduced here, especially as they relate to ecoregional planning in the Northeast and East.

Two criteria for assessing conservation sites have become part of the new thinking - "functionality" and size. Functional sites are simply those in which ecological processes are sufficiently intact to sustain focal species and natural communities over the long term. Size is important because large, complex, multi-scale and relatively intact conservation areas – or landscapes - are likely to be the most efficient and effective at conserving biodiversity. These ideas have dovetailed with the developing need to identify examples of common, widespread natural community types as conservation targets in ecoregional portfolios, and have led to the inclusion of *matrix-forming* communities (especially forest communities in the Eastern U.S.) as a landscape-scale conservation target in ecoregional plans.

Ecoregional plans that address both the rare and the common, at the species, community, and landscape or watershed levels, will guide the Conservancy's actions for years to come. Using all available data on the distribution of ecosystems, communities, and species, Conservancy teams and our partners are working to design *networks* of conservation areas within each ecoregion.

Ecoregional plans identify a set of *portfolio sites*, or areas that need to be protected in order to conserve the native biodiversity of the region into the future. The plan is a product of a collective initiative between many people and organizations who participated in the project as partners, experts and advisors. Members of this cooperative effort generally include Conservancy staff, Natural Heritage Program scientists, university professionals, state and federal agencies, other conservation organizations, and local experts.

Conservation sites that make up the portfolio generally range from small (several acres) to very large (tens of thousands of acres) sites. Local Conservancy units chose a subset of these sites, their *ten-year action sites*, where they will focus conservation activity in the next ten years. For these areas, the Conservancy will develop detailed *Conservation Area*

Plans which will spell out the specific actions needed to protect the site's biological integrity.

Conservation Goals

Our overarching goal is to maintain the long-term viability of all native plant and animal species and examples of all natural communities across their natural ranges of occurrence and variation within the ecoregion while maintaining the natural processes critical to ensuring long-term ecological integrity.

Specifically, the conservation objectives adopted by the planning team were:

> To ensure the continued existence of the matrix communities found in the ecoregion and restore the natural processes, including succession, to promote the development of mature (old growth) stands;
>
> To protect multiple viable examples of all the region's natural communities through the development of a portfolio of conservation areas. The examples should represent the range of variability found within each of the communities in the ecoregion;
>
> To incorporate into the portfolio viable examples of all declining, disjunct, or otherwise vulnerable species, with the goal of protecting multiple viable populations of each species in the variety of habitats and ecoregional contexts in which it naturally occurs.
>
> To protect the full array of aquatic systems found within the ecoregion.

This Ecoregional Plan Report

This report includes the results of the first iteration assessment of the Lower New England — Northern Piedmont ecoregion, last revised in January 2001. The report has been reorganized to include methods chapters developed in 2003 as part of a standard template for ecoregional plans in the Northeast. In addition, full methods and results of the LNE aquatics analyses are presented here for the first time. Note that the methods chapters are meant to be relatively independent of one another, and so occasionally repeat some concepts or definitions.

Following a general description of the ecoregion are several chapters that describe methods and results for various ecoregional targets:

- Focal species
- Terrestrial ecosystems and patch communities
- Matrix-forming ecosystems
- Aquatic systems

Acknowledgements

Edited Version and Plan Template

Conservation Science Support (CSS), formerly known as Eastern Conservation Science (ECS) and located at the Eastern Resource Office (ERO, formerly the Eastern Regional Office) in Boston, is responsible for this product. Most of the ecoregional plan documents refer to ECS.

CSS provides leadership for science-based ecoregional and landscape-scale planning and design; geospatial and statistical terrestrial and aquatic analysis; data dissemination and training; and other specialized professional services to the Northeast and Caribbean Division of The Nature Conservancy. At the time of publication, CSS staff included: Mark Anderson, Director of Conservation Science; Shyama Khanna, Information and Project Coordinator; Greg Kehm, Spatial Ecologist and Lab Manager; Arlene Olivero, Aquatic Ecologist; Charles Ferree, Landscape Ecologist; Dan Morse, GIS Analyst; and Susan Bernstein, Communications Consultant.

Methodologies

The standard methodologies sections created for this and all Northeast ecoregional assessment reports were adapted from material originally written by team leaders and other scientists and analysts who served on ecoregional planning teams in the Northeast and Mid-Atlantic regions. The sections have been reviewed by several planners and scientists within the Conservancy. Team leaders included Mark Anderson, Henry Barbour, Andrew Beers, Steve Buttrick, Sara Davison, Jarel Hilton, Doug Samson, Elizabeth Thompson, Jim Thorne, and Robert Zaremba. Arlene Olivero was the primary author of freshwater aquatic methods. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

LNE/NP Planning Team and Working Groups

We assembled a Core Team made up of the Conservancy operating units responsible for this ecoregional plan to guide the process and report interim results to each office. In addition, we established working groups to cover different elements of biodiversity. These teams developed minimum ecoregional standards and selected examples of matrix forests, aquatics, natural communities, animals, and plants. The teams used guidance from outside experts to develop information used in selecting sites for matrix forests and aquatics. The ECS GIS lab took on spatial assessment of the entire ecoregion for both matrix forests and aquatics. The state Natural Heritage Programs associated with the plan provided data for natural communities, animals, and plants.

See Appendix 7 for all original members of the Lower New England — Northern Piedmont Planning Team.

An Introduction to the Ecoregion

The Setting

It is difficult to identify any small number of characteristics that can adequately describe the Lower New England – Northern Piedmont ecoregion (LNE-NP) as a cohesive geographic unit. Its long north – south axis and the lack of a single waterbody or mountain range with regional significance may be responsible, in part. For instance, the North Atlantic Coast ecoregion to the east is largely defined by the moderating influence of the sea and the littoral deposits along its shore. The Northern Appalachians Ecoregion to the west and north is characterized by tall granitic massifs and the regions cold, continental climate. The LNE-NP ecoregion lacks any such strong environmental gradient along a shore or mountain range instead being influenced by a little of both among other things. This lack of any clear defining feature(s) fuels a continuing discussion on where the regions boundaries should be drawn.

The LNE-NP ecoregion includes portions of 12 states and the District of Columbia (Map 1. Ecoregion boundaries). The Lower New England ecoregion extends from southern Maine and New Hampshire with their formerly glaciated, low mountain and lake studded landscape through the limestone valleys of western Massachusetts and Connecticut, Vermont and eastern New York. Rhode Island, eastern Massachusetts and Connecticut are distinctive in that the communities are more fire adapted including pitch pine and oak dominated forests on glacially deposited sandy till that forms a broad plain with many ponds. The Northern Piedmont in Maryland, northern Virginia and eastern Pennsylvania was never glaciated and is characterized by broad gently-rolling hills and valleys upon which dry oak woods and remnant mesophytic forests occur on remnant sites, steep slopes and ridgelines. The valleys contain significant wetlands many of which are calcareous.

Large portions of the Appalachian Mountains lie within the ecoregion including the Palisades in New York and New Jersey, the Taconics and the Berkshires in Massachusetts, New York, Vermont, and Connecticut, and the widely strewn *Monadnocks* of southern New Hampshire. Large rivers originating in the Appalachians cut across the Atlantic slope lowlands generally from north or west to east emptying into the Atlantic Ocean. The Potomac, Susquehanna, Delaware, Hudson, Housatonic, Connecticut, Merrimack, and Saco Rivers provide a diversity of high- and low-energy aquatic habitats and most support conservation targets of this plan. The natural character of the ecoregion is perhaps best seen in the 8% of the region currently within existing protected lands, primarily state-held, including Mt. Greylock State Park in Massachusetts, Mt. Pisgah State Park in New Hampshire, Yale-Myers Forest in Connecticut, Palisades Park in New York and New Jersey, Sterling Forest in Pennsylvania, and the Potomac Gorge in Maryland and the District of Columbia.

The Atlantic slope of North America was shaped by many tectonic, volcanic, and glacial events that created a diverse geology, interesting landforms, and topographic elevations that range from sea-level to 3800 feet (Map 3. Bedrock Geology and Map 4. Topography). The region receives 36 – 50 inches of precipitation annually. This in turn creates a diversity of wetlands and aquatic systems. An Ecological Land Unit (ELU) analysis of the region identified 486 biophysical combinations of a potential 630 combinations based on surficial geology, topography, and elevation (See Appendix 5 for a complete description of Ecological Land Units.). Assuming that ELU's are a surrogate for natural community diversity where field data are lacking would suggest that this ecoregion is quite diverse. A number of endemic species occur in LNE-NP and the regions long north-south axis captures species and natural communities more representative of the Northern Appalachian Boreal ecoregion in higher elevations and southern species in the Piedmont. The large rivers, particularly those that are tidal in their lower reaches, provide habitat for estuarine species more indicative of the North Atlantic Coast ecoregion.

Europeans settled the ecoregion soon after their arrival. The following century of widespread and intensive land use significantly influenced the distribution and composition of the region's landscapes and natural communities. More than 90% of the original forest cover was removed and only a few patches of *old growth* forest remains in remote, inaccessible mountain coves and ravines. With the decline of farming at the turn of the last century much of the region returned to forest. Today, approximately 67% of the region is forested; 70% is in natural cover of one form or another. Black bear, moose, white-tail deer, turkey, bobcat, fisher, pine marten, and beaver can all be found, once again, throughout the northern and central portions of the Lower New England ecoregion and generally appear to be expanding their ranges.

Nonetheless, the ecoregion remains one of the most highly populated in the country with many cities including Nashua and Manchester, NH, Springfield and Worcester, MA, Hartford, CT, Albany, NY and New York City, Baltimore, MD, York and Lancaster, PA, and Washington, D.C. Added to this are the suburbs for the cities of Boston, Providence, RI, New Haven, CT, New York, Philadelphia. The great forest expanses are now being increasingly fragmented by first and second home development. While the mountainous areas of the ecoregion are lightly settled, the valleys have long been developed for agriculture, and both are rapidly succumbing to development pressures (Map 6. Land Cover).

Subsections

Eighteen subsections have been characterized within the ecoregion and were used in the planning process to set geographic distribution goals for species targets. A more generalized sub-region map with 6 subregion divisions was created for evaluating the distribution and setting conservation goals for communities. Table 1 illustrates the divisions and lists the names of the subregions and subsections. Map 2 illustrates their geographic distribution.

Table 1. LNE-NP Subregions and Subsections

Lower New England/Northern Piedmont Ecoregion					
Lower New England				**Northern Piedmont**	
Hudson River Subregion	**Mountains & Highlands Subregion**	**Northeast LNE Plains Subregion**	**Southern New Engl. Plains Subregion**	**Reading Prong Subregion**	**Northern Piedmont Subregion**
221Ba Hudson Limestone Valley **221Bb** Taconic Foothills **221Bc** Hudson Glacial Lake Plains	**M212Cb** Taconic Mtns **M212Cc** Berkshire-Vermont Upland **M212Bb** N. CT River Valley **M212Bc** Sunapee Uplands **M212Bd** Hillsboro Inland Hills & Plains	**221Ai** Gulf of Maine **221Al** Sebago-Ossipee Hills & Plain **221Ah** Worcester-Monadnock Plateau	**221Ae** Hudson Highlands **221Af** Lower CT River Valley **221Ag** SE NE Coastal Hills & Plains	**221Am** Reading Prong	**221Db** Piedmont Upland **221Da** Gettysburg Piedmont Lowland **221Dc** Newark

Land Ownership

The Lower New England – Northern Piedmont ecoregion covers approximately 23,000,000 acres. Of this, 117,952 acres (0.5%) is in Federal ownership, 1,134,522 acres (4.9%) is in State ownership and the remainder is almost entirely private land. Only about 8% of the ecoregion is managed by public entities. Some of these lands are managed for conservation purposes (Map 8. Managed Area Ownership).

Priorities and Leadership Assignment

All features in the portfolio were sorted into groups based on implementation strategy:

- Partner lead
- TNC lead – no immediate action
- TNC lead – 5 year action

During separate meetings for each of the TNC operating units, each occurrence or cluster of occurrences of Heritage elements, plants, animals, and natural communities, matrix forest units, and aquatic system units was evaluated for several characteristics. A brief review of these features follows:

1. **Biodiversity importance**. Evaluated on a scale of 1-3:

1 (High)	Having a broad range of conservation targets, high number of individual occurrences, large scale features, or globally rare elements.
2 (Medium)	Moderate range of biodiversity features, multiple occurrences, or moderate importance in terms of globally rare elements.
3 (Low)	Having only one or two target occurrences, often species or natural communities in small or large patches without significant landscape context.

2. **Threats/urgency.** Evaluated as High, Medium or Low. What are the major threats facing this site? Will action be needed at this site in the next few years?
3. **Feasibility.** What is the potential for effective conservation action? Who currently owns the site? Is there program capacity to undertake this type of work?
4. **Lead in conservation action.** What organization should take the lead at this site?
5. **High priority for action.** Should action be taken in the next 5-10 years? Yes or No.

Action Sites

During the portfolio selection process, state teams selected element occurrences for inclusion in the portfolio based on goals set by the core and expert teams. In addition to selecting element occurrences, state teams (composed of state conservation scientists, state directors, and Natural Heritage Program staff) identified which sites should be prioritized for action within the next 10 years. “10-year action sites” are sites where it is feasible to take action to achieve measurable improvement in the conservation targets, abate threats to those targets, or increase the conservation capacity at the site. Improvements would result, at a minimum, in retaining the current quality of the conservation targets. These sites not only have a high probability of successful conservation action, but they are often the sites where reduction in threat status is most needed.

The remaining element occurrences not selected as “10-year action sites” were categorized into two groups; “TNC lead sites” and “partner sites”. TNC lead sites are sites that require less investment in new TNC resources or are under less threat. TNC preserves where a sustained commitment at current capacity is forecast are a good example. Partner sites are those at which we presume our conservation partners will take the lead in implementing conservation. At a minimum, we must measure success towards maintaining the conservation target and be willing to provide our partners assistance if required. Ownership patterns at 10-year action sites are very similar to those described for all portfolio sites collectively.

Based on these criteria, the state teams selected 25 Tier 1 preferred matrix forest occurrences, and 450 element occurrences as 10-year action sites. Approximately 13% of the element occurrence 10-year action sites (n= 131) are contained within a Tier 1 preferred matrix forest occurrences. The portfolio also contains 144 element occurrences that were selected as TNC lead sites and another 332 partner lead sites. Map 17 shows all 10-year action sites in LNE-NP.

State chapters will now proceed to develop threats assessments and strategies for action at these sites over the next few years, with the expectation of achieving positive conservation results within 10 years. There is interest in organizing a regional implementation team that would consider cross-state landscape-scale projects, create a network of conservation sites, and evaluate threats and design strategies regionwide. In the interim, a meeting has been scheduled for November for state directors to begin considering plan implementation.

Portfolio Summary

A total of 1,028 species populations and terrestrial community examples, 43 matrix forest areas, and 8140 miles of streams were selected for the conservation portfolio.

Collectively, the portfolio totals 2.7 million acres, accounting for about 11.5% of the 23.3 million acre ecoregion. Matrix forest ecosystems encompass 2.2 million acres and focal species and patch community examples, with 1000-acre buffer areas, account for another half million acres.

A little less than one-fifth of the portfolio is under management. (The analysis of managed areas may include lands that are not managed for conservation. For instance, military reservations are included in the tally of federal acreage under management.) State governments have protected the largest amount, including 15% of forest matrix sites and 9% of focal species and terrestrial community examples. Federal ownership comprises less than two percent of the total managed area; private organizations manage approximately four percent of total area for species and patch-forming communities.

Ecoregional Target	# Primary Focal Species or Ecosystem Types	# Examples Selected for Portfolio	Contributing to Numeric and Distribution Goals were:
Plants	42	154	10 of 42 Plants
Vertebrates	8	76	2 of 8 Vertebrates
Invertebrates	57	213	7 of 57 Invertebrates
Terrestrial Ecosystems and Communities	17 Community Groups 142 NVC Association Types	433*	433 of 1772 Community Examples

* Database and report totals differ

Ecoregional Target	# Forest-Landscape Groups	# Examples Selected for Portfolio	# Viable Species Populations and Patch Community Examples Contained Within
Matrix Forests	11	43	176 (17% of those found in ecoregion)

Ecoregional Target	# Watershed Types	# Portfolio Stream Miles in Northern LNE
Large Rivers	19	856
Medium Rivers	24	1619
Headwaters to Small Rivers	38	5061

PLANNING METHODS FOR ECOREGIONAL TARGETS: SPECIES[*]

Coarse-filter and fine-filter targets

The mission of the Nature Conservancy is the long-term conservation of all species present in all ecoregions. This broad objective encompasses every living thing from large mobile carnivores to ancient rooted forests to transient breeding birds to microscopic soil invertebrates. Such comprehensive protection can only be approached using a "coarse-filter / fine-filter" strategy. "Coarse-filter" species are protected implicitly through the conservation of ecosystems, communities and landscapes – a strategy that accounts for roughly 99% of the species present in the ecoregion. "Fine-filter" species are those that we believe can not be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention. The latter group of species, requiring direct attention, we termed *primary species targets* and are the focus of this section.

Primary species targets

Primary species targets consist of a heterogeneous set of species warranting extreme conservation concern in the ecoregion. Typically they cross many taxonomic lines (mammals, birds, fish, mussels, insects and plants) but each species exhibits one or more of the following distribution and abundance patterns:

- globally rare, with less than 20 known populations (G1-G3)[1],
- endemic to the ecoregion
- currently in demonstrable decline
- extremely wide ranging individuals
- designated as threatened or endangered by federal or state authorities

The implication of a species being identified as a *primary target* is that its conservation needs were addressed explicitly in the ecoregional plan. This means that the science team: 1) set a quantitative goal for the number and distribution of local populations required to conserve the species, 2) compiled information on the location and characteristics of known populations in the ecoregion, and 3) assessed the viability of

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[*] Anderson, M.G. and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Species. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

The standard methodologies sections created for this and all Northeast ecoregional assessment reports were adapted from material originally written by team leaders and other scientists and analysts who served on ecoregional planning teams in the Northeast and Mid-Atlantic regions. The sections have been reviewed by several planners and scientists within the Conservancy. Team leaders included Mark Anderson, Henry Barbour, Andrew Beers, Steve Buttrick, Sara Davison, Jarel Hilton, Doug Samson, Elizabeth Thompson, Jim Thorne, and Robert Zaremba. Arlene Olivero was the primary author of freshwater aquatic methods. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

[1] G1 refers to a global rarity rank where there are only between 1-5 viable occurrences of an element rangewide. G2 references a global rarity rank based on 6-20 viable occurrences rangewide, and G3 on 21-100 occurrences rangewide. Transitional ranks like G3G4 reflect uncertainty about whether the occurrence is G3 or G4 and T-ranks reflect a rarity rank based on rarity of a subspecies or other taxonomically unique unit (Maybury 1999).

each local population with respect to its size, condition, landscape context and ultimately its probability of persistence over the next century.

Viable examples of local populations ("occurrences") were spatially mapped and their locations were given informal "survey site" names. The number and distribution of viable occurrences were then evaluated relative to the conservation goals to identify portfolio candidates, inventory needs and information gaps for remediation. Ultimately each viable population occurrence and its survey site will require a local and more extensive conservation plan to develop a strategy for long term protection of that population at that location.

Secondary species targets

A second set of species, termed *secondary targets*, was also identified based on the life history, distribution and demographics of the species. Secondary targets were species of concern in the ecoregion due to many of the same reasons as the primary targets except that we had reasonable confidence that they would be conserved through the "coarse-filter" conservation of ecosystems (see the section on Matrix-Forming Ecosystems). To insure this, the compiled list of secondary targets was used in developing viability criteria for the ecosystem targets. For instance, the breeding needs of the conifer forest dwelling blackburnian warbler were used (along with other information from other species) to develop the size and condition factors for conifer forest matrix ecosystems. This guaranteed that the conservation of these forest ecosystems would be performed in such a way as to ensure the protection of the characteristic species that breed in this habitat. Additionally, known breeding concentration areas influenced the selection of which examples of this ecosystem were prioritized for conservation action.

Developing the target list

Development of the primary and secondary species target lists began with a compilation of all species occurring in the ecoregion that exhibited the characteristics mentioned above (see also Table SPP1 for definitions of selection criteria). The initial list was compiled from state or provincial conservation databases, Partners-in-flight and/or American Bird Conservation lists for corresponding ecoregions, literature sources and solicited expert opinion. The database searches begin with all species occurring in the ecoregion for which there were fewer than 100 known local populations (G1-G3G4 and T1-T3). Commoner species (G4, G5) were nominated for discussion by each of the state programs and by other experts.

Table SPP1. Criteria for selecting species targets

Imperiled species	Have a global rank of G1-G2 (T1-T2), that is, recognized as imperiled or critically imperiled throughout their ranges by Natural Heritage Programs/Conservation Data Centers. Regularly reviewed and updated by experts, these ranks take into account number of occurrences, quality and condition of occurrences, population size, range of distribution, threats and protection status.
Endangered and threatened species	Federally listed or proposed for listing under the Endangered Species Act.
Species of special	Ranked G3-G5 by Natural Heritage Programs/Conservation Data

concern:	Centers, but match one or more of the following criteria:
Declining species	Exhibit significant, long-term declines in habitat and/or numbers, are subject to a high degree of threat, or may have unique habitat or behavioral requirements that expose them to great risk.
Endemic species	Restricted to the ecoregion (or a small geographic area within an ecoregion), depending entirely on the ecoregion for survival, and may be more vulnerable than species with a broader distribution.
Disjunct species	Have populations that are geographically isolated from other populations.
Peripheral species	Are more widely distributed in other ecoregions but have populations in this ecoregion at the edge of their geographical range.
Vulnerable species	Are usually abundant and may or may not be declining, but some aspect of their life history makes them especially vulnerable (e.g., migratory concentration or rare/endemic habitat).
Focal species	Have spatial, compositional, and functional requirements that may encompass those of other species in the region and may help address the functionality of ecological systems. Focal species can include: *Keystone species*: those whose impact on a community or ecological system is disproportionately large for their abundance. They contribute to ecosystem function in a unique and significant manner through their activities. Their removal initiates changes in ecosystem structure and often a loss of diversity. *Wide-ranging species*: regional-scale species that depend on vast areas. These species often include top-level predators (e.g., wolves, grizzly bear, pike minnow, killer whale), wide-ranging herbivores (e.g., elk), and wide-ranging omnivores (e.g., black bear) but also migratory mammals, anadromous fish, birds, bats and some insects.

The exhaustive initial list was whittled down to a smaller final set through discussion and agreement by technical teams of scientists familiar with the species in the ecoregion. Virtually all ecoregional assessments had separate technical teams for plant species and animal species. Many regions also divided the zoology team further, having, for example, separate teams for birds, aquatic species, herptiles, mammals or invertebrates. The compiled results were rolled up to create the final species target list. To some extent the justifications for including each target species have been archived in ecoregional databases.

No single defining factor guaranteed that a species would be confirmed as a primary target. Thoughtful consideration was given to each species' range-wide distribution, the reasons for its rarity, the severity of its decline both locally and globally, its relationships to identifiable habitats and the importance of the ecoregion to its conservation. As the list was refined, species were eliminated for different reasons. Some were removed because of questions about the taxonomic status of the species, others because they were considered to be more common throughout their range than reflected in the current global rank; the global rank for the latter species needs to be updated. Among species for which distribution information was considered to be inadequate, several were retained on a potential target list for future consideration. Table SPP2 illustrates the range of numbers of species targets selected by teams across several ecoregional plans.

Table SPP2. Comparison of the numbers of primary species targets across several ecoregions

SPECIES TYPE	LNE	NAP	NAC	HAL	STL	CAP	CBY	WAP
Mammals	3	2	1	3	2	7	2	3
Birds	0	n/a	2	0	0	1	4	0
Herptiles	2	n/a	1	2	3	7	2	6
Fish	3	1	2	6	6	7	2	15
Invertebrates	57	12	50	22	11	95	16	29
Vascular Plants	42	25	42	22	12	73	32	24

LNE: Lower New England/Northern Piedmont; NAP: Northern Appalachian/Boreal Forest; NAC: North Atlantic Coast; HAL: High Allegheny Plateau; STL: St. Lawrence/Champlain Valley; CAP: Central Appalachian Forest; CBY: Chesapeake Bay Lowlands; WAP: Western Allegheny Plateau

Setting Minimum Conservation Goals for Species Targets

The minimum conservation goal for a primary target species in an ecoregional plan was defined (conceptually) as the minimum number and spatial distribution of viable local populations required for the persistence of the species in the ecoregion over one century. Ideally, conservation goals should be determined based on the ecology and life history characteristics of each species using a population viability analysis.

Because it was not possible to conduct such assessments for each species during the time allotted for the planning process, generic minimum goals were established for groups of species based on their distribution and life history characteristics. These minimum goals were intended to provide guidance for conservation activity over the next few decades. They should serve as benchmarks of conservation progress until more accurate goals can be developed for each target. The generic goals were not intended to replace more comprehensive species recovery plans. On the contrary, species that do not meet the ecoregional minimum goals should be prioritized for receiving a full recovery plan including an exhaustive inventory if such does not already exist.

Quantitative global minimums

Our conservation goals had two components: numeric and distributional. The *numeric* goal assumed that a global minimum number of at least 20 local populations over all ecoregions was necessary to insure the persistence of at least one of those populations over a century (see Cox et al 1994, Anderson 1999, Quinn and Hastings 1987 and reliability theory for details). This number is intended to serve as a initial minimum not a true estimate of the number of local populations need for multi-century survival of the species. Subsequently, the number 20 was adjusted for the ecoregion of focus based on the relative percentage of the total population occurring in the ecoregion, the pattern of the species distribution within the ecoregion and the global rarity of each species (see Table SPP3). When the range of a rare species extended across more than one ecoregion, the assumption was made that the species would be included in the protection plans of multiple ecoregions. Such species may require fewer protected examples within the ecoregion of focus relative to a species whose ranges is contained entirely within the ecoregion.

To highlight the importance of the ecoregion to the species, each primary target species was assigned to one of four rangewide distribution categories – Restricted, Limited, Widespread, Peripheral – all measured relative to the ecoregion (Table SPP3). Assignments were made by the species technical teams using distribution information available from NatureServe, the Heritage Programs, and from other sources available at the Eastern Conservation Science (ECS) center. In general, for species with a "restricted" distribution, the ecoregional goals was equal to the global minimum and set at 20; for species with a "limited" distribution, the ecoregional goal was set at 10. For species with "widespread" or "peripheral/disjunct" distributions, the goal was set at 5 for the entire ecoregion.

Table SPP3. Conservation goals based on distribution categories and global rarity rank (Grank). Numbers refer to the minimum number of viable populations targeted for protection.

CATEGORY	DEFINITION	G1	G2	G3-G5
Restricted	Occurs in only one ecoregion	20	20	20
Limited	Occurs in the ecoregion and in one other or only a few adjacent ecoregions	10	10	10
Widespread	Widely distributed in more than three ecoregions	5	5	5
Peripheral or Disjunct	More commonly found in other ecoregions	5	5	5

Distribution and Stratification goals

The distribution component of the conservation goal, referred to as the *stratification* goal, was intended to insure that independent populations will be conserved across ecoregional gradients reflecting variation in climate, soils, bedrock geology, vegetation zones and landform settings under which the species occurs. In most cases the distribution criteria required that there be at least one viable population conserved in each subsection[2] of the ecoregion where the species occurred historically, i.e. where there is or has been habitat for the species. The conservation goal is met for a species when both the numerical and stratification standards are met.

In addition to the scientific assumptions used in setting conservation goals, the goals contain institutional assumptions that will require future assessment as well. For example, the goals assume that targeted species in one ecoregion are targeted species in all ecoregions in which they occur. That is likely the case for rare (G1-G3) species, but not a certainty for commoner (G4, G5) species. After the completion of the full set of first

[2] Subsections are geographic sub-units defined for ecoregions (Bailey et al 1994; Keys et al 1995).

iteration ecoregional plans, species target goals should be assessed, reevaluated and adjusted. Rangewide planning should eventually be undertaken for all targets.

Assessing the Viability of Local Populations

The conservation goals discussed above incorporate assumptions about the viability of the species across the ecoregion. The goals assume that local populations unlikely to persist over time have been screened out by an analysis of local viability factors. This section describes how the planning teams evaluated the viability of each local population or "occurrence" at a given location.

Merely defining an occurrence of a local population can be challenging. The factors that constitute an occurrence of a species population may be quite different between species of differing biology and life histories. Some are stationary and long lived (e.g. woody plants), others are mobile and short lived (e.g. migrating insects), and innumerable permutations appear in between. Irrevocable life history differences between species partially account for the critical importance of the coarse-filter strategy of ecosystem and habitat conservation. Nevertheless, for most rare species the factors that define a population or an occurrence of a population have been thought through and are well documented in the state Natural Heritage databases. The criteria take into account metapopulation structure for some species, while for others they are based more on the number of reproducing individuals. Whenever it was available we adopted the Heritage specifications, termed "element occurrence specifications" or EOspecs for short (where *element* refers to any element of biodiversity) [3].

Whenever possible, the local populations of each species selected for a conservation portfolio should exhibit the ability to persist over time under present conditions. In general, this means that the observed population is in good condition and has sufficient size and resilience to survive occasional natural and human stresses. Prior to examining each occurrence, we developed an estimate of potential viability through a succinct assessment of a population's **size**, **condition**, and **landscape context**. These three characteristics have been recorded for most occurrences by Natural Heritage programs that have also developed separate criteria for evaluating each attribute relative to the species of concern. This information is termed "element occurrence ranking specifications" and these "EO rank specs" served as our primary source of information on these issues.

As the name implies, element occurrence ranking specifications were not originally conceived to be an estimate of the absolute viability of a local population but rather a prioritization tool that ranked one occurrence relative to another. Recently, however, the specifications have been revised in concept to be a reasonable estimate of occurrence viability. Unfortunately, revising the information for each species is a slow process and must be followed by a reevaluation of each occurrence relative to the new scale. Fortunately, the catalog records for each population occurrence tracked in the Heritage/CDC database contain sufficient information on its size, condition and

[3] An Element Occurrence, or EO, is a georeferenced occurrence of a plant or animal population or a natural community recorded in a Natural Heritage database.

landscape context that a generic estimate of occurrence viability may be ascertained from the heritage records.

The synthesized priority ranks (EO rank) currently assigned by the state Heritage Program staff reflected evaluations conducted using standard field forms and ranking criteria that were in use at the time that the occurrence was first documented by a field biologist. These ranks, while informative, were somewhat variable for similar occurrences across state lines. Thus for viability estimation the EO rank was supplemented by the raw tabular information on size, condition and landscape context. Additionally, several ecoregion teams further augmented this with a spatial GIS assessment of the land cover classes and road densities located in a 1000 acre proximity of the occurrence's central point. The latter served as an objective measure of landscape context.

All known occurrences for each primary target species were assembled at ECS from the state Heritage Programs through data sharing agreements. The occurrences were sorted by species, and spreadsheets for the species targets were prepared for group discussion, using the information described above. Further data included: a unique occurrence identification number, the species name, global rank, site name, and date of last observation. Tables of all occurrences were provided to each technical team member along with ecoregional distribution maps of the occurrences. Final decisions on the estimated viability of each local population was provided by the technical team and reviewed by the appropriate state and divisional scientists.

RESULTS FOR SPECIES[*]

Modification to Standard Method

Most of the data used for assembling the portfolio was derived from participating Natural Heritage programs. The analyses were based on data received before August 1, 2000. Massachusetts element occurrence data were assembled manually by TNC staff from published reports and expert interviews and placed in an interim database, as official data was not available from the Massachusetts Natural Heritage and Endangered Species Program. All element occurrences ranked A (excellent), B (good), or C (fair) by Heritage programs were included in the portfolio, provided their rank was supported by expert review – both by the expert teams and again by state teams comprised of Heritage Programs and Chapter Offices. In many cases, occurrences of species had either not been assigned an EO Rank or had been given a rank of “E,” meaning that the occurrence is extant but has not been given a rank. In both cases these occurrences were reviewed by the expert teams and appropriate Heritage program or TNC staff.

The LNE-NP plan does include some species EOs that do not meet the minimum viability criteria. They were included because state participants assured the team that better information supporting a higher viability rank was available but had not yet found its way into the databases. The remaining unranked and “E” ranked occurrences were not accepted into the portfolio. EOs for which there was insufficient documentation and knowledge, but where there was reason to suspect that the EO was viable, were given a provisional viability rank of *maybe* (M) and placed on a list for further inventory and evaluation pending future inclusion in the portfolio.

In the LNE-NP plan, some species targets with Restricted distributions but larger number of known meta-populations were assigned a larger than standard numerical goal of 30.

Summaries of Results for Species

A total of 3,317 Element Occurrences were considered by the planning team for inclusion in the portfolio (Map 9. Element Occurrence Viability). Appendix 1 contains the following lists and tables:

- Table: List of all Primary and Secondary Targets
- Table: Distribution and Viability of EOs across Subsections
- Table: Success towards Conservation Goals

Appendix 2 contains the following lists and tables:

- Table: List of Secondary Targets
- Table: Portfolio Sites that Capture Viable Secondary Target EOs
- Table: Secondary Targets with EOs in Portfolio Sites and 10 Year Action Sites

A short list of migratory birds were also included as secondary targets. The birds chosen as secondary targets all had Partners in Flight risk scores of 19 or more. Additionally, the Expert Team considered whether the LNE-NP ecoregion provided habitat for a

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[*] Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for species. Based on Barbour, H. 2001. Lower New England – Northern Piedmont Ecoregional Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

significant portion of their global population. The result was a list of 11 bird species that fit both criteria (Appendix 2).

Vertebrates

Eight vertebrates were selected as primary target species. A total of 365 EOs were evaluated from which 76 were selected for the Portfolio. Goals were met and exceeded (doubled and quadrupled) for two of the eight vertebrate species; timber rattlesnake and bog turtle. These two species will receive an unnecessarily high level of conservation attention unless these occurrences are removed from the portfolio during the second iteration. Including marginal EOs makes for an inefficient portfolio. Alternatively, and as may be the case with the Bog Turtle, we may raise the goal to meet new federal recovery plan goals. None of the other vertebrate species came close to meeting their goals.

Invertebrates

57 invertebrate species were chosen as primary target species. A total of 419 EOs were evaluated from which 213 were selected for the Portfolio. Goals were met for seven species, including dwarf wedgemussel, karner blue butterfly, and ringed boghaunter. Many species did not meet their goals because of a lack of occurrences to choose from in the database. 15 invertebrate targets had no EOs documented in BCD. Extensive inventory is required for the majority of invertebrate targets as 50 species (88%) did not meet their goals.

Plants

42 plant species were chosen as primary target species. A total of 334 EOs were evaluated from which 154 were selected for the Portfolio. Goals were met for 10 species, including northeastern bulrush, ram's-head lady's-slipper orchid, and Maryland bur-marigold. Only two species have distributions that are restricted to this ecoregion; Ogden's pondweed and basil mountain mint. Neither species met its conservation goal and both require additional inventory.

Additional inventory is required for most species but several things need to be kept in mind.. 1) The global rank for an element in many cases reflects the amount of inventory done for a species or group. Additional inventory for many will undoubtedly lead to revisions to the global rank for the species. Some may drop to G4 or G5 and no longer need to be part of the portfolio as primary targets. 2) Many species, even with extensive inventory will not meet their goals because they are naturally rare. This is acceptable where it can be shown that there never were sufficient populations to meet the goal. Alternatively, reintroduction and/or the restoration of extant sites with poor current viability, or introduction at sites with suitable habitat, should be considered.

Secondary Targets

The expert teams selected 14 vertebrate animals, 24 invertebrate animals, and 47 plant species as secondary targets. A total of 818 occurrences for 69 secondary targets were evaluated, of which 241 were captured in Portfolio Sites. Of these, 124 occurrences were selected as 10-year action occurrences. However, most secondary targets are poorly documented in BCD making analysis very difficult. There were no occurrences in the database for 18 secondary targets.

Secondary target occurrences selected for the portfolio were not evenly distributed among species. 13 secondary target species had no occurrences selected, and 26 species had no occurrences identified as 10-year action occurrences. Additionally, 45 secondary targets had 3 or less occurrences selected for the portfolio, and 56 secondary targets had 3 or less occurrences selected as 10-year action occurrences. Some of the secondary targets require interior forest conditions or require large home-ranges, yet only 67 secondary target occurrences (for all species) were captured by Tier 1 matrix forest occurrences. Of these, only 36 were captured in Tier 1 10-year matrix forest occurrences. Table 3 provides a tabular accounting of secondary target element occurrence by portfolio status.

Table 3. The status of secondary target element occurrences in matrix and patch sites chosen for other targets.

Secondary Targets Inside:	All Secondary eos	% Secondary eos
Tier 1 Matrix	67	8.19
Tier 1 Matrix 10yr Site	36	4.40
Tier 2 Alternate Matrix	23	2.81
Not in a Matrix Site	728	89.00
In Portfolio Patch Site	174	21.27
In Portfolio Patch 10yr Site	88	10.76
Total secondary eos	818	
Total Secondary eos in portfolio	**241**	**29.46**
Total Secondary eos in 10yr portfolio	**124**	**15.16**

Secondary target species require additional evaluation and occurrence selection for the LNE-NP portfolio. With assistance from Heritage Programs, occurrences need to be identified and selected for targets that are not represented or under-represented in the portfolio. This will require inventory and the development of target and stratification goals. In the interim, however, we can presume that some undocumented secondary targets will be captured by other portfolio occurrences.

Birds

Eleven species of migratory bird were selected as secondary target species. The Expert Team believes that Tier 1 Preferred Sites for matrix-forming forest communities will provide adequate protection for the following forest-dependent bird species:

- Black-throated Blue Warbler in northern hardwood forests,
- Cerulean Warbler in swamps and bottomlands within matrix sites,
- Louisiana Waterthrush in deciduous forests mid-region,
- Prothonotary Warbler in larger swamps and bottomlands in the Piedmont,
- Wood Thrush in deciduous forests mid-region,
- Worm-eating Warbler in deciduous forests midregion.

Additional review of Portfolio sites will be required to ensure that an adequate number of suitable habitats have been selected regionwide for the remaining five species.

- Blue-winged Warbler in wet, old fields and moist, early successional woodlands,
- Golden-winged Warbler in old fields, forest openings, and thickets in the Piedmont and NY,

- Prairie Warbler in open sandy areas with shrubs, and dry brushy pasture,
- Bicknell's Thrush in stunted conifer forests at high elevation in Lower New England.

PLANNING METHODS FOR ECOREGIONAL TARGETS: TERRESTRIAL ECOSYSTEMS AND COMMUNITIES[*]

Coarse-filter and fine-filter targets

The mission of the Nature Conservancy is the long-term conservation of all biodiversity (ecosystems, communities, species and sustaining processes) present in all ecoregions. This broad objective encompasses every living thing from rare salamanders or large carnivores to whole ecosystems such as montane spruce-fir forest with all its associated species diversity, structural components and ecosystem functions. The Nature Conservancy describes its comprehensive protection approach as “coarse-filter / fine-filter” strategy. “Coarse-filter” targets are the ecosystems and communities that characterize the ecoregion and define its landscapes. These targets are the subjects of this chapter. It is a significant topic, as coarse filter targets not only implicitly conserve up to 99% of the species present in the ecoregion but also help maintain the larger ecological context and processes of the region. “Fine-filter” targets are those species that we believe can not be adequately conserved by the protection of ecosystems alone but require explicit and direct conservation attention. They are the subjects of the chapter *Planning Methods for Ecoregional Targets: Species*.

It is worth considering the meaning of “conserving an ecosystem’s associated species, structural components and ecosystem functions.” “Associated species” include everything from breeding habitat for birds and mammals to complex vegetation layers to soil invertebrates. “Structural components” refer to vegetation structure and, more broadly, to all the accumulating organic materials that link a system historically to a place and stabilize the ecosystem. These features, collectively termed *biological legacies*, include coarse woody debris, seed banks, soil nutrient reservoirs and extensive fungal networks — essentially the by-products of previous or current residents. The third term, “important ecosystem functions,” refers to processes such as water filtering and storage, nutrient transformations, solar energy capture and carbon sequestration that an ecosystem performs. Keeping these three dimensions of an ecosystem in mind can help clarify the criteria for defining ecosystem types, assessing the viability of examples and selecting places for conservation action.

Ecosystem and community targets: Introduction

Unlike focal species targets, where a small proportion of all the potential species are selected for direct conservation attention, for ecosystems and communities *all* types

[*] Anderson, M.G. and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Terrestrial ecosystems and communities. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

The standard methodologies sections created for this and all Northeast ecoregional assessment reports were adapted from material originally written by team leaders and other scientists and analysts who served on ecoregional planning teams in the Northeast and Mid-Atlantic regions. The sections have been reviewed by several planners and scientists within the Conservancy. Team leaders included Mark Anderson, Henry Barbour, Andrew Beers, Steve Buttrick, Sara Davison, Jarel Hilton, Doug Samson, Elizabeth Thompson, Jim Thorne, and Robert Zaremba. Arlene Olivero was the primary author of freshwater aquatic methods. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

occurring in the ecoregion were automatically considered primary targets in the ecoregional plan. In Northeastern plans the number of systems under consideration is a function of the diversity of varying environmental conditions in the ecoregion and the idiosyncrasies of the system taxonomy. Across all plans the numbers of ecosystems range from 60 to 250 per ecoregion, certainly a manageable set compared to the number of species.

Ecosystems and communities

A source of confusion is the use of the terms: *ecosystem*, *ecological system*, *community*, and *natural community*. As used in the Northeast these terms are interchangeable with no hard definitions separating their meanings. All the terms refer to a repeatable and recognizable organization of biodiversity, with a typical species composition, structure, environmental setting and set of sustaining processes.

A difference of emphasis is implied in the choice of terms. The term *ecosystem* emphasizes a feature's structure, environmental setting and sustaining processes, accepting a more generalized species composition. The term *community* puts more emphasis on a feature's specific species composition. In many Northeastern states the term *natural community* refers to an inventory unit most similar in concept to an ecosystem, since these units are recognized as much by a landscape and environmental setting as by a specific composition. Many ecologists conceive of ecosystems as mosaics of one to several communities that occur together under the same environmental conditions and controlling processes. These are only conventions, however, and the terms do not imply a spatial hierarchy, which we discuss below.

Our understanding of the ecosystem and community concepts depends on how well we grasp the dynamics of natural systems and the spatial patterning that develops within them. For example, a wetland ecosystem may be composed of relatively distinct vegetation communities with their spatial configuration corresponding to water depth. Understanding the cause of the spatial zonation may add insight into the internal dynamics of the system. However, there is ample evidence that in many systems the distinctiveness and stability of vegetation communities within the ecosystem is more apparent than real. In spite of individual preferences for "lumping vs. splitting," ecologists agree that we should strive to conserve the ecosystem (or, if one prefers, the mosaic of communities) as a holistic unit.

The term ecosystem also has a variable relationship to the term *habitat*. Again, the difference is primarily one of perspective. A freshwater marsh ecosystem is "habitat" for many marsh-breeding species. Moreover, as discussed later in this section, if a specific marsh ecosystem does not provide habitat for multiple breeding populations of marsh breeding species, then in our analysis it will fail to meet the viability criteria for that ecosystem. Finally, the term habitat is most often defined relative to the needs of a particular species and may include multiple ecosystem types for breeding, foraging and dispersal.

Ecosystems and scale

The term ecosystem, as used here, does not imply any particular scale of feature. Rather, it focuses on the distinctiveness of the biota, setting and processes that define the system. Floodplain forests, freshwater marshes, peat-forming bogs, fire-adapted forests on coarse sandy outwash and forested swamps are a few examples of moderately sized ecosystems found in the Northeast that are quite distinct in biota and process. At smaller scales, we recognized cliff and talus slope ecosystems, rocky summit ecosystems, toe-slope and ravine ecosystems, lake and pond shore ecosystems, and seepage channel ecosystems. Most of these systems are associated with a particular topographic or geologic setting or a locally dominant process such as fire or flooding. Because they occur across a landscape in relatively distinct patches we referred to these as *patch-forming ecosystems*. A few ecosystem types dominate much of the natural land area in and around the patch systems. Because these ecosystems form the background matrix we referred to them as *matrix-forming ecosystems* (adopting the terms from Forman 1995). In the Northeast, all the matrix-forming ecosystems are forest types, but in other regions they may be open shrublands or herbaceous grassland.

When examining a landscape, it becomes immediately clear that patch-forming ecosystems nest within matrix-forming ecosystems. By definition, this way of grouping systems recognizes a spatial hierarchy. For example, a large area dominated by lowland conifer forest (a matrix-forming system) may, on close examination, reveal a network of bogs, fens, marshes and rolling hills (large patch systems). These may contain even smaller settings of cliffs, outcrops and shores (small patch systems). Some authors reserve the term ecosystem only for the dominant matrix-forming system and refer to the smaller ecosystems as “special habitats” or “biotic hotspots.” However, the smaller ecosystems meet the criteria of being repeatable and recognizable organizations of biodiversity with a typical composition, structure, environmental setting and set of maintaining processes. Patch-forming ecosystems are often richer in species diversity than the matrix-forming ecosystems they are embedded in and are thus of great interest to conservationists. Regardless of the scale at which they occur in a landscape setting, ecosystems and communities are still “coarse-filter” targets in that they are composed of many individual species populations and conservation activity is best directed at maintaining the entire system.

In this section we will use the term *ecosystem* to refer to the coarse filter unit at any scale, supplementing it occasionally with the term *community* to emphasize certain points. Although nature is fundamentally variable and dynamic, a conscientiously applied ecosystem classification is a tool that significantly clarifies the best places and strategies for conservation work.

Ecosystems and physical setting

The physical environment is closely related to ecological processes and biotic distributions. Climate, bedrock, soils, and topography appear to be strongly linked to ecosystem patterns and processes. To incorporate the physical setting into our identification of ecosystem targets, we developed a comprehensive ecoregion-wide data layer or map of physical features that we termed *ecological land units* or ELUs.[1] The next section illustrates the use of ELUs in developing the target list of ecosystems.

[1] Development of ELUs is the subject of a separate chapter, *Ecology of the Ecoregion*, incomplete as of July 2003, but see Ferree 2003

Developing the target list

Not every landscape feature, geologic formation or natural process forms a distinct ecosystem. It was the task of the ecology technical team to highlight, name and describe those settings that do and, by default, to ignore those that do not. Thus, developing the target list for terrestrial ecosystems was synonymous with developing and applying a standard classification system to the ecoregion. The results catalog and describe an unambiguous set of ecosystem targets for each region (see Table COMM1 below).

Table COMM1. Examples of ecosystem types in the LNE/NP ecoregion selected as targets.

ECOSYSTEM/COMMUNITY GROUP	SAMPLE ECOSYSTEM TARGET
Bogs & Acidic Fens	Highbush Blueberry / Peatmoss species Shrubland
Calcareous Fen	Eastern red cedar / Shrubby cinquefoil / Yellow sedge - Rigid sedge Shrub Herbaceous Vegetation
Deciduous or Mixed Woodland	Red Oak / Eastern Rockcap Fern Woodland
Palustrine Forest & Woodland	Eastern Hemlock / Great Rhododendron / Peatmoss spp. Forest
Ridgetop/ Rocky Summit	White Pine - Red Oak / Poverty Grass Acid Bedrock Herbaceous Vegetation
Sandplains	White Pine - Grey Birch / Sweetfern / Little Bluestem Woodland
Terrestrial Conifer Forest	Red Spruce - Balsam Fir - American Mountain-Ash Forest

The ecology technical team was composed of scientists familiar with the systems of the ecoregion. For the most part, these were state-based ecologists who had developed classification systems for their respective states. Leaders of the technical teams came from a variety of organizations including state Natural Heritage programs, NatureServe and TNC.

As a starting point, a list of all potential ecosystems was compiled for the ecoregion based on the U.S. National Vegetation Classification (NVC[2]), which is a hierarchical classification based primarily on vegetation structure and water conditions. Preliminary units for ecoregional targets were identified at the hierarchical scale of the *association.* An association is defined by three characteristics: vegetation structure, full floristic composition, and environmental setting. Through a series of two to eight meetings the technical team made a significant effort to clarify and improve the NVC specific to the ecoregion.

The results were compiled into an ecosystem or community document that was adopted by the states and served as the baseline target list for the ecoregion. In the document, each ecosystem is characterized by information on its composition, structure, associated species, environmental setting and general concept (see sample page at end of chapter).

Auxiliary information on each ecosystem

By necessity, the process of developing the ecosystem classification also involved developing a number of conventions for working with the classification that helped overcome some inherent problems. These conventions included identifying a size scale

[2] Grossman et al. 1998; Anderson et al. 1998; Maybury 1999. The NVC itself was developed from the classification work of state ecologists that has been reviewed and compiled into a single overarching framework. The framework is based on a modified version of the UNESCO world vegetation classification.

and distribution pattern for each ecosystem, constructing hierarchies for aggregating similar fine-scale ecosystem types into broader types, and identifying explicit connections between ecosystems and their topographic, geologic and climatic setting.

This information, collected during the technical team meetings and in subsequent interviews, was later used extensively to set conservation goals, establish viability criteria, assess ecoregional gradients and develop accurate maps for each ecosystem type. Team members were asked to:

1. Determine the distribution for each association by **subsection** within the ecoregion
2. Evaluate the distribution of each association within the ecoregion in relation to its **global distribution**
3. Determine the patch **size** (matrix, large patch, small patch, or linear) for each association
4. Describe the topographic position, substrate type and other features of the **physical setting** for each association to facilitate making connections between associations and Ecological Land Units (ELUs)
5. Identify any **new associations** not represented in the NVC subset already linked to the ecoregion.

As part of this data-refining process, descriptions of NVC associations were adjusted to reflect the floristic composition and physical setting of the association specific to the ecoregion. Characteristic breeding species of birds, mammals, reptiles and amphibians were collected in some ecoregions from the ecologists, while in others they were assembled after the fact by a different team.

Methods for developing auxiliary information

Subsection distribution pattern: The distribution of the ecosystem within the ecoregion was characterized by an expert-opinion estimate of its occurrence within geographically defined subregions (USFS subsections, Keys et al. 1995). For each ecosystem, ecoregional subsections were marked as to the occurrence of the system using a three-part scale: 0=absent, 1=probably present, and 2= present with certainty. This allowed for a simple map showing the estimated distribution of the ecosystem across the ecoregion.

Global range and distribution pattern: To assess and highlight the importance of a particular ecosystem with respect to this ecoregion, each type was tagged with one of four rangewide distribution categories — Restricted, Limited, Widespread, Peripheral — all measured relative to the ecoregion. The ecology technical teams accomplished this by using global distribution estimates available from the state Heritage Programs, NatureServe and other sources available at the Eastern Conservation Science center. The definitions listed below were treated as approximations allowing for a certain amount of acceptable error. Determining and clarifying the true range-wide distribution of each community type is a long-term goal of the classification authors.

Restricted/Endemic: Occurs primarily in this ecoregion; it is either entirely endemic to the ecoregion or generally has more than 90% of its range within the ecoregion.

Limited: Occurs in the ecoregion of interest, but also within a few other adjacent ecoregions (i.e., its core range is in one or two ecoregions, yet it may be found in several other ecoregions).

Widespread: Is distributed widely in several to many ecoregions and is distributed relatively equally among those ecoregions in which it occurs. A ecosystem that is widespread is not necessarily "common" in the ecoregion.

Peripheral: The ecosystem is more commonly found in other ecoregions (generally less than 10% of its total distribution is in the ecoregion of interest). The distribution in the ecoregion of interest is continuous with that in adjacent ecoregions. *Disjunct* ecosystems were considered a special case, where the occurrence of the ecosystem in the ecoregion was disjunct from its core distribution outside the ecoregion.

Ecosystem scale and patch size: Ecosystems were categorized as matrix-forming, large patch-forming, or small patch-forming depending on their scale of occurrence in the ecoregion and based on the following definitions.

Matrix-forming: Dominant systems (they are all forest types in the Northeast) that form extensive and contiguous cover on the scale of 1000s to millions of acres. Matrix forests occur on the most extensive landforms and typically have wide ecological tolerances. They may be characterized by a complex mosaic of successional stages resulting from characteristic disturbance processes (e.g., New England northern hardwood-conifer forests) or they may be relatively homogeneous. Matrix-forming ecosystems are influenced by large-scale climatic processes and cross broad elevation and topographic gradients. They are important habitat for wide-ranging or large area-dependent fauna, such as large herbivores or forest interior birds. Specific examples include red spruce–balsam fir montane forest, maple-beech-birch northern hardwood forest, white pine – red oak mixed forest and a variety of successional types. In some ecoregions, the aggregate of all matrix forest types covers, or historically covered, 75-80% of the natural vegetation of the ecoregion.

Large Patch-forming: Ecosystems that form large (50–5000 acres) but discretely defined areas of cover (several orders of magnitude smaller than the matrix types). Large patch systems are associated with environmental conditions that are more specific than those of matrix forests. Thus they are subsequently less common or less extensive in the landscape. Large-scale processes influence large-patch systems, but their influence tends to be overridden by specific site features that drive the local processes (e.g. hydrology or soil erosion). Examples include red maple swamps, cattail marshes, black spruce bogs, alpine krumholtz, or pine barrens. We considered *linear* systems, which most often occur along rivers (e.g. floodplain forests or alluvial marshes), to be a special form of large patch systems

Small Patch-forming: Ecosystems that form small, discrete patches of cover. Individual occurrences of these systems range in size from 1 to 50 acres. Small patch ecosystems occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. They are often dependent on the maintenance of ecological processes in the surrounding matrix and large patch communities. Small patch ecosystems often contain a disproportionately large percentage of the total flora, and may support a specific and restricted set of associated fauna (e.g. reptiles, amphibians, or invertebrates) dependent on specialized conditions. Examples include calcareous fens, calcareous cliffs, acidic rocky summits, enriched cove forests and rivershore grasslands.

Explicit links to ecological land units: Each system was ranked as to its degree of association with each of several bedrock types, topographic positions and elevation classes (see table below). Development of these ecological land units or ELUs[3] is the subject of a separate chapter, *Ecology of the Ecoregion*, and details may be found there.[4]

Table COMM2. Ecological Land Unit variables

ECOLOGICAL LAND UNITS: generalized example. An ELU is any combination of these three variables.		
TOPOGRAPHY	GEOLOGY	ELEVATION ZONE
Cliff	Acidic sedimentary	Very Low (0-800')
Steep Slope	Acidic shale	Low (800-1700')
Slope Crest	Calcareous	Medium (1700-2500')
Upper slope	Moderately Calcareous	High (2500-4000')
Sideslope –N facing	Acidic granitic	Alpine (4000+'}
Sideslope – S facing	Intermediate or mafic	
Cove or toeslope-N facing	Ultra mafic	
Cove or toeslope–S facing	Deep fine-grained sediments	
Low hilltop	Deep coarse-grained sediments	
Gently sloping flat		
Dry flat		
Valley bottom		
Wet flat		
Slope bottom flat		
Stream		
River		
Lake or pond		

New systems: Some associations were described in the NVC, but not formally recognized as occurring in the focal ecoregion; others were not yet described. For these "new" associations, the team created a standard name and wrote a description. The new system is intended to be combined and coordinated with other newly identified associations from other ecoregions in an update of the NVC. (Until the process has been completed the ecoregion-specific name for the new ecosystem should be considered provisional.)

[3] While the variables that we used are physical ones, the classes were based on biological considerations (e.g., tree distribution, for Elevation Zone).
[4] Incomplete as of July 2003, but see Ferree 2003.

Setting Minimum Conservation Goals for Ecosystem Targets

Goal setting, viability analysis and locating ecosystem examples followed somewhat different methods depending on whether the ecosystem was a matrix-forming type or a patch-forming type. In all ecoregions, patch-type ecosystems were the most numerous type of ecosystem and the evaluation of them followed the methods presented below. Matrix-forming ecosystems, although consisting of only a handful of types, required a separate set of analyses and some different approaches to locating and evaluation. Those methodologies are described in the chapter on Matrix-forming Ecosystem Targets.

The minimum conservation goal for an ecosystem target in an ecoregional plan was defined as the minimum number and the spatial distribution of viable examples required to insure the persistence of the ecosystem over one century. Because it was not possible to conduct full assessments of the dynamics and processes of each ecosystem during the time allotted for the planning process, generic minimum goals were established for groups of similar ecosystems.

Quantitative global minimums

Our approach to patch-forming ecosystems assumed that because these ecosystems occur in a discrete and localized way, they were amenable to treatment as "occurrences" in a form analogous to local populations. For instance, an example of a distinct freshwater marsh ecosystem can be described as to its species composition, structure and topographic setting, evaluated with respect to its size, condition and landscape context, and tracked in a spatial database relative to its occurrence at a particular place. Moreover, the set of all marsh "occurrences" can be counted, their distribution patterns examined, and each one evaluated as to the probability of its persistence. While this pragmatic way of dealing with more discrete ecosystem types proved to be workable it does not imply that there are not important connections (e.g. hydrologic or topographic) between occurrences. Whether occurrences in close proximity should be evaluated as one or many can be confusing. In most cases, state Natural Heritage programs, which struggle with these issues regularly, have developed clear guidelines for determining what defines a single occurrence. Whenever available we adopted these guidelines.

Conservation goals for patch ecosystems had two components: numeric and distribution. Patch size type and the range-wide distribution of an ecosystem were used to determine both the number of occurrences needed to preserve an association throughout the ecoregion and the spatial distribution of occurrences (i.e., stratification) necessary to represent both the range-wide rarity and environmental variability of each community type.

The numeric component of the conservation goal (the replication goal) assumed that across a small patch-forming system's entire range, a minimum number of 20 viable occurrences was necessary to insure the persistence of at least one of those occurrences over a century.[5] Subsequently, the minimum goal of 20 was adjusted for the focal ecoregion based on the relative percentage of the systems total distribution was concentrated in the ecoregion and the scale of the system type. Thus, replication goals within an ecoregion were equal to 20 for small patch-forming systems that were restricted

[5] Cox et al. 1994 and Quinn and Hastings 1987

to that ecoregion alone. Those systems depend entirely on conservation efforts within that area for long-term protection.

For ecosystems that occurred across a few ecoregion (e.g. had a “limited” distribution), the ecoregional goal was lower (14). For species with “widespread” or “peripheral/disjunct” distributions, the goal was set even lower under the assumption that conservation of these ecosystems will be repeated across several ecoregions. In a similar way, conservation goals were highest for small patch communities that have the highest probability of extinction over the next century and lowest for large systems that are unlikely to disappear (see Table COMM3 for large- and small-patch ecosystem goals).

Table COMM3. Conservation goals for patch-forming ecosystems.
In this table a large patch ecosystem that was restricted to the ecoregion had a numeric goal of 16 viable examples distributed across the major subregions of the ecoregion.

PATCH–FORMING ECOSYSTEMS	LARGE PATCH Stratification goal in parentheses	SMALL PATCH Stratification goal in parentheses
Restricted/Endemic	16 (4)	20 (4)
Limited	8 (2)	14 (2)
Widespread	4	4
Peripheral	*	*

*****Objectives determined on a case by case basis.

Distribution goals

The distribution component of the conservation goal, sometimes referred to as the *stratification* goal, was intended to insure that independent ecosystem examples would be conserved across gradients reflecting variation in climate, soils, bedrock geology, vegetation zones and landform settings under which the system occurs. As the parenthesized values in Table COMM4 indicate, the amount of stratification necessary for each target was weighted such that Restricted ecosystem types required the most extensive within-ecoregion stratification and Widespread ecosystems required no stratification within the ecoregion. This insured that examples of each ecosystem were conserved across the ecoregion and not all concentrated in one geographic region.

To develop a stratification template for the ecoregion, US Forest Service subsections (Keys et al. 1995) were grouped into subregions based on an analysis of biophysical factors. The subregions were made up of clusters of subsections that were more related to each other in terms of ELUs than to other units. Table COMM4 shows an example for one ecoregion. Numbers in parentheses are acres.

Table COMM4. Example of stratification table for the Northern Appalachians (Anderson 1999). Acres are shown in parentheses.

Northern Appalachian / Boreal Ecoregion						
Northern Appalachian Mountains (16.8M)				Boreal Hills and Lowlands (15.4M)		
Adirondacks / Tug Hill (6.7M)		White and Green Mountains (10.2M)		Northern Boreal Hills (5.3M)	Southern Boreal Hills (10.1M)	
Tug Hill Plateau	Adirondack Mountains	White Mountains	Green Mountains Vermont Piedmont	Northern Boreal Hills	Central Maine Lowland	Southern Maine Coastal
M212F	M212D	M212A	M212C M212B	M212Aa,b 212Aa	212A,B 212C,D	212C 212D
(700K)	(5.9M)	(6.8M)	(3.4M)	(5.3M)	(6.9M)	(3.1M)

Based on the two preceding tables, examples of a Restricted ecosystem in the NAP ecoregion would be protected across four subregions: the Adirondack/Tug Hill, the White and Green Mountains, the Northern Boreal Hills and the Southern Boreal Hills (assuming it occurred in all four). Ecosystems with a Limited distribution would be protected across two subregions: the Northern Appalachian Mountains and the Boreal Hills and Lowlands.

The conservation goal was met for a ecosystem target when we were able to identify enough *viable* examples (see below) distributed across the ecoregion such that both the numerical and stratification standards were met. *For most targets we were not able to do this.* The plans not only highlight a set of places for conservation attention but also identify gaps in our knowledge in a very precise manner.

In addition to the scientific assumptions used in setting conservation goals, the goals contain institutional assumptions that will require future assessment as well. For example, the goals assume that targets in one ecoregion are targets in all ecoregions in which they occur. After the completion of the full set of first iteration ecoregional plans, target goals should be assessed, reevaluated and adjusted.

Assessing the Viability of Individual Ecosystem Examples

The conservation goals discussed above incorporate assumptions about the viability of the *ecosystem type* across the ecoregion. The goals assume that instances that are of low quality or too small have been screened out through an analysis of local viability factors. This section, concerns the evaluation of viability of each ecosystem example or “occurrence” at a given location.

Ideally, the local occurrences of each ecosystem selected for inclusion in a conservation portfolio should exhibit the ability to persist over time under present conditions. In general, this means that the observed occurrence is in good condition, has sufficient resilience to survive occasional natural and human stresses, and is of a size that is adequate to contain multiple breeding populations of the characteristic species associated with the ecosystem.

Locating examples of patch-forming communities

For most patch-forming ecosystems, the factors that define an example have been thought through and are documented in state Natural Heritage databases. Whenever Heritage program "occurrence specifications" were available we adopted them for use.

In the Northeast, a variety of mapping and predictive modeling techniques have been recently developed for locating examples of ecosystems. However, the examples of patch communities that were incorporated into the ecoregion portfolios were almost exclusively those documented by Natural Heritage element occurrence records and thus ground-verified. There are several reasons for this. First, the information needed to assess the example and determine whether an occurrence passed the viability screening criteria was readily available in the record. Second, the Heritage element occurrences databases in the East are extensive, selective and have matured to the point where the best examples of most ecosystem types are already well documented—particularly the small patch ecosystems. Third, we believe that ground verification is a wise step before any conservation action takes place.

To coordinate community occurrences across state lines, assess the viability of occurrences, and set goals, all community occurrences in the database were assigned to one of several ecological groups. Each of these occurrences was initially identified within their respective state classifications, and thus needed to be linked ("crosswalked" or "tagged") to the NVC classification developed for the ecoregion. Each occurrence, with its state name, was crosswalked to an NVC name by the state Heritage ecologist, or by staff from ECS with review by the state ecologist.

Viability screening criteria

Prior to examining ecosystem occurrences, we developed a set of qualifying criteria (a rough estimate of viability) through a succinct assessment of three attributes historically used by Natural Heritage programs to evaluate occurrences: **size**, **condition** and **landscape context**.

Size: Size of an occurrence was considered fundamental for predicting both the stability and the resilience of an ecosystem occurrence and the diversity of plant and animal species within the occurrence. Size criteria for ecosystems integrated three independent sources of information. The first was the *actual size range* of the system in the ecoregion. This measure was highly correlated with the specific landscape setting and conditions that define the ecosystem. Second was the scale and extent of the *disturbance processes* that affect the ecosystem. In particular, we used the size of severe damage patches to estimate the minimum dynamic area of an ecosystem. Third, we examined the *breeding territory* or minimum area requirements of the associated species we expected to be conserved through the protection of this ecosystem type. For example, breeding territory sizes of bitterns and rails were used to inform freshwater marsh conservation, and territory sizes for Lincoln's sparrow, palm warblers, and bog lemmings were important for dwarf shrub bogs. The chapter on Matrix-Forming Ecosystem Targets includes an extensive discussion of size.

The size of an ecosystem occurrence was a standard field in the Heritage element occurrence database; however, over the many thousand of occurrences we examined, only about two-thirds included a value for the field. When size data was included we used the information directly. When it was not we used some combination of expert interviews with ecologists, GIS analysis based on ecological land units and land cover, and airphoto analysis to confirm the size of an example. A number of cross check tests over occurrences, experts, and GIS methods confirmed that we have used accurate information on the size of ecosystem examples in the Northeast plans.

Condition: A variety of observable features affect the condition of a community occurrence. Primary among the features that we considered were *fragmentation* by roads, trails or land conversion, *invasion* by exotics, and *anthropogenic manipulation*, such as cutting, grazing, mowing, altered soils, and altered natural processes, usually reflected in changes in vegetation structure and composition. Additionally, *positive features* such as the development of biological legacies or evidence of historical continuity were considered evidence of good condition.

With the exception of roads and other fragmenting features, current condition is presently very difficult to evaluate without actual site visits. The standard field form for occurrence and site evaluation used by the ecologists in the state Heritage programs (Sneddon 1993) addresses much of this information in a standardized way. However, evaluation of over a thousand completed forms suggested that there has been a wide range in how consistently and thoroughly this form had been used across states. A good approximation of condition can be found in the Heritage database field for Element Occurrence Rank if, indeed, the occurrence has been identified. Descriptive notes on the occurrence in Heritage databases were very useful when they existed. We supplemented this information by asking the state ecologists to rank the occurrence using a simple three-part scale:

1 = **high**, no signs of anthropogenic disturbance, no exotics, no obvious fragmenting features, system well developed, biological legacies present and abundant.

2 = **moderate**, some signs of anthropogenic disturbance, some exotics present, some fragmenting features, system moderately well developed, biological legacies present but not abundant.

3 = **poor**, obvious signs of anthropogenic disturbance, many exotics present, obvious fragmenting features, system poorly developed, critical biological legacies absent or present in very low quantities.

We also flagged certain ecosystems occurrence with an “old-growth” designator, defined as having trees 180 years old or greater, or containing other evidence of historical continuity such as peat build up of several meters.

Landscape quality or context: For patch-forming ecosystems, the surrounding landscape is important in the evaluation of viability. This concept is well understood by ecologists who have observed the degradation and disappearance of ecosystem occurrences once believed to be protected. Patch-forming ecosystems have degraded when fire regimes were altered (e.g. pine barrens), the surrounding hydrology was interrupted (e.g. fens and pond shores), water chemistry was altered (e.g. freshwater wetlands and ponds), or seasonal disturbance regimes were altered (e.g. rivershore grasslands and ice-scour communities). Wetland, floodplain and other lowland communities are particularly susceptible to alterations in landscape processes, as lowland features tend to accumulate, concentrate and depend on materials from outside their own systems. Conversely, high elevation or upper slope systems on poor substrate types may be more biologically isolated and thus more tolerant of degradation or changes in the surrounding landscape.

A precise estimate of the landscape area relevant to the processes that sustain each ecosystem should take into account the features discussed above. However, assessing and quantifying how intact the specific critical landscape processes were surrounding each occurrence of a patch system was beyond the scope of possibility for the ecoregion assessment. As an alternative we examined a 1000 acre buffer area surrounding each patch-forming ecosystem occurrence, using the occurrence location as the center point of the buffer. For each occurrence, we collected expert opinion and also performed a standardized GIS analysis of landcover and roads. In both cases we condensed the data to a four-part ranking system.

> **1** = Area surrounding the occurrence is composed of intact matrix forest or a mosaic of natural systems.
>
> **2** = Area surrounding the occurrence is mostly forest or undisturbed lands but there may be a small proportion of developed land, agriculture or clearcutting within the buffer.
>
> **3** = Area surrounding the occurrence is characterized by fragmented forest, agricultural land or rural development.
>
> **4** = Area surrounding the occurrence is mostly developed.

The numerical ranges and cutoffs that defined each rank operationally varied somewhat among ecoregions. The GIS landscape context landcover values for the LNE/NP ecoregion, for example, are shown in Table COMM5.

Table COMM5. Landscape Context Landcover Criteria for Natural Terrestrial Communities in the Lower New England/Northern Piedmont Ecoregion

1	Surrounded by > 90% natural land with < 5% (50 acres) of low and high density residential development and industrial development and < 5000 meters of any type of fragmenting features.
2	Surrounded by > 80% natural lands with < 5% (50 acres) of low and high density residential development and industrial development and < 5000 meters of any type of fragmenting features.
3	Surrounded by > 60% natural lands with < 5% (50 acres) of low and high density residential development and industrial development and < 10000 meters of any type of fragmenting features.
4	Surrounding area < 60% natural land or > 50 acres of more intensely developed than in class or > 10000 meters of any type of fragmenting feature.

State ecologists reviewed the GIS assessment of the 1000-acre landscape context for each occurrence. Generally, there was high agreement between the expert opinion, auxiliary information and the GIS estimate.

We arrived at the 1000 acre buffer area using the assumption that the landscape scale is an order of magnitude larger than the occurrence scale and therefore the size of the assessment area should be an order of magnitude larger than the mean size of the patch communities. Based on an sample of 1300 patch-forming ecosystem occurrences we calculated *10 time the mean size* (101 acres x 10) or two orders larger than the modal size (which was 10 acres) and rounded this to 1000 acres. This value was subsequently used to approximate the landscape scale for all occurrences. However, in a few cases, particularly for small patch, globally rare systems, 1000 acres was considered to be too large to assess context. These occurrences were evaluated more critically using the judgment of the ecologists.

Combining the viability criteria

An algorithm was used to assess viability for patch-forming ecosystems based on the possible combinations of size, condition, and landscape context (see Table COMM6). Different size standards were used for large patch systems of various types (generally >100 acres), and small patch systems(generally > 25 acres, but variable). The combinations were intended to maximize the probability that an occurrence was viable, functional as a coarse filter, and associated with a reasonably intact site. Occurrences that ranked low for one criterion had to be ranked high for one or both of the other criteria in order to be considered viable. Where there was uncertainty about the classification of a community to patch type (e.g., large vs. small), generally the more conservative criteria (in parentheses) were applied.

Table COMM6. Generalized table of qualifying criteria combinations for patch-forming ecosystems.

Current Condition (1-3)	Landscape Context (1-4)	Size: Large Patch (acres)		Size: Small Patch (acres)				Viability Estimate
		Forest/ Woodland	Shrub/ Herb	Forest	Wood-land	Shrub	Herb	
1	1	100	50	20	10	5	5 (1)	Yes
2	1	100	50	20	10	5	5 (1)	Yes
3	1	100	50	20	10	5	5(1)	Maybe
1	2	100	50	20	10	5	5 (1)	Yes
2	2	100	50	20	10	5	5 (1)	Maybe
3	2	100	50	20	10	5	5 (1)	Maybe
1	3	200	100	50	50	10	10	Yes
2	3	200	100	50	50	10	10	Maybe
3	3	200	100	50	50	10	10	No
4	Any	Any						No
any	4	Any						No

Addressing Gaps in the Data

Future field inventories and analyses of existing data sets will supply additional detail on subregion distribution of ecosystems. These components can be added to future versions of the classification and will further our understanding of how many of the ecosystems occur across the entire region. Our assumption is that the large matrix forests will encompass many of the associations within the ecoregion even where ground-verified inventory, which would confirm their presence, is lacking. Other sites will be added in future revisions of the plans where significant gaps in representation have been identified.

The minimum goals based on generic ecosystem types were intended to provide guidance for conservation activity over the next few decades. They should serve as benchmarks of conservation progress until more accurate goals can be developed for each target. The generic goals were not intended to replace more comprehensive restoration plans. On the contrary, ecosystems that do not meet the ecoregional minimum goals should be prioritized for receiving a restoration plan including an exhaustive inventory if such does not already exist.

Quercus rubra / Polypodium virginianum Woodland (CEGL006320 ECS) — G3G5
LNP SUGGESTED NAME: Quercus rubra – Betula alleghaniensis / Polypodium virginianum Woodland
Red Oak / Eastern Rockcap Fern Woodland
[Red Oak Talus Slope Woodland]
Description: Open, bouldery, acidic talus slope woodlands in the Northern Appalachian and Lower New England / Northern Piedmont ecoregions. Habitat (large talus and boulders) rather than geography differentiates this association from *Quercus rubra / Vaccinium spp. / Deschampsia flexuosa* Woodland (CEGL006134). Ericads generally lacking, vines and ferns more characteristic. Common associates are species of *Corydalis, Woodsia, Dryopteris* as well as *Parthenocissus quinquefolia, Polypodium virginianum, Tsuga canadensis, Pinus strobus*. 6/98 NAP Very open to moderately closed canopy, heterogeneous composition of *Quercus rubra, Acer saccharum, Betula nigra, Betula alleghaniensis, Betula papyrifera, Betula populifolia, Fagus grandifolia, Acer rubrum*. Scattered and clumped tall shrubs/small trees include *Acer spicatum, Acer pensylvanicum, Rubus spp., Viburnum acerifolium* (occasional), *Ribes* spp. Prevalent component of vines are *Parthenocissus quinquefolia, Parthenocissus vitacea, Toxicodendron radicans, Celastrus scandens, Polygonum cilinode*. Scattered ferns and herbs are *Dryopteris marginalis, Polypodium virginianum, Pteridium aquilinum, Carex pensylvanica, Corydalis sempervirens (*localized*), Solidago bicolor, Solidago caesia*, and others. Acidic talus slopes of low-elevation valleys. Substrate is bouldery talus derived form acidic bedrock. Elevation range is roughly 500-2000 feet. Groundcover is exposed talus, moss-covered boulders and deciduous litter.
LNP Scale: Small to large patch **Distribution**: Limited
TNC Ecoregions: 61:C, 62:C, 63:C
References:

State	SRank	State Name
CT		S?
MA	S4	Acidic Talus Forest / Woodland+
ME	S3	Acidic Talus+
NH	S?	Red oak-black birch/marginal woodfern talus forest/woodland
NJ?	SP	
NY	S?	Acidic talus slope woodland
VT		S3 Transition Hardwood Talus Woodland+

Quercus rubra / Vaccinium spp. / Deschampsia flexuosa Woodland (CEGL006134 ECS) — G3G5
LNP SUGGESTED NAME: Quercus rubra – Quercus prinus / Vaccinium spp. / Deschampsia flexuosa Woodland
Red Oak / Blueberry species / Wavy Hairgrass Woodland
[Central Appalachian High Elevation Red Oak Woodland]
Description: Dry, open, rocky slope or summit woodlands in the Northern Appalachian, Lower New England / Northern Piedmont and Central Appalachians ecoregions. Open, stunted to somewhat closed canopy of *Quercus rubra*. *Quercus prinus* may be codominant. Common associates are *Quercus alba, Betula lenta* and *Acer rubrum* with minor component of *Quercus velutina, Betula populifolia, Betula papyrifera* and *Pinus rigida*. Tall-shrub layer is often lacking but may include *Acer spicatum, Sambucus racemosa, Rhus typhina, Kalmia latifolia, Hamamelis virginiana, Viburnum nudum var. cassinoides, Rhododendron* spp. Ericaceous shrubs and graminoids are characteristic. Well-developed low-shrub cover of *Vaccinium angustifolium, Vaccinium pallidum, Gaylussacia baccata, Kalmia angustifolia*. Scattered grasses include *Deschampsia flexuosa, Danthonia spicata, Carex pensylvanica*, and herbs *include Gaultheria procumbens, Aralia nudicaulis*. Herbs: *Pteridium aquilinum, Aralia nudicaulis, Maianthemum canadense, Aster acuminatus, Corydalis sempervirens, Deschampsia flexuosa, Carex pensylvanica, Polypodium virginianum*. Environmental setting: Talus slopes, rocky slopes and summits of low, moderate or high elevations. Soils are shallow, well-drained, nutrient-poor acidic gravels and coarse sands. Exposed bedrock prominent. Grades into *Quercus prinus* Forest, *Pinus rigida* woodlands or sparsely vegetated rocky summits (*Pinus strobus, Quercus rubra) / Danthonia spicata* Sparsely Wooded Herbaceous Vegetation CEGL005101.
LNP Scale: Small patch or large patch? **Distribution:** Widespread
TNC Ecoregions: 59:C, 61:?, 62:C, 63:C
References: Thompson and Sorenson 2000

State	SRank	State Name
CT		S?
DE	S?	
MA	S4	Ridgetop Chestnut oak Forest / Woodland
ME	S1	chestnut oak woodland=
NH	S?	Appalachian oak – pine Forest+ and Red oak – pine / heath rocky ridge woodland+
NY	S?	pitch pine oak heath rocky summit+
PA	S?	Dry oak-heath woodland
VA?	SP	
VT		S2 Dry oak woodland
WV	S?	

Results for Terrestrial Communities and Systems*

Modification to Standard Method

The selection and exact spatial arrangement of the target element occurrences was left to the understanding and judgment of the state Heritage Programs, TNC Field Offices, and other partners with guidance offered by the community working group. However, it is noteworthy that this has also allowed states to select for the portfolio occurrences that do not appear to meet established size, condition, or landscape context criteria. The consequence has been that the portfolio contains an excess number of occurrences for some community types, some of which do not meet their minimum viability criteria. Occurrences with questionable viability were also selected for community associations that did not meet their goals, with the understanding that 1) the database records be edited to reflect the new and improved viability information, and 2) certain portfolio sites may need to be removed in the future if the portfolio goal can be met with better, more viable, occurrences. In short, there is a mixed degree of confidence that all the community sites selected should or will remain in the portfolio. An improved process is required to maintain suitably conservative viability standards and a scientifically rigorous portfolio while still allowing states the opportunity to select which occurrences should become a part of the portfolio.

Community classification

In developing the Lower New England – Northern Piedmont Classification (Lundgren et al, 2000) an initial list of approximately 200 vegetation associations was selected as potentially occurring in the ecoregion based on known or suspected ranges of each association. Following review, a number of types were determined not to occur in the ecoregion or were not deemed as recognizable or distinct associations. One addition was described and several new types were proposed for further study. The result was a total of 153 NVC (National Vegetation Classification) associations currently described within this ecoregion with an additional 7 more to be defined with additional classification and inventory in the future. A total of 107 NVC Alliances (broader than association level) were represented: 40% Forests (>60% cover of trees), 14% Woodlands (30-60% tree cover), 12% Shrublands, and 34% Herbaceous types.

The revised National Vegetation Classification associations were not available for the analysis of documented community occurrences in LNE-NP during this stage of the assessment process. Therefore, to coordinate community occurrences across state lines, conduct an assessment of occurrence viability, and set goals, all community occurrences in the database were assigned to one of seventeen ecological groups which are listed in Table 4.

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for terrestrial communities and systems. Based on Barbour, H. 2001. Lower New England – Northern Piedmont Ecoregional Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Table 4. Ecological or community groups in LNE-NP

Bogs and acidic fens
Calcareous fens
Cliff/outcrop
Deciduous or mixed woodland
Floodplain forest and woodland
Marsh and wet meadow
Palustrine forest and woodland
Pond and lake
Ridgetop/rocky summit
River and stream
Sandplains
Serpentine barrens
Terrestrial conifer forest
Terrestrial deciduous forest
Terrestrial mixed forest
Tidal
Other

The combined LNE-NP Heritage databases contain 1381 community element occurrences for LNE-NP. Of these, some were for aquatic communities which were analyzed with another method; some were for cave communities; and others did not include enough data for analysis. Where it was not possible to assign a community occurrence to one of these broad community groups or insufficient data were available for any type of viability analysis, the element occurrence was not used in selecting portfolio sites. A total of 1090 natural community element occurrences were used as the basis for viability analysis and site selection. Of the 153 community associations (representing 107 community alliances) in the LNE-NP ecoregion, about 7% are matrix types, 23% are large patch types, and 70% are small patch types.

Goals and viability assessment

In LNE-NP planning, we set the minimum stratification level for a restricted community at 6 (meaning we wanted some occurrences in each of the six subregions). We set a bare minimum of 5 occurrences per subregion, which totals 30 occurrences for the ecoregion stratified into 6 subregions which we adopted as a reasonable minimum benchmark for the type. From this number we worked backwards to the other types decreasing the numbers and stratification levels for the larger and less restricted community types (Table 6).

Table 6. Minimum conservation benchmarks for communities as a function of patch size and restrictedness

		Patch Size	
	Minimum stratification level	Large Patch: 4	Small Patch: 5
Restricted	6	24	30
Limited	3	12	15
Widespread	2	8	10
Peripheral	1	4	5

For patch communities, we ranked the **condition** of each occurrence based on a combination of data available in the element occurrence record, usually summarized as an EO rank, and from expert and state chapter interviews. We used the assumption that if the occurrence were contained in a block less than 1000 acres, there was reason to be skeptical of its long-term persistence. Additionally, we assumed that if the occurrence fell within a selected matrix site, its landscape condition was probably good. Table 5 shows the viability ranking grid used to evaluate community viability in LNE-NP.

Table 5. LNE-NP viability ranking grid

Landscape context	Condition/Rank	Size: Large Patch	Size: Small patch	Viability estimate
1	A, AB, B, ?, E	>100	>0	Yes
1	BC,C			Maybe
2	A,AB,B,?,E	>100	>0	Yes
2	BC,C			Maybe
3	A,AB,B,?,E,	>100	>25	Yes
3	BC,C			No
4	A,AB,B,?,E	>100	>50	Maybe
4	BC,C			No
ANY	D			No

Summary of Results

Of the original 1381 EORs reviewed in the database, 585 were selected for the portfolio. The portfolio status of these sites include 229 occurrences that were selected as 10-year Action Sites, 82 that were selected as TNC Lead Sites, and the remaining 204 were designated as Partner Lead sites. One community group, cliff and outcrop communities, met and exceeded its goal by 220%. No other community group met its ecoregional goal (Table 7). Appendix 3 contains the following lists and tables:

- Table: Viable Community Occurrences Grouped by Subregion
- Table: Community Associations arranged by group type, subregion, and subsection with distribution and goals

Table 7. Progress towards goals for large and small patch community groups

Community Group	No. of Associations (community types)	Goal for Community Group*	Total No. of Occurrences in the Portfolio	Percentage of Goal Achieved
Bogs and acidic fens	6	65	56	86
Calcareous fens	11	260	23	9
Cliff/outcrops	1	30	66	220
Dec. of mixed woodlands	3	34	21	62
Floodplain forest and woodland	10	146	16	11
Marsh and meadow	4	40	8	20
Palustrine Forest and woodland	33	384	47	12
Pond and lake	6	75	18	24
Ridgetop/rocky summit	11	97	28	29
River and stream	7	110	20	18
Sandplain	7	162	4	3
Serpentine barrens	2	54	3	6
Terrest. Conifer forest	7	37	10	27
Terrest. Decid. Forest	18	132	71	54
Terrest. Mixed forest	8	81	2	3
Tidal	8	65	40	62

* These goals represent the rarity and distribution goal for each association type multiplied by the number of associations in the community group.

From these data there are several clear trends that reflect the composition of the Heritage databases, the current state of the national classification, and their effect on achieving goals and conservation success in LNE-NP. Some general observations include:

- The inventory efforts of the Heritage Programs have been focused primarily on rare and small patch communities. There are abundance of occurrences for bogs, fens, and white cedar swamps, but few documented occurrences of palustrine and upland forests. TNC and Heritage Programs need to inventory and identify high quality occurrences of more common community types as these data are lacking.
- Many occurrences were eliminated during analysis because they were not considered viable or their viability was in question. 60% of the 1090 occurrences were not selected for the portfolio. Of these, 324 are classed as “maybe viable” and might be accepted into the portfolio pending additional information. The majority of occurrences (226) are for community associations underrepresented in the portfolio.
- Goals were set based on patch size and distribution. The goal for a small patch, restricted community was 30 for the whole ecoregion. Some of the rarest communities are well below their goal because there are in fact few occurrences for these communities. New goals should be set for these targets during the 2nd iteration.

- The National Vegetation Classification is well developed in some areas and only roughly sketched out in other areas. For example, there are 11 types of calcareous fens in the classification, but only 7 types of rivers and streams. There are 33 palustrine forests and woodlands, but only 4 marsh and meadow types.

PLANNING METHODS FOR ECOREGIONAL TARGETS: MATRIX-FORMING ECOSYSTEMS*

One of the goals of ecoregional planning is to identify viable examples of all types of ecosystems at appropriate scale to conserve their component species and processes. Natural terrestrial vegetation communities vary greatly in terms of their sizes and ecological specificity; some types cover large areas of varying topography, geology, and hydrology, while others occur only in small patches under very specific environmental conditions.

Matrix-forming (or dominant) ecosystems may extend over very large areas of 1000 to many millions of acres, often covering 80% or more of the undeveloped landscape. Matrix systems are generally forests in the Eastern United States; the terms *matrix forest*, *matrix community*, *matrix-forming community*, and *matrix site* are used interchangeably in the Northeast ecoregional plans. Matrix community types are often influenced by regional-scale disturbances such as hurricanes, insect outbreaks, or fire. They are important as "coarse filters"[1] for the conservation of most common species, wide-ranging fauna such as large herbivores, predators, and forest interior birds. The size and natural condition of the matrix forest allow for the maintenance of dynamic ecological processes and meet the breeding requirements of species associated with forest interior conditions. Nested within the matrix forests are the smaller *patch-forming ecosystems*,[2] with more specific ecological tolerances and often more restricted species.

Although differing in size and scale, matrix-forming systems were considered a special case of terrestrial ecosystem in the Northeast ecoregional plans. Most of the approaches and assumptions discussed under the terrestrial ecosystem chapter are directly applicable to matrix systems. However, the Natural Heritage Programs that provided the basis for identifying examples of patch-forming ecosystems had not, to date, developed a comprehensive method of identifying viable examples of the dominant forest communities that constitute the background "matrix" within which all other biodiversity is found.

Matrix forest assessment within ecoregional planning was developed in conjunction with the New England Natural Heritage programs to fulfill this need. The methodology has evolved significantly during the past several years, and has been applied to a broad range

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* Anderson, M.G. and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Matrix-forming ecosystems. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

The standard methodologies sections created for this and all Northeast ecoregional assessment reports were adapted from material originally written by team leaders and other scientists and analysts who served on ecoregional planning teams in the Northeast and Mid-Atlantic regions. The sections have been reviewed by several planners and scientists within the Conservancy. Team leaders included Mark Anderson, Henry Barbour, Andrew Beers, Steve Buttrick, Sara Davison, Jarel Hilton, Doug Samson, Elizabeth Thompson, Jim Thorne, and Robert Zaremba. Arlene Olivero was the primary author of freshwater aquatic methods. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

[1] The concept of coarse filter is discussed in the chapter on Terrestrial Ecosystems and Communities.
[2] Patch-forming ecosystems are discussed in the chapter on Terrestrial Ecosystems and Communities.

of ecoregions, from the Northern Appalachians where forests remain large, contiguous, and in good condition to the Chesapeake Bay Lowlands where forest remnants occur only in small areas and are in poor condition. The work to conserve the values of these formerly contiguous forested areas ranged from identifying areas within intact forests where old growth features can reemerge over time, to identifying areas for intensive restoration efforts to reclaim, reestablish and ensure the persistence of the matrix forest.

Most of the Northeast U.S. was cleared for agriculture or pasture in the mid to late 1800. As the region reforested, forests have been repeatedly logged for saw timber, pulp and firewood. Thus, although the matrix forest system is semi-contiguous across most of the Northeast ecoregions, the forests are young in age, have little structural diversity and lack important features such as large coarse woody debris or big standing snags. Moreover, they are densely crisscrossed with fragmenting features such as roads, powerlines, logging trails, housing developments, rural sprawl, agricultural lands, ski areas and mining operations. The Northeast's dominant tree species have lifespans ranging from a quarter to half a millennium. Historical effects of farming, pasturing and logging as well as current effects of climate change and pest/pathogen outbreaks suggest that they are unlikely to have reached any type of equilibrium state at this time.

Assessing viability criteria for matrix-forming forest ecosystems

To identify those areas where forest protection was most critical or where ecosystem restoration would most likely be successful it was necessary to develop clear *viability criteria* against which we could evaluate any given site's potential as a target for conservation activity.

In concept, a viable matrix forest ecosystem was defined as one that exhibits the qualities of *resistance* (e.g. the ability to dampen out small disturbances and prevent them from amplifying into large disturbances) and *resilience* (e.g. the ability to return to some previous level of productivity and structure following a catastrophic disturbance) leading to dynamic *persistence* over centuries. Additionally we required that the example of the forest ecosystem have a high probability of being a *source breeding habitat* for interior forest species (Anderson and Vickery, in press).

Matrix forests in the Northeast are large and dynamic ecosystems. Direct assessment of resistance and resilience requires a determination of the intactness of a forest's structure, biological legacies, composition and processes. As extensive ground-based inventory was beyond the scope of this work, we developed an estimate of viability based on three less direct but measurable characteristics:

- **Size**: based on the key factors of minimum dynamic area and species area requirements.
- **Condition:** based on the key factors of structural legacies, fragmenting features, and biotic composition.
- **Landscape context:** based on the key factors of edge-effect buffers, wide-ranging species, gradients, and structural retention.

After developing clear criteria for these three attributes we used a combination of expert interviews, GIS analysis, written descriptions and the study of aerial or satellite imagery to obtain the detail we needed to make a determination of viability. The criteria for each of the three factors are discussed below.

Size

The size of a contiguous forest example is particularly important with respect to the viability of matrix-forming ecosystems. To establish how large examples should be, two key factors were considered: the size and frequency of *natural disturbances* and the size of the habitat needed by selected *interior forest species* within the ecoregion in order to breed.

Natural disturbances and minimum dynamic area: Examples of matrix forest ecosystems should be large enough to withstand the full range of natural disturbances that influence the system. To estimate the critical area needed to ensure that an ecosystem could absorb, buffer, and recover from disturbance, we first listed the expected catastrophic disturbances typical of the ecoregion. In the Northeastern U.S., these disturbances include hurricanes, tornadoes, fires, ice storms, downbursts and insect/pathogen outbreaks. Sizes of these disturbances were established from historical records, vegetation studies, air photo analysis and expert opinion.

Numerically, most disturbances are small and frequent; however large, infrequent, catastrophic events have had the greatest impact on most of the present landscapes.[3] Thus, although Shugart and West (1981) suggested that minimum dynamic areas be scaled to the mean disturbance patch size, Baker (1992) emphasized that it should be scaled to the maximum disturbance size to account for the disproportional influence of catastrophic disturbances. Likewise, Peters et al. (1997) suggested scaling the minimum dynamic area to the largest disturbance event expected over a 500-1,000 year period.

Damage from catastrophic natural disturbances is typically dispersed across a landscape in a uneven way such that severe damage patches are embedded in a larger area of moderate or light damage. We focused on this pattern and determined the maximum size and extent of *severe damage patches* expected over a one century interval for each disturbance type (see examples in Table MAT1 and Figure MAT1).

Table MAT1. Comparison of characteristics among infrequent catastrophic disturbances in the Northern Appalachian Ecoregion (adapted from Foster et al. 1998)

Disturbance characteristic	Tornado	Hurricane	Down-bursts	Large Fires	Insect outbreak	Ice Storm	Flood
Duration	Minutes	Hours	Minutes	Weeks /months	Months	Days	Week /months
Return interval in years	100-300	60-200	?	400-6000	10	2	50-100
Maximum size of severe damage patches (acres)	5000	803	3400	57-150	?	<5	?

[3] Oliver and Stephens 1977, Turner and Dale 1998.

How much larger than the severe damage patch size should a particular ecosystem example be to remain adequately resilient? Presumably this is a function of disturbance return intervals, the condition of each example and the surrounding landscape context. Rather than develop a model for each specific place, we assumed that if we replicated the presettlement proportions of disturbed to undisturbed forests at a matrix scale, the example should be of adequate size to accommodate natural disturbance events. Information on historic vegetation patterns suggested that recently disturbed systems accounted for 11-35% of the landscape in New England. We used this information to develop a guideline that an individual instance of a matrix forest ecosystem should be about *four times* the size of the largest severe damage patch within the forest[4]. This estimate of the *minimum dynamic area*[5] should insure that over time each example will express a range of forest successional stages including recently disturbed areas, areas under recovery, mature and old-growth areas.

The upper half of Figure MAT1 below illustrates how we applied this logic to estimate the size of contiguous forested area needed to accommodate a variety of regional-scale disturbances. For example, based on historical records, hurricanes tend to create a mosaic of disturbance, with patches of severe damage ranging up to about 1000 contiguous acres. From this we estimate that an ecosystem example or a forest reserve would need to be at least four times that size, or 4000 acres, to remain viable with respect to hurricanes.

Breeding territories and area sensitive species: The size of matrix forests needed to support characteristic and area-sensitive species was determined by an assessment of the female breeding territory sizes of specific animals that utilize interior forest condition. In the Northeast, these species include many birds (broad-winged hawk, barred owl, neotropical warblers), mammals (pine marten), herptiles and insects.

In developing the methodology to estimate minimum area needs we compiled the mean female breeding territory for a variety of interior-forest dwelling birds and mammals in the ecoregion (Table MAT2 shows examples for birds in one ecoregion) using the generalization that these species typically establish and make use of mutually exclusive territories during the breeding season. Furthermore, to address the actual habitat size needed for a matrix forest to support a genetically diverse population, we multiplied the mean female home range by 25 to reflect the so-called "50/500" rule[6].

The 50/500 rule, which was developed for zoo population, suggests that at least 50 genetically-effective individuals are necessary to conserve genetic diversity within a metapopulation over several generations. We did not use this guideline to address needed population sizes but rather as a reasonable order-of-magnitude estimate of the *minimum area* required to ensure a genetically effective local population[7] embedded in a larger regional population. In using the guideline we assumed that all the available habitat within the ecosystem example was suitable for breeding, and that the occurrence was semi-isolated. The first assumption is not particularly realistic, but, again, we were not

[4] Anderson 1999, based on Foster and Boose 1992, Canham and Loucks 1984, and Lorimer 1977
[5] Pickett and Thompson 1978.
[6] Franklin 1980, Soule 1980
[7] Lande 1988, Meffe and Carroll 1994

advocating for an actual population size of 50 individuals, we were approximating the absolute minimal area needed to accommodate 25 breeding females.

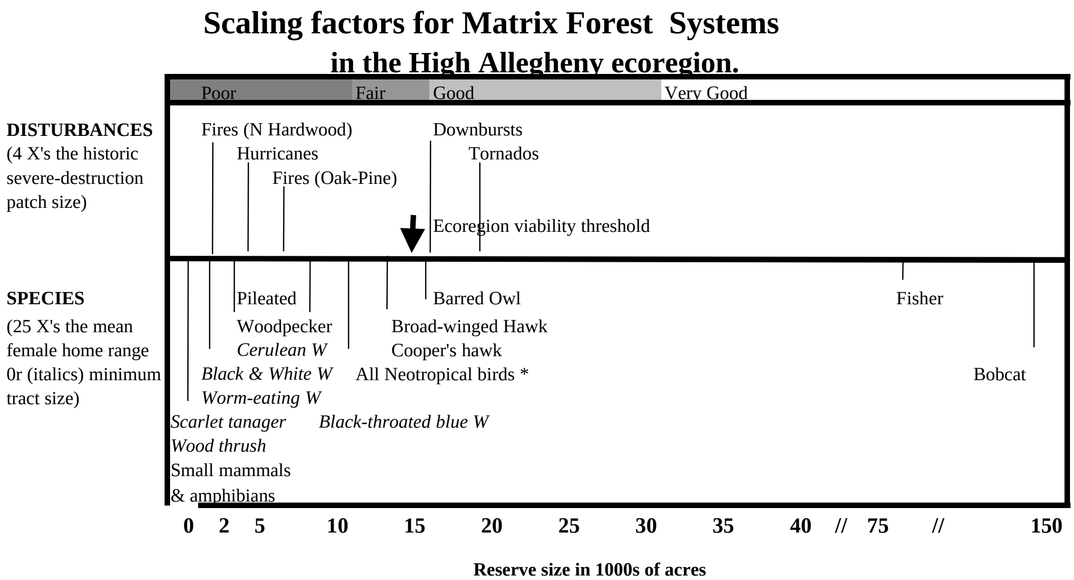
Table MAT2. Example of nesting territory sizes for some deciduous tree nesting birds in Lower New England. The literature-derived mean for 25-female breeding territory in shown in column 2. (See complete table with references at end of chapter.)

SPECIES	Acres x 25	Mean Territory (acres)
Broad-winged hawk	14225	569
Cooper's Hawk	12500	500
Northern Goshawk	10500	420
Eastern Wood-Pewee	300	12
Yellow-throated Vireo	185	7.4
Philadelphia Vireo	87.5	3.5
Warbling Vireo	82.5	3.3
Baltimore Oriole	75	3
Cerulean Warbler	65	2.6
Blue-gray Gnatcatcher	42.5	1.7

Many species avoid small patches of forest for breeding even if the patch size is theoretically large enough to accommodate many female territories. Thus, as the full table indicates, we also investigated the literature to identify any species for which *minimum area requirements* have been identified. For species with such requirements we used the larger of the two area requirements (25 female territories or minimum area requirements) for our critical size estimates.

Combining size factors: After developing a list of characteristic breeding species and deriving an estimate of area requirements, we plotted the area needs of the more space-demanding species against the minimum dynamic area estimate derived from the disturbance scales. The lower half of Figure MAT1 indicates, for one sample ecoregion, how large a matrix site should be to expect multiple breeding populations of interior forest species, while the upper half indicates minimum dynamic area.

As the size of a matrix forest increases, it has a higher probability of viability as defined above. For each ecoregion, an acceptable size threshold was set by the ecology team to serve as the criterion for evaluating potential matrix forest systems (shown as a dark black arrow – 15,000 acres in Figure MAT1). Presumably an occurrence size above the threshold is likely to accommodate all the disturbance and species to the left of the arrow but be vulnerable to factors shown to the right of the arrow. In the High Allegheny example an occurrence size of 30,000 acres has a higher probability of accommodating all factors than our minimum threshold of 15,000 acres.



Factors to the left of the arrow should be encompassed by a 15,000 acre reserve
*Neotropical species richness point based on Robbins et al. 1989, and Askins, see text for full explanation]

Figure MAT1. Scaling factors for matrix forest systems in the High Allegheny Ecoregion. Note: Fisher and bobcat are included in the figure for context; they were not considered to be interior-forest-requiring species.

Current condition

In describing and evaluating the condition of an ecosystem, ecologists often group the ecosystem's characteristics into structure, composition, and processes: *Structure* is the physical arrangement of various live and dead pieces of an ecosystem. Examples of structure include standing trees, snags, fallen logs, multilayered canopy, soil development. C*omposition* is the complex web of species, including soil microorganisms, arthropods, insects, spiders, fungi, lichens, mosses, herbs, shrubs, trees, herptiles, breeding birds, and mammals. Internal *Processes* are the dynamic activities performed by species such as energy capture, biomass production, nutrient storage and recycling, energy flows, and disturbance responses. (External processes are considered under "landscape context.")

Identifying reliable indicators of ecosystem "health" is still in its early stages.[8] Symptoms of stress on a community include changes in species diversity, poor development of structure, nutrient cycling, productivity, size of the dominant species, and a shift in species dominance to opportunistic short-lived forms.[9] Viability is affected by human activity, such as fragmentation, alteration of natural disturbance processes, introduction of exotic species, selective species removal, and acid deposition. Many of these symptoms are subtle and hard to detect, particularly in the absence of good benchmarks or reference examples. Our criteria for current condition revolved around three ecological

[8] Odum 1985, Waring 1985, Rapport 1989, Ritters et al. 1992.
[9] Rapport et al. 1985

factors: *fragmenting features*, *ecosystem structure and biological legacies*, and *exotic or keystone species*.

Fragmenting features: Fragmentation changes an ecosystem radically by reducing total habitat area and effectively creating physical barriers to plant and animal dispersal. Highways, dirt roads, powerlines, railroads, trails — each can fragment an ecosystem. Most have detrimental effects on at least some species and populations. Road kill is familiar to most people. In the U.S., one million vertebrates per day are killed by direct vehicle collision. Less obvious, perhaps, are the cumulative effects of fragmenting features for certain species. Species that are naturally rare, reproduce slowly, have large home ranges, depend on patchily distributed resources, or in which individuals remain with their parent populations are disproportionately affected by fragmentation.[10]

A critical factor in measuring fragmentation is the judgment of which features and at what density reduce the integrity of the system to an unacceptable degree.[11] We focused particularly on roads, which became an integral part of locating examples (see below).

In forested regions, the degree to which a road acts as a selective barrier to species is a function of its width, surface material (contrast), traffic volume, and connectivity, and also of the size, mobility, and behavior of the species in question.[12] Beetles and adult spiders avoid 2-lane roads and rarely cross narrow, unpaved roads.[13] Chipmunk, red squirrel, meadow vole, and white-footed mouse traverse small roads but rarely venture across 15-30 m roadways.[14] Amphibians may also exhibit reduced movement across roads.[15] Mid-size mammals such as skunks, woodchuck, raccoon and eastern gray squirrel will traverse roads up to 30 m wide but rarely ones over 100 m.[16] Larger ungulates and bears will cross most roads depending on traffic volume, but movement across roads is lower than within the adjacent habitat and many species tend to avoid roaded areas.[17] A variety of nesting birds tend to avoid the vicinity of roads.[18]

Roads also serve to reduce the core area of an ecosystem by making it more accessible. Small, rarely driven, dirt roads are used for movement by ground predators, herbivores, bats, and birds (especially crows and jays[19]). Open roadside areas are well-documented channels for certain (often exotic) plants and small mammals.[20] Roads allow access into the interior regions of a forested tract, and brings with it a decrease in forest interior area. For forest dwelling birds high road densities are associated with increased nest predation and parasitism,[21] increased resource competition and a decrease in adequate nesting sites.[22]

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[10] Forman 1995; Meffe and Carroll 1994
[11] Forman and Alexander 1998.
[12] Forman and Alexander 1998.
[13] Mader 1984, Mader et al. 1988.
[14] Oxley et al. 1974.
[15] Hodson 1966, van Gelder 1973, Langton 1989.
[16] Oxley et al. 1974.
[17] Klein 1971, Singer 1978, Rost and Bailey 1979, Singer and Doherty 1985, Curatolo and Murphy 1986, Brody and Pelton 1989.
[18] Ferris 1979, van der Zande et al. 1980, Reijnen et al. 1987.
[19] Forman 1995.
[20] Verkaar 1988, Wilcox and Murphy 1989, Panetta and Hopkins 1992, Huey 1941, Getz et al. 1978.
[21] Paton 1994, Hartley and Hunter 1997, Brittingham and Temple 1983.
[22] Burke and Nol 1998.

Roads are also source areas for noise, dust, chemical pollutants, salt, and sand. Traffic noise, in particular, may be primary cause of avoidance of roads by interior-breeding species.[23] Presumably, the conduit function of roads is not tightly associated with road size as larger roads tend to have more "roadside" region that may be utilized like a small-unpaved road. Although powerlines share some of the same features as low use roads, the filter and barrier effects may be softened if they are allowed to obtain a shrub cover and the conduit effects appear to be reduced.[24]

Ecosystem structure and biological legacies: Forest structure refers to the physical arrangement of various live and dead pieces of an ecosystem, such as standing trees, snags, fallen logs, multilayered canopy, and soil aggregates. Because many of these features take centuries to develop and accumulate, they are often referred to as *biological legacies*. Emphasizing their role in ecosystem viability, Perry (1994) defines legacies as anything of biological origin that persists and through its persistence helps maintain ecosystems and landscapes on a given trajectory. In Northeastern forests, legacies also include a well-developed understory of moss, herbs and shrubs, and reservoirs of seeds, soil organic matter and nutrients, features that were widely decreased during the agricultural periods of the 1800s. The development of many of these "old-growth characteristics" may take considerably longer than the life span of a single cohort of trees.[25] Although there may be ways to speed up or augment the development of legacies[26] it is probably more economical and strategic to locate those ecosystem examples that have the longest historical continuity and focus reserve development around them whenever possible. As few current restoration efforts can guarantee success over multiple centuries, it was crucial to identify ecosystem examples that currently contain the greatest biological legacy.

Although not well studied in the Northeast, the presence and persistence of biological legacies has a large effect on the resistance and resilience of an ecosystem. For instance, moisture stored in big accumulations of large downed logs provides refuges for salamanders, fungi and other organisms during fires and droughts. Moreover, "young forests" that develop after natural disturbances often retain a large amount of the existing legacies in contrast to "managed forests" where many of the legacies are removed or destroyed.[27] Thus, although disturbance removes and transforms biomass, the residual legacies of organisms influence recovery and direct it back towards a previous state.[28] Some biological legacies may even function to increase particular disturbances that benefit the dominant species (e.g. fire-dependent systems).

Accumulating legacies and forest structure also have a large effect on the density and richness of associated species. Insects such as the ant-like litter beetles and epiphytic lichen are both more abundant and richer in species in New England old-growth forests.[29] Breeding bird densities are significantly higher in old growth hemlock hardwood forests

[23] Ferris 1979, van der Zande et al. 1980.
[24] Schreiber and Graves 1977, Chasko and Gates 1982, Gates 1991.
[25] Duffy and Meier 1992, Harmon et al 1986, Tyrrell and Crow 1994.
[26] Spies et al. 1991.
[27] Hansen et al 1991.
[28] Perry 1994.
[29] Chandler 1987, Selva 1996.

when contrasted with similar forest types managed for timber production.[30] Pelton (1996) has argued that many mammal and carnivore species in the East benefit from forest components such as tip-up mounds, snags, rotted tree cavities. Most of the above patterns were correlated with more abundant coarse woody debris, more developed bark textures and differences in snag size and density. Identifying examples of forest ecosystems that have intact structure and legacy features is important in insuring that the examples function as *source habitat* for many associate species.

Exotic or keystone species: The species composition of an entire ecosystem is a difficult thing to measure as it may consist of hundreds to thousands of species. Relative to all species in a forest system, vascular plant vegetation and vertebrates together probably account for less than 15% of the total biota.[31] The majority of species are the smaller but overwhelmingly more numerous types (invertebrates, fungi, and bacteria) that carry out critical ecosystem functions such as decomposition or nitrogen fixation.[32] Additionally, ecological lag-times, internal system dynamics and the temporally variable nature of ecosystems makes determining the "correct" composition of an ecosystem example an intractable problem (as does the lack of reference sites and an abundance of conflicting perspectives from opinionated ecologists!).

Consequently, we focused on certain individual species (harmful exotics or keystone species) whose presence or absence may signal, directly or indirectly, a disproportionately large effect on the viability of an ecosystem. Total loss of a dominant species or a keystone predator may have a large direct effect. The presence of exotic understory species or forest pathogens may indirectly suggest something about the human history of the site, and so help us to judge the likelihood of successful restoration outcomes.

Condition factors summarized: In summary, our criteria for viable forest condition were: low road density with few or no bisecting roads; large regions of core interior habitat with no obvious fragmenting feature; evidence of the presence of forest breeding species; regions of old growth forest; mixed age forests with large amounts of structure and legacies or forests with no agricultural history; no obvious loss of native dominants (other than chestnut); mid-sized or wide-ranging carnivores; composition not dominated by weedy or exotic species; no disproportional amount of damage by pathogens; minimal spraying or salvage cutting by current owners.

Our condition criteria were more descriptive than quantitative. We could evaluate some attributes like roads and known old-growth sites directly from spatial databases, but the complexities of how the features were distributed and the unevenness of their severity and size were difficult to reduce to a single measure. Most of the detailed information on structure came from state foresters, Natural Heritage ecologists, literature and other expert sources. These descriptions are now stored in text databases for reference. Finally, as we assessed hundreds of potential areas throughout the Northeast, we discovered much that we did not anticipate such as the presence of prisons, abandoned nuclear reactors, streams made sterile from nearby mine tailing, or hunt-club "zoos" with African

[30] Haney and Schaadt 1996.
[31] Steele and Welch 1973, Falinski 1986, Franklin 1993.
[32] Wilson 1987, Franklin 1993.

ungulates. We simply discussed these cases and made a judgment on their potential effects.

Landscape context

The general condition of the landscape surrounding a particular forest was relatively easy to determine from land cover and road density maps in combination with air photos and satellite imagery. More difficult to resolve were the potential effects of the patterns on the viability of the ecosystem. During the planning process we thought of landscape context mostly in reference to buffers against edge effects, evidence of disruption in ecological processes, possible isolation effects on island-like forest areas, and the position of the area relative to landform features. Some evidence in the literature points to isolated reserves that have lost species over time, but most of these refer to much smaller reserves than meet our size criteria. Large reserves that have lost species are, conversely, often in very good landscape settings. Until we have a better grasp of the long term implications of landscape settings, and until we better understand the need for buffers around and connections between ecosystems, we cannot make reliable judgments about landscape context. At the end of this chapter, we discuss new work that has begun on these thorny issues.

Planning teams evaluated and recorded information on the surrounding landscape context for all matrix communities. As a viability criterion, we generally considered areas embedded in much larger areas of forest to be more viable than those embedded in a sea of residential development and agriculture. However, use of this measure as a threshold was complicated by the fact that the matrix forests in many of the poorer landscape contexts currently serve as critical habitat for forest interior species and are often the best example of the forest ecosystem type as well. Thus, no area was rejected solely on the basis of its landscape context. Rather, this criterion was used to reject or accept some examples that were initially of questionable size and condition.

Viability factors summarized

Each ecoregion had somewhat different criteria based on disturbance patterns, species pools, forest types, and anthropogenic setting of the region. Based on the analysis and concepts discussed above the general guidelines for all ecoregions were as follows:

- **Size**: 10,000 – 25, 000 acre minimums
- **Current condition:** low road density, large regions of core interior habitat, large patches of old growth forest, large amounts of structure and legacies features or continuous forest history. Composition dominated by native non-weedy species, confirmed evidence of forest breeding species and mid-sized carnivores. Minimal spraying or salvage cutting by current managers.
- **Landscape context:** examples surrounded by continuous forest or natural cover or, if isolated amidst agriculture and residential development, area clearly meeting the size and condition criteria.

Locating examples of matrix-forming forests

With the matrix forest viability criteria established, the next step of the process was to comprehensively assess the ecoregion to identify and delineate forested areas that met our criteria with respect to size, condition and landscape context. Patch systems had been delineated in a standard way by the state Natural Heritage programs[33] but no 10,000 – 25,000 acre examples of any system types were contained in the current Natural Heritage databases. Thus, an independent assessment of large contiguous forested areas in the ecoregion was needed to determine where the viable matrix-forming forest examples were.

In recent years, a variety of methods have been developed to assess the location and condition of large unfragmented pieces of forest. These methods include delineating contiguous areas of forest on aerial photos, identifying forest signatures on satellite images / land cover maps, or using arbitrarily bounded polygons or "moving windows" in conjunction with road density.[34] Additionally, other conservation site selection projects have used watersheds, regular grids, or political jurisdictions as sampling and selection units for large areas.[35]

Matrix blocks

The surface area of each Northeast ecoregion is effectively tiled into smaller polygons by an extensive road network. The method we used to delineate matrix community examples built on the discrete polygons created by roads, which we referred to as *blocks*. Each block represented an area bounded on all sides by roads, transmission lines, or major shorelines (lake and river polygons) from USGS 1:100,000 vector data. All roads from class 1 (major interstates) to class 4 (local roads) and sometimes class 5 (logging roads) were used as boundaries (see Table MAT3). The blocks could have "dangling" roads within them as long as the inner roads did not connect to form a smaller block. Subsequently, we combined these road-bounded polygons with 30 meter land cover maps and delineated potential forest block areas as those blocks that met a certain size threshold and a certain percentage of forest cover as specified by the ecoregion matrix criteria (e.g., 25,000 acres and 98% natural cover for the Northern Appalachian ecoregion). These forested blocks of land were subsequently evaluated by experts during a series of state by state interviews.

Using road-bounded blocks to delineate matrix examples had practical advantages. They were based on easily accessible public data, which are updated regularly by various organizations. They were easy to register with remotely sensed data. Further, because blocks partition a landscape into boundaries and interior area, they have meaningful area and boundary attributes such as size, shape, and core area. Blocks can be hierarchically nested based on road class, or grouped into larger blocks for spatial analysis. Unlike watersheds, blocks include, rather than divide, peaks and ridges, allowing mountainous areas to be treated as whole units. Additionally, blocks are an effective census unit because they are easy to locate in the field and their locations are recognizable to most people. They are well correlated with parcel, zoning, census, and conservation site boundaries, placing appropriate emphasis on the impact that humans have on nature and biodiversity. Blocks can be used as *draft* conservation site boundaries for regional scale analysis. However, to actually implement conservation at a site, a detailed site

[33] See the chapter on Terrestrial Ecosystems and Communities methods.
[34] D. Capen, pers. com.
[35] Stoms et al. 1997.

conservation plan must be done to refine boundaries and define internal protection and management zones.

Table MAT3. Road and trail classes used in matrix forest delineation.

Class	Designation	Description
1	Primary route	Limited access highway.
2	Secondary route	Unlimited access highway.
3	Road or street	Secondary or connecting road.
4	Road or street	Local road, paved or unpaved. Includes minor, unpaved roads useable by ordinary cars and trucks.
5	4-wheel drive vehicle trail	Usually one-lane dirt trail, often called a fire road or logging road and may include abandoned railroad grade where the tracks have been removed.
6	Other trails and roads	Not part of the highway system and inaccessible to mainstream motor traffic, includes hiking trails.
20, 30, 50, 70	Other bounding features	Stream or shoreline, railroad, utility line, airport or miscellaneous

Data sources: Macon USA TIGER 94; GDT Major Roads from ESRI Maps and Data 1999.

The core idea behind the road-bounded block, however, was not their practicality but that roads have altered the landscape so dramatically that block boundaries and attributes provide a useful way of assessing the size and ecological importance of remaining contiguous areas of forest.[36] Roads subdivide an otherwise homogenous area into smaller areas. Their effect on the surrounding forest was discussed earlier under the topic of fragmenting features.

Blocks have some limitations for matrix forest delineation. Although they include lake and river polygons, which hold different attributes than land blocks, they do not work as well for aquatic elements as for terrestrial ones because they tend to dissect watersheds, and run parallel to streams. For this reason, we developed an equivalent census of watersheds using similar indices and attributes meaningful for aquatic elements.

Collecting expert information on the matrix blocks

Once all the potential forest blocks were identified using a GIS analysis of roads and forest cover, we gathered more information on the critical characteristics of each block in state-by-state expert interviews with Natural Heritage ecologists, Nature Conservancy staff, and state and federal foresters. The objective of the expert interview process was to refine the boundaries of the blocks using local knowledge, collect information on the types and condition of features occurring within the block boundaries, determine which blocks qualified as matrix examples, and rank them according to their potential as conservation areas.

During the expert meetings, a wide variety of supplemental paper maps, atlases, imagery, and reports were used. Every block larger than the size threshold was examined and the boundaries and interior roads assessed to determine the degree to which they should be

[36] Forman and Alexander 1998.

considered barriers. We discussed road width, traffic volume, surface composition, gates, and other aspects of roads that could be significant. Based on these assessments and field knowledge we accepted, split or aggregated blocks to form new block boundaries.

Experts added supplementary information on the dominant forest types, forest condition, forest composition, land use, forestry practices, hydrologic features, rare species, patch communities, presence of old growth forest, and forest diversity. Information was collected and stored in a systematic way for each block using a questionnaire. After discussing each proposed block, the group scored it on a 5-point scale as to whether it met the viability criteria. Blocks receiving a low score of 2 (“unlikely”) or 1 (“no”) were discarded from further analysis. Site boundaries for each block were revised as determined at the expert workshops and comments about each block were entered into a permanent database.

Representing forest blocks across all landscape types

Our goal was to identify and conserve forest ecosystems across all types of landscapes typical of the ecoregion. The expert interview process eliminated a large number of areas on the first cut, leaving a smaller subset of potential large forest blocks for detailed evaluation. In every ecoregion, however, the smaller subset was composed of heterogeneous sets of forest areas situated across a variety of landscapes. For example, some forest blocks encompassed mostly conifer forests on high-elevation, resistant granite mountains; others encompassed deciduous forests in lowland and valley settings underlain by rich calcareous and sedimentary soils. In some blocks the dominant forest types were similar, but one set of blocks might be situated so as to contain extensive steeply cut rivers, while another set occurred within a landscape of moist flats with low rolling hills. Thus, our next step was to determine the ecological characteristics of each potential forest area to evaluate which blocks could be considered interchangeable replicates of the same forested landscape and which blocks, or groups of blocks, were not interchangeable.

Ecoregion-wide representation is a critical part of the strategy of conserving forests in the face of severe region-wide threats such as climate change, acid deposition or suburban sprawl. Another reason for representing forests across all types of landscapes was to maximize the inclusion of various patch-forming communities or focal species within the blocks. In the previous examples the high-elevation, high-relief areas might be studded with acidic cliffs, alpine meadows, rocky summit ecosystems and Bicknell’s thrush populations while the lowland calcareous areas would tend to contain rich fens, floodplain forests, rivershore grasslands and rare freshwater mussels.

To assess the landscape diversity and ensure the protection of forest areas over ecological gradients we developed a comprehensive ecoregion-wide data layer or map of physical features that we termed *ecological land units* or ELUs. Development of ELUs is the subject of a separate chapter, Ecology of the Ecoregion, and details may be found there.[37] Briefly every 30 square meters of the ecoregion was classified[38] as to its topographic

[37] Incomplete as of July 2003.

[38] While the variables that we used are physical ones, the classes were based on biological considerations (e.g., tree distribution, for Elevation Zone).

position, its geology and its elevation zone (Table MAT4), identifying units such as "cliff on granite in the alpine zone" or "north facing sideslope on sedimentary rock at low elevations."

Table MAT4. Ecological Land Unit variables

ECOLOGICAL LAND UNITS: generalized example. An ELU is any combination of these three variables		
TOPOGRAPHY	GEOLOGY	ELEVATION ZONE
Cliff	Acidic sedimentary	Very Low (0-800')
Steep slope	Acidic shale	Low (800-1700')
Flat summit or ridgetop	Calcareous	Medium (1700-2500')
Slope crest	Moderately Calcareous	High (2500-4000')
Sideslope –N facing	Acidic granitic	Alpine (4000+'}
Sideslope – S facing	Intermediate or mafic	
Cove or footslope-N facing	Ultra mafic	
Cove or footslope–S facing	Deep fine-grained sediments	
Hilltop flat	Deep coarse-grained sediments	
Hill / gentle slope		
Valley bottom or gentle toeslope		
Dry flat		
Wet flat		
Flat at bottom of steep slope		
Stream		
River		
Lake or pond		

By overlaying the potential forest blocks on the ecological land unit data layer, and tabulating the area of each ELU, we summarized the types and amounts of physical features contained within each forest block. Subsequently we used standard quantitative classification, ordination, and cluster analysis programs (PCORD) to aggregate the forest matrix blocks into groups that shared a similar set of physical features. The resulting groups may be thought of as identifiable *forest-landscape combinations*. To continue the previous examples, one such group might be blocks that are composed of conifer spruce-fir forests on high-elevation, resistant granite mountains, while another group might be oak-hickory and rich mesic deciduous forests in lowland and valley settings underlain by sedimentary soils. Each forest-landscape combination, which we referred to as "ELU-groups," contained a set of blocks that were relatively interchangeable with respect to their dominant forest types and landscape or physical features. Based on this methodology each ecoregion had anywhere from five to twenty forest-landscape groups, depending on the range of forest types and physical features within the ecoregion. Additional tests using Natural Heritage element occurrences[39] indicated that many patch-

[39] An Element Occurrence, or EO, is a georeferenced occurrence of a plant, animal, or natural community contained in a Natural Heritage database.

forming ecosystems and focal species locations were highly correlated with the types and diversity of the ELUs. Thus, we assumed that the forest-landscape groups were a useful surrogate for the biodiversity contained within each matrix block.

	Example 1	**Example 2**
Identified forest block	conifer forest on high-elevation, resistant granite mountains	deciduous forest in lowland and valley setting underlain by rich calcareous and sedimentary soils
Associated patch-forming communities or focal species	acidic cliffs, alpine meadows, rocky summit ecosystems, Bicknell's thrush populations	rich fens, floodplain forests, rivershore grasslands, rare freshwater mussels
	ELU Group A	*ELU Group B*
Resulting forest-landscape group	Conifer spruce-fir forests on high-elevation, resistant granite mountains	Oak-hickory and rich mesic deciduous forests in lowland and valley settings underlain by sedimentary soils

Figure MAT2. Development of forest-landscape groups. These examples illustrate the result of analyzing and clustering forest blocks by physical features in order to represent all types of landscapes in the conservation portfolio.

Prioritizing and selecting matrix forest areas for the portfolio

The final step in the analysis of matrix forest areas was to individually evaluate each forest-landscape group and prioritize the set of forest sites within them for conservation. Recall that all blocks under consideration had passed the viability criteria, so the purpose of this final selection was to focus our initial conservation actions, rather than to eliminate non-viable examples.

A final workshop was held in which a group of core team members, TNC state directors, and local experts met to complete the task. Initially the members reviewed the forest-landscape groupings to ensure they captured the logical range of diversity within the ecoregion. Subsequently, within each forest-landscape group, participants prioritized the included blocks based on their *relative biodiversity values*, the *feasibility of protection* and the *urgency of action*.

After prioritizing the blocks within each group they were sorted into two tiers. Tier 1 blocks were identified as the best possible block or set of blocks to represent the forest-landscape group of which it was a member. Tier 2 blocks were less ideal but considered to be acceptable alternatives to the Tier 1 blocks. Experts used their judgment as to how many Tier 1 blocks were needed to represent each landscape group. If, for example, the blocks in a given group were in close proximity and very homogeneous in their ELU composition, then one Tier 1 block was often thought to be enough. On the other hand, if the blocks in a landscape group were geographically dispersed and less homogeneous in ELU composition, then the experts often recommended two or three Tier 1 blocks to represent that group.

The experts were provided with block reports[40] and comparison tables that summarized the features within each block, including comments from the previous expert review of

[40] Block reports are one- or two-page formatted documents that summarize all important descriptive and quantitative information about a matrix block. They are included on the ecoregional data distribution CDs

this block, miles of streams, dams and toxic release points, miles of roads, number and types of ground-surveyed patch ecosystems and rare species, acres of conservation lands, number of ownerships, types and numbers of ELUs, and acres/percents of various landcover classes. A 30 meter resolution satellite image was provided for each block. Maps showing features such as plant hardiness zones allowed the experts to investigate the spatial arrangement of the blocks and determine whether any one block was situated in a particularly important location or if two blocks complemented each other in a particularly useful way.

Overall, however, most of the Tier 1 blocks were identified because they were not only areas with the highest forest integrity but they were also full of embedded patch-forming ecosystems, aquatic features, and focal species populations that were likely to pass their respective viability criteria. Because conservation action would already be targeted for these places due to the clusters of patch features, the addition of a large forest target was a particularly effective way to concentrate biodiversity protection as well as ensure good landscape context for the smaller scale targets. In these cases the Tier 1 and Tier 2 distinctions were obvious but in other cases (parts of northern Maine, for example) in spite of all our collected information the set of alternative blocks all appeared roughly identical and the choice of the Tier 1 block was a somewhat arbitrary judgment.

The set of Tier 1 matrix blocks was our best estimate of the ideal set of matrix forest sites on which to focus conservation action. It is this "optimum" set that was selected for the first iteration of the portfolio. There are, however, a number of alternative solutions that would be very acceptable and the final, implemented, solution may differ from the optimal solution. The identification of Tier 2 blocks should allow us to be flexible but still scientifically rigorous in meeting the conservation mission of the Conservancy.

Numeric goals and total acreage

Our methodology required that we comprehensively assess every possible large scale, unroaded forested area. Unlike the patch-forming ecosystems and focal species work we did not set a quantitative numeric goal for matrix forest sites in the ecoregion. Rather, we assessed the entire region first for potentially viable forest areas, then for representation of landscape features and ecological diversity within those viable sites. Within each forest-landscape combination we prioritized all areas in the set and selected 1 to 4 Tier 1 blocks for inclusion in the portfolio based on the heterogeneity of the group.

Our minimum goal was to identify the number of forest blocks recommended by the team, with at least one block for each forest-landscape group. We set no maximum, but the largest number recommended for any group was 4; most were in the 1 to 2 range. For a few forest-landscape groups even the best forest block was of questionable size and condition. In those cases, our selection was identified as "the best site for restoration." In some plans these restoration sites were included with several caveats. In other plans they were omitted, leaving the issue to be addressed in subsequent updates of the plan.

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for all plans in which they were used. When block reports were not generated, expert teams were given tables containing similar data. See a sample block report page at the end of this chapter.

Assumptions and future needs

The set of forest matrix blocks identified in each ecoregional plan is intended as a minimum set that, if protected, will have a huge impact on biodiversity conservation. We do not know if it is enough. Several outstanding assumptions require further research.

All the plans assume that the current land cover status of the ecoregion remains the same, or becomes more forested. It was necessary to develop the plans relative to the current status of the ecoregion, but now that we have completed this first assessment we can begin to model threats and future change scenarios that will inform a broader strategy of forest protection.

Some TNC ecoregional plans have developed baseline percentages for each matrix system target, such as 10% of the existing cover. We examined these methodologies but did not find them suitable for the Northeast. One reason is that the existing cover is not representative of the historic cover. Diminishing and degrading ecosystems, such as red spruce forests in the Central Appalachians, are already just a fraction of their previous extent.

A second more theoretical issue in using percentages as a basis for goal setting is that the percentage figures are typically derived from species-area curves and island biogeography theory. We used this same body of research to examine isolated or fragmented *instances* of forest. *Ecoregions*, however, are both contiguous with each other and completely permeable. Thus, they do not meet the assumptions of being “island-like” in character.

As an alternative we approached the question of “how much is enough?” by breaking it into two parts: How large and contiguous does a single example have to be to be functional and contain multiple breeding populations of all associated species? And how many of these are needed to represent all the variations of landscape types across the ecoregion? By multiplying the size of the matrix blocks by the number of blocks, we obtained an estimate of the minimum land area needed for conservation. These summaries may also be done by individual forest types or for other groups of targets.

Northeastern ecologists think that we will have to take measure to ensure that these critical areas continue to reside within a larger forested landscape. To address this we have formed a working group, hosted a conference, and produced an initial literature summary document (Anderson et al. 2000) that begins to untangle these issues. In our current protection work we are beginning to identify protection zones along the model shown in Figure MAT3, such that, for example, high protection and land purchase (Gap status 1) is focused on core regions, somewhat lower protection status (Gap status 2) is developed for areas directly surrounding the cores, even lower protection status — forest easements (Gap status 3) — has been enacted on the surrounding landscape, which in turn is embedded in harvested land with forest certification (Gap status 4).

Connecting Area or Ecological Backdrop

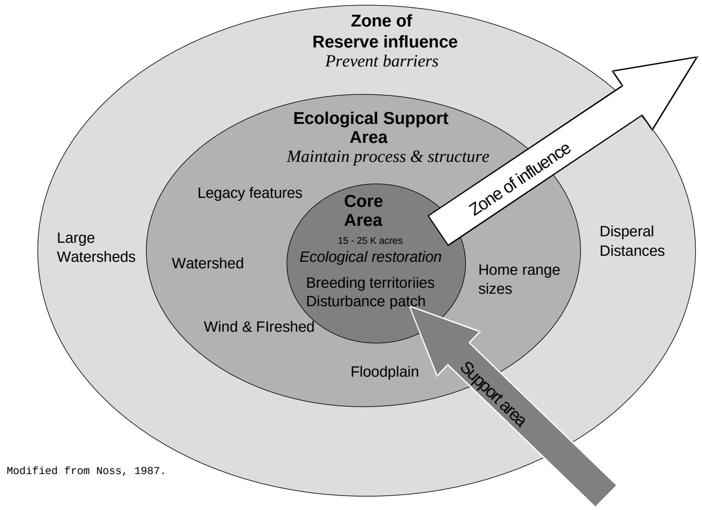


Figure MAT3. Model of protection zones, based on Noss (1987).

Table MAT2-Expanded. Example of nesting territory sizes for some deciduous tree nesting birds in Lower New England. The literature-derived mean for 25-female breeding territory is shown in column 2. Column 5 is Robbins et al. 1989 estimate of minimum area requirements (MAR). Columns 6 and 7 illustrate Partners-in-Flight (PIF) importance score for the species within the ecoregion.

SPECIES	Acres x 25	Mean territory (acres)	Mean Home Range	MAR acres	PIF 10 score	PIF 27 score	References
Broad-winged hawk	14225	569		0	3	4	.89miles between nests (569acres) Goodrich et al 1996, 1-2 square miles (Stokes)
Cooper's Hawk	12500	500	2718	0	3	2	densities 0.2 pairs/100 acres (Stewart & Robbins 58)// Little information on territoriality but minimum distance between nests is 0.7-1.0 km
Northern Goshawk	10500	420	5028	0		3	1-2 square miles (Stokes). // 170 ha surrounding the nest BNA =420 acres
Eastern Wood-Pewee	300	12		0	5	4	1.4-3.1: Fawver 1947, 2-6 (Stokes)// 2.2 ha Iowa, 7.7 ha in Wisconsin averages BNA =12.2 acres
Yellow-throated Vireo	185	7.4		0	3	2	3 males/100 acres in MD floodplain, 8/100 in riparian swamp, 19/100 in deciduous forest, (Stewart & Robbins 1958 //Populations are sparse and little competition evident but most activity occurs within 100 m of nest or 3 ha area. (BNA)
Philadelphia Vireo	87.5	3.5		0		2	0.3-0.8 ha Ontario, 0.5-4.0 NH. Overlap with red-eyed Vireo.
Warbling Vireo	82.5	3.3		0	2	3	10 males/100 acres in MD riparian and field, (Stewart & Robbins 1958)// 1.2 ha AZ, 1.45 ha CA, 1.2 IL, 1.2-1.5 Ontario, 1.5 ha Alberta =avg 1.34 ha=3.3 acres
Baltimore Oriole	75	3	1.6	0	4	5	3 acres (Stokes). //Varies with habitat quality, food availability, population density and time of breeding. Only nesting area defended (BNA)
Cerulean Warbler	65	2.6		1729	2		5 males per 50 acres in birch basswood forest (Van velzan) //Mean breeding territories 1.04 ha SD 0.16 BNA =2.6 acres
Blue-gray Gnatcatcher	42.5	1.7	9.8	91	4	1	7 pairs/100 acres in MD floodplain, (Stewart & Robbins 1958)// Mean territory size: 0.4 ha FL.1.8 ha CA, 0.7 ha VT, (=1.7 acres VT) Difference may reflect environment. Territory size decrease over season and adults tend to stay within 50 meters of nest.

MATRIX SITE: 26 **RANK:** Y

NAME: Merry Meeting Lakes **SUBSECTION:** 221Al Sebago-Ossipee Hills and Plains

STATE/S: NH

COMMENTS:

collected during potential matrix site meetings, Summer 1999

Old growth:	unknown; mature forest
Logging history:	less of an agricultural history here because higher elevation and rougher topography. 3rd and 4th growth or more.
Other comments:	invasives, two 10-15K blocks. Divided by rt. Kings Highway – local road, paved and canopy covered for large portions and just a little development.
Road density:	low (maybe moderate) mixed paved and gravel except the two larger. A number of class six trails. A number gated.
Unique features:	some neat geology; some mining. Some active low bush blueberry management on the peaks. Period burning. Ledges – ravens, turkey vultures, bobcat. Fairly uneven terrain.
Aquatic features:	headwaters of the cocheco River, number of lakes and ponds. Some of Merrymeeting marsh emergent wetland.
General comments/rank:	YES, great blue blocks.
Landscape assessment:	contiguous to south with a block NW and east chewed up.
Ownership/ management:	State F and W – 4,000, hunting and wildlife improvement cuts; Forest Society has 600+ - forest management, recreation and hunting. Large woodlot ownership.
Boundary:	
Cover class review:	0.93

Sample Block Report

Ecological features, EO's, Expected Communities:	Isotria, acidic pondshore communtiy, acidic rocky summit; spruce-fir in lowlands.Pinus strobus-Quercus-Fagus alliance

SIZE:

Total acreage of the matrix site:	**49,738**
Core acreage of the matrix site:	**39,015**

Total acreage of the matrix site:	49,738
Core acreage of the matrix site:	39,015
% Core acreage of the matrix site:	78
% Core acreage in natural cover:	98
% Core acreage in non- natural cover:	2

(Core acreage = > 200m from major road or airport and >100m from local roads, railroads and utility lines)

INTERNAL LAND BLOCKS OVER 5k: 42 %

Average acreage of land blocks within the matrix site:	1,333
Maximum acreage of any land block within the matrix site:	11,567
Total acreage of the matrix site that is part of 5000 + acre sized land blocks:	20,870
% of the total acreage of the matrix site that is made up of 5000 + acre sized land blocks:	42

Internal Land Block Size Distribution:

Acres	# Blocks
<100	12
100 - 500	9
500 - 1000	3
1000 - 2000	5
2000 - 5000	5
5000 - 10000	1
10000 - 15000	1
15000+	

MANAGED AREAS: 7 %

(Conservation and other Federal / State managed parcels > 500acres)

	# Parcels in block	Percent	Acres
Managed Area Total	17	7	3,564

15 Largest managed area parcels within site

	Name	Acres	Type
1	Jones Brook WMA	1,547	STA
2	Jennings Forest	358	PVT
3	Merrymeeting Marsh WMA	302	STA
4	Beaver Brook WMA	255	STA
5	Marks Memorial Forest	240	PVT
6	Seavey	236	STA
7	Eley	184	STA
8	UNH - Jones Property	156	STA
9	Powdermill Fish Hatchery	101	STA
10	Abbotts Grant - Farmington Town Forest	53	PVT
11	Middleton Park	50	MUN
12	Middleton Town Forest	31	MUN
13	New Durham Ballfield	20	MUN
14	Hoopes	14	STA
15	Milton Mills WMA	10	STA

LANDCOVER SUMMARY:

Natural Cover: 96 %

	Percent
Open Water:	4
Transitional Barren:	0
Deciduous Forest:	39
Evergreen Forest:	11
Mixed Forest:	34
Forested Wetland:	6
Emergent Herbaceous Wetland:	1
Deciduous shrubland:	0
Bare rock sand:	0
TOTAL:	96

Non-Natural Cover: 4 %

	Percent
Low Intensity Developed:	1
High Intensity Residential:	0
High Intensity Commercial/Industrial:	0
Quarries/Strip Mines/Gravel Pits:	0
Hay Pasture:	0
Row Crops:	3
Other Grass (lawns, city parks, golf courses):	0
Orchards, Vineyards, Tree Plantations:	0
Plantations:	0
TOTAL:	4

(Landcover summary based on total area of the matrix site)

ROADS, ETC.:

Miles / 1k acres: **2**

Internal Transportation Linework	Miles	Miles / 1,000 Acres
Major Roads (Class 1-3):	7	0
Local Roads (Class 4):	97	2
Railroads:	0	0
Utility Lines:	0	0
4-Wheel Drive Trails		
Foot Trails:		
Other (ski lift, permanent fence, airstrip)	0	0
TOTAL:	105	2

Boundary Linework

% Of site boundry which is made up of major roads:	32

Results for Matrix-Forming Ecosystems*

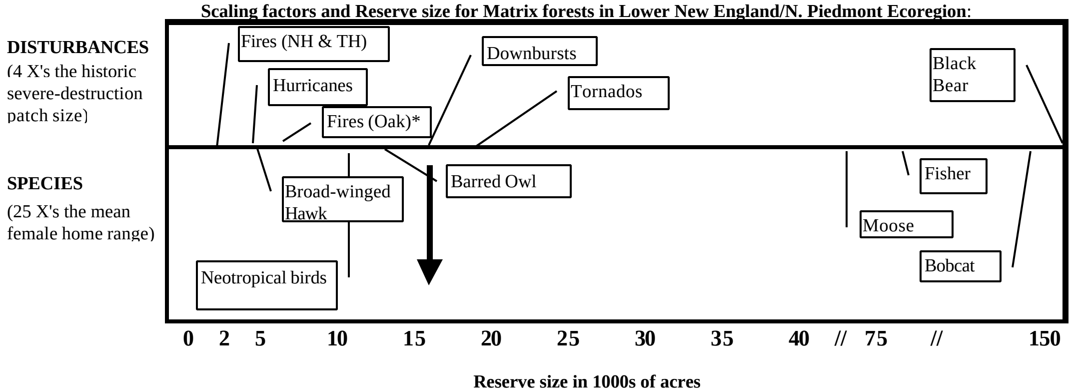
Modifications to Standard Method

Size criteria

For area-sensitive and breeding territory analyses of species, we developed a list of forest–interior dependent species typical of LNE-NP that included cavity-nesting, non migratory bird species such as Barred Owls *(Strix varia)* that prefer deep woods with large cavity trees and neotropical migratory species such as: Hairy Woodpecker *(Picoides villosus),* Broad-winged Hawk *(Buteo platypterus),* Eastern Wood-Peewee *(Contopus virens),* White-breasted Nuthatch *(Sitta carolinensis),* Veery *(Catharus fuscescens),* Wood Thrush *(Hylocichla mustelina),* Black-and-white Warbler *(Mniotilta varia),* Canada Warbler *(Wilsonia canadensis),* Northern Waterthrush *(Seiurus noveboracensis),* Black-throated Blue Warbler *(Dendroica caerulescens),* American Redstart *(Setophaga ruticilla),* Ovenbird *(Seiurus aurocapillus),* Scarlet Tanager *(Piranga olivacea),* and Yellow-throated Vireo (*Vireo flavifrons).* There were no mammals in this ecoregion that were completely dependent on interior forest although grey fox prefers dense forest with numerous logs for denning.

We adopted Robbins' (1989) 10,000 acres guideline assuming it takes 10,000 acres of road-bounded area to get a 7500 acre core area for retaining all neotropical bird species based partially on a recommendation from Bob Askins who had found similar patterns and results in southern Connecticut (Askins et al. 1987) a region he considered roughly similar to Robbins' study area with regard to forest cover (Askins pers. comm.). The resulting scaling factors and reserve sizes for LNE-NP are shown below:

Scaling factors and Reserve size for Matrix forests in Lower New England/N. Piedmont Ecoregion:



Factors to the left of the arrow should be encompassed by a 15,000 acre reserve NH = N. hardwoods (Maple-Beech-Birch)
TH = Transitional Hardwoods (Red oak-White Pine, Red Oak -Sugar Maple)
* Oak forests are dependent on relatively high-frequency, moderate fires, info on catastrophic fires is sketchy
Neotropical estimates based on Robbins et al. 1989. see text for full explanation.

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for matrix-forming ecosystems. Based on Barbour, H. 2001. Lower New England – Northern Piedmont Ecoregional Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Block development

Two sets of ecoblocks were developed for LNE-NP (Maps 10 and 11 - Major and minor road bounded blocks). The first set, “Major Road Bounded Blocks”, consisted of primary highways, primary roads, and secondary roads from TIGER 1994 1:100k, with an update of major road classes from GDT 1998. The second set, “Minor Transportation Feature bounded blocks”, were similar but also included local roads, utility lines, and major streams and shorelines from Macon USA TIGER 1994 1:100K. A description of the transportation features bounding blocks is shown in table 9. The size distribution of the blocks is shown in Table 10. The larger blocks were found primarily in the northern subregions of LNE. The Northern Piedmont contained no minor road bounded block > 10,000 acres.

Table 9. Block bounding feature types

1. Primary highway with limited access: Interstate highways and some toll highways. Distinguished by the presence of interchanges, access ramps, and opposing traffic lanes separated by a median strip.
2. Primary road without limited access: Nationally and regionally important highways that do not have limited access. Mostly US highways but may include some state and county highways that connect larger cities May be divided or undivided and have multilane or single lane characteristics.
3. Secondary and connecting road: Mostly state highways that connect smaller towns. Must be concrete or asphalt and are usually undivided with single-lane characteristics.
4. Local, neighborhood, and rural road: Used for local traffic and usually have a single lane or traffic in each direction. Includes paved and unpaved roads.
5. Waterbodies: Lakes and wide rivers.
6. Railroads
7. Major Utility Lines: Pipelines or Powerlines
8. Airport runways, permanent fences, ski lifts

Table 10. Distribution of road bounded blocks by size.

	Number of Blocks per size class					
	2.5-5K	5-10K	10-5K	25-50K	50-75K	>75K
Major Road bounded blocks (max = 150K)			397	110	34	75
Minor Road bounded blocks (max = 16K)	627	160	55	6	1	

A GIS analysis of size, landcover, road density and managed areas of the major road bounded blocks resulted in 295 potential matrix sites. Potential sites were identified using the following criteria:

For matrix forest occurrences in the Northeast LNE Plain, LNE Mountains and Highlands, Southern New England Plain (portions), and Hudson River subregions potential matrix sites are major road bounded blocks which meet one of the following criteria:

1. Contains >= one 10,000 acre local road bounded block
2. Area of block is >= 5,000 acres with >= 75% natural land cover **AND**
   a. Contains >= 20,000 acres of natural land cover **OR**
   b. Contains >= 80% natural land cover **and** >= one 2,000 acre local road bounded block **and** managed area >= 20% or >= 4,000 acres.

For matrix forest occurrences in the Southern New England Plains (portions), Reading Prong, and Northern Piedmont subregions potential matrix sites are all major road bounded blocks > 5,000 acres with > 55% natural land cover.

Different criteria were used due to the differing patterns of land use and lack of large major roaded bounded blocks in natural cover in the southern subregions of LNE-NP. The inclusion of potential matrix forest blocks of lesser size and condition, especially blocks whose size was increased by incorporating lands that are functionally separated by major roads, was cause for numerous theoretical discussions on viability and the need to maintain scientific rigor and functional landscapes through the planning process. Valid concerns were raised regarding whether we were ignoring our own scientific evidence for what constitutes a viable matrix forest occurrence. By doing so TNC has accepted into the portfolio occurrences that may not be viable. This issue was never fully resolved but it was generally decided that prudence favored the inclusion of small matrix forest occurrences with diminished condition where no alternative occurrences could be identified. The potential for these blocks to provide habitat for some interior forest species (e.g. neotropical migrant birds) and serve as “seed points” for forest restoration and expansion seemed to be a more prudent decision than discarding the occurrences entirely.

Block selection

Expert interviews resulted in 128 of the 295 blocks being ranked for further consideration as Yes, Maybe-Yes, or Maybe. Boundaries for these 128 blocks were revised as determined at the expert workshops and grouped within three dominant-forest types; Central, Transitional, and Northern Hardwoods (Map 13).

Eleven different Ecological Land Unit groups were defined (See Map14: Matrix Sites by ELU Group) and are listed below in Table 12.

Table 12. A description of the eleven ELU groups in LNE-NP

ELU Group	Description
1	Very low to low elevation landforms, acidic sedimentary with shale and calcareous features, little granite
2a	Very low elevation landforms, granitic/sandy outwash plain
2b	Very low elevation landforms, granitic/sandy outwash plain
3a	Very low elevation landforms, acidic sedimentary/granitic, northern piedmont
3b	Very low elevation landforms, acidic sedimentary/granitic, northern piedmont
4a	Low to very low elevation landforms, sedimentary with some calcareous and granitic features
4b	Low to very low elevation landforms, sedimentary with some calcareous and granitic features
5	Low to very low elevation landforms, granitic slopes, scattered sedimentary/ultramafic features
6a	Low to very low elevation landforms, sedimentary/granitic with little calcareous features
6b	Low to very low elevation landforms, sedimentary/granitic with little calcareous features
7a	Mid to low elevation landforms, sedimentary and granitic sites with minor calcareous features
7b	Mid to low elevation landforms, sedimentary and granitic sites with minor calcareous features
8	High to low landforms elevation, primarily mid elevation, sedimentary/granitic with high elevation patches
9	Diverse, very low to high elevation, sedimentary and calcareous features, little granite
10	Mid elevation landforms, shale and sedimentary, little granite
11	Outliers

Summary of Results

At the January, 2000 meeting 95 of the 128 matrix forest occurrences were selected for the portfolio. 25 occurrences were eliminated altogether based on new information regarding their size, condition, or landscape context. 43 of the 95 were chosen as Tier 1 occurrences for the portfolio and 52 were chosen as Tier 2 alternative matrix forest occurrences that will be held in reserve (Map 15). Where a Tier 1 occurrence is no longer deemed to be viable or its conservation feasible, an alternative matrix forest occurrence within the same ELU group may be substituted by the ecoregional planning team.

Two or more Tier 1 matrix forest occurrences were selected within each ELU group except in Group 10 where only one was chosen. At least two Tier 1 occurrences were selected in each subregion except the Reading Prong where no matrix forest occurrences were selected. An analysis of Tier 1 matrix forest occurrences designated as 10-year Action Sites (n = 25) reveals that two subregions are without any occurrences and the remainder are largely grouped into just two others (n = 21). Table 13 offers a breakdown of Tier 1 matrix forest occurrences and 10-year Action Sites by Subregion.

The 43 Tier 1 matrix forest occurrences selected nearly doubles the minimum conservation goal of 22. In part, this was necessary to capture the range of environmental variability present in the region. However, some Tier 1 matrix forest occurrences were selected because TNC already has a presence within the occurrence area, would like to have a presence in the occurrence area, or the occurrence is situated adjacent to another block selected as a Tier 1 preferred occurrence. Though these decisions are more programmatic in nature, it was the will of the matrix forest selection team to accept all of the proposed Tier 1 occurrences.

All 11 matrix-forming forest community types are presumed to be captured in Tier 1 occurrences, though a lack of information on these associations distribution and a lack of inventory to support this analysis make this analysis suspect and in need of additional work. The 11 matrix community types usually occur in mosaics with each other (usually 2 – 3 types in a given area), in various successional stages and are usually embedded with patch communities. These mosaics reflect stand variation due to environmental gradients, forest practices, historical land use, and disturbances. See Appendix 4, Matrix Forest Associations Captured within Tier 1 Matrix Forest Occurrences for a preliminary analysis.

Table 13. Tier 1 matrix forest occurrences and action site distribution by subregion.

Lower New England/Northern Piedmont Ecoregion					
Lower New England				Northern Piedmont	
Hudson River Subregion	**Mountains & highlands Subregion**	**Northeast LNE Plains Subregion**	**Southern New Engl. Plains Subregion**	**Reading Prong Subregion**	**Northern Piedmont Subregion**
Tier 1 Preferred Sites **4**	**18**	**7**	**14**	**0**	**3**
Tier 1 Action Sites **0**	**13**	**2**	**8**	**0**	**2**

Ecological Land Units

A total of 371 ecological land unit types were identified in LNE-NP. Tier 1 matrix forest occurrences capture 90% (n=335) of these while those identified as 10-year action sites protect 79% (n=294). The full portfolio captures 93% (n=344)of the ELU diversity in the region and the full portfolio of 10-year action sites conserves 84% (n=311) of the ELUs.

62% of LNE-NP consists of gently sloping to flat or dry flat ELU types (valley and coastal plain ELU types). Approximately eight percent of the total area covered by valley ELU types is within the portfolio and half of this area is within 10-year action sites. More than half of the valley ELU acreage in LNE-NP is in natural cover (54%). Approximately 6% of the total area in natural cover is captured in Tier 1 matrix forest occurrences. Two-thirds of this acreage is in 10-year action sites. A number of the valley ELU types are poorly represented in the LNE-NP portfolio, especially all of those on dry flats. A special effort should be made during the second Iteration to capture more of these ELU types.

16% of the region is on sideslopes, cliffs, and summits (rolling hill and low mountain ELU types). The Portfolio captures 20% of the montane ELU type acreage present in the region; nine percent is captured in 10-year Action Sites. Natural cover is present across 92% of the acres in these ELU types and a high percentage of these acres are captured in Portfolio and 10-year Action Sites.

There are 27 ELU types entirely missing from the portfolio. Collectively they comprise less than 6,000 acres (0.0003% of the ecoregion). Ultramafic (serpentine) deposits are characteristic of 11 types. Serpentine outcrop ELUs and communities may need to be added during the next iteration.

TNC portfolio sites and those proposed for conservation action are not distributed across ELU types proportionate to their area in the ecoregion. For instance, 26% of the region and 24% of the portfolio is made up of ELUs on dry sloping flats. By comparison, only 13% of the ecoregion is on sideslopes but they comprise 26% of the acreage in the portfolio. ELUs on dry flats comprise 36% of the ecoregion but only 21% of the portfolio. Furthermore, only 12% of the acreage on dry flat ELU types captured by the portfolio are in natural cover. A summary table of the Ecological Land Unit Gap Analysis is in Appendix 5.

PLANNING METHODS FOR ECOREGIONAL TARGETS: FRESHWATER AQUATIC ECOSYSTEMS AND NETWORKS[*]

Introduction

Freshwater biodiversity conservation is vital to The Nature Conservancy's mission of biodiversity conservation. Compelling documentation of the perils facing freshwater biodiversity indicate that many of the most endangered species groups in the U.S. are dependent on freshwater resources. Approximately 70% of freshwater mussels, 52% of crayfish, 42% of amphibians and 40% of freshwater fish are classified as vulnerable or higher with respect to extinction risks. Additionally, water itself is a critical resource to terrestrial species and ecosystems and its patterns of drainage and movement have shaped the larger landscape in the Northeast.

Freshwater rivers, streams, lakes and ponds are diverse and complex ecological systems. Their permanent biota is comprised of fish, amphibians, crayfish, mussels, worms, sponges, hydras, hydromorphic plants, mosses, algae, insects, diatoms and a large number of microscopic protists adapted to life in freshwater. As with terrestrial species the patterns of species distributions occur at many scales and correspond both broad climatic and historic factors as well as very local factors such as stream size and velocity, bottom substrate, water chemistry and dissolved oxygen concentrations.

The objective of the freshwater analysis was to identify the most intact and functional stream networks and aquatic lake/pond ecosystems in such a way as to represent the full variety of freshwater diversity present within an ecoregion.

Geographic Framework for Aquatic Assessments

Patterns of freshwater diversity corresponds most directly with major river systems and the large watershed areas they drain. These drainage basins cut across the TNC Ecoregions that were developed based on terrestrial processes. In order to assess freshwater systems we needed a separate stratification framework of regions and drainage basins that made ecological sense for aquatic biodiversity patterns. To this end, we adopted an existing national map of freshwater ecoregions developed by the World Wildlife Fund[1] after Maxwell's Fish Zoogeographic Subregions of North America.[2] Within each freshwater ecoregion, the Nature Conservancy's Freshwater Initiative developed a further stratification level of Ecological Drainage Units. The

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[*] Olivero, A.P. (author) and M.G. Anderson, and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Freshwater aquatic ecosystems and networks. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

The standard methodologies sections created for this and all Northeast ecoregional assessment reports were adapted from material originally written by team leaders and other scientists and analysts who served on ecoregional planning teams in the Northeast and Mid-Atlantic regions. The sections have been reviewed by several planners and scientists within the Conservancy. Team leaders included Mark Anderson, Henry Barbour, Andrew Beers, Steve Buttrick, Sara Davison, Jarel Hilton, Doug Samson, Elizabeth Thompson, Jim Thorne, and Robert Zaremba. Arlene Olivero was the primary author of freshwater aquatic methods. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

[1] Abell et al. 2000.

[2] Maxwell et al. 1995

Freshwater Ecoregions and Ecological Drainage Units together serves as an analog to the terrestrial ecoregions and subsections for the Northeast.

Zoogeographic Subregions/Freshwater Ecoregions: describe continental patterns of freshwater biodiversity on the scale of 100,000-200,000 sq. miles. These units are distinguished by patterns of native fish distribution that are a result of large-scale geoclimatic processes and evolutionary history.[3] For North America, we adopted the freshwater ecoregions developed by the World Wildlife Fund.[4] Examples include the St. Lawrence Subregion, North Atlantic to Long Island Sound Subregion, Chesapeake Bay Subregion, and South Atlantic Subregion.

Ecological Drainage Units (EDUs): delineate areas within a zoogeographic sub-region that correspond roughly with large watersheds ranging from 3,000–10,000 square miles. Ecological drainage units were developed by aggregating the watersheds of major tributaries (8 digit HUCs) that share a common zoogeographic history as well as local physiographic and climatic characteristics. These judgements were made by staff of TNC's Freshwater Initiative after considering USFS Fish Zoogeographic Subregions, USFS Ecoregions and Subsections, and major drainage divisions.[5] Ecological drainage units are likely to have a distinct set of freshwater assemblages and habitats[6] associated with them. Depending on the amount of ecological variation within them, some large river systems such as the Connecticut River were divided into more than one EDU.

Finer-Scale Classification of Aquatic Ecosystems and Networks

Within the geographic framework of the zoogeographic subregions and ecological drainage units there exits a large variety of stream and lake types. If you contrast equal sized streams, some develop deep confined channels in resistant bedrock and are primarily fed by overland flow while others are fed by groundwater and meander freely through valleys of deep surficial deposits. Variation in the biota also exists as the stream grows in size from small headwater streams to large deep rivers near the mouth. We needed a way to systematically describe and assess the many types of stream networks and aquatic features that was both ecologically meaningful and possible to create and evaluate in an 18 month time frame. For these purposes, and in conjunction with the Freshwater Initiative, we developed a multiple scale biophysical watershed and stream reach classification within Ecological Drainage Units. This classification framework is based on three key assumptions about patterns in freshwater biodiversity.[7]

- Aquatic communities exhibit distribution patterns that are predictable from the physical structure of aquatic ecosystems[8]
- Although aquatic habitats are continuous, we can make reasonable generalizations about discrete patterns in habitat use and boundaries distinguishing major transitions[9]
- By nesting small classification units (watersheds, stream reaches) within large climatic and physiographic zones (EDUS, Freshwater Ecoregions), we can account for community

[3] Maxwell et al. 1995
[4] Abell et al. 2000
[5] Higgens et al. 2002
[6] Bryer and Smith 2001
[7] Higgins et al. 1998
[8] Schlosser 1982; Tonn 1990; Hudson et al. 1992
[9] Vannote et al. 1980; Schlosser 1982; Hudson et al. 1992

diversity that is difficult to observe or measure (taxonomic, genetic, ecological, evolutionary context)[10]

Multiple-Scale Watershed Classification: Aquatic Ecological System Types: Watersheds contain networks of streams, lakes, and wetlands that occur together in similar geomorphologic patterns, are tied together by similar ecological processes or environmental gradients, and form a robust cohesive and distinguishable unit on a map. When a group of watersheds of similar size occur under similar climatic and zoographic conditions and share a similar set of physical features such as elevation zones, geology, landforms, gradients and drainage patterns they may be reasonably expected to contain similar biodiversity patterns patterns.[11] The following four primary physical classification variable were chosen for use in the watershed classification because they have been shown to strongly affect the form, function, and evolutionary potential of aquatic systems at watershed level scales.

Primary Classification Variables

1. Size: Stream size influences flow rate and velocity, channel morphology, and hydrologic flow regime.
2. Elevation Zones: Elevation zones corresponds to local variation in climate. Climatic differences are correlated with differences in forest type, types of organic input to rivers, stream temperature, flow regime, and some aquatic species distribution limits.
3. Geology: Bedrock and surficial geology influence flow regime through its effect on groundwater vs. surface water contribution, stability of flow, water chemistry, sedimentation and stream substrate composition, and stream morphology.
4. Gradient and Landform: Gradient and landform influence stream morphology (confined/meandering), flow velocity, and habitat types due to differences in soil type, soil accumulation, moisture, nutrients, and disturbance history across different landforms. For example, the morphology of streams differs substantially between mountains and lowland areas due to contrast in the degree of landform controls on stream meandering. Lower gradient streams also vary in substrate composition, as in New England, low gradient streams typically have sand, silt and clay substrates while high gradient streams typically have cobble, boulder, and rock substrates.

Stream size is among the most fundamental physical factors related to stream ecology. The *river continuum concept* provides a qualitative framework to describe how the physical size of the stream is related to river ecosystem changes along the longitudinal gradient between headwaters and mouth.[12] See Figure 1 at the end of this chapter for an illustration of the river continuum concept.

Stream size measures based on drainage area are highly correlated with other recognized measures of stream size such as stream order, the number of first order streams above a given segment, flow velocity, and channel. In the Northeast U.S., TNC used the following stream size

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[10] Frissell et al. 1986; Angermeier and Schlosser 1995

[11] Tonn 1990, Jackson and Harvey 1989, Hudson et al. 1992, Maxwell et al. 1995, Angermeier and Winston 1998, Pflieger 1989, Burnett et al. 1998,Van Sickle and Hughes 2000, Oswood et al 2000, Waite et al. 2000, Sandin and Johnson 2000, Rabeni and Doisy 2000, Marchant et al 2000, Feminella 2000, Gerritsen et al 2000, Hawkins and Vinson 2000, Johnson 2000, Pan et al 2000

[12] Vannote et al. 1980

classes: size 1) headwaters to small streams with 0-30 sq. mi. drainage areas, size 2) medium streams with 30-200 sq. mi. drainage areas, size 3) large mid-reach streams and small rivers with 200-1000 sq. mi. drainage areas; and size 4) very large river systems with > 1000 sq. mi. drainage areas. For different landscapes and regions, ecologically significant class breaks in stream size can differ, but relationships between stream size and potential river reach ecosystems appear to hold. For example relationships between stream size, stream order, and reach level community types in the Northeast are as follows:

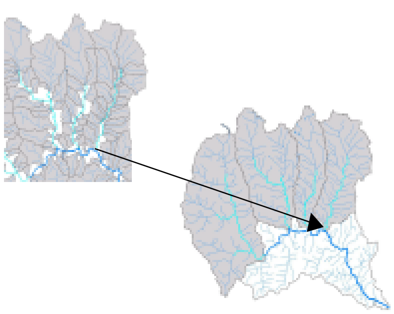
Table 1: Generalized Stream Size and Community Relationships

STREAM SIZE	STREAM ORDER	Stream reach level community occurrence
1	1-2	Rocky headwater
1(2)	1-3	Marshy headwater
2,3	3-4	Confined river
3,4	4+	Unconfined river

See the Appendix at the end of this chapter for more detailed descriptions of potential biological assemblages of fish, macroinvertebrates, and plants associated with specific types of the above generalized stream community types in Vermont.

Watersheds of streams in the four size classes were used as system classification units. These units serve as "coarse filters" to represent the species, ecological processes, and evolutionary environments typical of that size stream network or watershed. Watersheds are defined as the total area draining to a particular river segment. Watersheds themselves are a physically defined unit, bounded by ridges or hilltops. We derived a set of watersheds in GIS for each river segment. The individual reach watersheds were then agglomerated into larger watershed sampling units. Watersheds were agglomerated above the point where a stream of a given size class flowed into a stream of a larger size class. The resultant watersheds represented the direct drainage area for each river in a size class. The agglomerated watersheds were used as sampling units in the further size 1, size 2, size 3, and size 4 system classification.

Example of how size 1 watersheds are agglomerated into size 2 watersheds at the point where a size 2 river merges into a size 3 river.



Watersheds were grouped into similar aquatic system groups within each size class according to the physical characteristics of bedrock and surficial geology, elevation, and landform within the watershed. A statistical analysis of the elevation, geology, and landform landscape characteristics within each watershed was performed by sampling the Ecological Land Units (ELUs) within watersheds. The ELU dataset classifies each 90m cell in the landscape according to its elevation zone, bedrock and surficial geology, and landform. Elevation zones were based on the general distribution of dominant forest types in the region, as this climax vegetation provides a proxy for the climatic variation across the region. The bedrock and surficial geology classes were based on an analysis of the ecological properties of bedrock and soils in terms of chemistry, sediment texture, and resistance.[13] The bedrock included acidic sedimentary and metasedimentary rock, acidic granitic, mafic/intermediate granitic, acidic shale, calcareous, moderately calcareous, and ultramafic bedrock. The surficial types included coarse or fine surficial sediment. The landform model was developed by M. Anderson according to how terrestrial communities were distributed in the landscape. The landform model had 6 primary units (steep slopes and cliffs, upper slopes, side slopes and coves, gently sloping flats, flats, and hydrologic features) that differentiate further into 17 total landform units. Landforms control much of the distribution of soils and vegetation types in a landscape as each different landform creates a slightly different environmental setting in terms of the gradient, amount of moisture, available nutrients, and thermal radiation. The results of the statistical cluster analysis (TWINSPAN), was adjusted by hand, to yield a final set of watershed aquatic ecological system types which were used as the coarse filter aquatic targets.[14]

Figures 2 and 3 below show an example landscape with superimposed ELUs, watersheds, and derived watershed system types. The Moosup and Pachaug watersheds are imbedded in a very similar landscape dominated by acidic granitic bedrock, low elevation flats and gentle hills, large areas of wet flats and coarse grained sediment flats along the rivers. The Westfield Middle Branch watershed is located in a very different landscape dominated by acidic sedimentary bedrock, gentle hills and sideslopes ranging from low to mid elevation, fewer areas of wet flats, more confined channels, and higher gradient streams. The Moosup and Pachaug would serve as interchangeable members of size 2 watershed system type 3, while the Westfield would represent a different size 2 watershed system type of 9. We would expect these systems to have different aquatic habitats and ecological potentials due to their different environmental setting.

[13] Anderson 1999
[14] For more information on the detailed GIS and statistical methods used to build the stream network, stream reach classification, and watershed classification, see Olivero 2003.

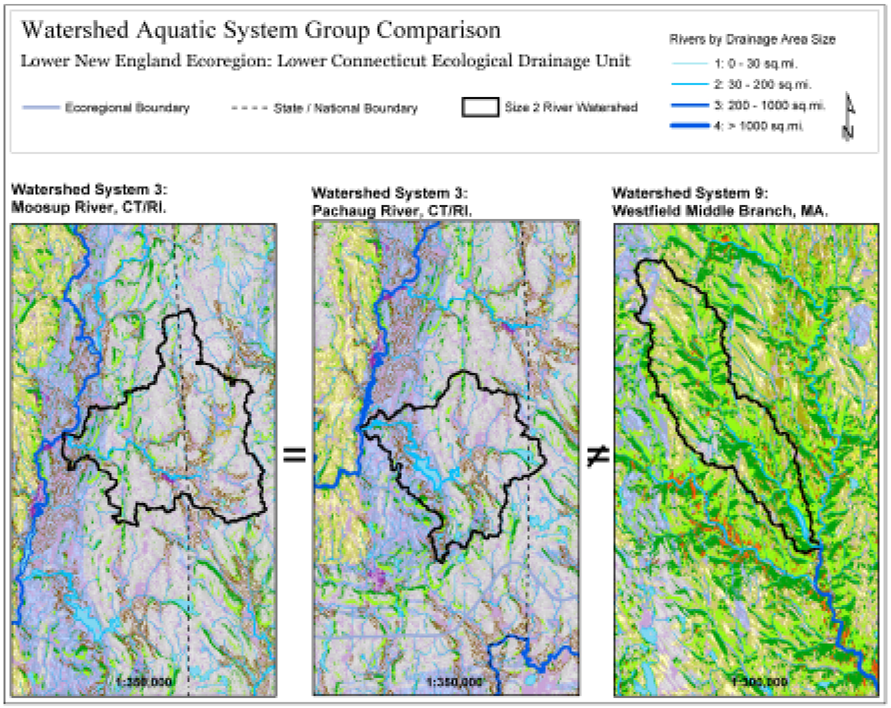


Figure 2: Watershed Aquatic System Group Comparison

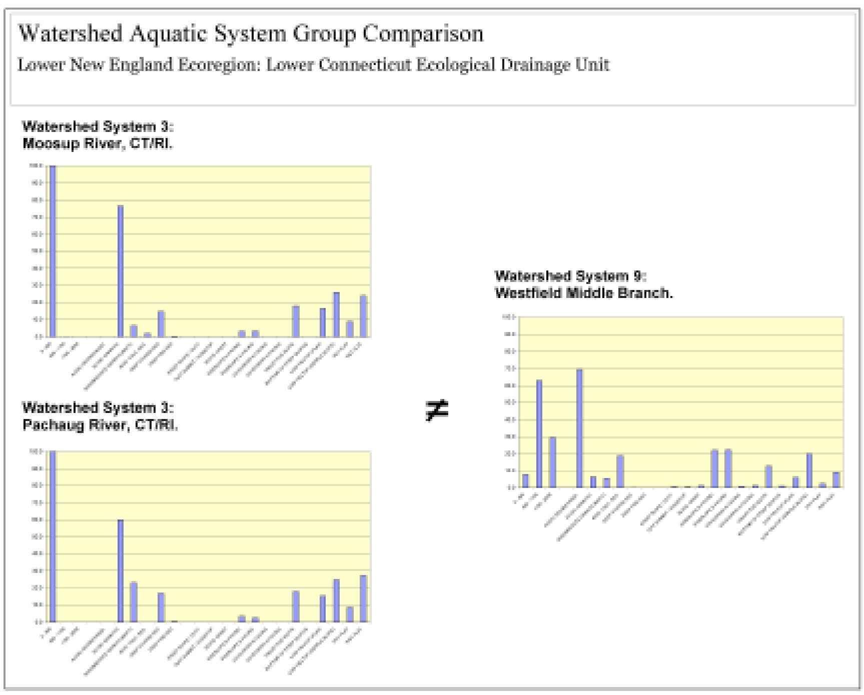


Figure 3: Watershed Aquatic System Component Summary

Stream Reach Classification: Macrohabitats A reach is defined as the individual segment of a river between confluences or as the shoreline of a lake. A stream reach classification was performed using physical variables known to structure aquatic communities at this scale and that can be modeled in a GIS. These variables include factors such as stream or lake size, gradient, general chemistry, flashiness, elevation, and local connectivity[15]. The physical character of macrohabitats and their biological composition are a product of both the immediate geological and topographical setting, as well as the transport of energy and nutrients through the systems. Macrohabitats represent potential different aquatic communities at the reach level and are useful on ecoregional and site conservation planning as a surrogate for biological aquatic communities at this scale

Table 2 : Macrohabitat Classification

Driving processes, modeled variables, GIS datasets, and modeled classes used to define Macrohabitats.[16]

Ecosystem Attribute	Modeled Variable	Spatial Data	Classes/Glass Breaks
Zoogeography	1) Region 2) Local Connectivity	1) Ecological Drainage Unit 2) Hydrography	1) Ecological Drainage Unit break 2) upstream and downstream connectivity to 1 = stream, 2=lake, 3=ocean
Morphology	1) Size (drainage area) 2) Gradient	Hydrography and DEM	1) 0-30 sq. mi., 30-200 sq. mi., 200-1000 sq. mi., > 1000 sq. mi. 2) 1=0-.5%, 2=.5-2%, 3=2-4%, 4=4-10%, 5=>10%
Hydrologic Regime	Stability/Flashiness and Source	Hydrography, Physiography, Geology	Stable or Flashy (complex rules based on stream size, bedrock, and surficial geology)
Temperature	Elevation	DEM	1=0-800ft 2=800-1700ft 3=1700-2500ft 4=2500ft+ [17]
Chemistry	Geology and Hydrologic Source	Geology	is cal-neutral for size 1-2's if > 40% calcareous; is cal-neutral for size 3-4's if 30% is calcareous

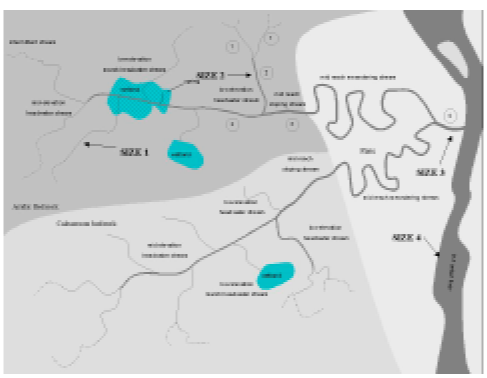


Figure 4: Anatomy of a Stream Network Macrohabitat Model

Selecting Aquatic Targets

The team selected both fine scale and coarse scale conservation targets. The aquatic fine-scale species targets such as rare and declining species (e.g. dwarf wedgemussel) are discussed in the section of this plan on Species Targets. In addition to rare and declining species, aquatic species

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[15] The macrohabitat model is based on work done by Seelbach et al. 1997, Higgins et al. 1998, and Missouri Gap Valley Segment Classification 2000.

[16] See the documentation on TNC Freshwater Initiative web site's science page (www.freshwaters.org) or the methods section of Olivero 2003 for more information on the GIS tools and scripts used to develop these attributes.

[17] Breaks from ecoregional ELU analysis

targets should also include consideration of regional-scale migratory fish (e.g., Atlantic salmon) whose life history needs extend beyond the boundaries of the planning area and who may face a unique set of threats (e.g. lack of fish passage at mainstem dams).

The focus of our coarse filter target selection was the watershed size 2 and size 3 level aquatic system classification. The size 2 and 3 watersheds were chosen as the coarse scale targets because 1) they represented an intermediate scale of river system which recent literature has emphasized as the scale where many processes critical to populations and communities occur,[18] 2) the size 1 watersheds and reach classification were well correlated with the larger scale size 2 and 3 watershed types, and 3) they provided management "units" around which TNC felt the core of a site conservation planning effort would operationally develop.

Setting Goals

Goals in ecoregional planning define the number and spatial distribution of on-the-ground occurrences of conservation targets that are needed to adequately conserve the target in an ecoregion. Setting goals for aquatics biophysical systems in ecoregional planning is a much less well developed process than setting goals for terrestrial communities because we have not yet defined the exact biological communities associated with each watershed ecosystem type.

In terrestrial settings, the minimum number of viable occurrences needed in the portfolio for each terrestrial community is related to the patch size and restrictedness of the target. The minimum number of occurrences needed is determined by the relative increase in probability of environmental or chance events reducing the ecological integrity of the target community. Because we have not developed biological community descriptions of our surrogate coarse filter watershed system targets, and as a result have not applied specific biologically based viability standards to these targets; the TNC team set conservative initial minimum goals.

Representation Goals

An initial minimum representation goal of one example of each size 2 and size 3 watershed type was set. It is unlikely one example is truly enough for all watershed ecosystem types, so the ecoregional team was allowed to use their professional judgement to add additional examples of system types into the portfolio given that 1) the team had strong feelings other examples were needed to represent the diversity within the system, 2) there were equally intact interchangeable units for which priority of one or the other could not be decided, or 3) if there were other compelling reasons to include more examples of a system type (i.e. additional very critical area for species level aquatic target; could create a good terrestrial/aquatic linkage; another example was needed to fill out regional connectivity network; active partners already working on the example and TNC could gain partnerships by expanding our work and including this example even if it wasn't the most intact example).

More specific abundance goals will have to be set in future iterations of the plan once the biological descriptions and distinctiveness between and within watershed types are more fully understood. Research should also be done to determine how the changes in number of examples of various size classes influences how many examples of each size class should be included in the portfolio.

[18] Fausch et al 2002

Connectivity Goals

Connectivity of aquatic ecological systems is based on the absence of physical barriers to migration or water flow. Connectivity is of critical importance for viable regional and intermediate-scale fish and community targets and for maintaining processes dependent on water volume and flooding. The regional scale connectivity goal was to provide at least one "focus network" of connected aquatic ecological systems from headwaters to large river mouth for each size 3 river type where a regional wide-ranging species was present. A secondary intermediate scale connectivity goal was to provide the best pattern of connectivity for intermediate-scale potadromous fish, intermediate scale communities, and processes. The goal for these intermediate scale targets was to provide at least one connected suite of headwaters to medium sized river. Again, here the focus was on functional connections at the mouth of a size 2 river and some functional connections from the size 2 to its size 1 tributaries.

Assessing Viability

Viability refers to the ability of a species to persist for many generations or an Aquatic Ecological System to persist over some specified time period. In aquatic ecosystems, viability is often evaluated in the literature by a related term "biotic integrity". Biotic integrity is defined as the ability of a community to support and maintain a balanced, integrated, adaptive community of organisms having species compositions, diversity, and functional organization comparable to that of a natural habitat of the region.[19]

A myriad of anthropogenic factors contribute to lower viability and biologic integrity of aquatic systems. Dams and other hydrologic alteration, water quality degradation from land use change, and introduced species all have well documented negative impacts on the structure and functioning of aquatic ecosystems. Dams alter the structure and ecosystem functioning by 1) creating barriers to upstream and downstream migration, 2) setting up a series of changes upstream and downstream from the impoundment including changes in flow, temperature, water clarity; and 3) severing terrestrial/aquatic linkages critical for maintaining the riparian and floodplain communities. The spread of human settlement has intensified agriculture, road building, timber harvest, draining of wetlands, removal of riparian vegetation, and released many harmful chemicals into the environment. This land use alteration has led aquatic habitats to become fragmented and degraded through increased sedimentation, flow and temperature regime alteration, eutrophication, and chemical contamination. Introduced nonindigenous species have also had negative impacts as they compete with indigenous species for food and habitat, reduce native populations by predation, transmit diseases or parasites, hybridize, and alter habitat. Introductions and expansions of nonindigenous species are causing an increasing threat to aquatic systems and are usually extremely difficult if not impossible to undo.

Quality Assessment

Assessing the viability and condition of the coarse scale watershed system targets presented a unique challenge. In the Northeast U.S., State level Index of Biotic Integrity ranks and datasets only exist in Pennsylvania and Maryland, and even these focus only on wadeable rivers. Although some water quality and biomonitoring data existed in various states, this information was not readily available or in a standardized comparable format across states. Viability thresholds for condition variables related to the biological functioning of aquatic ecosystems

[19] Moyle and Randal 1998

have also not been extensively researched and developed, with the exception of impervious surface thresholds. There was also limited time and funding to compile and analyze existing instream sample data and its relation to the intactness and functioning of aquatic ecosystems.

Given these challenges, a two phase approach was taken. First, available spatial data was used to perform a GIS condition screening analysis to rank all watersheds and individual stream segments according to landscape factors that previous research has shown are correlated with biological integrity of aquatic communities.[20] Second, this preliminary assessment was refined and expanded during a series of expert interviews conducted with scientists and resource managers across the planning region. Experts were asked to comment on the TNC aquatic classification, identify threats and local conditions that were not modeled in the GIS screening, and highlight location of best examples of high-quality aquatic sites in the ecoregion.

The GIS screening analysis was used as a surrogate, but standardized, method of evaluating current condition of the aquatic ecosystems. It used landscape variables such as percent developed land, road density, density of road/stream crossings, percent agriculture, dam density, dam storage capacity, drinking water supply density, and point source density. These variables were divided into three generally non-correlated impact categories 1) Land cover and Road Impact to represent changes in permeable surfaces and other threats from roads, urbanization, or agriculture; 2) Dam and Drinking Water Supply Impacts to represent changes in hydrologic regime and migration barriers from dams; and 3) Point Source Impact to represent potential point source chemical alteration threats.

Ordinations were run on a subset of variables in the Land cover and Road Impact, Dam and Drinking Water Supply Impact, and Point Source Impact categories to develop a rank for each size 2 watershed in each impact category. The ordination ranks were used to highlight the most intact watershed examples within each watershed system type. Three variables, percent developed land, percent agriculture land, and total road density per watershed area, were also used to develop a simplified overall “landscape context” rank for each size 2 watershed. See Table 3 for the landscape context component rank criteria. The overall Landscape Context watershed rank was determined by worst individual component category score.[21]

Table 3: Watershed Landscape Context Ranking

Landscape Context Rankings			
Rank	%Developed	% Agriculture	Road Density (mi.rd./sq.mi. watershed
1	<1%	<3%	<1
2	1-2%	3-6%	1-2.5
3	2-6%	6-10%	2.5-3.5
4	6-15%	>10%	>3.5
5	>15%		

At the aquatic expert interviews, experts at the state level were engaged for information on local conditions that could not be modeled in a GIS such as stocking, channelization, introduced

[20] Fitzhugh 2000
[21] For more information on the reach and watershed level condition variables and statistical ranking analysis, see Olivero 2003.

species, dam operation management techniques, and local water withdrawal. TNC field offices hosted a series of expert workshops to engage aquatic experts with land or resource management agencies, academic institutions, private consulting firms, and/or non-profit organizations based in the region. At these meetings experts provided input on previous work conducted by TNC such as the aquatic classification, GIS condition screening, and conservation planning approach. Experts were also specifically asked to delineate areas of aquatic biological significance on maps and provide descriptions of these areas by filling out a description form (see Appendix 2) on each area of aquatic biological significance.

Assembling the Portfolio

A portfolio assembly meeting was held with one or two representatives from each of the TNC state offices in the ecoregion. Prior to this meeting, each state had prioritized Size 2, 3, and 4 Aquatic Ecological System examples within their state for each watershed system group. Each office ranked occurrences based on the GIS screening analysis and expert information, such as best example of an intact system, presence of rare species, presence of native fish community, presence of excellent stream invertebrates, great condition, or free from exotics.

At the portfolio assembly meeting, field office representatives discussed and compared examples of given system groups that crossed state boundaries to select examples for the portfolio. The team was asked to identify the Portfolio Type Code categories for selected examples (Table 4 and 5). The team also identified the regional connected focus networks that would be part of the plan.

A considerable amount of professional judgement was exercised in assembling the conservation portfolio. In relatively intact landscapes where there were many high quality examples of each Aquatic Ecological System type, we included more than one instance of each watershed system in the conservation portfolio. In these cases, priorities for conservation action may depend on opportunity and imminence of threat. Conversely, in some degraded landscapes, there were few or no high quality examples of certain system types. In these areas, we recognize that restoration may be necessary to elevate the condition of systems included in the portfolio.

Table 4: Portfolio Type Code

PORT-S1c	Best available example of a stream/river system type and part of a regional or intermediate scale connected stream network
PORT-S1	Best available example of a stream/river system type but disjunct/not part of a focus connected stream network
PORT-S2c	Additional good example of a stream/river system type and part of a regional or intermediate scale focus connected stream network, but not the best example of its system type
PORT-S2	Additional good example of a stream/river system (often included the headwaters in all matrix sites) but disjunct from larger focus connected network
PORT-Sxc	Connector. Not an excellent or additional good best example of a stream/river system. It is considered as part of the portfolio as a connector segment in a focus connected stream network. These connectors usually are the lower mainstem reaches in a focus network that are highly altered but needed for connectivity. This connector occurrence is necessary to meet regional connectivity needs

Table 5: Confidence Code

1	High Confidence. We have high confidence that these expert recommended systems are both important and viable as aquatic conservation targets. Confidence 1 AESs often fall within the optimal condition analysis (% natural cover, road density, dams) as well.
2	Lower Confidence. These occurrences are only *conditionally* in the portfolio. Confidence 2 occurrences require more evaluation before we would take conservation action at these sites. They appear to be good aquatic conservation areas and appear to be necessary additions to the portfolio, but we need more information on these sites.

AQUATICS APPENDIX 0

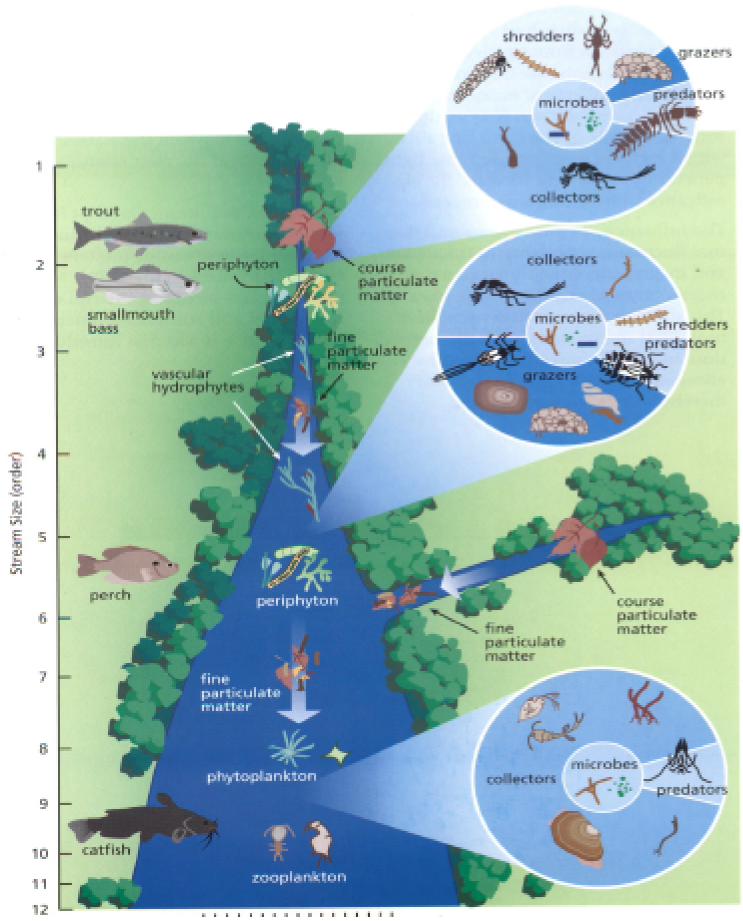

Figure 1: River Continuum in Size

AQUATICS APPENDIX 1

Proposed Aquatic Biota Relationship to Upper Connecticut and Middle Connecticut Ecological Drainage Units Aquatic Classification Units. Based primarily on Vermont Community Classification (Langdon et al 1998, St. Lawrence Ecoregional Aquatics Classification (Hunt 2002), and New York Community Classification (Reschke 1990). Compiled by Mark Anderson 3/2001.

TYPE	CHARACTERISTICS	ELU signature
SIZE 1 STREAM NETWORKS	**Riffles (50%) Pools (50%) Occur on all elevation/slope classes Cool – cold water, Headward erosion, Minimal deposition, Leaf shredders dominant**	**Size 1 Watershed, 0-30 sq. mi.**
A: SIZE 1, HIGH GRADIENT	Cold water over eroded bedrock, Energy source is terrestrial leaf litter, Shaded with 75-100% canopy cover, Mosses and Algae, few rooted plants. Substrate is boulder cobble gravel	Watershed dominated by slopes > 2% . Features: Sideslopes, steep slopes, cliffs, coves, gentle slopes
SIZE 1, HIGH GRADIENT, ACIDIC BEDROCK Plants: acid tolerant bryophytes, non vegetated areas Macroinverts: acid tolerant leaf shredders, low species diversity: Caddisflies (*Parapsyche, Palegapetus*)-Stoneflies (*Capniidae*)-Non-biting midges (*Eukiefferella*), Mayflies (*Eurylophella*).Other preferential taxa Caddisflies?(*Symphitpsyche*), Stoneflies (*Leuctridae, Taenionema, Chloroperlidae, Peltoperla*), Water strider (pools). Possible taxa Alder flies, Beetles (*Psephenidae*), Mollusca (*Elliptio*), Mayflies (*Heptagenidae*).		Watershed composed primarily of acidic bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ' Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak – pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700' elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800' elevation zone, Deciduous or Mixed
SIZE 1 HIGH GRADIENT CIRCUM-NEUTRAL BEDROCK Plants: circumneutral, *acid intolerant* bryophytes, non vegetated areas Macroinverts: circumneutral , *acid intolerant* leaf shredders: Mayflies (*Rithrogenia*)-Caddisflies (*Symphitopsyche?, Glossosoma*)-Flies (*Simulium, Antocha*) Stoneflies (*Peltoperla, Chloroperlidae, Malikrekus, Capniidae, Agnetina*), Beetles (*Oulimnius, Optioservus, Ectopria*), Non-biting midges (*Crictopus, Polypedilum*), Mayflies (*Ephemerella, Serratella*), Flies (*Hexatoma*), water striders (pools)		Watershed composed primarily of calcareous bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ' Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak – pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700' elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800' elevation zone, Deciduous or Mixed
B: SIZE 1, LOW GRADIENT (MARSHY) STREAMS	Cool to cold water small brook that flows through a flat marsh, fen, swamp or other wetland. Energy source is leaf litter, may be open or shaded. Substrate is clay-silt-sand dominated, Sand >silt/clay, cold, usu associated with springs, Complete canopy cover of dense veg, alder, willows, dogwood, cedar, marsh veg:	Watershed dominated by flats < 0-2 % Slopes Features: wet flats, valley bottoms, dry flats, marshes and bogs
SIZE 1, LOW GRADIENT, ACIDIC BEDROCK Plants Potamogeton sp, Brasenia schreberii, Vallisneria sp, Myriophylum sp Macroinvert Indicators: Mollusca (*Pisidium*)-Caddisflies (*Polycentropus*)-Mayflies (*Litobrancha*)-Dragon/damselflies (*Cordulegaster*)		Watershed composed primarily of acidic bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ' Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak – pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700' elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800' elevation zone, Deciduous or Mixed
SIZE 1, LOW GRADIENT , CIRCUMNEUTRAL BEDROCK Plants: Potamageton spp, Elodia, Nymphaea		Calc bedrock Slope 0-2%

	Macroinverts: Flies (*Tipula, Atherix, Simulum*)-Non-biting midges (*Apsectrotnypus, Rheocricotopus*)-Crustacae (*Hyallela*)-Mollusca (*Pisidium*)-Mayflies (*Stenonema*) (Vt type 7 (very low, in Champlain valley))	
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ' Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak –pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700' elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800' elevation zone, Deciduous or Mixed
SIZE 2 MIDREACH STREAM	**Riffles, Pools and Runs, Open or partial canopy, Algal shredders/scrapers usually well represented, low to very low elevations only. Generally slightly alkaline**	**Size 2 Watershed: 30-200 sq.mi.**
Sloping, confined channel, midreach stream in low mountains.	Riffles (33%), Runs (33%), Pools (33%) (VT macro type 3 and 4) Average 35%-45% canopy, Typically in mountainous areas Plants: emergents, macrophytes, algae and bryophytes Macroinvertebrates: Algae shredders and scrapers: (Vt type 3) mt areas: Stoneflies (*Chloroperlidae*)-Caddisflies (*Dolophilodes, Rhychophila*)-Flies (*Hexatoma*)-Beetles (*Oulimnius*) Generally poor mussel diversity, with acid tolerant species. Other preferential Taxa: Caddisflies (*Brachycentrus, Lepidostoma, Apatania, Symphitopsyche?, Polycentropus*), Beetles (*Promoresia, Optioservus*), Non-biting midges (*Eukiefferella, Tvetenia, Parachaetocladius, Micropsectra, Microtendipes, Polypedilum*), Mayflies (*Epeorus, Rhithrogena*), Dragon/damseflies (*Gomphidae*), Stoneflies (*Capniidae, Peltoperla, Leuctridae, Agnetina, Isogenoides*). Fish: Brook trout, Blacknose dace, Longnose dace, Creek chub, Longnose sucker, White sucker,	Slope >2 Or stream on slope-bottom flat Elev 800-1700'
Sloping, confined channel, midreach stream in very low valleys.	Riffles (33%), Runs (33%), Pools (33%) (VT macro type 3 and 4) Average 35%-45% canopy, Typically in lower reaches of small rivers, gen in lower valleys of major watersheds, Plants:emergents, macrophytes, alge and bryophytes. Macroinverts: (Vt type 4 lower valleys) Stoneflies (*Chloroperlidae*)-Caddisflies (Dolophilodes, Rhychophila)-Flies (*Hexatoma*)-Beetles (*Oulimnius*) Mayflies (*Isonychia*), Non-biting midges (*Polypedilum*), Beetles (*Dubiraphia, Promoresia*). Other possible taxa: Beetles (*Psephenidae*), Alder flies (*Corydalidae*), Dragon/damseflies (good diversity; *Calyopterygidae*), Mollusca (Elliptio, Pyganodon, Sphaerium, questionably Margaritifera), Mayflies (Ephemeridae), Crustacea (Cambaridae) (green stoneflies (Chloroperlidae), Dolophilodes, Hexatoma, Rhychophila, Oulimnius). Poor NYHP understanding of assemblage. (Promoresia, Neoperla, Chimarra, Stenelmis) Fish: transitional cold/warm species: Blacknose dace, Longnose dace, White sucker, Creek chub, Flathead minnow, Bluntnose minnow	Slope >2 Or stream on slope-bottom flat Elev 0-800'
Flat meandering midreach stream	Runs (50%), Pools (50%) (VT macrotype 6) Average 35% canopy, broader valleys with low slopes of large drainage areas Plants: Alders, willow along banks, Floodplain forest and other rivershore communities Macroinvertebrates: Beetles (*Dubiraphia*)-Non-biting midges (*Polypedilum*)-Mayflies (*Leptophelbidae*)-Mollusca (*Pisidium*)-Odonota (*Aeshinidae*) Broad winged damselflies *Calopterygidae*, Narrow winged damselflies *Coenagrionidae*, Clubtails	Slope 0-2% (wetflats) and not a slope bottom flat

			Gomphidae)-Caddisflies (*Hydaphylax, Dubiraphia, Polypedilum)* Fish, warmwater species, coldwater absent: Bluntnose minnow, Creek chub, Blacknose dace, Tessellated darter, White sucker.	
		Midreach stream entering large lakes	Need more information, Mollusca (*Potamilus, Lampsilis, Leptodea, Pyganodon, Sphaerium, Pisidium*)-Mayflies (*Hexagenia*)-Beetles (*Dubiraphia*)-Caddisflies (*Phylocentropus*)-Crustacea (*Gammarus*)-Non-biting midges (*Polypedilum*)-Flies (*Spheromias, Culicoides*) Fish 80 + warmwater species in Lake Champlain region	Under 150' elev???
LARGE, SIZE and SIZE 4 RIVERS				**Size 3: 200-1000 sq.mi.; Size 4: > 1000 sq.mi.+**
		Large main channel river	Each river and drainage basin should be treated separately Fish include American shad, Atlantic salmon, and other warmwater species	
SPECIAL SITUATIONS			Small patch situation that may not be predictable but are usually associated with one or several of the main types. For example backwater sloughs are primarily associated with 3-5 order meandering streams.	
			1: Seeps (treated through palustrine veg class)	
			2: Backwater slough (associated with 3-5 order meandering streams)	
			3: Lake outlet and inlet streams (need clarity from lake classification)	
			4: Subterranean stream (associated with limestone bedrock, EOs present)	
			5: Intermittent stream (associated with 1st order streams)	

AQUATICS APPENDIX 2

Specific Information on Nominated Areas of Aquatic Biological Significance

Expert Name(s):

____

Site Code:

____

(Please write your initials, date of description (mmddyy), and sequential letter for sites you describe). For example: **GS020802A** = (George Schuler - Feb. 8, 2002 – first site described)

Site Name:

____

Describe any current Conservation Work being done at this site:

____

____

Who is/are the lead contact person(s) for additional information about this site?

Name ___________________________

Agency/Address_________________________________

Email ______________________ Phone

____

Name ___________________________

Agency/Address_________________________________

Email ______________________ Phone

____

Biological description (e.g., native species assemblages, indicator or target species, unique biological features, important physical habitat, etc.):

____

____

____

Key Ecological Processes: (e.g., the dominant disturbance processes that influence the site such as seasonal flooding or drought, ice scouring, groundwater recharge, seasonal precipitation events, etc.)

____

____

____

Major stresses: Using the following list, rank the major stresses at this site:

- Habitat destruction or conversion
- B. Habitat fragmentation
- C. Habitat disturbance
- D. Altered biological composition/structure
- E. Nutrient loading
- F. Sedimentation
- G. Extraordinary predation/parasitism/disease
- H. Modification of water levels; changes in flow
- I. Thermal alteration
- J. Groundwater depletion
- K. Resource depletion
- L. Extraordinary competition for resources
- M. Toxins/contaminants
- N. Exotic species/invasives
- O. Other: ______________________________

Major sources of stress: Using the following list, circle up to 3 sources of stress at this site:

A. **Agricultural** (Incompatible crop production, livestock, or grazing practices)

B. **Forestry** (Incompatible forestry practices)

C. **Land Development** (Incompatible development)

D. **Water Management** (Dams, ditches, dikes, drainage or diversion systems, Channelization, Excessive groundwater withdrawal, Shoreline stabilization)

E. **Point Source Pollution** (Industrial discharge, Livestock feedlot, Incompatible wastewater treatment, Marina development, Landfill construction or operation)

F. **Resource Extraction** (Incompatible mining practices, Overfishing)

G. **Recreation** (Incompatible recreational use, Recreational vehicles)

H. **Land/Resource Management** (Incompatible management of/for certain species)

I. **Biological** (Parasites/pathogens, Invasive/alien species)

J. **Other:**

____

Further description of stresses or sources of stress:

____

____

<u>TNC RANKING - Site Description:</u>

Describe each site according to each of the three components of viability below (i.e., size, condition, landscape context). Once described, attach a status rating (i.e., Very Good,

Good, Fair, Poor) for each of the three components and provide written justification for your assessment.

Size: (e.g., describe the species and specific life history stages (if known) that use the site and any information about specific life history stages):

____

____

Condition: (e.g., describe aspects of biotic composition, local anthropogenic impacts, degree of invasive species, etc.):

____

____

Landscape (Waterscape?) Context: (e.g., describe the altered flow regime, connectivity with other aquatic habitats, watershed impacts, unique or notable physical features, landscape setting, etc):

____

____

Additional Comments not captured by this survey:

____

____

Aquatic Systems Results for Lower New England

Results for Aquatic Systems*

Classification Results

Geographic Framework for Aquatic Assessments

Zoogeographic Regions

The analysis area occurred within the North Atlantic World Wildlife Fund (WWF) North American Fish Ecoregion. The North Atlantic WWF Fish Ecoregion stretches from eastern Delaware to southern Nova Scotia and covers and area of 130,000 sq.miles. The northern portion is defined by the large watersheds of the St. Croix, Penobscot, Kennebec, Merrimack, and Connecticut, while the southern portion is dominated by the Delaware and Hudson. The North Atlantic region is distinguished by runs of anadromous fish such as Atlantic salmon, shad, and herring. Atlantic sturgeon and shortnose sturgeon also occur. Most of this ecoregion has been glaciated as recently as 10,000-15,000 which has prevented the development of endemic freshwater fauna except in the very southern extent of the region which was not glaciated (Abell et al. 2000).

Ecological Drainage Units (EDUs)

The analysis region covered 5 Ecological Drainage Units (EDUs) within the North Atlantic WWF Fish Ecoregion. The 5 EDUs covered an area of 28,190 sq.mi. and included the **Upper Connecticut**, **Middle Connecticut**, **Lower Connecticut**, **Saco/Merrimack/Charles**, and **Cape Cod** Ecological Drainage Units. EDUs in New England were qualitatively delineated by the TNC Freshwater Initiative program in 1999 using USFS Fish Zoogeographic Subregions, USFS Ecoregions and Subsections, and major drainage divisions (Bryer and Smith, 2001). The EDUs were defined by grouping 8-digit US Geological Survey Hydrologic Units watersheds into units that were thought to contain aquatic systems with similar patterns of physiography, drainage density, hydrologic characteristics, connectivity, and zoogeography (Bryer and Smith 2001).

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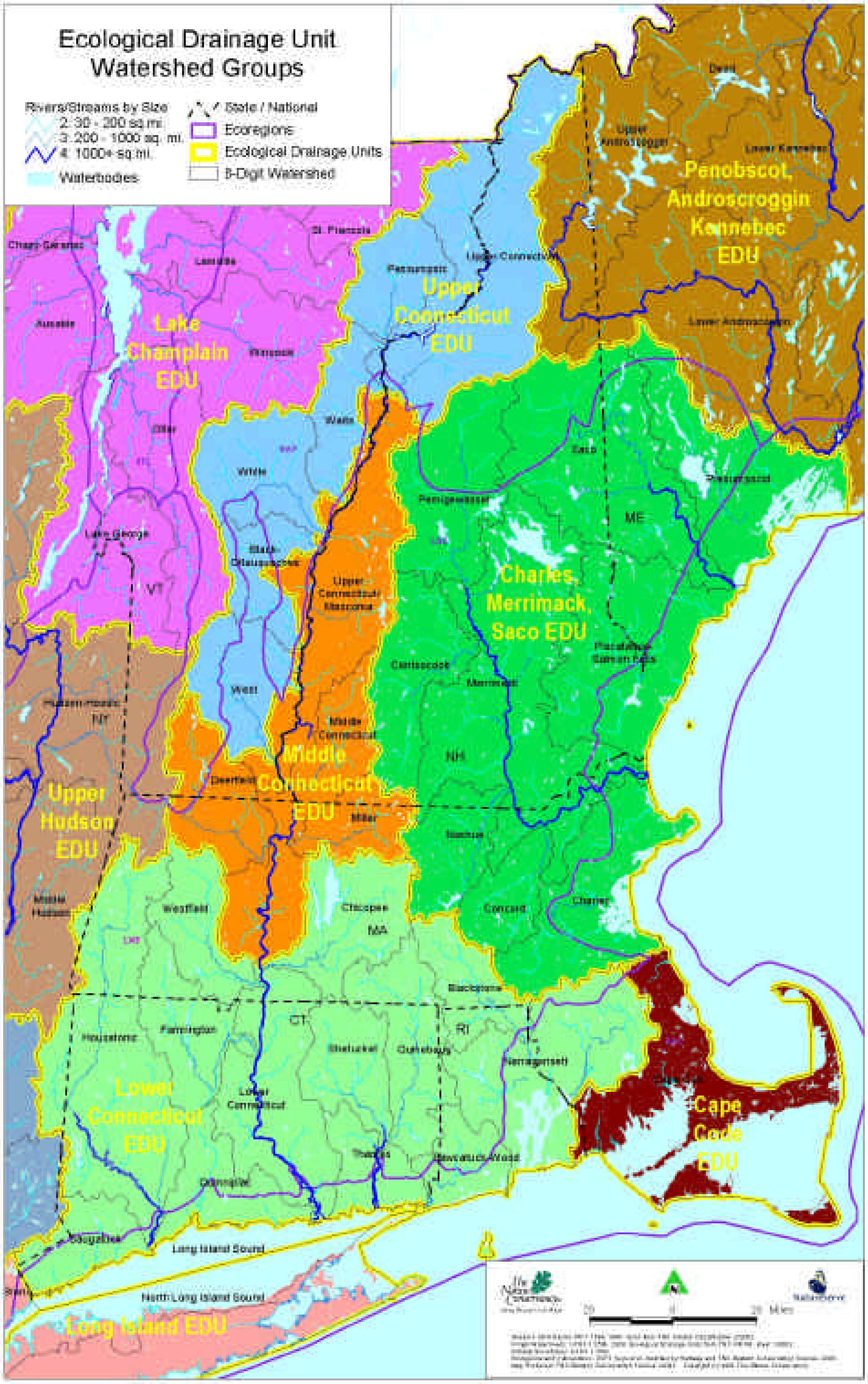
* Olivero, A.P. 2003. Results for aquatic systems. Lower New England – Northern Piedmont Ecoregional Conservation Plan; First Iteration.The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Figure 1: Ecological Drainage Unit Watershed Groups.



Although the five EDUs had been previously qualitatively derived by TNC Freshwater Initiative staff in 1999-2000, this analysis developed more quantitative descriptions of the physical setting and fish and mussel biota of the Ecological Drainage Units as follows:

Physical Descriptions

Table 1: Physical Descriptions of Ecological Drainage Units

EDU: Total Area and river length by river size class	Rivers	Physical Description
I. **Cape Cod** 1160 sq.mi. Rivers: Size 2 = 86 mi. Size 1 = 916 mi.	Includes Cape Cod coastal rivers directly draining to the ocean such as North, Sippican, Washpee, Quaeshunt, Slogums, West Port, along with many smaller coastal tributaries and intermittent streams.	Low elevation, very low gradient, acidic rivers primarily upon coarse grained sediments. The elevation is entirely within the 0-800ft elevation zone, with the highest elevation being 377ft. Landforms are dominated by dry flats (64%) and wet/moist flats (19%). Bedrock is primarily acidic granitic (46%) or recorded as extremely deep coarse grained sediment (47%). A small amount of acidic sed/metased and intermediate granitic/mafic bedrock exists. Surficial material is primarily coarse-grained stratified sediments (73%) or till (13%) with small amount of fine-grained sediment (6%) along the Taunton River. The EDU is 72% natural land cover with 8% in agricultural use and 21% developed.
II. **Saco – Merrimack – Charles** 9750 sq.mi. Rivers: Size 4 = 345 mi. Size 3 =695 mi. Size 2 =1603 mi. Size 1 = 12295 mi.	Very large rivers (size 4) include the Saco and Merrimack. Large inland rivers draining to the coast include the Presumpscot, Piscataqua-Salmon Falls, and Charles. Large inland rivers draining to the Merrimack include the Pemigewasset, Contoocook, Piscataquog, Suncook, Nashua, and Concord. Large tributaries of the Saco include the Ossipee and Swift. Medium sized coastal rivers draining directly to the coast include the Neponset, Charles, Saugus, Ipswich, Parker, York, Mousam, Kennebunk, Little, and Royal.	This EDU includes a diversity of aquatic habitats from northern mountainous, high elevation, high gradient systems dominated by cliffs, steep side slopes, coves and confined channels to southern, low elevation, very low gradient, meandering marshy, coastal systems. These systems cross a variety of bedrock and surficial material leading streams to have a variety of acidic to calc-neutral chemistry and flashy to stable hydrologic regimes. The elevation ranges from 0m to 6200 ft. in the White Mountains of New Hampshire. The vast majority of the EDU is within the 0-800 ft. zone (76%) and a moderate amount in the 800-1700 ft. zone (19%). Landforms are dominated by gently sloping flats (26%) and dry flats (27%), but include substantial amounts of sideslope/summit features (22%). Bedrock is primarily acidic granitic (50%) with large amounts of acidic sed/metased (24%), and small amounts of mafic/intermediate granitic (7%). A moderate amount of calcareous material is found (4% very calcareous, 15% moderately calcareous) with the calcareous material concentrated in local areas of the Nashua River and Saco River and covering nearly all the lower sections of the Presumpscot, Merrimack, and coastal rivers of the Piscataqua-Salmon Falls watershed. Surficial material is primarily till (47%), with moderate amounts of coarse-grained stratified sediments (22%) and patchy quaternary (19%), small amount of fine-grained sediment (9%). The patchy material occurs in the higher elevation mountainous areas of New Hampshire and Maine. The coarse-grained and fine-grained deposits are found primarily along the courses of the medium to larger rivers, with an additional large area of fine-grained sediment of marine clay origin near the coast in the Presumpscot, Saco, and Piscataqua-Salmon Falls Watersheds. The EDU is 81% natural land cover with 8% in agricultural use and 12% developed.
III. **Lower Connecticut** 9190 sq.mi. Rivers: Size4 = 338 mi. Size 3 = 570 mi. Size 2 = 1358 mi. Size 1 = 11546 mi.	Very large rivers (size 4) include the Housatonic, Connecticut, and Thames, with the Connecticut being by far the largest river. Large rivers draining to the coast include the Pawcatuck-Wood, Pawtuxet, Blackstone, and Taunton. Large rivers draining to the	Primarily acidic, low elevation, low to very low gradient rivers, with only a few medium gradient headwater systems. The Housatonic watershed contains substantial areas of calcareous bedrock influence. The vast majority of the EDU falls within the 0-800 ft. zone (76%) and a moderate amount in the 800-1700 ft. zone (22%). The elevation ranges from 0m to over 2605ft in the Berkshire/Taconic mountains in Massachusetts. Landforms are dominated by dry flats (39%), and gently sloping flats (25%), with some sideslopes/summits (13%). (Bedrock is primarily acidic sed/metased (48%) with significant amounts of acidic granitic (26%) and mafic/intermediate granitic (16%). A small amount of calcareous material occurs (5% very calcareous sed/metased, 5% moderately calcareous sed/metased), concentrated in the Upper Housatonic and the Shebaug. Surficial material is primarily till (71%), with a moderate amount of coarse

	Connecticut include the Farmington, Westfield, and Chicopee. Large river tributaries of the Thames include the Shetucket and Quinebaug. Medium rivers draining directly to the ocean include the Saugatuck, Mill, Hammonasset, Niantic, Palmer.	grained stratified sediment (22%), and small amount fine grained sediment (4%). The fine-grained sediment is concentrated along the direct floodplain of the mainstem Lower Connecticut. The EDU is 72% natural land cover with 12% in agricultural use and 16% developed.
IV. **Middle Connecticut** 3450 sq.mi. Rivers: Size 4 = 402 mi. Size 3 = 158 mi. Size 2 = 339 mi. Size 1 = 4359 mi.	The only very large river is the Connecticut. Large tributaries of the Connecticut include the Ashuelot, Deerfield, Millers, and Sugar.	Primarily medium elevation, medium gradient rivers headwaters draining to low elevation, low gradient systems entering the Connecticut mainstem. Predominantely acidic chemistry system except for small calcareous areas west of the Connecticut mainstem. The elevation ranges from 0m to 4728ft, with the majority of the EDU within the 800-1700 ft. zone (56%), a large amount of in the 0-800 ft. zone (32%) and a small amount in the 1700-2500 ft. zone (10%). Landforms are dominated by sideslopes/summits (44%) and gently sloping flats (22%). Bedrock is primarily acidic sed/metased (44%) with large amount of acidic granitic (26%), and small amount mafic/intermediate granitic (13%). A small amount of calcareous material is found on the western side of the Connecticut mainstem, particularly in the lower Deerfield (8% very calcareous, 7% moderately calcareous). Surficial material is primarily till (65%) with large amount of patchy quaternary (15%) and some coarse-grained stratified (13%) and fine-grained (7%). The fine-grained sediment is found primarily along the Connecticut River mainstem. The EDU is 84% natural land cover with 11% agricultural use and 5% developed.
V. **Upper Connecticut** 4640 sq.mi. Rivers: Size 4 = 140 mi. Size 3 = 228 mi. Size 2 = 537 mi. Size 1 = 3606 mi.	The only very large river is the Connecticut. Large tributaries of the Connecticut include the Ammonoosuc, Black, Ottauquechee, Passumpsic, Upper Ammonoosuc, West, and White	Medium to high elevation systems with a range of gradients but large amount of high gradient tributaries. Acidic chemistry systems are dominant east of the Connecticut mainstem, while west of the Connecticut calcareous systems dominate. The elevation ranges from 0m to 6250ft in the White Mountains of New Hampshire. The majority of the EDU is within the 800-1700 ft. zone (61%), with a large amount of in the 1700-2500 ft. zone (27%) and a small amount in the 0-800 ft. zone (6%) and 2500+ ft. zone (6%). Landforms are dominated by sideslopes/summits (70%) and gently sloping flats (17%). Bedrock is a mixture of acidic sed/metased (33%), acidic granitic (28%), very calcareous sed/metased (18%), moderately calcareous sed/metased (15%), with only a small amount of mafic/intermediate granitic (6%). The calcareous material is concentrated on the western side of the Connecticut mainstem. Surficial material is primarily till (56%) and patchy quaternary (37%), with a small amount of coarse-grained sediment (7%) and fine-grained sediment (2%). The EDU is 90% natural land with 8% in agricultural use and 1% developed.

Characteristic Fish and Mussels (from NatureServe Database, 2002)

Fish and rare mussel species distribution data by 8-digit watershed was obtained from NatureServe's Fish and G1-G3 Mussel datbase of 2002 and summarized by Ecological Drainage Unit (Table 3). A tabulation of the 61 fish species that occurred in the analysis area showed that 32 species (28 native) occurred in the Upper Connecticut EDU, 41 (36 native) occurred in the Middle Connecticut EDU, 53 (44 native) occurred in the Lower Connecticut EDU, 48 (43 native) occurred in the Saco-Merrimack-Charles EDU, and 35 (31 native) occurred in the Cape Cod EDU. Of the 3 G1-G3 Mussels for that distribution data was available, the Dwarf Wedgemussel occurred in all 5 EDUs, the Brook Floater occurred in all except the Cape Cod EDU, and the Yellow Lampmussel occurred in only the Middle Connecticut EDU.

Migratory fish were not addressed in the species analysis of the LNE Plan 2000, but a tabulation of the migratory fish species in these EDUs shows migratory fish occur in each EDU. Thus maintaining functional connected stream networks from headwaters to the ocean for migratory fish will be critical in all EDUs. The migratory fish by EDU are listed in Table 2. These fish include diadromous fish, which move between freshwater and saltwater, and potamodromous fish which move entirely within freshwater. Anadromous species spawn in freshwater and primarily grow in salt water. Catadromous species spawn in saltwater and primarily grow in freshwater. Amphidromous species may spawn and grow in either freshwater or saltwater, but have a migration to the opposite habitat for feeding and this migration is usually brief. Potamodromous fish move entirely within freshwater during their lifecycle – from as little as 1 mile to over 100 miles.

Table 2: Migratory Fish Distribution by Ecological Drainage Unit

Migratory Fish by Ecological Drainage Unit

Life History	Saco-Merrimack-Charles	Upper Connecticut	Middle Connecticut	Lower Connecticut	Cape Cod
Anadromous	Atlantic Sturgeon Blueback Herring Alewife American Shad Striped Bass Rainbow Smelt Sea Lamprey Atlantic Salmon	Rainbow Smelt Sea Lamprey Atlantic Salmon	Atlantic Sturgeon Blueback Herring Striped Bass Sea Lamprey Atlantic Salmon	Atlantic Sturgeon Blueback Herring Alewife Smerican Shad Striped Bass Rainbow Smelt Sea Lamprey Atlantic Salmon	Blueback Herring Alewife American Shad Striped Bass Rainbow Smelt Sea Lamprey
Catadromous	American Eel	American Eel	American Eel	American Eel	American Eel
Amphidromous	Shortnose Sturgeon Hickory Shad Banded Killifish Rainwater Killifish White Perch Ninespine Stickleback	Banded Killifish	Stortnose Sturgeon Banded Killifish White Perch	Shortnose Sturgeon Hickory Shad Fourspine Stickleback Sheepshead Minnow Gizzard Shad Banded Killifish White Perch Ninespine Stickleback	Shortnose Sturgeon Hickory Shad Fourspine Stickleback Gizzard Shad Banded Killifish Rainwater Killifish White Perch Ninespine Stickleback
Potamodromous	Lake Whitefish Brook Trout	Lake Whitefish Brook Trout	Lake Whitefish Brook Trout	Brook Trout	Brook Trout

Table 3: Fish and Mussel Distribution by Ecological Drainage Unit

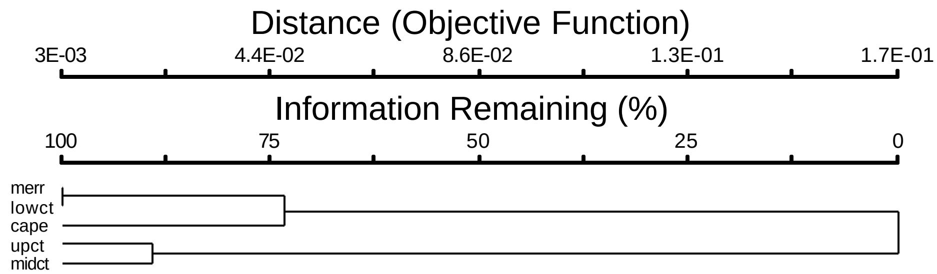
FISH AND G1-G3 MUSSELS by Ecological Drainage Unit

COMMON NAME	NATIVE	UP CT	MID CT	LOW CT	SACO MERR	CAPE	COMMON NAME	NATIVE	UP CT	MID CT	LOW CT	SACO MERR	CAPE
ALEWIFE	Nat.	0	0	1	1	1	LAKE TROUT	Nat./Intro.	1	1	0	1	0
AMERICAN BROOK LAMPREY	Nat.	0	0	1	1	1	LAKE WHITEFISH	Nat.	1	1	0	1	0
AMERICAN EEL	Nat.	1	1	1	1	1	LARGEMOUTH BASS	Intro.	1	1	1	1	1
AMERICAN SHAD	Nat.	0	1	1	1	1	LONGNOSE DACE	Nat.	1	1	1	1	0
ATLANTIC SALMON	Nat.	1	1	1	1	0	LONGNOSE SUCKER	Nat.	1	1	1	1	0
ATLANTIC STURGEON	Nat.	0	1	1	1	0	MUSKELLUNGE	Nat.	0	1	0	0	0
BANDED KILLIFISH	Nat.	1	1	1	1	1	NINESPINE STICKLEBACK	Nat.	0	0	1	1	1
BANDED SUNFISH	Nat.	0	1	1	1	1	NORTHERN REDBELLY DACE	Nat.	1	1	0	1	0
BLACKNOSE DACE	Nat.	1	1	1	1	0	PEARL DACE	Intro.	0	0	1	0	0
BLUEBACK HERRING	Nat.	0	1	1	1	1	PUMPKINSEED	Intro	1	1	1	1	1
BLUNTNOSE MINNOW	Intro.	0	0	1	0	0	RAINBOW SMELT	Nat./Intro.	1	0	1	1	1
BRIDLE SHINER	Nat.	0	1	1	1	1	RAINBOW TROUT	Intro.	1	1	1	1	1
BROOK TROUT	Nat.	1	1	1	1	1	RAINWATER KILLIFISH	Nat.	0	0	1	0	1
BROWN BULLHEAD	Nat.	1	1	1	1	1	REDBREAST SUNFISH	Nat.	1	1	1	1	0
BROWN TROUT	Intro	1	1	1	1	1	REDFIN OR GRASS PICKEREL	Nat.	0	1	1	1	1
BURBOT	Nat.(Intro. to Lower CT EDU)	1	1	1	1	0	ROCK BASS	Intro.	0	1	0	0	0
CHAIN PICKEREL	Nat.	1	1	1	1	1	ROUND WHITEFISH	Intro	0	0	1	0	0
COMMON SHINER	Nat.	1	1	1	1	1	SATINFIN SHINER	Nat.	0	0	1	0	0
CREEK CHUB	Nat.	1	1	1	1	0	SEA LAMPREY	Nat.	1	1	1	1	1
CREEK CHUBSUCKER	Nat.	0	1	1	1	1	SHEEPSHEAD MINNOW	Nat.	0	0	1	0	1
CUTLIPS MINNOW	Intro	0	0	1	0	0	SHORTNOSE STURGEON	Nat.	0	1	1	1	1
EASTERN SILVERY MINNOW	Nat.	1	1	0	0	0	SLIMY SCULPIN	Nat.	1	1	1	1	0
FALLFISH	Nat.	1	1	1	1	1	SPOTTAIL SHINER	Nat.	1	1	1	1	0
FATHEAD MINNOW	Intro.	0	0	0	1	0	STRIPED BASS	Nat.	0	0	1	1	1
FINESCALE DACE	Nat.	1	0	0	0	0	SWAMP DARTER	Nat.	0	0	1	1	1
FOURSPINE STICKLEBACK	Nat.	0	0	1	1	1	TESSELLATED DARTER	Nat.	1	1	1	1	1
GIZZARD SHAD	Nat./Expanding North	0	0	1	0	0	THREESPINE STICKLEBACK	Nat.	0	0	1	1	1
GOLDEN SHINER	Nat.	1	1	1	1	1	TROUT-PERCH	Intro.	0	0	1	0	0
HICKORY SHAD	Nat.	0	0	1	1	1	WHITE PERCH	Nat.	0	1	1	1	1
LAKE CHUB	Nat.	1	1	1	1	0	WHITE SUCKER	Nat.	1	1	1	1	1
							YELLOW PERCH	Nat.	1	1	1	1	1

Review of the fish distribution information shows that certain species are widespread throughout the analysis area. Native fish occurring in all of the 33 watersheds in the analysis area include white sucker, golden shiner, brown bullhead, yellow perch, brook trout, and chain pickerel. Fish occurring in all EDUs and 28-32 of the 33 watersheds include common shiner, longnose dace, tessellated darter, banded killifish, redbreast sunfish, American eel, blacknose dace, and fallfish. These fish are associated with the widespread and common aquatic habitats of the region and appear to tolerate the ranges of climate and stream temperature that normally occurs across the region. Although all these fish occur throughout the analysis area, some species such as white suckers, yellow perch, golden shines, and common shiners appear to be aquatic habitat generalists. They use a wide range of local habitats from creeks to small and medium rivers to large lakes and have ranges that extend significantly outside the region (Page and Burr 2001). Other species such as brown bullhead, brook trout, dace, fallfish, and tessellated darter prefer specific habitats that although specific, are widespread throughout the analysis region. For example, Brown bullheads need the deep water of large lakes and rivers, that occur in every EDU (Williams 2002). Brook trout need cool, oxygen-rich creeks to medium rivers that are also common habitats throughout the region. Blacknose dace, fallfish, and longnose dace prefer faster current streams with gravel to rocky substrate. Blacknose and longnose dace prefer springs and cool, clear creeks with moderate to swift currents over gravel or rocks, with longnose dace preferring slightly faster currents. Fallfish avoid small streams but prefer gravel, rubble bottomed pools and runs of small to medium rivers and lake margins. Certain widely distributed fish in this region such as banded killifish and tessellated darter prefer slower current waters that are also commonly found in this region. American eels are fish with a unique catadromous life history that are widely distributed throughout the region. Non-native fish that occur in the region included the bluntnose minnow, brown trout, cutlips minnow, fathead minnow, largemouth bass, pearl dace, pumpkinseed, rainbow trout, rock bass, round-whitefish, and trout-perch. Lake trout, rainbow smelt, and burbot were native in some of the watersheds and non-native in others.

The increased numbers of species present in the Lower Connecticut EDU and Saco-Merrimack-Charles EDU in comparison to the Middle Connecticut, Upper Connecticut, and Cape EDU likely represents the increased diversity of aquatic habitat niches within these EDUs, particularly their direct connection with the ocean. The Lower Connecticut and Saco-Merrimack-Charles EDU have both diverse upland areas of habitat as well as significant sections of large, medium, and small coastal rivers where estuarine habitat is abundant and where there are access points for anadromous and catadromous species. The Cape Cod EDU has direct connection with the ocean and estuarine habitat; however, the sizes of rivers in the Cape Cod EDU are quite small; there are no size 3 rivers and only 5 examples of size 2 rivers. The Cape Cod EDU is also quite uniform in its physical habitat diversity that may also limit the number of species that can find adequate habitat in this EDU. The dominance of higher gradient stream systems, higher elevations and colder temperatures, and the lack of estuarine habitat limits the aquatic habitat niches available in the Middle and Upper Connecticut EDUs. Certain species likely experience physiological limits to the colder climate in these EDUs which may explain the lower number of species in these EDUs.

Native Fish and G1-3 Mussels by EDU



A Sorensen Similarity Distance Index analysis using all native fish and G1-G3 mussel distribution (current and historical presence/absence) showed the distribution of species within the Saco-Merrrimack-Charles EDU and Lower Connecticut EDU are extremely similar. The Lower Connecticut EDU and Saco-Merrimack-Charles EDU shared 40 of 47 species. The only differences was that satinfin shiner, gizzard shad, rainwater killifish, sheepshead minnow did not occur in the Saco-Merrimack-Charles and lake trout, lake whitefish, and northern redbelly dace did not occur in the Lower Connecticut. The satinfin shiner, rainwater killifish, sheepshead minnow, and gizzard shad appear to be at the northeastern limit of its range. The satinfin shiner occurs in only the Saugatuck watershed within the Lower Connecticut EDU, but its distribution extends extensively south to North Carolina. The sheepshead minnow, rainwater killifish, and gizzard shad occur in coastal estuarine areas from Cape Cod to Texas but do not appear to have been able to colonize north of the Cape (Williams 2002). Lake trout and lake whitefish are likely absent from the Lower Connecticut EDU as they prefer cold deep lakes and cold large rivers that are lacking in the Lower Connecticut EDU. Northern redbelly dace prefer colder boggy water and sluggish mud bottom creeks and boggy ponds that are also absent in the Lower Connecticut EDU.

The next most similar EDU to the Lower Connecticut and Saco-Merrimack-Charles is the Cape Cod EDU. These three EDUs share 29 of the total 53 fish species . All fish in the Cape Cod EDU also occured in the Lower Connecticut EDU, and 27 of the 29 Cape fish also occurred in the Saco-Merrimack-Charles EDU (Sheepshead minnow and rainwater killifish were missing from the Saco-Merrimack-Charles, per above distribution limit discussion.) The fish fauna of the Cape thus appears to be a subset of the fauna of the Lower Connecticut and Saco-Merrimack-Charles edu. Native Fish that occurred in all EDUs except for the Cape Cod EDU included lake trout, spottail shiner, lake chub, longnose sucker, atlantic salmon, slimy sculpin, creek chub, longnose dace, redbreast sunfish, and blacknose dace. As mentioned previously, the Cape Cod EDU lacks any rivers greater than size 2 and has quite uniform low gradient physical habitat throughout and this limited physical habitat diversity likely limits the number of species that can find adequate habitat in this EDU.

The Upper Connecticut EDU and Middle Connecticut EDU show greater divergence from the Cape, Lower Connecticut, and Saco-Merrimack-Charles EDUs. The Upper Connecticut and Middle Connecticut EDUs share 26 species of their 38 total species. One species, eastern silvery minnow, occurred in both the Middle Connecticut and Upper Connecticut but was missing from the Lower Connecticut, Cape, and Saco-Merrimack-Charles. Eight fish species (alewife, American brook lamprey, fourspine stickleback, hickory shad, ninespine stickleback, striped bass, swamp darter, and threespine stickleback) occurred in the Lower Connecticut, Cape, and Saco-Merrimack-Charles but did not occur in either the Upper or Middle Connecticut EDU.

Many of these were anadromous (alewife, hickory shad) that only migrate a short distance inland to spawn and thus do not get up into the Middle and Upper Connecticut. Other appear to be fish adapted to the estuarine environment such as striped bass and threespine stickleback. Fourspine stickleback, ninespine stickleback, three spine stickleback, and swamp darter appears to occupy low gradient coastal rivers from Connecticut to Louisiana and although they are not strictly estuarine, they do not appear to occupy rivers more than 100 miles from a coast. Fish that occurred in all EDUs except for the Upper Connecticut EDU include shortnose sturgeon, blueback herring, banded sunfish, American shad, white perch, redfin or grass pickerel, creek chubsucker, and bridle shiner. Again, many of these fish are migratory fish that migrate from coastal rivers to spawn and use habitat within the Middle Connecticut but do not migrate further up into the Upper Connecticut (shortnose sturgeon, blueback herring, American shad). The finescale dace only occurred in the Upper Connecticut EDU, and similar to the northern redbelly dace, it prefers cold boggy creeks and lakes that are more common in the more northern watersheds. No fish occurred in all EDUs except for the Middle Connecticut EDU. The NatureServe database did show muskellunge and rock bass only occurring in the Middle Connecticut EDU, but this may be an error in the database as other fish distribution references show muskellunge also in Vermont and rock bass not in New England, but in New York. Trout-perch, bluntnose minnow, gizzard shad, and pearl dace occurred only in the Lower Connecticut EDU. The geographic range of trout-perch, bluntnose minnow, and gizzard lies primarily west of New England. No fish species occurred in all 3 Connecticut EDUs and not in the Cape Cod and Saco-Merrimack-Charles EDU.

Watershed Classification: Aquatic Ecological Systems

The watershed classification resulted in following multiple scale watershed Aquatic Ecological System types distributed as follows:

Table 4: Watershed Aquatic Ecological System Groups by Size and Ecological Drainage Unit

Number of System Types by EDU and Size	Saco-Merrimack-Charles EDU	Upper CT EDU	Middle CT EDU	Lower CT EDU	Cape EDU	Total Number of types
Size 3: large rivers (200-1000 sq.mi.)	7	5	3	6	0	19
Size 2: medium rivers (30-200 sq.mi.)	7	5	5	8	1	24
Size 1: headwaters to small rivers (0-30 sq.mi.)	9	12	3	14	0	38
Note total # of Size 3 types does not equal sum of the individual EDU counts because type 17 and type 15 occur in both Upper CT and Middle CT						
Note total # of Size 2 types does not equal sum of the individual EDU counts because type 5 and 17 occur in both Upper CT and Middle CT						

Figure 2: Size 2 Watershed Systems

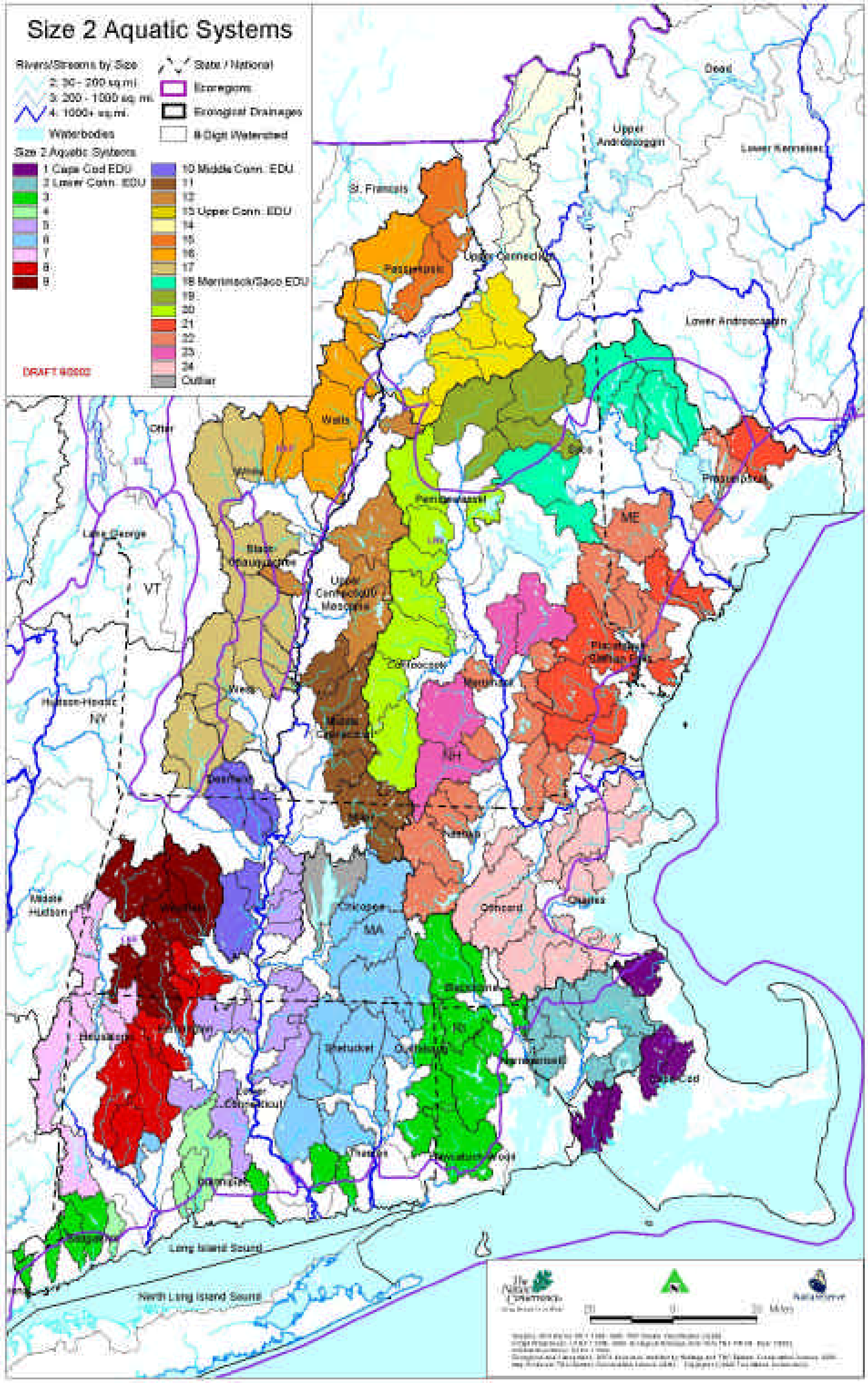
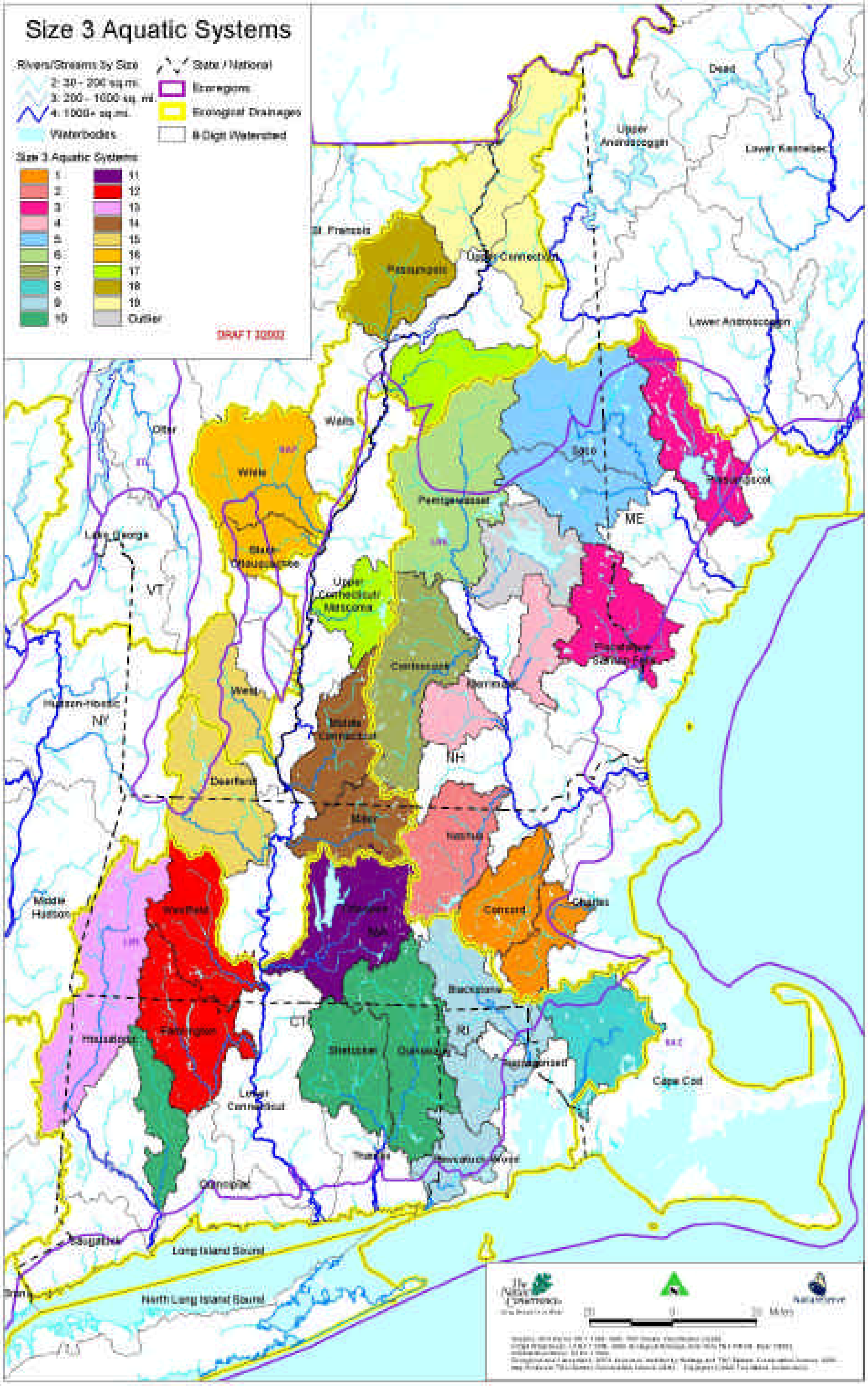


Figure 3: Size 3 Watershed Systems



TWINSPAN Relationships

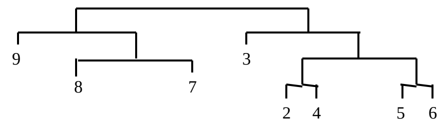
The hierarchical relationships among the system are shown in Figures 4 and 5. Number on these hierarchical flow figures represent the system types. Two-Way Indicator Species Analysis (TWINSPAN) statistical cluster analysis was performed using watersheds as classification units and ELUs as species to derive these hierarchical relationships. TWINSPAN analyses were run with pseudospecies cuts of 0, 2%, 5% 10% 20%, 40%, 60%, and 80%. TWINSPAN is a multivariate classification method based on correspondence analysis designed for sample unit x species data (Hill 1979). TWINSPAN is a top-down classification technique that repeatedly divides a correspondence analysis ordination space using an underlying gradient at each cut. At each successive cut, the previous groups are bifurcated into two more additional groups.

The output TWINSPAN clusters formed the basis of the watershed classification major systems. Although many of the 2^{nd} level cluster splits were used as systems, in some cases 3^{rd} and even 4^{th} level clusters were used where they were deemed to have ecological significance. The TWINSPAN groupings for size 3 and size 2 systems were extensively reviewed by Arlene Olivero and Mark Anderson. Manual review was necessary to determine ecologically significant clusters because certain groups contain much more diversity than others and it was determined that in these cases a lower level of clustering should be used to obtain a cluster group with more homogenous members. In certain cases, certain watersheds were also removed or added to major system groups for spatial cohesiveness, connectivity issues, and other spatial issues TWINSPAN does not incorporate. For example, in some coastal areas of the analysis, we felt the connectivity to the coast should have been weighted heavier in the classification so we combined and broke a few TWINSPAN clusters accordingly. In the TWINSPAN analysis it was also not possible to more heavily weight certain “species” other than with the percentage values, so additional ecological weighting of certain features such as coastal estuarine habitat had to be added manually. Size 1 systems have not undergone a thorough manual review and are based on the raw TWINSPAN output. The systems were reviewed by experts during the expert meetings and although no system type was eliminated, in three cases the experts recommended moving a particular watershed into a neighboring system group.

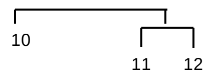
Elevation explained the first splits, with bedrock and landform driving further splits. Analysis was performed separately for each EDU for size 2 systems due to the large number of watershed examples in each EDU. Analysis was performed for all five EDUs together for the size 3 systems due to the smaller number of watershed examples. See the specific discussion below for further information on which physical characters drove the system splits.

Figure 4: Size 2 Watershed System TWINSPAN Splits

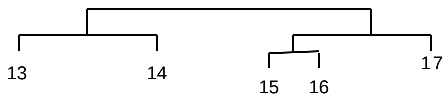
Size 2: Lower Connecticut EDU TWINSPAN Splits



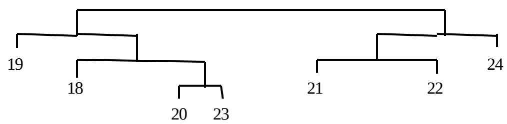
Size 2: Middle Connecticut EDU TWINSPAN Splits



Size 2: Upper Connecticut EDU TWINSPAN Splits



Size 2: Saco /Merrimack/Charles EDU TWINSPAN Splits



<u>Explanation of Size 2 Watershed TWINSPAN System Splits</u>

Lower Connecticut

7-9 split from 2-6 because 7-9 where primarily moderate elevation and 2-6 were low elevation. 9 split from 7-8 because 9 was not heavily calcareous or moderately calcareous. 7 split from 8 because 7 was highly calcareous and 8 was only moderately calcareous. 3 split from 2,4,5,6 because 2 was primarily acidic granitic and 2,4,5,6 were primarily acidic sedimentary. 2,4 split from 5,6 because 5,6 included some moderate elevation and had more gentle slopes. 2 split from 4 because all of 4's members were coastal connected and had more fine grained flats. 2 drained to Rhode Island bay and had more coarse sediment and wet flats. 5 split from 6 as 5 included short rivers that connected to the Connecticut River mainstem where the valley was dominated by broad areas of flat fine grained sediment flats near the Connecticut mainstem.

Middle Connecticut

10 split from 11 and 12 because elevation was lower in 10 and 10 had a swath of moderately calcareous bedrock along the western side of the Connecticut River as the valley begins to rise. All of 10 had some calcareous tributaries and some had calcareous mainstem systems. 10 has large areas of fine grained flats near the Connecticut River mainstem, with the 2 more northern Deerfield watershed drainage examples in more mountainous setting and a potential subgroup within system 10. Both 11 and 12 are acidic and very similar in landform, however 12 is dominated by acidic granitic bedrock and 11 is primarily acidic sedimentary.

Upper Connecticut

13 and 14 split from 15-17 primarily due to elevation as 13,14 have significant amounts of high and some very high elevation areas. 13 split from 14 because 13 is primarily acidic granitic and 14 is acidic sedimentary. Both are similar in landform. 15 and 16 split from 17 because 15 and 16 have calcareous or moderately calcareous bedrock and 17 is primarily acidic sedimentary. 15 split from 16 as 16 is more strongly calcareous and 16 has more steep slopes.

Saco/Merrimack/Charles

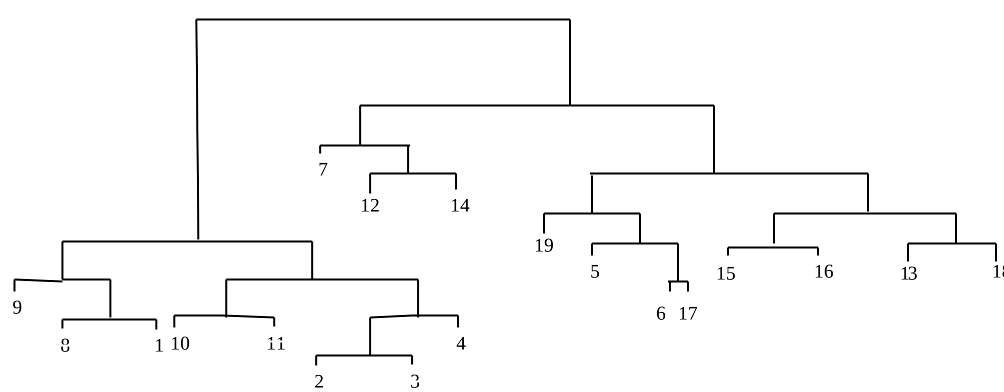
18,19,20,23 split from 21,22,24 because 21,22,24 were coastal low elevation systems while 18, 19, 20, 23 had some moderate to high elevation areas and were inland. 19 split from 18, 20, 23 as 19 was the only system primarily in the high elevation zone, with even some areas of very high elevation. 18 split from 20 and 23 as 18 was more dominantly acidic granitic and drain directly to east coast Maine while 20 and 23 are more mixed acidic granitic and acidic sedimentary and drain to the Merrimack River. 20 split from 23 due to 23 being more southerly and including more low elevation and gentle slopes. 24 split from 21 and 22 as 24 was extremely flat while 21 and 23 were hilly. 21 split from 22 as 21 was flatter and flowed directly into the ocean or estuary bays without going through a size 3 river.

Cape Cod

There were only 5 size 2 examples in the Cape Cod EDU. They were all so similar in physical setting, the decision was made not to split them into further system classes.

Figure 5: Size 3 System TWINSPAN Splits

Size 3 Watershed TWINSPAN Splits



Explanation of Size 3 Watershed System TWINSPAN Splits

9,8,1,10,11,2,3,4 split from 7,12,14,19,5,6,17,15,16,13,18 due to elevation with 9,8,1,10,11,2,3,4 all being in the low elevation while 7,12,14,19,5,6,17,15,16,13,18 were all primarily within the moderate to high elevation zone. Within 9,8,1,10,11,2,3,4 group, 9,8,1 split from 10,11,2,3,4 because 9,8,1 were all entirely extremely low in elevation and dominated by flats while 10,11,2,3,4 were dominated by gentle slopes and although they were low in elevation they did included some areas of moderate elevation. 9 split from 8,1 because 9 had less coarse sediment flats and less wetflats and more gentle slopes, although all three had a large amount of coarse sediment flats and wet flats. 9 also had a greater proportion of acidic granitic bedrock. 8 split from 1 because 8 had more fine grained sediment and less till, more acidic sedimentary bedrock, much fewer gentle slopes, and more moist wet/flats. 10,11 split from 2,3,4 primarily because of differences in landform and drainage position; both had the same elevation and mixture of bedrocks. 10,11 drained to Long Island Sound directly or through the Connecticut River and had more dry flats on till and more wetflats. 2,3,4 drained directly to the Atlantic coast and had more summits, upper slopes, sideslopes, and slope bottoms. 10 split from 11 as 10 was coastal, more predominantly in low elevation and had more acidic granitic bedrock. 11 drained to the Connecticut mainstem and had more had more mafic intermediate granitic bedrock, more coarse sediment, and more wet/moist flats. Although 2,3 and 4 all had predominantly acidic granitic bedrock, 2,3 split from 4 because 2,3 also had substantial amounts of calcareous and moderately calcareous bedrock while 4 had no moderately calcareous or calcareous bedrock. 2 split from 3 as 3 was lower in elevation and had more moderately calcareous and less calcareous bedrock and less coarse sediment.

Within 7,12,14,19,5,6,17,15,16,13,18 group, 7,12,14 split from 19, 5, 6, 17,15,16,13,18 as 7,12,14 had a larger percentage of area in the low elevation and were dominated by gentle slopes with substantial flats and little sideslopes and coves. 7 split from 12, 14 as 7 had some areas in higher elevation zones, more acidic granitic, and more sideslopes/coves. 12 split from 14 as 14 had more patchy surficial, less flats, and although both 12 and 14 had small areas of locally moderately calcareous bedrock, 12.had larger amounts of these small areas. 19, 5, 6, 17 split from 15,16,13,18 because 15,16,13,18 all had substantial large areas of moderately calcareous or calcareous bedrock. 15, 16 split from 13, 18 again primarily because of the influence of calcareous bedrock and its associated features, with 13 and 18 having more calcareous/moderately calcareous bedrock than 15, 16. 18 split from 13 as 18 had a much higher percentage of calcareous/moderately calcareous bedrock (80%) than 13 (44%). 18 also had more summits, steep slopes, sideslopes and coves. 15 split from 16 because 15 had more higher elevation areas and more acidic granitic bedrock while 16 had more moderately calcareous/calcareous bedrock and much more summits, steep slopes, and sideslopes.

Summary System Physical Descriptions

The systems were characterized by different landscape characteristics in elevation , geology, gradient, landform, and connectivity. See LNEsize2.xls and LNEsize3.xls for a more detailed description of the physical setting of each watershed system. A short textual summary of the physical characteristics of each watershed system type is provided in Tables 5 and 6.

Table 5: Size 2 Watershed System Summary Descriptions

Size 2 Systems	Connectivity to Size 3 System or direct to ocean	Physical Descriptions
1	ocean	Low elevation, very low gradient rivers on glacial outwash till and coarse sandy sediment over acidic granitic bedrock, significant portion of watershed may be tidal and brackish; numerous wetlands; chemistry acidic
2	8(9), some ocean	Low elevation watershed dominated by flats; low to very low gradient trunks and tribs; on thin till and acidic metasedimentary bedrock, some coarse sediment outwash; numerous wetlands; chemistry acidic
3	9,10, some ocean	Low elevation watershed dominated by flats and gentle slopes; low gradient rivers meandering over gentle slopes on till, acidic to intermediate granitic bedrock; chemistry acidic; some brackish
4	ocean	Low elevation watershed dominated by flats and gentle slopes; low gradient rivers meandering over gentle slopes on till, acidic sedimentary bedrock; chemistry acidic; brackish
5	12	Low elevation watershed dominated by gentle slopes and flats;low gradient river system in central valley on till and coarse grained sediments over acidic sedimentary bedrock; small rivers joining directly to CT mainstem; large areas of fine grained sediment in valley along CT mainstem; chemistry acidic
6	10,11	Low elevation watershed dominated by gentle slopes and flats;low gradient river systems with some moderate gradient tributaries as the elevation rises on valley margins; till over acidic sedimentary to granitic metamorphic bedrock w/ some intermediate granitic;
7	13	Moderate to low elevation watershed dominated by gentle slopes with some sideslopes/coves along with flats; low gradient trunks with moderate to high gradient tributaries in the "marble valley"; till over calcareous bedrock; chemistry calcareous-neutral
8	12	Moderate to low elevation watershed dominated by gentle slopes along with large areas of flats and some sideslopes/coves; low gradient trunks and more moderate gradient trunks along sideslopes and coves; till on acidic sedimentary and moderately calcareous bedrock; chemistry: calc/neutral
9	12,13	Moderate elevation river systems over mainly gentle slopes with some area of sideslopes and coves along with pervasive flats; low to moderate gradient trunks with moderate to very high gradient tribs; till over acidic sed/metased and granitic bedrock; chemistry acidic
10	15	Low to moderate elevation watershed dominated by sideslopes and coves with some gentle slopes and steep slopes; low to moderate gradient river trunks with moderate to high gradient tributaries; till over on acidic sedimentary bedrock with large areas of locally calcareous to moderately calcareous sediments;
11	14	Moderate to low elevation watershed dominated by gentle slopes with substantial sideslopes and coves; acidic sedimentary/metasedimentary and acidic granitic till. Moderate gradient trunks with moderate to high gradient tribs
12	17	Moderate to high elevation watershed dominated by sideslopes and coves with substantial steep slopes and gentle hills; high gradient headwaters flowing into lower gradient trunks; primarily acidic granitic, acidic sedimentary/ metasedimentary, and some mafic/intermediate granitic till.
13	17	Moderate to high or very high watershed dominated by sideslopes with substantial areas of steep slopes and gentle hills; high gradient headwaters flowing into lower gradient trunks; primarily acidic granitic till (with some areas of mafic/intermediate granitic till).
14	19	High elevation watershed dominated by sideslopes; acidic sedimentary/ metasedimentary till. Swath of mafic-intermediate granitic till across CT Lakes, with scattered wet/moist flats.

15	18	Moderate to high elevation with large amount of cliff/steep slope/upper slope/summit/sideslope features; primarily acidic granitic with some acidic sedimentary, also high percentage of moderately calcareous bedrock; mainly till
16	16,18	Primarily moderate elevation, some high elevation; very large amount of summits, upper slopes, sideslopes; over 90% calcareous with 60% strongly calcareous and 30% moderately calcareous; mainly till
17	15,16	Moderate to high elevation with some very high elevation; very large amount of cliff/steep slope/summit/upper slope/sideslopes; Primarily acidic sedimentary with also large areas of acidic granitic; primarily patchy with also large amount of till;
18	5	Low to moderate elevation watershed dominated with sideslopes, coves/steep slopes/summits concentrated at Ossippee Mtns. Widespread flats and gentle slopes with acidic granitic till. Dry flat-coarse grained sediments occur in relatively large patches, particularly around Ossippee Lake.
19	5,6	High elevation mountainous watershed; dominated by coves/steep slopes/cliffs/summits. Scattered areas of acidic granitic and acidic sedimentary/metasedimentary till.
20	6,7	Moderate elevation watershed dominated by mountainous terrain esp. in Pemigewasset, with acidic granitic till. Isolated patches of acidic sedimentary/ metasedimentary and moderately calcareous till interspersed with wet/moist flats. Terrain less mountainous in Contoocook.
21	ocean	Low elevation and low relief dominated by flats and gentle hills; primarily acidic granitic with acidic sedimentary, but also large percentage of moderately calcareous (38%); till with large amount of coarse and fine sediment
22	2,3	Low elevation watersheds with widespread flats and gentle slopes with acidic granitic and acidic sedimentary/ metasedimentary till, interspersed with dry flats with coarse-grained sediments. Low gradient trunks with moderate gradient tribs
23	4	Low elevation watershed dominated by gentle slopes with acidic granitic and sedimentary/metasedimentary till. Isolated, very small patches of moderately calcareous till and dry flats with coarse grained sediments (more common near mainstem of the Merrimack).
24	1, some ocean	Low elevation watershed with low gradient rivers and streams on mostly acidic igneous and metamorphic bedrock(locally calcareous), some tidal in lower reaches

Table 6: Size 3 Watershed System Summary Descriptions

Size 3 Systems	Physical Description
1	Low elevation watersheds dominated by gentle slopes and flats; on primarily acidic granitic bedrock with surficial till and some coarse sediment
2	Low elevation watersheds dominated by gentle slopes and flats; on primarily acidic granitic with large areas of acidic sedimentary, moderately calcareous and calcareous bedrock; surficial till and some coarse sediment
3	Low elevation watersheds dominated by gentle slopes and flats; on primarily acidic granitic bedrock with surficial till and some coarse and fine sediment
4	Low elevation watersheds dominated by gentle slopes with substantial areas of sideslopes;on a mixture of acidic sedimentary and acidic granitic bedrock with surficial till and some areas of patchy and coarse sediment.
5	Low elevation watersheds dominated by sideslopes with substantial amounts of steep slopes and gentle slopes; on primarily acidic granitic bedrock with primarily patchy surficial
6	Moderate to low elevation watersheds dominated by sideslopes and steep slopes; on acidic granitic and acidic sedimentary bedrock with patchy surficial.
7	Moderate to low elevation watersheds dominated by sideslopes and gentle slopes; on acidic granitic and acidic sedimentary bedrock with till surficial.
8	Low elevation watersheds dominated by dry flats, wet flats, and coarse sediment flats; on acidic sedimentary and acidic granitic bedrock with surficial primarily coarse sediment with some areas of till
9	Low elevation watersheds dominated by flats; on acidic granitic and acidic sedimentary bedrock with surficial till with some coarse sediment
10	Low elevation watersheds dominated by gentle slopes and flats; on primarily acidic sedimentary bedrock with surficial till
11	Low and moderate elevation watersheds dominated by gentle slopes and flats; on primarily acidic sedimentary bedrock with surficial till
12	Moderate to low elevation watersheds dominated by gentle slopes with substantial areas of flats and sideslopes; with acidic sedimentary bedrock with surficial till
13	Moderate to low elevation watersheds dominated by sideslopes; on primarily calcareous bedrock with surficial till
14	Moderate to low elevation watersheds dominated by gentle slopes; on primarily acidic sedimentary bedrock on surficial till
15	Moderate to high elevation watersheds dominated by sideslopes with substantial gentle slopes and sideslopes; on acidic sedimentary bedrock with surficial till and patchy quarternary sediment
16	Moderate to high elevation watersheds dominated by sideslopes with substantial steep slopes; on acidic sedimentary, calcareous, and moderately calcareous bedrock with surficial till and patchy quarternary sediment
17	Moderate to high elevation watersheds dominated by sideslopes with gentle slopes and steep slopes; on primarily acidic granitic bedrock with surficial till
18	Moderate to high elevation watersheds dominated by sideslopes and gentle slopes; on calcareous and moderately calcareous bedrock with surficial till
19	Moderate to high elevation watersheds dominated by sideslopes and gentle slopes; on acidic sedimentary and acidic granitic bedrock with surficial till; some areas of locally moderately calcareous bedrock

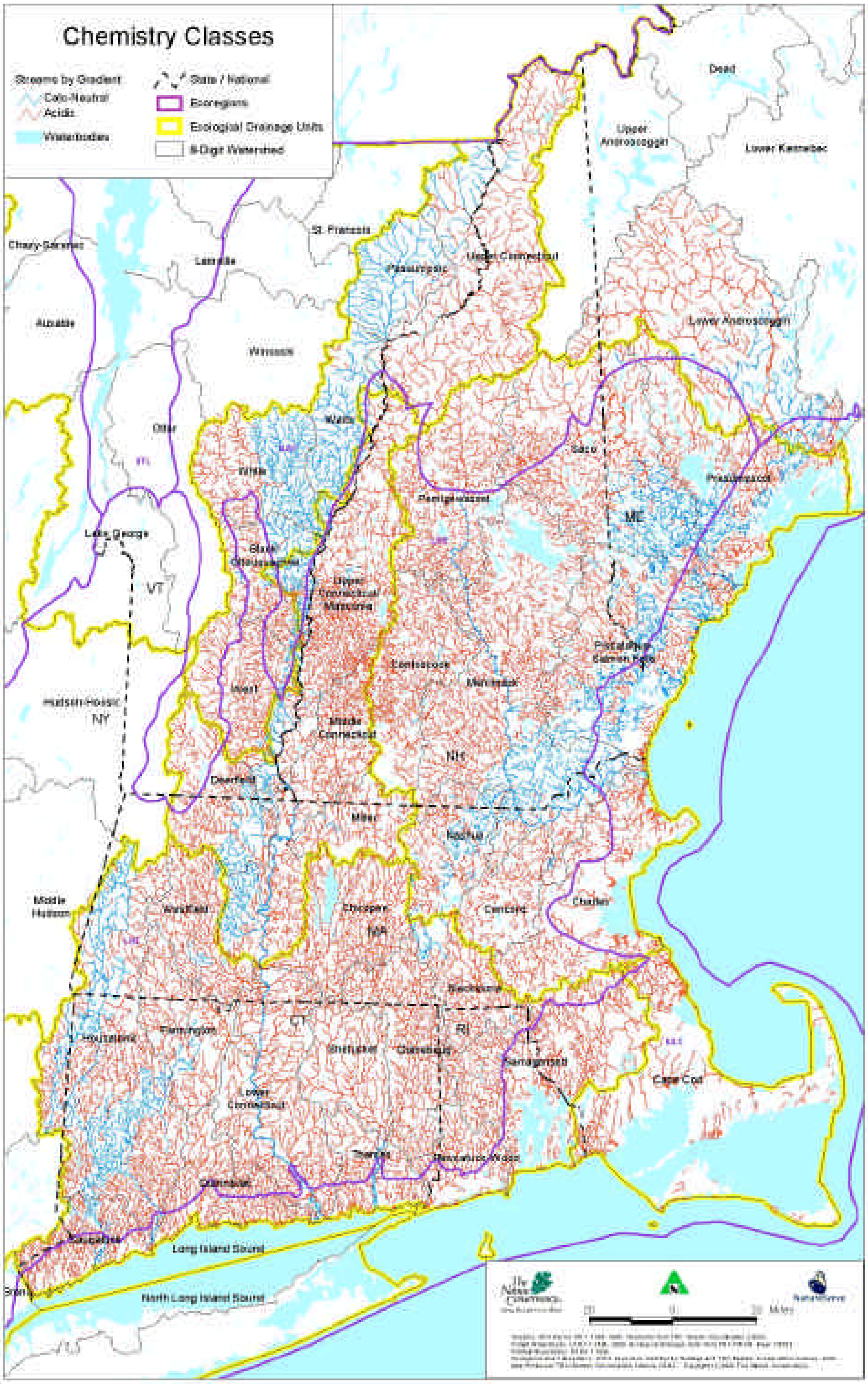
Reach Level Classification: Macrohabitats

The reach level macrohabitat analysis had 480 possible unique combinations based on unique combinations of their size class (4 classes) x elevation class (4 classes) x gradient classes (5 classes) x chemistry classes (2 classes) and connectivity classes (3 classes). Distributions of individual attributes such as size, gradient, or chemistry can be reviewed by studying the following figures:

Figure 6: Reach Size Classes

Figure 7: Reach Gradient Classes

Figure 8: Reach Simplified Chemistry Classes



Of these 480 possible combinations, 143 unique combinations occurred in the analysis area. The most common types and most rare types of size 1, 2, and 3 reaches are listed in the tables below. The patterns of common and rare types reflect the overall distribution of aquatic habitats in the region as low elevation, low gradient acidic streams predominate and calcareous and higher elevation streams are less common. For example, 4 of the 5 most common size 1 types were acidic reaches in low elevation, with low, very low, or moderate gradient. One of the 5 most common size 1 types was a moderate elevation, high gradient, acidic stream type. Four of the 5 most common size 2 types were in low elevation with low or very low gradient. 3 of these 4 were acidic. One of the 5 most common size 2 types was in moderate elevation, with low gradient and an acidic chemistry. All of the most common size 3 types were in low elevation with low, very low, or moderate gradient. 4 of these 5 had acidic chemistry. The least common types were dominated by calcareous, high gradient, and high elevation types.

Table 7: Most Common Size 1-3 Reach Macrohabitat Types

MACRO	# EDUS	# Reaches	Description
11211	5	3600	size1, low elevation, low gradient, acid, stream connected
11111	5	2548	size1, low elevation, very low gradient, acid, stream connected
11311	5	1740	size1, low elevation, moderate gradient, acid, stream connected
12411	4	1572	size1, moderate elevation, high gradient, acid, stream connected
11212	5	1311	size1, low elevation, low gradient, acid, lake connected
21111	5	883	size2, low elevation, very low gradient, acid, stream connected
21211	5	472	size2, low elevation, low gradient, acidic stream connected
21121	4	201	size2, low elevation, very low gradient, calc-neutral, stream connected
21112	5	177	size2, low elevation, very low gradient acid, lake connected
22211	4	134	size2, moderate elevation, low gradient, acid, stream connected
31111	4	588	size3, low elevation, very low gradient, acid, stream connected
31211	4	256	size3, low elevation, low gradient, acid, stream connected
31121	3	105	size3, low elevation, very low gradient, calc-neutral, stream connected
31311	4	56	size3, low elevation, moderate gradient, acid, stream connected
31112	4	32	size3, low elevation, very low gradient, acid, lake connected

Table 8: Least Common Size 1-3 Reach Macrohabitat Types

MACRO	# EDUS	# Reaches	Description
12522	2	2	size1, moderate elevation, very high gradient, calcareous, lake connected
11423	1	1	size1, low elevation, high gradient calcareous, ocean connected
13221	1	1	size1, high elevation, low gradient, calcareous, stream connected
14412	1	1	size1, very high elevation, high gradient, acid, lake connected
14521	1	1	size1, very high elevation, very high gradient, calcareous, stream connected
22122	1	1	size2, moderate elevation, very low gradient, calc-neutral, lake connected
22321	1	1	size2, moderate gradient, moderate gradient, calc-neutral, stream connected
23111	1	1	size2, high elevation, very low gradient, acid, stream connected
23212	1	1	size2, high elevation, low gradient, acid, lake connected
23311	1	1	size2, high elevation, moderate gradient, acid, stream connected
31123	1	1	size3, low elevation, very low gradient, calc-neutral, stream ocean connected
31213	1	1	size3, low elevation, low gradient, acid, ocean connected
31412	1	1	size3, low elevation, high gradient, acid, lake connected
31422	1	1	size3, low elevation, high gradient, calc-neutral, lake connected
31512	1	1	size3, low elevation, very high gradient, acid, lake connected

Classification: Discussion and Conclusion

Freshwater ecological systems are highly dynamic and diverse ecosystems that exist along a continuum, from headwaters to large river mouths. Within these ecosystems, abiotic and biotic interactions occur at multiple spatial and temporal scales to influence the form, function, and patterns of aquatic biodiversity. To identify the different types of aquatic ecosystems in Lower New England, this assessment implemented a multiple scale physical classification based on the principles of evaluating nested watersheds at multiple scales within a regional climate and biogeographic framework (Maxwell 1995, Frissell 1986, Higgens et al. 1998).

The classification provides an apriori hypotheses regarding how large-scale suites of environmental features directly or indirectly influence aquatic biota. When watersheds of similar size occur under similar climatic and zoogeographic conditions and share a similar set of physical features such as elevation zones, geology, landforms, gradients and drainage patterns, they may be reasonably expected to contain similar aquatic biodiversity patterns (Tonn 1990, Jackson and Harvey 1989, Hudson et al. 1992, Maxwell et al. 1995, Angermeier and Winston 1998, Pflieger 1989, Burnett et al. 1998, Van Sickle and Hughes 2000, Oswood et al 2000, Waite et al. 2000, Sandin and Johnson 2000, Rabeni and Doisy 2000, Marchant et al 2000, Feminella 2000, Gerritsen et al 2000, Hawkins and Vinson 2000, Johnson 2000, Pan et al 2000). The physical landscape classification variables in this analysis were chosen because they 1) displayed low spatial and temporal variation at the given watershed scale under consideration and 2) have been shown to strongly affect the form, function, and evolution of aquatic ecosystems and ecological processes at the considered scales (Frisell 1986).

Classification watershed scale variables included watershed size, elevation, bedrock, surficial geology, and landform. Stream watershed area was used as a proxy for stream size. Watershed area is correlated with local scale measures of stream width, depth, flow velocity and also influences flow rate, velocity, regime, and channel morphology. Elevation was used to represent local climate variation which limits some aquatic species distributions, influences forest type and organic input to rivers, stream temperature, and flow regime due to differences in snow melt and precipitation. Bedrock and surficial geology were used due to their control of water chemistry, stability of flow, and sedimentation which influence the hydrologic character and habitat of streams. For example sediment texture and cohesion impacts the stability of flow as sediments with higher porosity (coarse grained sandy surficial sediments, acidic sedimentary/metasedimentary bedrocks, calcareous bedrocks) are likely to have more stable groundwater dominated flows as precipitation in these landscapes is more likely to percolate into the groundwater than to runoff overland into streams. Less porous sediments (fine grained clay surficial, acidic granitic bedrock, other crystalline bedrocks) are likely to have more flashy hydrologic regimes as surface water flows predominate unless the watersheds contain sufficient multiple fracture/fault zones for groundwater recharge. Gradient and landform were used because they influence stream morphology (confined/meandering), flow velocity, substrate composition, and habitat types due to differences in soil type, flow velocity, moisture, nutrients, and disturbance history. For example, the morphology of valley floors differs substantially between mountains and lowland areas due to contrast in the degree of landform controls on stream meandering. Likewise, lower gradient streams in New England typically have sand, silt and clay substrates while high gradient streams typically have cobble, boulder, and rock substrates (Argent et al 2002).

The classification used WWF Fish Zoogeographic Ecoregions and Ecological Drainage Units to place the physical watershed and reach classification within the context of its regional geoclimate and zoogeographic setting. Large-scale geologic and climate factors constrain the development of both physical habitat and biological structure of smaller spatial scales through their large-scale controls on temperature, chemistry, hydrology, stream morphology, nutrient and sediment delivery, and on patterns of disturbance (flood, fires, hurricanes, major geologic events) that operate over this scale (Frisell 1986, Poff and Allan 1995, Hawkins et al. 2000). Geoclimate settings also influence zoogeographic distributions of aquatic biota as the current and historical pattern of linked aquatic networks has influenced isolation, dispersion, and speciation. Analysis of the physical characteristics and fish and mussel distributions between Ecological Drainage

Units supported the distinctiveness between these units. Although the fauna of the Cape Cod EDU appeared very similar to the fauna of the Lower Connecticut EDU, its physical and climatic setting provides a unique physical setting in which these species are adapted to live. Analysis of the fauna of the EDUs also highlighted the presence of migratory fish within each of the EDUs, including species such as atlantic sturgeon, blueback herring, alewife, american shad, rainbow smelt, sea lamprey, atlantic salmon, shortnose sturgeon, hickory shad, banded killifish, and brook trout. These migratory fish and connected networks of aquatic systems will be conservation targets within each EDU.

The classification shows a wide diversity of aquatic ecosystem types occur in the region. These systems can be hierarchically classified into a smaller number of "most similar "groups at successively larger spatial scales. The classification can be used to highlight patterns in regional diversity and spatially reference all examples of the distinctive classification unit types. Complex relationships of how elevation, geology, and landform interact to dominate physical patterns within watersheds can be teased apart by studying the classification break points. For example, elevational differences followed by variation in bedrock geology dominated upper levels of the watershed classification break points, with finer breaks primarily due to finer differences in landform and both bedrock and surficial geology.

Simple queries can be performed to highlight watershed systems with a similar ecological signature. For example watersheds with large areas of highly calcareous bedrock (size 2: 7, 8, 10, 15, 16, 22; size 3: 15, 16, 13, 18,3, 12) or watershed of low elevation with high amounts of coarse grained sediments (size 2: 1, 2, 3, 4; 24, 22,21 size 3: 8, 2, 3). Watershed system groups with similar physical signatures, but in different Ecological Drainage Units can be highlighted such as size 2 system 24 and 3 that are both low elevation flat watersheds with some gentle hills on primarily on acidic granitic bedrock with surficial till and large areas of coarse sediment deposits. The difference is that system 3 is in the Lower Connecticut EDU draining into Long Island Sound or Narraganset Bay, while system 24 is in the Saco, Merrimack, Charles EDU and drains into Boston Harbor or the northshore of the Atlantic. Other examples include size 2 systems 19 and 13 that are both high elevation to very high elevation mountainous watersheds dominated by sideslopes/coves and steep slopes on primarily acidic granitic with large amounts of patchy and till surficial. System 19 is in the Saco, Merrimack, Charles EDU and system 13 is in the Upper Connecticut EDU. Likewise, size 2 system type 11 and 20 are very similar as they are both moderate to low elevation watersheds dominated by sideslopes and gentle hills on primarily acidic granitic bedrock with till surficial. System 20 is in the Saco, Merrimack, Charles EDU while system 11 is in the Middle Connecticut EDU. Similar patterns can be found in the size 3 systems between systems 6 (Upper Connecticut) and 17 (the Saco, Merrimack, Charles EDU) and between 8 (Saco, Merrimack, Charles EDU) and 9 (Lower Connecticut EDU). Finer scale patterns in environmental diversity within the watersheds can also be identified by studying the reach classification and Ecological Land Unit distribution within the watersheds.

Although this analysis did not explore the correlation of the watershed or reach level classification to specific aquatic species assemblages, assemblage differences (and/or population genetic differences) are currently expected or expected to develop over evolutionary time between the different types given their different environmental settings. Future studies will be necessary to investigate the level of association between species assemblages and this classification; however, certain generalized relationships can be postulated. For example, for proposed associations between aquatic biota and the reach level classification in the Upper

Connecticut and Middle Connecticut Ecological Drainage Units see the Appendix of the Aquatic Methods section.

Condition Results

GIS Screening

Size 2 Watershed: Within System Relative Analysis

A "Within System" Analysis was run to highlight the highest ranked watershed within each system type. A subset of the related condition variables were used in a Principle Components Analysis (PCA) Ordination within each of 3 relatively non-correlated impact categories. PCA Ordination runs were made separately within each EDU for the Land Cover/Road Impact and for the Dam/Drinking Water Supply Impact. The 1st output axis, which explained most of the variance of watersheds in terms of that impact area, was used to create a single reduced "rank variable" to rank the watersheds from best to worst in terms of that impact area. Simple ranking, instead of ordination, was ultimately used to create a summary rank for the Point Source Impact because all the input point source response variables were extremely highly correlated with the variable *total point sources / stream mile*.

The input variable set for PCA Ordination/Ranking Analysis was as follows:

Land Cover/Road Impact Ordination Variables:

- P_imp - % impervious surfaces
- P_nat - % nat land cover
- Rdx_pstmi - # road stream crossings per stream mile
- Rdtot_psqmi - total miles of roads per square miles of the watershed

Dam / Hydrologic Alteration Impact Ordination Variables:

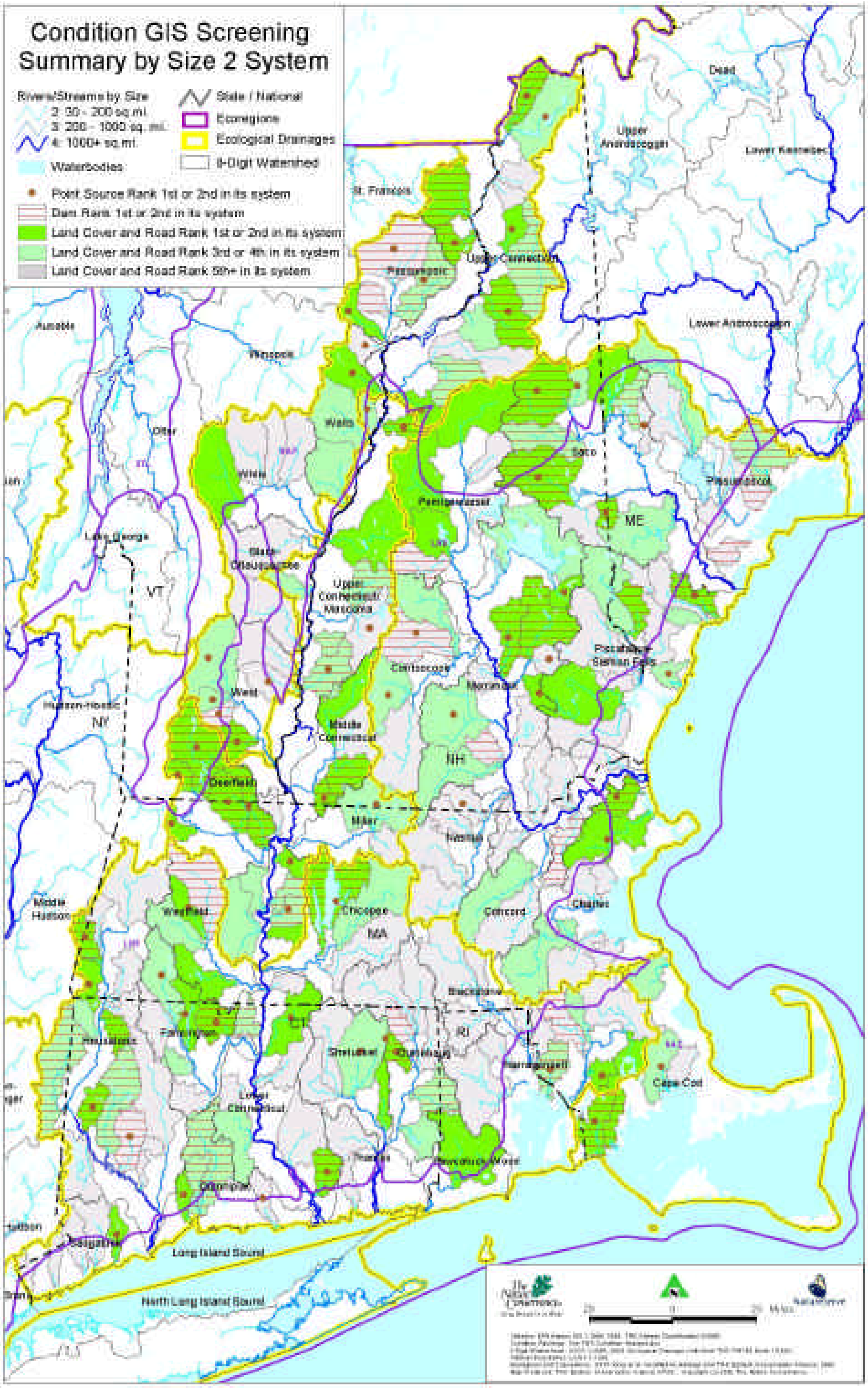
- Damst_stmi - total NID dams per stream mile
- Ldam_stmi - # large dams ([Nid_height] >= 20 or storage > 1000 if NID height was less than 20 feet)
- Tsto_pstmi = total storage in acre/feet per stream mile
- Dwspmi - # drinking water supply per stream mile

Point Source Impact (simple ranking):

- TPS_pstmi - total point sources per stream mile (CERCLIS, IFD, PCS, TRI, MINES)

Figure 9 displays the size 2 watersheds that ranked high within their system type. This map highlighted watersheds that had scored 1st –4th within the system type in terms of land cover/road impacts as a solid, those that had scored 1st or 2nd in dam/drinking water supply impacts as a hatch, and those that had scored 1st in point source impacts as a dot.

Figure 9: Size 2 Watershed Relative Ranking Summary Map



Size 2 Watershed: Landscape Context Non-Relative Ranking

A “Non-System Relative” analysis was run to investigate the range of Landscape Context of size 2 watersheds in the entire analysis area (Figure 10). By measuring the watersheds on a single “ruler” or scale across the entire analysis area, it provided a template to compare size 2 watershed examples across different system types. A simplified set of condition variables were used to explore the range in quality within the analysis area. Percent developed land cover, percent agriculture land cover, total road density per watershed area were chosen because these variables were considered to summarize distinct and important classes of impacts to aquatic systems.

The following class breaks were used to integrate the input variables into an overall Landscape Context rank of watersheds into classes 1-5 (Table 9). These categories were developed in consultation with Mark Anderson after review of the population distribution for each variable. The lowest class of the percent developed category, greater than 15%, is well supported in the literature as a threshold beyond that streams show clear signs of degradation and fair to poor Indices of Biotic Integrity (IBIs) (Jones and Clark 1987, Steedman 1988, Couch et al. 1997, Dreher 1997, Wang et al. 1997, Yoder et al. 1999, Gordon and Majumder 2000, Schueler 1994). This category was choosen to stand alone as a “maximum threshold category”/ unique rank 5 category due to its known biological relevance. The remaining percent developed distribution was broken into 4 categories. A narrow very good (1) class to represent the best 10% of watersheds, followed by a rank 2 and 3 class that each represented 25% of the watersheds, and a category 4 that represented 20% of the watersheds. For the percent agriculture and road density variables, no thresholds have been uniformly identified in the literature (Fitzhugh 2000). For these variables, 4 categories were used due to the imprecision of identifying a biologically significant category 5 or maximum threshold category. The following class breaks were made by examining the range and distribution of data. A narrow best (1) category was used to represent the top 10% of watersheds, followed by another rather narrow rank 2 category representing about 20% of the watersheds, a rank 3 category representing 35% of the watersheds, and a category 4 representing 35-40% of the watersheds (similar to combining the categories 4 and 5 from the percent developed rank that also held 40% of the watersheds together). The overall Landscape Context watershed rank was determined by worst individual category score.

Table 9: Size 2 Watershed Landscape Context Ranking Criteria

Landscape Context Rankings			
Rank	%Developed	% Agriculture	Road Density (mi rd/sq.mi. watershed)
1	<1%	<3%	<1
2	1-2%	3-6%	1-2.5
3	2-6%	6-10%	2.5-3.5
4	6-15%	>10%	>3.5
5	>15%		

Figure 10: Size 2 Watershed Non-Relative Ranking Summary

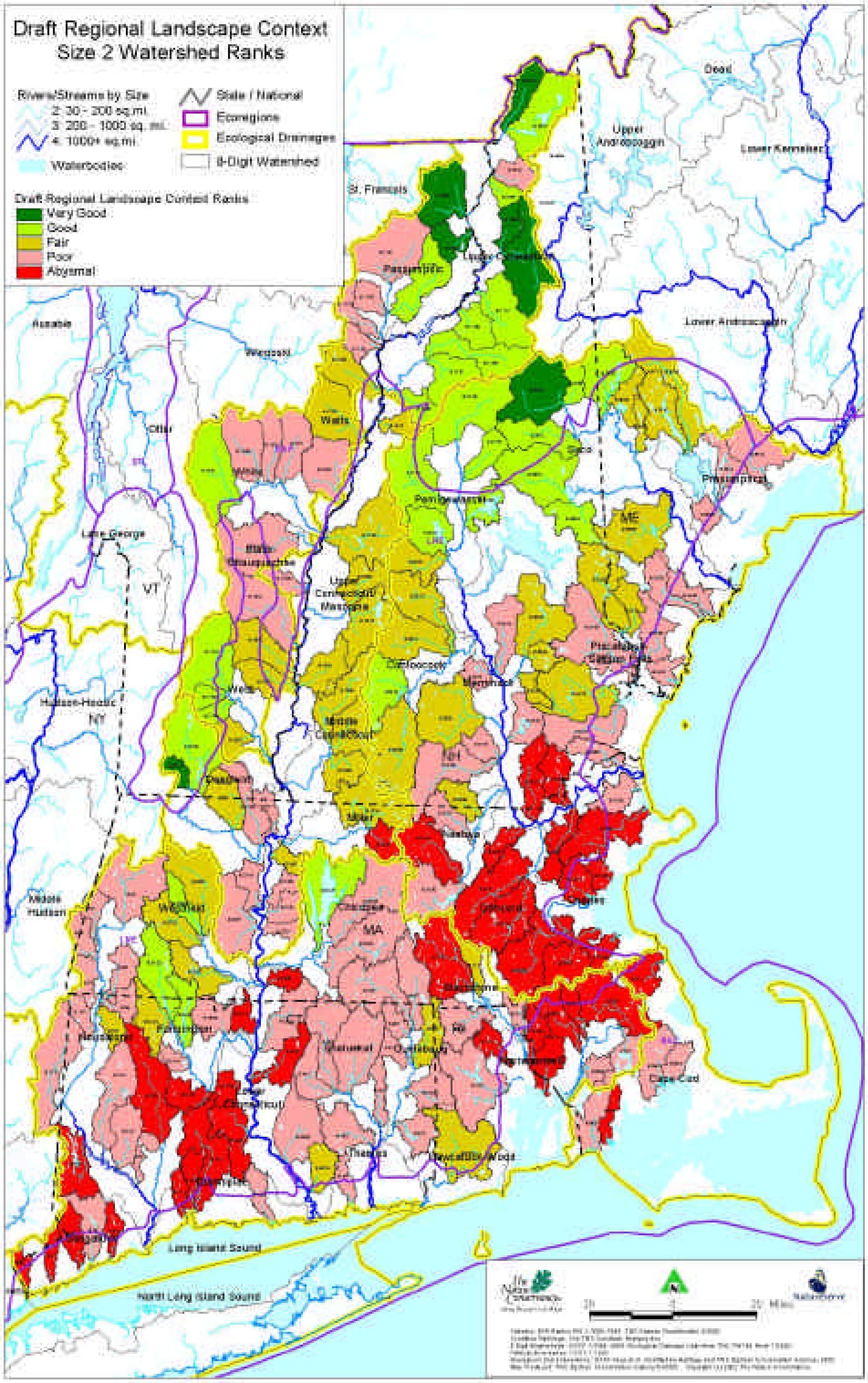


Table 10: Size 2 Watershed Landscape Context Ranking by Ecological Drainage Unit and Number and Percentage of Watersheds

# Size 2 Watersheds Falling into each category							% of Size 2 Watersheds Falling into each category						
Summary Rank	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total	Summary Rank	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total
1 (very good)	1		1	5		7	1	2	0	5	15	0	4
2 (good)	11	4	1	12		28	2	18	6	5	36	0	15
3(moderate)	17	9	11	5		42	3	28	13	50	15	0	22
4(fair-poor)	19	36	8	11	3	77	4	31	51	36	33	60	40
5 (very poor)	13	22	1		2	38	5	21	31	5	0	40	20
Grand Total	61	71	22	33	5	192	Grand Total	100	100	100	100	100	100

Table 11: Size 2 Watershed Percent Developed Ranking by Ecological Drainage Unit and Number and Percentage of Watersheds

# Size 2 Watersheds Falling into each category							% of Size 2 Watersheds Falling into each category						
%Developed	Saco-Merrimack-Charles (61_2)	Lower CT (61_6)	Middle CT (61_7)	Upper CT (63_2)	Cape Cod (62_3)	Grand Total	%Developed	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total
1: <1%	12	3	2	18		35	1	20	4	9	55	0	18
2: 1-2%	9	4	5	12		30	2	15	6	23	36	0	16
3: 2-6%	11	28	8	3		50	3	18	39	36	9	0	26
4: 6-15%	16	14	6		3	39	4	26	20	27	0	60	20
5: >15%	13	22	1		2	38	5	21	31	5	0	40	20
Total	61	71	22	33	5	192	Total	100	100	100	100	100	100

Table 12: Size 2 Watershed Road Density Ranking by Ecological Drainage Unit and Number and Percentage of Watersheds

# Size 2 Watersheds Falling into each category							% of Size 2 Watersheds Falling into each category						
Road Density (mi rd/sq.mi. watershed	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total	Road Density	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total
1: <1%	2		1	6		9	1	3	0	5	18	0	5
2: 1-2.5	19	11	7	26		63	2	31	15	32	79	0	33
3: 2.5-3.5	21	23	11	1	1	57	3	34	32	50	3	20	30
4: >3.5	19	37	3		4	63	4	31	52	14	0	80	33
								0	0	0	0	0	0
Total	61	71	22	33	5	192	Total	100	100	100	100	100	100

Table 13: Size 2 Watershed Percent Agriculture Ranking by Ecological Drainage Unit and Number and Percentage of Watersheds

# Size 2 Watersheds Falling into each category							% of Size 2 Watersheds Falling into each category						
% Agriculture	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total	% Agriculture	Saco-Merrimack-Charles	Lower CT	Middle CT	Upper CT	Cape Cod	Grand Total
1: <3%	7	2	1	10	1	21	1	11	3	5	30	20	11
2: 3-6%	13	7	3	7	2	32	2	21	10	14	21	40	17
3: 6-10%	29	25	10	5		69	3	48	35	45	15	0	36
4: >10%	12	37	8	11	2	70	4	20	52	36	33	40	36
								0	0	0	0	0	0
Total	61	71	22	33	5	192	Total	100	100	100	100	100	100

Dam Impacts

Table14: Dam Total Number and Density by River Size and Ecological Drainage Unit

EDU Dam Summary: # and density of dams on each size class river											
EDU	Total # dams	# dams per 10 sq.mi. of watershed	# dams per 10 miles of river	Total # dams on size 1	Total # dams on size 2	Total # dams on size 3	Total # dams on size 4	# dams on size 1 rivers per 10 miles of river	# dams on size 2 rivers per 10 miles of river	# dams on size 3 rivers per 10 miles of river	# dams on size 4 rivers per 10 miles of river
Saco	933	0.96	0.62	710	130	59	34	0.58	0.81	0.85	0.99
Lower CT	1480	1.61	1.07	1279	143	48	10	1.11	1.05	0.84	0.30
Middle CT	363	1.05	0.69	282	40	29	12	0.65	1.18	1.84	0.30
Cape	152	1.31	1.52	147	5			1.60	0.58		
Upper CT	176	0.38	0.39	129	24	17	6	0.36	0.45	0.75	0.43
Grand Total	3104	1.10	0.79	2547	342	153	62	0.78	0.87	0.93	0.51

Table 15: Dams by Type and Size within Ecological Drainage Units

EDU Dam Summary: Percentage of Dams within Summary Type and Size Categories										
EDU	Total # dams	%HYDRO ELECTRIC	%FLOOD CONTROL	% WATER SUPPLY	% RECREATION	%IRRIGATION	% OTHER	% <=15 feet high	% >15 feet and <= 50 feet high	% > 50 feet high
Saco	933	18	9	21	41	1	11	57	40	3
Lower CT	1480	5	4	23	55	3	10	45	49	6
Middle CT	363	18	3	15	54	1	9	39	54	7
Cape	152	2	4	7	25	61	1	79	21	0
Upper CT	176	19	6	9	54	0	13	39	53	9
Total %		11	6	20	49	4	10	49	46	5
Total # dams	3104	348	174	611	1520	138	313	1530	1422	152

Table 16: Dams on Size 2, 3,4 Rivers by Type

EDU Dams on Size 2, 3, 4 Rivers Summary: Percentage of Dams by Type Categories							
EDU	Total # dams	% HYDRO ELECTRIC	% FLOOD CONTROL	% WATER SUPPLY	% RECREATION	%IRRIGATION	% OTHER
Saco	223	55	14	4	18	0	8
Lower CT	201	29	7	23	21	0	19
Middle CT	81	63	6	5	21	1	4
Cape	5	20	0	0	20	60	0
Upper CT	47	62	9	2	13	0	15
Total %		47	10	11	19	1	12
Total # dams	557	263	56	61	107	4	66

Expert Interviews

452 expert interview site records were recorded as of 12/10/02. This represented interviews from over 85 individual experts. The sites were distributed as follows, 207 sites from Massachusetts, 95 sites from Connecticut, 21 sites from Rhode Island, and 129 sites from New Hampshire. Expert interviews were not conducted in VT because their recently completed Vermont Biodiversity Project provided the expert information needed. Expert interviews were also not completed for the coastal sections of Maine due to the desire of the Maine Chapter to gather expert interviews on these areas in late spring 2003.

Condition: Discussion and Conclusion

The overall landscape context non-system relative analysis highlighted the trend within the analysis area for the more northern and non-coastal areas to have better Landscape Context ranks. Over 80% of all watersheds in the Cape Cod EDU and Lower Connecticut EDU fell into the two most impacted categories, reflecting the high levels of urbanization and agriculture within these southerly and coastal EDUs. The Upper Connecticut EDU had the highest percentage of watersheds in the least impacted category 1 (15%) followed by the Middle Connecticut (5%) and Saco-Merrimack-Charles EDU (2%). Using the category where the highest percentage of watersheds in an EDU fell as a measure of the EDU's dominant condition, the Upper Connecticut EDU was predominantly good, the Middle Connecticut was moderate, Saco-Merrimack-Charles EDU was fair-poor, the Lower Connecticut was fair-poor, and Cape Cod was fair-poor.

In terms of the Landscape Context percent developed component, the Upper Connecticut EDU had the highest percentage of watersheds in the least impacted category 1 (55%), followed by Saco-Merrimack-Charles EDU (20%). The Cape Cod EDU had the highest percentage of watersheds in the most impacted category 5 (40%), followed by the Lower Connecticut EDU (31%). Numerous studies have found a negative relationship between the amount of catchment urban area and stream reach level aquatic Index of Biotic Integrity (IBI) scores (Jones and Clark 1987, Steedman 1988, Couch et al. 1997, Dreher 1997, Wang et al.,1997, Yoder et al. 1999, Gordon and Majumder 2000). Impervious surfaces associated with development are widely cited as major sources of non-point pollution such as sedimentation and alteration of the flow regime as water rapidly runs off relatively impervious surfaces, especially in storm or snowmelt events. The increased silt and sediment load increases turbidity in streams, alters nutrient levels and chemistry of water, reduces the quality of gravel spawning beds, and can change the distribution and distinction between riffle, pool, and run habitat. These changes have been linked to significant changes in the diversity and abundance of species (Berkman, and Rabeni 1987).

Urbanization also leads to development on floodplains, road building, destruction of riparian ecosystems, increasing demands for water uses, and the release of point source pollution to aquatic systems.

In terms of the Landscape Context Road Density component, the Upper Connecticut EDU had the highest percentage of watersheds in the least impacted category 1 (18%), followed by Middle Connecticut EDU (5%). The Cape Cod EDU had the highest percentage of watersheds in the most impacted category 4 (80%), followed by the Lower Connecticut EDU (52%). Watershed-wide road density has been found to be significantly negatively related to stream IBI (Bolstad and Swank 1997). The amount of road near streams has also been noted as an indicator contributing to lower IBIs (Moyle and Randall 1998, Arya 1999). Roads near stream channels tend to restrict a stream's lateral movement and keep it in a single channel. Fast channelized currents erode the stream bottom, cutting deeply into the stream bed lowering the elvation of the active channel. The deeper channel restricts movement of water into the floodplain negatively impacting floodplain communities and lowering the local water table. Culverts at road-stream crossings can pose a significant barrier to the movement of many types of aquatic biota that will not cross culverts due to the change in cover, substrate, and flow velocity. Roads also increase the amount of impervious surfaces in the watershed that increases non-point pollution such as sedimentation as water rapidly runs off.

In terms of the Landscape Context percent Agricultural ranking component, the Upper Connecticut EDU had the highest percentage of watersheds in the least impacted category 1 (30%) followed by Saco-Merrimack-Charles EDU (11%). The Lower Connecticut EDU had the highest percentage of watersheds in the most impacted category 4 (52%) followed by the Cape Cod EDU (40%). Runoff of fertilizers, pesticides, and herbicides are major sources of non-point pollution in agricultural watersheds. Agriculture increases nutrient levels due to fertilizers and animal wastes and by soil erosion increasing the transport of phosphorus. Grazing simplifies the riverine-riparian ecosystem as animals trample and consume riparian vegetation inhibiting regeneration of natural plant communities and increasing sedimentation rates. Depletion of riparian large wood debris leads to increased temperatures instream and depletion of instream large woody debris will alter channel stabilization, habitat pools, and sinousity.

A total of 3104 dams occurred in the analysis area with an average density of .79 dams per 10 stream mile or 1.01 dams per 10 square mile of watershed. The Upper Connecticut EDU had the lowest overall dam densities followed by the Saco/Merrimack/Charles, Middle Connecticut, Lower Connecticut and Cape EDU. The majority of the dams occurred on size 1 rivers, however the overall dam density per stream mile was higher on the size 2 (0.87) and size 3 (0.93) rivers than on the size 1 (0.78) or size 4 (0.51), indicating a higher level of overall fragmentation on these medium to large rivers. This pattern holds when looking within Ecological Drainage Units for the Saco/Merrimack/Charles, Upper Connecticut, and Middle Connecticut EDU; however, in the Lower Connecticut and Cape EDU the size 1 rivers have a higher dam density than the size 2 or 3 rivers. This may be due to the fact that these EDUs are generally much flatter than the other 3 EDUs and dominated by low and very low gradient larger rivers. In these EDUs, most moderate to high gradient segments, where significant gradient changes and thus good dam locations occur, are likely within size 1 streams. The pattern may also be due to the fact that these EDUs are much more highly settled than the other 3 edus and it is possible all the ideal dam locations on size 2 and 3 rivers were exploited and people began to build dams extensively even on smaller rivers.

Most of the dams in the analysis region were recreational dams (49%), followed by watersupply dams (20%), hydroelectric dams (11%), and flood control dams (6%). If only dams on the larger size 2-4 rivers are considered, the predominant type of dam changes, with hydroelectric dams making up 47% of the dams, followed by recreational (19%), water supply (11%), and flood control (10%). The Upper Connecticut, Middle Connecticut, and Saco/Merrimack/Charles EDU had the highest percentages of hydroelectric dams. Few very high dams (> 50 ft.) existed in the analysis region (5%) with the remaining dams relatively equally distributed between the lower dam (< 15ft) and moderate (>15 and <= 50) category. Of the very large dams, the majority are water supply (38%), followed by flood control (32%) and hydroelectric (20%).

Dams alter the structure and ecosystem functioning of a river as it is transformed from a continuous free-flowing system into river segments interrupted by impoundments. In addition to causing barriers to upstream and downstream migration and severing the river from it floodplain, dams cause a series of changes downstream and upstream from the impoundment including changes in flow, oxygen, temperature, and water clarity (Allen 1995). For example, dams that release high discharges cause the scouring of fine material, the compaction of the surface substrate below the dam, channel downcutting, and bank erosion. Rivers are also often deepened and widened in the impoundments behind dams altering temperature, oxygen, and sedimentation regimes. The size, purpose, and operation of dams also highly influence their impact on river systems. Hydroelectric dams are some of the largest dams and store water for release to meet specific energy demands that vary seasonally and throughout a 24 hour period. Daily fluctuations in energy demands usually cause operators to only allow water flow through the turbines from mid-morning through early evening. Run-of-the-river dams are usually of low height and are thought to have small adverse effects as they release water at the rate it enters the reservoir. Irrigation dams store as much water as possible during the rainy season for release during the growing season. Flood control reservoirs maintain only a small permanent pool in order to maximize storage capacity in case of a flood event. Navigation dams store water to offset low flow conditions and are complemented by a system of locks and other dams. Recreational and water supply dams usually store a certain amount of water during the rainy season to sustain reservoir capacity and have a variety of release management practices (Allen 1995).

Results of the system relative ordination analysis highlighted the top ranked watersheds in each size 2 system type in terms of the land cover and road axis, dam and drinking water supply axis, and point source axis. The results found very few watersheds fell in the top category for all three axes, making it difficult to select one single “best” watershed per system type via the GIS screening alone. This was expected because previous correlation analysis showed the land cover and road variables were not highly correlated with the dam and drinking water or point source variables. For example, only 2 of the 206 watersheds were ranked 1st in all three categories of land cover/road, dams/drinking water, and point source impacts. Excluding the point source ranking, only 9 watersheds (representing 4% of all watersheds, 36% of the 25 system types) were ranked both 1st in land cover/road and 1st in dams/drinking water impacts. 19 watersheds (representing 10% all watersheds, 76% of systems) were ranked 1st or 2nd in land cover/road and 1st or 2nd in dams/drinking water impacts. The top ranked (1) watersheds in the system-relative landcover and roads axis also varied widely in their overall Landscape Context rank from 1 (10% of all relative ranked 1 watersheds) through 2(30%), 3(27), 4(27%), to 5(7%). This highlighted the fact that some system types occurred entirely within very poor landscape context areas where even the best ranked watershed fell in overall landscape context category 4 or 5. These systems types occurred in the Lower Connecticut and Cape Cod EDU.

The expert interviews provided critical information regarding the biological diversity and condition of sites across the region. Although a standardized information form was used to collect the 452 expert interview site records, the varying background of the interviewees led to vast differences in the level of detail recorded on the interview forms. Many fields were left entirely blank on most interview forms, including in nearly all cases the ranking fields for size, condition, and landscape context. For example only 38 of the 452 had any landscape context ranks listed. The significant blanks in relation to some of these larger scale condition attributes highlighted the inability of most interviewees and TNC staff to put the described sites into size, condition, or landscape rank categories given the available information. Ranking required detailed knowledge of the desired native natural biotic community vs. the current biotic community, understanding of the current and natural flow regime, the ripairian and watershed condition around site, and the ability to compare the site to the existing range of quality among other sites over large spatial watershed scales. Despite these blanks, much useful information on local conditions and biological diversity was collected through this interview process. The information on the presence of particular species, biological communities, substrate diversity, temperature, flow, and other key ecological processes at the sites was particularly helpful because this information could not be gathered from GIS. In many cases information on exotic species and other local condition information such as dam management, bank stability, smaller local water withdrawals/well, and riparian buffer condition were noted.

Although exotic species could not be comprehensively evaluated for each size 2 watershed, nonindigenous species are a significant threat to aquatic ecosystems in this analysis area. Nonindigenous species have a number of negative impacts such as competition with indigenous species for food and habitat, reduction of natives by predation, transmission of diseases or parasites, hybridization, and habitat alteration. The USGS Nonindigenous Aquatic Species database (http://nas.er.usgs.gov) that records of all introduced, regardless of whether or not they because established, lists 94 introduced fish species in New England, with 25 of those species exotic to the region. The most widespread introduced fish species in New England include the bluntnose minnow, brown trout, burbot, cutlips minnow, fathead minnow, lake trout, largemouth bass, pearl dace, pumpkinseed, rainbow smelt, rainbow trout, rock bass, round-whitefish, and trout-perch. In addition to fish, a large number of nonindigenous species of other taxa such as plants, amphibians, reptiles, mammals, mollusks, crustaceans, and sponges have also entered aquatic systems and caused significant ecosystem alteration. For example in New England, the USGS database referred to above reports 9 (7 exotic) amphibians, 1 exotic jellyfish, 8 (2 exotic) crustaceans, 1 exotic byozoan, 15 (10 exotic) mollusks, 17 (5 reptiles), 4 (1 exotic) tunicate, and 23 aquatic vascular plants. Although these introductions have not all resulted in established populations, some of the most problematic and invasive species within the 5 EDUs include the asiatic clam, purple loosestrife, common reed grass, Eurasian water-milfoil, water-chestnut, yellow iris, curly pondweed, two-leaf water-milfoil, European water-clover, Carolina fanwort, watercress, Brazilian waterweed, dotted duckweed, pond water-starwort, and hydrilla. These species have or can significantly alter physical and biological functions of aquatic systems. For example, the water chestnut is a highly invasive species that can out-compete native plants, choke the waterbodies it invades, and reduce oxygen levels that increases the potential for fish kills. Similarly, Eurasian watermilfoil, a stringy submerged plant, can quickly proliferate and aggressively compete with native plant communities to form large dense mats that clog waterbodies. Purple Loosestrife, an invasive wetland perennial plant, will grow densely in shallow waterbodies or wetlands and can eliminate food and shelter for wildlife including shallow water fish spawning grounds. Curly pondweed, a submerged perennia, can tolerate low light and low water temperatures, making it competitively superior especially early in the season as it forms new plants under ice cover. Mid-summer die offs of this plant may result in a critical loss of dissolved oxygen and decaying plant matter can increase water nutrients and contribute to subsequent algal blooms.

Portfolio Assembly Results

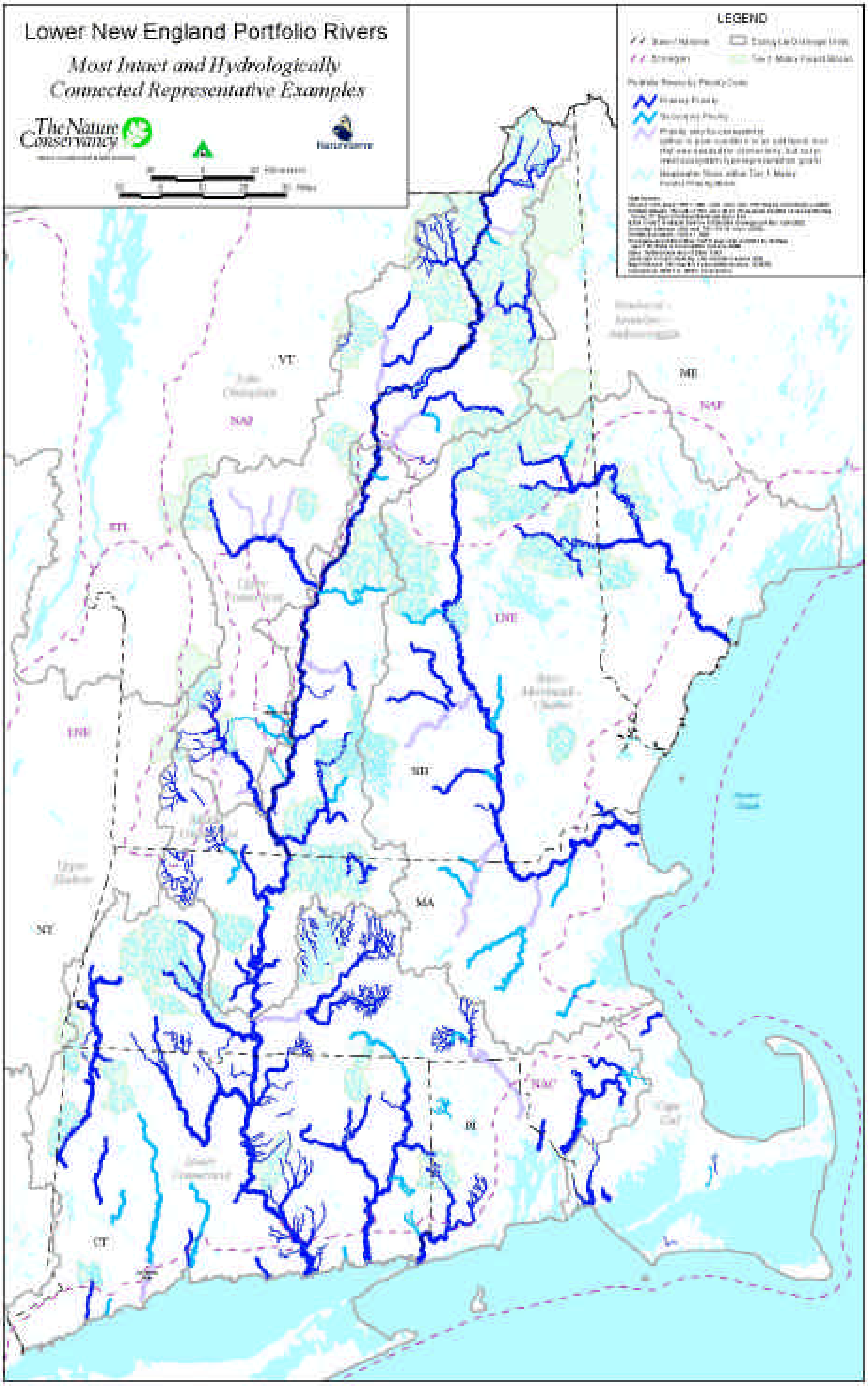
Portfolio Number and Miles

257 examples were selected for the portfolio (Table 17, Figure 11). These portfolio examples included 8140 stream miles. The decision was made to display the portfolio as line segments even though conservation of the portfolio will require watershed wide strategies. Note that the number of portfolio examples is larger than simply the number of named portfolio rivers because a portfolio river system that contained multiple size classes was broken at each size class for portfolio example record keeping. Thus, the Ashuelot River Size 1, Ashuelot River Size 2, and Ashuelot River Size 3 sections would be recorded as 3 portfolio examples, not simply one portfolio example. Named branches of rivers were also used to define portfolio example so the Westfield East Branch, Westfield Middle Branch, and Westfield West Branch were considered 3 examples even though they were all examples of a size 2_9 system type.

Table 17: Portfolio Examples by EDU, Portfolio Code, and Stream Size

Portfolio Milage by EDU, Portfolio Code, and Stream Size						
		SIZE				
EDUNAME	PORTCODE	1	2	3	4	Milage Totals
Cape Cod	S1c	15	38			53
	S2c	7				7
Cape Cod Total		23	38			60
Lower Connecticut	S1	162	55			216
	S1c	709	410	305	120	1543
	S2	28	13			41
	S2c	35	153	19		207
	S2m	763				763
	Sxc		2	69	13	85
Lower Connecticut Total		1697	632	393	133	2855
Middle Connecticut	S1	173	51			224
	S1c	22	114	27	203	366
	S2		13			13
	S2c		55			55
	S2m	886				886
	Sxc			18		18
Middle Connecticut Total		1080	233	45	203	1562
Saco-Merrimack-Charles	S1c	6	191	159	173	529
	S2c		184	6		190
	S2m	1364				1364
	Sxc			98		98
Saco-Merrimack-Charles Total		1371	375	263	173	2181
Upper Connecticut	S1	9				9
	S1c	178	228	111	95	612
	S2c	20	34			54
	S2m	684				684
	Sxc		79	44		123
Upper Connecticut Total		891	341	154	95	1481
Grand Total		5061	1619	856	604	8140

Figure 11: Aquatic Portfolio



Representation Goals

Representation goals were met for all systems except the NH/ME coastal systems where expert interviews are not complete. See Table 18 for a report of the number of portfolio examples selected within each System Type.

Table 18: Portfolio Examples by Type and Portfolio Code

SIZE/EDU/SYSTEM TYPE DOWN; PORTFOFOLIO CODE ACROSS; NUMBERS REPRESENT COUNT OF PORTFOLIO EXAMPLES CONTAINING THIS CATEGORY													
Size-System	S1	S1c	S2	S2c	Sxc	Grand Total	Size-System	S1	S1c	S2	S2c	Sxc	Grand Total
1	10	37	1	5		53	3_1					1	1
2_1		3				3	3_2					1	1
2_2		4		2		6	3_3						0
2_3		8		3	1	12	3_4				1		1
2_4		1		2		3	3_5		2				2
2_5		4		1		5	3_6		1				1
2_6		7		1		8	3_7					1	1
2_7	6					6	3_8		1				1
2_8	1		1	1		3	3_9		1			1	2
2_9		5				5	3_10		3		1		4
2_10	1	3	1			5	3_11		2			1	3
2_11	2	3		1		6	3_12		3				3
2_12		1		2		3	3_13		1				1
2_13		1		1	1	3	3_14		1				1
2_14		5		1	1	7	3_15		1				1
2_15		3				3	3_16		1				1
2_16		1			3	4	3_17					2	2
2_17	1	4		2	3	10	3_18					1	1
2_18		2				2	3_19		1			1	2
2_19		4		1		5	4		7			1	8
2_20		2		1		3	Grand Total	21	128	3	33	19	257
2_21						0							
2_22		2		2		4							
2_23		2		1		3							
2_24		1		4		5							

Connectivity Goals

180 of the 257 portfolio examples were part of a connected network. See the map of the portfolio, Figure 11 for a spatial representation of the network and non-network portfolio examples. The identified networks represent the team's estimation of the best representative river examples to focus on maintaining of developing functional networks for migratory fish. The 5 largest rivers in the analysis area, the Connecticut, Merrimack, Saco, Thames, and Housatonic were all chosen as important network portfolio examples, however only the lower section of the Housatonic was included due to the high level of fragmentation on the middle section of the Housatonic. Migratory target fish occurred in all of the size 3 river system types so the network goal was that all size 3 river systems required functional networks from larger river mouth to headwaters for migratory. See Table 19 regarding which migratory fish use which size 3 system types.

Table 19: Size 3 Watershed System Type by Migratory Fish

Sys. Size 3	ALEWIFE	AMERICAN EEL	AMERICAN SHAD	ATLANTIC SALMON	ATLANTIC STURGEON	BANDED KILLIFISH	BLUEBACK HERRING	FOURSPINE STICKLEBACK	GIZZARD SHAD	HICKORY SHAD	NINESPINE STICKLEBACK	RAINBOW SMELT	RAINWATER KILLIFISH	SEA LAMPREY	SHEEPSHEAD MINNOW	SHORTNOSE STURGEON	STRIPED BASS	WHITE PERCH	Grand Total
1	1	1	1			1	1	1		1	1	1		1			1	1	12
2		1				1													2
3	1	1	1	1		1	1	1		1	1	1		1			1	1	13
4	1	1	1	1	1	1		1			1			1		1	1	1	12
5	1	1	1			1	1					1		1			1	1	9
6			1	1														1	3
7	1					1												1	3
8	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	16
9	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	17
10	1	1	1		1	1	1											1	7
11		1				1													2
12		1	1	1		1	1							1				1	7
13	1	1	1		1	1												1	6
14		1	1	1	1	1	1							1		1		1	9
15		1		1		1								1					4
16		1		1		1													3
17		1	1	1		1	1					1		1				1	8
18		1		1															2
19		1		1								1							3
Grand Total	9	17	12	12	6	16	9	5	1	4	5	5	2	10	2	4	6	13	138

Networks were identified for all size 3 system types except system 3_3 which was a coastal Maine system that was not fully evaluated in this analysis due to lack of expert review in Maine and system 3_13 which was the Housatonic River whose mainstem is fragmented by a number of large reservoirs which the team felt were permanent barriers to developing a functional network. Although networks were identified for each system type, they vary in quality and many currently contain dams. For example, the only size 3 portfolio river with no dams on its mainstem to the ocean, potentially the most functional network example in the portfolio, is the Taunton River. Some rivers were included in the portfolio for connectivity purposes, but are were coded as Sxc because the team felt they did not meet the criteria for a S1 (best) or S2 (good/second best) rank within their system type given their current condition. These Sxc examples usually contain many dams or have other serious current condition problems making them poor examples of their type, but they are still necessary if functional networks are going to be restored for all size three system types. Sxc rivers that were identified as part of the portfolio include the Chicopee, Blackstone, Concord, Nashusa, Contoocook, Sugar, Ammonoosuc, Wild Ammonoosuc, Passumpsic.

Table 20: Size 3 Portfolio Network Examples

EDU	Lower Connecticut EDU	Downstream connectivity	Portfolio Code	Size 3 System Type
Lower Connecticut EDU	Chicopee	Connecticut	Sxc	11
Lower Connecticut EDU	Farmington	Connecticut	S1c	12
Lower Connecticut EDU	Westfield	Connecticut	S1c	12
Lower Connecticut EDU	Blackstone	Ocean	Sxc	9
Lower Connecticut EDU	Pawcatuck	Ocean	S1c	9
Lower Connecticut EDU	Quinebaug	Thames	S1c	10
Lower Connecticut EDU	Shetucket	Thames	S1c	10
Lower Connecticut EDU	Tauton	Ocean	S1c	8
Middle Connecticut	Ashuelot	Connecticut	S1c	14
Middle Connecticut	Sugar	Connecticut	Sxc	17
Upper Connecticut	Ammonoosuc	Connecticut	Sxc	17
Upper Connecticut	Passumpsic	Connecticut	Sxc	18
Upper Connecticut	Upper Ammonoosuc	Connecticut	Sxc	19
Upper Connecticut	West	Connecticut	S1c	15
Upper Connecticut	White	Connecticut	S1c	16
Saco/Merrimack/Charles	Concord	Merrimack	Sxc	1
Saco/Merrimack/Charles	Contoocook	Merrimack	Sxc	7
Saco/Merrimack/Charles	Nashua	Merrimack	Sxc	2
Saco/Merrimack/Charles	Pemigewasset	Merrimack	S1c	6
Saco/Merrimack/Charles	Piscataquog	Merrimack	S2	4
Saco/Merrimack/Charles	Ossipee	Saco	S1c	5
Saco/Merrimack/Charles	Saco River	Saco	S1c	5

Network were also identified for all size 2 system types except for system 2_7 which occurred in upper section of the Housatonic drainage. The team felt the large number of problems breaking the connectivity of the upper Housatonic from the lower Housatonic (dams, reservoir, contamination) make it unrealistic for the team to target this as a connected system in the near future. Note that the size 1 connected network has not been fully defined as the size 1 portfolio was not fully addressed in this analysis.

Threats Across the Portfolio

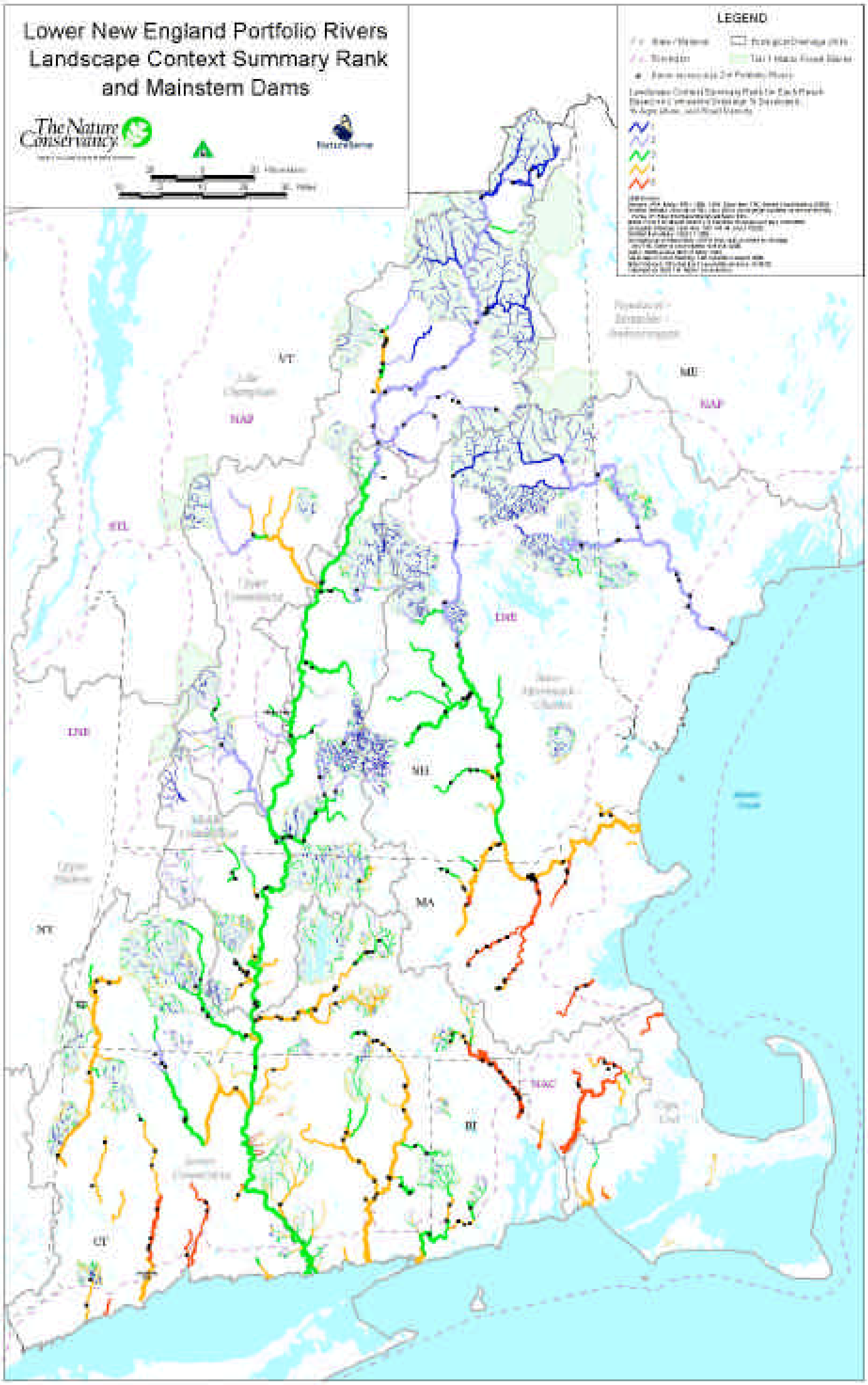
Impact from Non-Point Point Pollution

The portfolio examples varied significantly in overall landscape context rank within and between EDUs (Table 21, Figure 12). The data show that 13% of portfolio examples fall in the overall landscape context categories of very good (1) category, 22% fall in the good (2) category, 23% fall in the moderate/fair (3) category, 35% fall in the poor (4) category, and 8% fall in the very poor (5) category. The portfolio examples for size 1-3 rivers ranged across all landscape context ranking from very good (1) to very poor (5). The portfolio examples for size 4 rivers ranged from category 2-4. The Upper Connecticut and Middle Connecticut have no portfolio examples falling in the very poor category. The Cape Cod EDU and Lower Connecticut EDU have no examples falling in the very good (1) category. See PortfolioOccurrences.txt or .xls for a list of all portfolio examples by their Landscape Context Ranks.

Table 21: Portfolio Examples by EDU, Size, and Overall Range in Landscape Context Ranking

Portfolio Sites by EDU, Size, and Landscape Context Summary Rank							
EDUNAME	size	1	2	3	4	5	Grand Total
Cape Cod	1				3	1	4
	2				2	1	3
Cape Cod Total					5	2	7
Lower Connecticut	1		4	14	19	2	39
	2		2	11	25	8	46
	3			2	9	3	14
	4			1	2		3
Lower Connecticut Total			6	28	55	13	102
Middle Connecticut	1	2	6	6	5		19
	2	1	2	8	6		17
	3			2			2
	4			1			1
Middle Connecticut Total		3	8	17	11		39
Saco-Merrimack-Charles	1	5	6	1	3		15
	2	2	5	7	4	4	22
	3		3	1	2	1	7
	4		2		1		3
Saco-Merrimack-Charles Total		7	16	9	10	5	47
Upper Connecticut	1	14	12	2	1		29
	2	7	11	3	5		26
	3	1	3		2		6
	4		1				1
Upper Connecticut Total		22	27	5	8		62
Grand Total		32	57	59	89	20	257

Figure 12: Range in Portfolio Landscape Context Rank



Range in Landscape Context Ranking within EDU by Ecosystem Type

Review of the landscape context ranking within certain system types shows that certain systems are more heavily affected by the condition of the surrounding landscape. See the tables and summaries below for more information.

Table 22: Cape Cod Portfolio Landscape Context By System And Portfolio Code

Cape Cod EDU		Landscape Context Summary Rank		
SIZESYS	PORTCODE	4	5	Grand Total
1	S1c	3		3
	S2c		1	1
1 Total		3	1	4
2_1	S1c	2	1	3
2_1 Total		2	1	3
Grand Total		5	2	7

All the portfolio examples fall within the category 4 and 5.

Table 23: Lower Connecticut Portfolio Landscape Context By System And Portfolio Code

Lower Connecticut EDU		Landscape Context Summary Rank					
SIZESYS	PORTCODE	1	2	3	4	5	Grand Total
1	S1		1	2	2		5
	S1c		1	5	11	2	19
	S2			1			1
	S2c				2		2
	S2m		2	6	4		12
1 Total			4	14	19	2	39
2_2	S1c				1	3	4
	S2c				2		2
2_2 Total					3	3	6
2_3	S1c			5	3		8
	S2c				3		3
	Sxc					1	1
2_3 Total				5	6	1	12
2_4	S1c					1	1
	S2c					2	2
2_4 Total						3	3
2_5	S1c				2	1	3
2_5 Total					2	1	3
2_6	S1c			2	5		7
	S2c				1		1
2_6 Total				2	6		8
2_7	S1			1	5		6
2_7 Total				1	5		6
2_8	S1				1		1
	S2				1		1
	S2c				1		1
2_8 Total					3		3
2_9	S1c		2	3			5
2_9 Total			2	3			5
3_10	S1c				3		3
	S2c					1	1
3_10 Total					3	1	4
3_11	S1c			1	1		2
	Sxc				1		1
3_11 Total				1	2		3
3_12	S1c			1	2		3
3_12 Total				1	2		3
3_13	S1c				1		1
3_13 Total					1		1
3_8	S1c					1	1
3_8 Total						1	1
3_9	S1c				1		1
	Sxc					1	1
3_9 Total					1	1	2
4	S1c			1	1		2
	Sxc				1		1
4 Total				1	2		3
Grand Total			6	28	55	13	102

The Lower Connecticut EDU portfolio examples range from landscape context category 2-5, with most of the examples falling in category 4(54%) or 3(28%). Although a few Size 2 portfolio examples fall within the category 2, none of the Size 3 or 4 portfolio examples fall in a category higher than 3. Of the size 2 systems, only system 2_ 9 has any examples in the landscape context category 2; these being the Farmington West Branch and Westfield Middle Branch. Size 2 system types 2_3, 2_6, 2_7, 2_8, and 2_9 have some examples in landscape context category 3. Size 2 system types 2_2, 2_4, and 2_5 have all their portfolio examples in category 4 or 5, with all portfolio examples of system 2_5 in the lowest landscape context category 5. Of the size 3 systems, systems 3_8, 3_9, 3_10, and 3_13 are in the poorer condition, with the only example of system 3_8, the Tauton, in the lowest category 5.

Table 24: Middle Connecticut Portfolio Landscape Context By System And Portfolio Code

Middle Connecticut EDU		Landscape Context Summary Rank				
SIZESYS	PORTCODE	1	2	3	4	Grand Total
1	S1	1	1	2		4
	S1c		1	1	1	3
	S2m	1	4	3	4	12
1 Total		2	6	6	5	19
2_10	S1				1	1
	S1c				3	3
	S2			1		1
2_10 Total				1	4	5
2_11	S1		1		1	2
	S1c			3		3
	S2c			1		1
2_11 Total			1	4	1	6
2_12	S1c			1		1
	S2c		1	1		2
2_12 Total			1	2		3
2_17	S1	1				1
2_17 Total		1				1
2_5	S1c				1	1
	S2c			1		1
2_5 Total				1	1	2
3_14	S1c			1		1
3_14 Total				1		1
3_17	Sxc			1		1
3_17 Total				1		1
4	S1c			1		1
4 Total				1		1
Grand Total		3	8	17	11	39

The Middle Connecticut EDU portfolio examples range from landscape context 1 to 4, with the highest percentage in category 3 (44%). The portfolio examples in landscape context category 1 include 2 size 1 examples and the system 2_17 example in the upper West River watershed. Portfolio examples in landscape context category 2 include system 2_11 and 2_12. system Systems 2_5, 2_10, and 2_11 include portfolio examples in the lowest category of 4.

Table 25: Upper Connecticut Portfolio Landscape Context By System And Portfolio Code

Upper Connecticut EDU		Landscape Context Summary Ranking				
SIZESYS	PORTCODE	1	2	3	4	Grand Total
1	S1	1				1
	S1c	7	3	1		11
	S2c		1		1	2
	S2m	6	8	1		15
1 Total		14	12	2	1	29
2_13	S1c		1			1
	S2c		1			1
	Sxc		1			1
2_13 Total			3			3
2_14	S1c	4	1			5
	S2c	1				1
	Sxc				1	1
2_14 Total		5	1		1	7
2_15	S1c	2	1			3
2_15 Total		2	1			3
2_16	S1c		1			1
	Sxc				3	3
2_16 Total			1		3	4
2_17	S1c		4			4
	S2c			2		2
	Sxc		1	1	1	3
2_17 Total			5	3	1	9
3_15	S1c		1			1
3_15 Total			1			1
3_16	S1c				1	1
3_16 Total					1	1
3_17	Sxc		1			1
3_17 Total			1			1
3_18	Sxc				1	1
3_18 Total					1	1
3_19	S1c		1			1
	Sxc	1				1
3_19 Total		1	1			2
4	S1c		1			1
4 Total			1			1
Grand Total		22	27	5	8	62

Portfolio examples in the Upper Connecticut EDU range from 1-4, with the highest percentage in category 2 (44%) or 1(36%). System types 1, 2_14, 2_15, and 3_19 have portfolio examples in landscape context category 1. System types 2_13, 2_16, 2_17, 3_15and 3_17 have some portfolio examples in landscape context category 2. System types 2_16, 2_17, 3_18, and 3_16 have portfolio examples in the lowest category of 4, although these 2_16 and 2_17 portfolio examples are already coded Sxc.

Table 26: Saco-Merrimack-Charles Portfolio Landscape Context By System And Portfolio Code

Sum of count		LCR_SUM					
SIZESYS	PORTCODE	1	2	3	4	5	Grand Total
1	S1c				1		1
	S2m	5	6	1	2		14
1 Total		5	7	2	2		15
2_18	S1c		2				2
2_18 Total			2				2
2_19	S1c	2	2				4
	S2c		1				1
2_19 Total		2	3				5
2_20	S1c			2			2
	S2c			1			1
2_20 Total				3			3
2_22	S1c				2		2
	S2c			1	1		2
2_22 Total				1	3		4
2_23	S1c			2			2
	S2c				1		1
2_23 Total				2	1		3
2_24	S1c				1		1
	S2c					4	4
2_24 Total					1	4	5
3_1	Sxc					1	1
3_1 Total						1	1
3_2	Sxc				1		1
3_2 Total					1		1
3_4	S2c				1		1
3_4 Total					1		1
3_5	S1c		2				2
3_5 Total			2				2
3_6	S1c		1				1
3_6 Total			1				1
3_7	Sxc			1			1
3_7 Total				1			1
4	S1c		2		1		3
4 Total			2		1		3
Grand Total		7	16	9	10	5	47

Saco/Merrimack/Charles portfolio examples range from landscape context ranking 1-5, with the highest percentage in category 2 (34%). System types 1 and 2_19 have examples in category 1. System types 2_18, 3_5, and 3_6 have examples in category 2. System types 2_20, 2_22, 2_23, and 3_7 have examples in category 3. System types 2_24, 3_1, 3_2, and 3_4 have examples only on category 4 or 5, with the only portfolio example for system 3_1, the Concord, occurring in category 5.

Heavy Agricultural Impacts

136 (53%) portfolio examples fell within the Landscape Context Agricultural Impact Rank category 3 or 4. Of the 100 size 2+ portfolio examples in Landscape Context Agricultural Impact Rank category 3 or 4, 52 fell in category 3 and 48 fell in category 4. The 48 examples falling in category 4 are listed below. They occur in every EDU.

Table 27: Portfolio Size 2-4 Examples falling in Category 4 Heavy Agricultural Impacts

Portfolio Examples for Size 2-4 Rivers with Landscape Context Agricultural Rank 4 (> 10% agriculture in the watershed)								
SIZESYS	PORTCODE	EXAMPLENAME	PTOT_AGR	EDUNAME	CT	MA	NH	VT
2_1	S1c	Slocums River	12.03	Cape Cod		x		
2_1	S1c	West Port River	12.82	Cape Cod		x		
4	S1c	Thames River	13.36	Lower Connecticut	x			
4	Sxc	Housatonic River	14.73	Lower Connecticut	x			
3_13	S1c	Housatonic River	15.54	Lower Connecticut	x	x		
3_11	S1c	Quaboag River	14.33	Lower Connecticut		x		
3_11	Sxc	Chicopee River	10.25	Lower Connecticut		x		
3_10	S1c	Quinebaug River	12.95	Lower Connecticut	x			
3_10	S1c	Hop River / Willimantic River	12.90	Lower Connecticut	x			
3_10	S1c	Shetucket River	13.56	Lower Connecticut	x			
3_10	S2c	Naugatuck River	11.33	Lower Connecticut	x			
2_8	S1	Shepaug River	19.73	Lower Connecticut	x			
2_8	S2	Pomperaug River	20.37	Lower Connecticut	x			
2_8	S2c	Naugatuck River	12.98	Lower Connecticut	x			
2_7	S1	Blackberry River	10.51	Lower Connecticut	x			
2_7	S1	Green River	14.20	Lower Connecticut		x		
2_7	S1	Salmon Creek	17.62	Lower Connecticut	x			
2_7	S1	Williams River	12.47	Lower Connecticut		x		
2_7	S1	Schenob Brook	16.76	Lower Connecticut		x		
2_6	S1c	Salmon River	12.98	Lower Connecticut	x			
2_6	S1c	Quaboag River	15.03	Lower Connecticut		x		
2_6	S1c	Ware River	10.95	Lower Connecticut		x		
2_6	S1c	Hop River	11.76	Lower Connecticut	x			
2_6	S1c	Shetucket River	11.80	Lower Connecticut	x			
2_5	S1c	Coginchaug River	20.68	Lower Connecticut	x			
2_5	S1c	Scantic River	26.55	Lower Connecticut	x			
2_5	S1c	East Branch Salmon Brook	15.15	Lower Connecticut	x			
2_4	S2c	Mill River (Saugatuck Drainage)	10.60	Lower Connecticut	x			
2_4	S2c	Quinnipiac River	12.95	Lower Connecticut	x			
2_3	S1c	Queens River	10.35	Lower Connecticut				
2_3	S2c	Pachaug River	10.24	Lower Connecticut	x			
2_2	S1c	Palmer River	14.44	Lower Connecticut		x		
2_2	S2c	Winnetuxet River	10.19	Lower Connecticut		x		
2_5	S1c	Fort River	18.72	Middle Connecticut		x		
2_10	S1	Green River	10.58	Middle Connecticut		x		x
2_10	S1c	Manhan River	11.82	Middle Connecticut		x		
2_10	S1c	Roaring Brook	16.79	Middle Connecticut		x		
3_4	S2c	Piscataquog River	10.13	Saco-Merrimack-Charles			x	
3_2	Sxc	Nashua River	10.34	Saco-Merrimack-Charles		x	x	
2_24	S2c	Assabet River	10.90	Saco-Merrimack-Charles		x		
2_22	S1c	Baboosic Brook	11.22	Saco-Merrimack-Charles			x	
3_18	Sxc	Passumpsic River	10.43	Upper Connecticut			x	x
3_16	S1c	White River	12.78	Upper Connecticut				x
2_17	Sxc	White River, Third Branch	12.40	Upper Connecticut				x
2_16	Sxc	Passumpsic River	10.47	Upper Connecticut				x
2_16	Sxc	White River, First Branch	18.82	Upper Connecticut				x
2_16	Sxc	White River, Second Branch	23.36	Upper Connecticut				x
2_14	Sxc	Mohawk River	15.92	Upper Connecticut			x	
					21	18	5	7

Heavy Development and Road Impacts

146 (57%) portfolio examples fell within the Landscape Context Road Density or Development Rank categories 3, 4, or 5. Of the 97 size 2+ portfolio examples falling within the Landscape Context Road Density or Development Rank categories 3, 4, or 5, 51 fell in category 4 or 5 and 42 fell in category 3. The 51 examples falling in category 4 or 5 are listed below. They occur in all EDUs except the Upper Connecticut.

Table 28: Portfolio Size 2-4 Examples falling in Category 4 or 5 for Heavy Development and Road Impacts

Portfolio Examples for Size 2-4 Rivers with Landscape Context Road Density or Development Ranks 4 or 5
(>6% developed or > 3.5 miles roads/watershed sq.mi.)

SIZESYS	PORTCODE	EXAMPLENAME	RD_SQMI	%DEV	EDUNAME	RI	CT	MA	NH
2_1	S1c	North River	5.09	23.71	Cape Cod			x	
2_1	S1c	Slocums River	3.88	14.85	Cape Cod			x	
2_1	S1c	West Port River	3.12	7.02	Cape Cod			x	
4	S1c	Thames River	3.57	6.91	Lower Connecticut		x		
4	Sxc	Housatonic River	3.84	9.88	Lower Connecticut		x		
3_9	S1c	Pawcatuck River	3.53	4.86	Lower Connecticut	x	x		
3_9	Sxc	Blackstone River	6.10	21.00	Lower Connecticut	x		x	
3_8	S1c	Taunton River	5.03	18.00	Lower Connecticut			x	
3_12	S1c	Farmington River	3.75	9.79	Lower Connecticut		x		
3_12	S1c	Westfield River	2.70	6.27	Lower Connecticut		x	x	
3_11	S1c	Quaboag River	3.62	6.51	Lower Connecticut			x	
3_11	Sxc	Chicopee River	3.17	6.41	Lower Connecticut			x	
3_10	S1c	Quinebaug River	3.57	6.70	Lower Connecticut		x		
3_10	S1c	Hop River / Willimantic River	3.53	7.00	Lower Connecticut		x		
3_10	S2c	Naugatuck River	5.66	19.20	Lower Connecticut		x		
2_8	S2	Pomperaug River	3.97	5.67	Lower Connecticut		x		
2_8	S2c	Naugatuck River	5.00	14.73	Lower Connecticut		x		
2_6	S1c	Salmon River	3.67	5.95	Lower Connecticut		x		
2_6	S1c	Quaboag River	3.51	5.69	Lower Connecticut			x	
2_6	S2c	Quinebaug River	3.79	7.64	Lower Connecticut		x	x	
2_5	S1c	Coginchaug River	5.82	28.16	Lower Connecticut		x		
2_5	S1c	Scantic River	3.71	11.55	Lower Connecticut		x		
2_4	S1c	Mill River (Quinnipiac Drainage)	7.95	40.04	Lower Connecticut		x		
2_4	S2c	Mill River (Saugatuck Drainage)	7.09	30.45	Lower Connecticut		x		
2_4	S2c	Quinnipiac River	7.37	37.57	Lower Connecticut		x		
2_3	S2c	Mumford River	3.50	8.05	Lower Connecticut			x	
2_3	S1c	Hammonasset River	3.98	5.29	Lower Connecticut		x		
2_3	S1c	Saugatuck River	5.13	12.57	Lower Connecticut		x		
2_3	S2c	Niantic River	3.40	7.88	Lower Connecticut		x		
2_3	Sxc	Blackstone River	6.62	26.48	Lower Connecticut			x	
2_2	S1c	Palmer River	4.78	16.04	Lower Connecticut	x		x	
2_2	S1c	Canoe River	4.81	20.28	Lower Connecticut			x	
2_2	S1c	Namasket River	3.54	7.51	Lower Connecticut			x	
2_2	S1c	Town River	5.16	20.56	Lower Connecticut			x	
2_2	S2c	Assonet	3.22	9.25	Lower Connecticut			x	
2_2	S2c	Winnetuxet River	3.47	9.65	Lower Connecticut			x	
2_5	S1c	Fort River	3.63	12.31	Middle Connecticut			x	
2_11	S1	Millers River, Upper Section	3.39	6.27	Middle Connecticut			x	
2_10	S1c	Manhan River	2.97	10.10	Middle Connecticut			x	
2_10	S1c	Mill River	2.88	9.30	Middle Connecticut			x	
4	S1c	Merrimack River	3.46	10.32	Saco-Merrimack-Charles			x	x
3_2	Sxc	Nashua River	4.41	13.97	Saco-Merrimack-Charles			x	x
3_1	Sxc	Concord River	6.16	23.77	Saco-Merrimack-Charles			x	
2_24	S1c	Parker River	4.15	12.03	Saco-Merrimack-Charles			x	

2_24	S2c	Assabet River	5.45	18.03	Saco-Merrimack-Charles			x	
2_24	S2c	Sudbury River	6.31	25.41	Saco-Merrimack-Charles			x	
2_24	S2c	Shawsheen River	9.12	43.65	Saco-Merrimack-Charles			x	
2_24	S2c	Neponset River	8.66	39.17	Saco-Merrimack-Charles			x	
2_22	S1c	Powwow River	4.29	12.91	Saco-Merrimack-Charles			x	x
2_22	S1c	Baboosic Brook	3.58	9.06	Saco-Merrimack-Charles				x
2_22	S2c	Squannacook River	3.47	6.87	Saco-Merrimack-Charles			x	
						3	20	31	4

Impact from Dams

Of the 257 portfolio examples, 184 examples (72% of all portfolio examples) had National Inventory of Dams (NID) dams within their upstream network. Of those 73 examples without dams fragmenting the upstream network, 68 (93%) of these examples were Size 1 examples, with 45 of these being S2M examples already within TNC priority forest matrix examples. Of the 5 non-size 1 portfolio examples without NID dams in their upstream network all 5 had a NID dam downstream before reaching the ocean.

Table 29: Portfolio Size 2-4 Examples without NID Dams in their upstream network with distance to nearest downstream dam

Portfolio Size 2 Examples without NID dams in their upstream watershed, by distance to nearest dam					Distanct to nearest downstream dam								
SIZESYS	PORTNAME	PORT CODE	SIZE_3	SIZE_4	none to ocean	0-4 mi.	5-9 mi.	9 - 14 mi.	15 - 19 mi.	20 - 29 mi.	30 - 39 mi.	40 - 49 mi.	50 mi. +
2_19	Saco River, East Branch	S2c		Saco					1				
2_17	Wardsboro Brook	Sxc		Connecticut							1		
2_16	Passumpsic River, East Branch	S1c		Connecticut		1							
2_15	Nulhegan River	S1c		Connecticut					1				
2_15	Nulhegan River, East Branch	S1c		Connecticut						1			

Considering just the medium to large portfolio rivers and just dams across their mainstem sections (not dams in their connected upstream size 1 network), of the 151 Size 2-4 portfolio examples, 69 (46%) had no dams on their mainstem sections. These examples included the above 5 above examples and the following 64 examples. However even though these 64 examples had no dams on their portfolio mainstem sections, 78% of these 64 examples had a dam downstream before reaching the ocean. The few portfolio rivers whose mainstems were not fragmented before reaching the ocean include the coastal size 2 rivers examples of the North, Slocums,West Port, Palmer, Hammonasset, Niantic, Mill, and Parker, the Eightmile tributary of the Connecticut, and the size 3 Taunton River and its size 2 tributaries of the Assonet, Namasket, and Winnetuxet. See Table 30 below for more information on distance to nearest dam downstream for the 64 examples that did not have a dam on their mainstem section.

Table 30: Size 2-4 Portfolio Examples without dams on their mainstem by Portfolio Code and Distance to nearest dam downstream

Portfolio Size 2-4 Examples without dams on their mainstem sections, by distance to nearest dam downstream					Distanct to nearest downstream dam								
SIZESYS	PORTNAME	PORT CODE	SIZE_3	SIZE_4	none to ocean	0-4 mi.	5-9 mi.	9 - 14 mi.	15 - 19 mi.	20 - 29 mi.	30 - 39 mi.	40 - 49 mi.	50 mi. +
Cape Cod													
2_1	North River	S1c		Ocean	1								
2_1	Slocums River	S1c		Ocean	1								
2_1	West Port River	S1c		Ocean	1								
Lower Connecticut													
2_2	Assonet	S2c	Taunton River	Ocean	1								
2_2	Namasket River	S1c	Taunton River	Ocean	1								
2_2	Palmer River	S1c		Ocean	1								
2_2	Winnetuxet River	S2c	Taunton River	Ocean	1								
2_3	Blackstone River	Sxc	Blackstone River	Ocean			1						
2_3	Eightmile River	S1c		Connecticut	1								
2_3	Hammonasset River	S1c		Ocean	1								
2_3	Niantic River	S2c		Ocean	1								
2_3	West River	S1c	Blackstone River	Ocean			1						
2_4	Mill River (Saugatuck Drainage)	S2c		Ocean	1								
2_5	East Branch Salmon Brook	S1c	Farmington River	Connecticut			1						
2_6	Hop River	S1c	Shetucket River	Thames				1					
2_6	Mount Hope River	S1c	Shetucket River	Thames		1							
2_6	Natachaug River	S1c	Shetucket River	Thames		1							
2_7	Blackberry River	S1	Housatonic River	Housatonic			1						
2_7	Green River	S1	Housatonic River	Housatonic					1				
2_7	Hollenbeck River	S1	Housatonic River	Housatonic		1							
2_7	Salmon Creek	S1	Housatonic River	Housatonic						1			
2_7	Schenob Brook	S1	Housatonic River	Housatonic					1				
2_7	Williams River	S1	Housatonic River	Housatonic						1			
2_8	Pomperaug River	S2		Housatonic			1						
2_9	Sandy Brook	S1c	Farmington River	Connecticut				1					
2_9	Westfield River, West Branch	S1c	Westfield River	Connecticut		1							
3_10	Hop River / Willimantic River	S1c	Hop River / Willimantic River	Thames			1						
3_11	Quaboag River	S1c	Chicopee River	Connecticut		1							
3_8	Taunton River	S1c	Taunton River	Ocean	1								
4	Housatonic River	Sxc		Housatonic	1								
Middle Connecticut													
2_11	Ashuelot River, South Branch	S1c	Ashuelot River	Connecticut		1							
2_11	Stockwell and Priest Brook	S1	Millers River	Connecticut		1							
2_12	Sugar River, South Branch	S1c	Sugar River	Connecticut				1					
2_17	Upper Deerfield Tributaries	S1	Deerfield River	Connecticut				1					
2_5	Fort River	S1c		Connecticut				1					
2_5	Sawmill River	S2c		Connecticut							1		
Saco-Merrimack-Charle													
2_18	Bear Camp River	S1c	Ossipee River	Saco			1						
2_18	Pine River	S1c	Ossipee River	Saco			1						
2_19	Pemigewasset River	S1c	Pemigewasset River	Merrimack						1			
2_19	Saco River	S1c	Saco River Size 3	Saco						1			
2_19	Swift River	S1c	Saco River Size 3	Saco				1					
2_20	Smith River	S2c	Pemigewasset River	Merrimack				1					
2_20	Warner River	S1c	Contoocook River	Merrimack			1						
2_22	Baboosic Brook	S1c	Souhegan River	Merrimack						1			
2_23	Soucook River	S2c		Merrimack			1						
2_24	Parker River	S1c		Ocean	1								
Upper Connecticut													
2_13	Wild Ammonoosuc River	Sxc	Ammonoosuc River	Connecticut		1							
2_14	Indian Stream	S1c	Connecticut River Size 3	Connecticut			1						
2_14	Mohawk River	Sxc	Connecticut River Size 3	Connecticut							1		
2_14	Nash Stream	S1c	Upper Ammonoosuc River	Connecticut		1							
2_14	Phillips Brook	S1c	Upper Ammonoosuc River	Connecticut				1					
2_14	Simms Stream	S2c	Connecticut River Size 3	Connecticut							1		
2_14	Upper Ammonoosuc River	S1c	Upper Ammonoosuc River	Connecticut		1							
2_15	Moose River	S1c	Passumpsic River	Connecticut		1							
2_16	White River, First Branch	Sxc	White River	Connecticut									1
2_16	White River, Second Branch	Sxc	White River	Connecticut									1
2_17	Saxtons River	S2c		Connecticut							1		
2_17	West River, Marlboro Brook	Sxc	West River	Connecticut					1				
2_17	West River, North Branch	S1c	West River	Connecticut							1		
2_17	White River	S1c	White River	Connecticut									1
2_17	Williams River	S2c		Connecticut		1							
2_17	Winhall River	S1c	West River	Connecticut			1						
3_15	West River	S1c	West River	Connecticut			1						
3_16	White River	S1c	White River	Connecticut								1	
					14	12	13	8	3	5	5	1	3

For the medium to large sized rivers, the 82 portfolio examples having dams on their size 2-4 mainstems were fragmented by 272 mainstem dams. 23 examples had dams over 50ft. high (32 dams) and 63 examples had dams between 15 and 50 feet (153 dams). The most frequent type of mainstem dam was a hydro dam, with 39 examples have a hydro dam on them (138 dams). Other common types of dams include 24 examples with flood control dams (33 dams), 20 examples with water supply dams (28 dams), and 31 examples with recreational dams (41 dams). See PortfolioOccurrences.txt or .xls for a column summarizing the number of dams on each portfolio example.

Table 31: Types and Sizes of Dams Across Portfolio Size 2-4 Mainstems

Number of Dams across the mainstems of size 2, 3, 4 Portfolio Rivers by EDU and Type

Ecological Drainage Unit	# NID Dams on size 2,3,4	<= 15 feet	>15 feet and <= 50 feet	> 50 feet	Hydroelectric	Flood control	Water supply	Recreation	Irrigation	Other
Lower Connecticut Summary	106	29	63	14	39	11	20	19	0	17
Middle Connecticut Summary	46	6	34	6	23	4	4	11	1	3
Saco-Merrimack-CharlesSummary	91	45	39	7	58	16	3	9	0	5
Upper Connecticut Summary	29	7	17	5	18	2	1	2	0	6
Totals	272	87	153	32	138	33	28	41	1	31

Ecological Drainage Unit	Total Height (ft.)	Maximum Height (ft.)	Total Storage (Acre-ft.)	Maximum Storage (acre-ft.)
Lower Connecticut Summary	3269	1826	705702	629273
Middle Connecticut Summary	1363	570	836817	227181
Saco-Merrimack-CharlesSummary	2080	860	617661	463299
Upper Connecticut Summary	1214	710	756254	443688
Totals	7926	3966	2916434	1763441

Portfolio Assembly: Discussion and Conclusion

Comprehensive conservation of aquatic biodiversity requires an understanding of the patterns of biodiversity and ecological processes operating at multiple scales. Aquatic landscape ecology has begun to focus on embracing the continuous, hierarchical and heterogeneous nature of aquatic habitats and in particular, 1) the consideration of aquatic conservation at multiple larger spatial and temporal scales, 2) the use of watersheds as more functional conservation units than reaches and 3) consideration of the connectivity in aquatic conservation assessments (Fausch et al 2002).

This new paradigm for aquatic conservation and stream fish ecology emphathizes a dynamic "riverine landscape" where connectivity is a critical environmental attribute. (Schlosser 1991, 1995, Schlosser and Angemeier 1995). This model notes the inherently patchy distribution of habitat features in aquatic systems at an intermediate scale and the necessity of stream fish to often move long distances to reach habitat patches required to complete their life history (for spawning, feeding, and rearing, refugia from disturbance, overwintering areas) and to maintain metapopulations through colonization and recolonization. Functional connectivity for aquatic systems is also important to protect key ecosystem processes such as water volume, flow rate, and flooding, that create and maintain the mixture of habitat patches needed. These processes are critical not only for maintaining instream habitat, but also on maintaining the riparian and floodplain communities and the complex interactions between the terrestrial and aquatic systems.

This conservation assessment's goal to 1) assess and represent aquatic biota at multiple scales, particularly at scales above the reach or individual species and 2) to include identification of connected networks fits well with these recent developments in aquatic landscape ecology. By using a multiple scale watershed classification, this assessment attempted to include aquatic biological characteristics that are fully representative of an area. Watersheds and their network of streams, wetlands, and lakes were used as the conservation targets because many scientific studies have documented that riverine systems are intimately coupled with and created by the characteristics of their catchment basins or watersheds. For example, watersheds integrate processes that connect the longitudinal (upstream-downstream), lateral (floodplain-upland), and vertical (groundwater zone-stream channel) dimensions. This assessment also set initial minimum conservation goals to define the number and spatial distribution/connectivity of the examples needed in a conservation plan.

Although the identified conservation portfolio met representation goals for all evaluated size 2 and 3 systems and identified current or restorable connected networks for all except the size 2 and 3 systems in the upper Housatonic drainage, the current condition of the portfolio examples varies widely. Portfolio examples in the Upper Connecticut and Middle Connecticut have consistently better overall landscape context rankings than the Saco/Merrimack/Charles and Lower Connecticut and Cape EDU. For example, among the 60 size 2 and 3 portfolio examples in the Cape and Lower Connecticut EDU, only 2 had an overall landscape context rank of 2 or 1 and these were both in system 2_9 (Westfield River Middle Branch, Farmington River West Branch). By looking at the landscape context rankings by system type, one can see the portfolio examples in certain system types are more heavily impacted. For example, all portfolio currently occur in our lowest two landscape context categories (4,5) for systems 2_1, 2_2, 2_4, 2_5, 2_24, 3_2, 3_4, 3_8, 3_10, 3_13, 3_16, 3_18. Systems where all our portfolio examples occur in the overall landscape context categories 3 and 4 include 2_3, 2_6, 2_7, 2_8, 2_10, 2_5, 2_20, 2_22, 2_23, 3_7, 3_14, 3_17. Reviewing the components of landscape context responsible for the overall landscape context ranks of size 2-4 portfolio examples, shows a large number of portfolio examples fell in our lower two landscape context agriculture categories (53% of portfolio examples) and lower two developed/road impact categories (57% of portfolio examples), again highlighting the pervasive human settlement within the analysis region. Although we have yet to determine where the biological thresholds for agriculture and roads/development lie for our aquatic systems in lower New England, the data allows us to begin by highlighting where impacts from agriculture and development might be larger problems within our portfolio river systems.

Review of the current level of fragmentation among the portfolio sites in terms of dams, yields a similar sobering result. 72% of all portfolio river examples had National Inventory of Dams dam within their upstream network. Of the 5 non-size 1 (headwater) portfolio examples without NID dams in their upstream network all 5 had a NID dam downstream before reaching the ocean. Considering just the medium to large portfolio rivers and just dams across their mainstem sections (instead of also counting dams fragmenting headwaters that connect to these larger rivers), of the 151 Size 2-4 portfolio river examples, 69 (46%) had no dams on their mainstem sections. However, 78% of these 69 examples had a dam downstream before reaching the ocean. This left only 14 portfolio examples, 9-10% of all portfolio size 2-4 rivers, where all the size 2, 3, 4 portions of their portfolio mainstems were not interrupted by a dam before the ocean. The few portfolio rivers whose mainstems were not represenative of all river system types. For example, the 14 mainstem unfragmented dams include the direct to coast connected size 2 rivers examples of the North, Slocums, West Port, Palmer, Hammonasset, Niantic, Mill, and Parker. Only the Eightmile tributary of the Connecticut and the size 3 Taunton River and its size 2 tributaries of the Assonet, Namasket, and Winnetuxet were unfragmented larger size 3 or 4 river section networks. The 82 size 2-4 portfolio examples having dams on their size mainstems were fragmented by a total of 272 mainstem dams. 23 portfolio examples had dams over 50ft high. The most frequent type of mainstem dam was a hydro dam, with 39 portfolio examples have a hydro dam on them (138 dams). Although the National Inventory of Dams does not even include all of the small dams of less than 6 feet high, many of which also occur in New England, this review at least highlights where some of the lesser fragmented portfolio examples currently exist.

In conclusion, this assessment shows

1. There are a diversity of aquatic ecosystem types within and between EDUs in Lower New England. These types represent different aquatic environmental settings and are likely to have or develop different aquatic habitats and biotic assemblages over time given their unique environmental setting.
2. Threats to aquatic systems are enormous. Agriculture, development, roads, point sources, and dams have significant and pervasive impacts in the region, with some higher elevation and non-coastal systems being less impacted.
3. Few free flowing rivers exist in this region. The region has an average National Inventory of dam density was .79 dams per 10 stream miles, and this density would be significantly higher if all the smaller (<6ft , <50 acre-ft) dams were considered.
4. Even the "best examples"/portfolio examples of each system have significant impacts/problems. Many of the portfolio rivers are impacted by high levels of development. Although we tried to identify the best potential networks for migratory fish, currently few functional networks exist and the portfolio is highly impacted by dams. 90% of our size 2-4 portfolio rivers had a dam downstream before reaching the ocean and 54% of our size 2-4 portfolio river segments had a mainstem dam currently on the identified portfolio sections.

Future recommendations based on this analysis include the following:

- Test and refine TNC's aquatic classification by compiling biological data sources (macroinvertebrate, herp., fishery data sets, etc.) to develop a more complete list of species and community targets within the classification types and to more fully integrate fish, macroinvertebrate, and other biological data into the classification.
- Refine GIS condition analysis and coordinate its use as a planning tool and as an adaptive tool to measure success at conservation areas and for TNC and partners.
- Identify and prioritize size 1 Aquatic Ecological Systems for conservation action.
- Conduct aquatic ecoregional planning for pond, lake, estuarine, and marine systems.
- Gather additional expert opinion data on aquatic systems and portfolio examples throughout the ecoregion by actively involving partners.
- Determine which dams have fish passage structures.
- Implement site conservation plans with detailed analysis of internal targets, key ecological factors, threats, and strategies for aquatic portfolio examples.

Future conservation strategies might include but not be limited to working with partners (Abell et al 2000) in order to:

- enact legislation that provides for the designation of freshwater systems as natural protected areas, particularly for the few remaining most intact and unaltered river systems.
- educate the public and policy makers about the biodiversity hidden from view in freshwater systems and the cumulative effects of land uses on downstream waters.
- promote conservation at the watershed scale, which requires cooperation and communication among multiple agencies with varying jurisdictions.
- reduce water consumption though implementation of sustainable agriculture and restrictions on nonessential water use and reducing groundwater pumping in sensitive areas.
- establish natural flow regimes in rivers by removing unneeded structures and modifying dam operations to resemble natural flow patterns.
- work to maintain and enforce legislation to protect federally listed species.
- prevent the introduction and spread of exotics into freshwater systems though public education and vigilant monitoring and enforcement.
- restore and protect riparian habitats by limiting grazing, promoting buffer strips, and restricting or promoting compatible development near stream and lake margins.
- work to reduce sedimentation associated with certain forms of logging, roads, and agriculture.
- reconnect stream reaches and drainage networks by removing impoundments, removing unneeded culverts, or creating structures to allow the passage of organisms and organic nutrients.
- remove flood-control structures in appropriate areas to allow for reestablishment of floods and maintenance of floodplain communities.
- restore and protect wetlands, which provide important filtering mechanisms for pollutants and contribute organic matter to freshwater systems.
- restore channelized streams to their original forms.
- remove or reduce point sources of pollution.

Threats Assessment

The Core Team made a conscious decision not to embark on a detailed threat assessment and strategy development for element occurrences. The core team had mixed opinions on the utility of threats analysis performed in adjacent ecoregions. The majority felt that threats (stresses and sources) are largely site specific and need to be addressed at a local or state level. There was also a feeling that a threats analysis exceeded the scope of this teams mandate to identify a portfolio of sites that conserve this region's biodiversity. Cross-site and cross-state threats should be discussed by individuals responsible for implementing the plan and there was considerable discussion about forming a regional "Implementation Team". A meeting of state directors in November, 2000 produced no strong desire to complete a regional threats analysis. Threat assessments will be completed by Chapter offices as they write site conservation plans for portfolio occurrences.

Opportunities, Needs, Lessons, and Next Steps

Preparation for a Second Iteration

This document represents the first iteration of what is expected to be an ongoing planning process with additional iterations forthcoming. In the near term, there is a need for the core team to work with chapter offices and Heritage Programs to prepare for future iterations by completing the following tasks:

- New portfolio occurrences may be submitted via BCD download to Eastern Conservation Science. The ecoregional planning team leader will determine which occurrences will be accepted based on viability criteria, conservation goals, and stratification goals. A review of proposed occurrences should be conducted twice a year or when there are sufficient submissions to warrant a review.
- Conduct a region-wide follow-up meeting to identify cross-border action sites and cross-site threats and abatement strategies (accomplished, 11/29/00)
- Refine the aquatic community classification, and identifying and incorporating aquatic target occurrences. Finer filter aquatic targets need to be identified and conserved within matrix forest occurrences where the landscape context and water quality is presumably better. Inventory should focus on watersheds selected through the EDU process.
- Identify a new team leader (Winter, 2000 – 2001).
- The number of occurrences accepted for the portfolio for timber rattlesnake and cliff\outcrop communities should be culled so that they do not exceed their conservation goal.
- The conservation goal for bog turtle should be reviewed in light of the new USFWS Recovery Plan for this species. The number of occurrences selected for the portfolio should meet but not exceed the goal. Currently, the goal has been exceeded.
- Review progress towards goals for karner blue butterfly once standard sites have been lumped into functional metapopulation sites in BCD by state Heritage Programs.
- Obtain a data-sharing agreement with the Massachusetts Natural Heritage Program that includes all target species element occurrences. Incorporate data from the Massachusetts Natural Heritage and Endangered Species Program and reevaluate all of the occurrences in the portfolio in relation to this new information.
- Conduct additional inventory for all species and community occurrences to help meet target goals. Focus special attention on the Reading Prong (221Am) and Worcester – Monadnock Plateau (221Ah) within which no viable community EOs were identified using current datasets. Heritage programs and relevant state agencies should receive lists of the planning targets that need inventory work.
- Draft EO specifications for all target species and communities with assistance from Heritage Programs and others.
- Incorporate all new data and ranks in Heritage Program BCD systems.

- Work with TNC Eastern Conservation Science on a multi-region target analysis to determine if target goals have been met across regions.
- Complete the LNE – NVC community classification and determine community distribution within subregions to better evaluate success towards stratification goals. Natural community occurrences currently contained in BCD need to be tagged at the association level once the classification is complete to determine whether all association types are adequately represented in the portfolio. A number of community types were recognized as needing more classification work including floodplain communities, river and stream communities, and rich forest and woodland communities.
- Identify forest community types that formerly occurred in the more developed valleys and lowlands and that were not adequately captured during the first iteration.
- Identify potential restoration sites for lowland forests and other targets for which viable occurrences can not be located.
- Determine the within-region distribution of all species targets by sub-section to evaluate success towards stratification goals. Create stratification goals for all species.
- Establish a methodology for updating and maintaining the database and the portfolio.
- Additional review of the portfolio is required to ensure that an adequate number of suitable habitats have been selected throughout the region for Blue-winged Warbler, Golden-winged Warbler, Prairie Warbler, and Bicknell's Thrush.
- Secondary target species require additional evaluation and occurrence selection for the LNE-NP portfolio. Targets that are not represented or under-represented in the portfolio need additional occurrences selected. This will require inventory and the development of provisional target and stratification goals.
- Extensive inventory is required for the majority of invertebrate targets as 50 species did not meet their goals.
- Species and communities for which an excessive number of occurrences were selected for the portfolio during the first iteration should be re-evaluated with a goal of reducing the number of portfolio occurrences to meet the goal.
- Determine which matrix forest types should be captured as large patch communities in certain area of the ecoregion. This will be less of an issue if the two regions are treated separately.
- A number of the valley ELU types are poorly represented in the LNE-NP portfolio, especially all of those on dry flats. A special effort should be made during the 2nd iteration to capture more of these ELU types.
- Serpentine or ultramafic ELUs are not well represented in the portfolio. Serpentine ELUs and communities may need to be added during the next iteration.
- Look at issues of site linkage and species movement and develop a plan for how to minimize the potential effects of site isolation.

Lessons Learned

All ecoregional planning processes present logistical, technical, and methodological challenges. Perhaps the most challenging aspect of this planning exercise has been coordinating the process with 13 participating TNC Chapter Offices and Heritage Programs. The coordination required, among other things:

- joining and matching GIS data sets across all states;
- creating a new community classification that "cross-walks" state classifications to the National Vegetation Classification (NVC) and to one-another as the NVC is not the standard in most eastern states,
- coordinating productive meetings and a workable process with more than 100 participants.

Specifically, we offer the following suggestions for improving future iterations.

- Part-time clerical assistance in the team leader's office is required to maintain frequent communication with all states, to assist with meeting logistics, and manage paper-flow. Information is often better conveyed by phone as many team members do not find the time to read materials.
- Notify Chapter Offices and Heritage Programs, in particular, six to nine months in advance of initiating the next iteration so that they can incorporate their participation into their work plans.
- Maintain monthly expert team leader meetings or conference calls to evaluate progress and share best practices and lessons learned.
- Provide bi-monthly memos to all core team members on progress to date, imminent deadlines, next steps, and action items.
- Maintain frequent communications to keep team members engaged. Be sure that their supervisors have made their participation an annual goal and have allocated sufficient time to be a team member.
- Expert team meetings that require field staff should not be conducted during the field season.
- Pick expert team members well: choose more than the number you believe you will need and extract a commitment to participate for the duration of the planning period. Provide a job description and an approximate time requirement.
- Expert team leaders should set aside a month just for communicating with experts or visiting with less available team members to choose and review targets, to review their regional distribution, and to research the latest taxonomic contortions for possible inclusion in the portfolio.
- A dedicated budget before work proceeds.
- Practice good project management skills and keep everyone to agreed upon deadlines to minimize rescheduling conflicts.

Glossary

These selective glossary entries are adapted from several sources, including the glossaries in Anderson et al. 1999 and Groves et al 2000.

Alliance: A level in the US National Vegetation Classification, defined as a group of plant associations sharing one or more diagnostic species (dominant, differential, indicator, or character), which, as a rule, are found in the uppermost strata of the vegetation. Aquatic alliances correspond spatially to macrohabitats.

Amphidromous: Refers to migratory fish species that may spawn and grow in either freshwater or saltwater, but migrate briefly to the opposite habitat for feeding. See also Diadromous, Catadromous, Potamodromous, Anadromous.

Anadromous: Refers to migratory fish species that spawn in freshwater and grow primarily in saltwater. See also Diadromous, Catadromous, Potamodromous, Amphidromous.

Aquatic Ecological System (AES): Dynamic spatial assemblages of ecological communities that 1) occur together in an aquatic landscape with similar geomorphological patterns; 2) are tied together by similar ecological processes (e.g., hydrologic and nutrients, access to floodplains and other lateral environments) or environmental gradients (e.g., temperature, chemical and habitat volume); and 3) form a robust, cohesive and distinguishable unit on a hydrography map.

Association or Plant Association: The finest level of biological community organization in the US National Vegetation Classification, defined as a plant community with a definite floristic composition, uniform habitat conditions, and uniform physiognomy. With the exception of a few associations that are restricted to specific and unusual environmental conditions, associations generally repeat across the landscape. They also occur at variable spatial scales depending on the steepness of environmental gradients and the patterns of disturbances.

Biological Diversity: The variety of living organisms considered at all levels of organization including the genetic, species, and higher taxonomic levels. Biological diversity also includes the variety of habitats, ecosystems, and natural processes occurring therein.

Block (or Matrix Block): The method used to delineate matrix community examples in all Northeast plans was based on roads and land cover, using GIS tools and data. The entire ecoregion was tiled into discrete polygons referred to as blocks. Each block represented an area bounded on all sides by roads, transmission lines, or major shorelines (lake and river polygons) from USGS 1:100,000 vector data. All roads from class 1 (major interstates) to class 4 (logging road and hiking trails) were used as boundaries. See also Matrix Community.

Catadromous: Refers to migratory fish species that spawn in saltwater and grow primarily in freshwater. See also Diadromous, Anadromous, Potamodromous, Amphidromous.

Coarse Filter Approach: The term coarse filter refers to conservation targets at the community or ecosystem level of biological organization. Coarse-filter targets can be used as surrogates for species conservation in areas where little is known about species patterns or ecological processes. Conservation of the majority of common and uncommon species (fine-filter targets depends on carefully selecting those examples of natural communities that most likely contain a full complement of their associated flora and fauna.

Community: Terrestrial or plant communities are community types of definite floristic composition, uniform habitat conditions, and uniform physiognomy. Terrestrial communities are defined by the finest level of classification, the “plant association” level of the National Vegetation Classification. Like ecological systems, terrestrial communities are characterized by both a biotic and abiotic component. Even though they are classified based upon dominant vegetation, we use them as inclusive conservation units that include all component species (plant and animal) and the ecological processes that support them.

Connectivity: Community examples and conservation reserves have permeable boundaries and thus are subject to inflows and outflows from the surrounding landscape. Connectivity in the selection and design of nature reserves relates to the ability of species to move across the landscape to meet basic habitat requirements. Natural connecting features within the ecoregion may include river channels, riparian corridors, ridgelines, or migratory pathways.

Conservation Focus: Those targets that are being protected and the scale at which they are protected (local scale species and small patch communities; intermediate scale species and large patch communities; coarse scale species and matrix communities; and regional scale species).

Conservation Goal: In ecoregional planning, the number and spatial distribution of on-the-ground examples of targeted species, communities, and ecological systems that are needed to adequately conserve the target in an ecoregion.

Conservation Status: Usually refers to the category assigned to a conservation target such as threatened, endangered, imperiled, vulnerable, and so on.

Conservation Target: see Target.

Diadromous: Refers to migratory fish species that move between freshwater and saltwater. See also Anadromous, Catadromous, Potamodromous, Amphidromous.

Disjunct: Disjunct species have populations that are geographically isolated from that of other populations.

Distribution Pattern: The overall pattern of occurrence for a particular conservation target. In ecoregional planning projects, often referred to as the relative proportion of the target’s natural range occurring within a given ecoregion (e.g. endemic, limited, widespread, disjunct, peripheral).

Ecological Drainage Unit (EDU): Aggregates of watersheds that share ecological and biological characteristics. Ecological drainage units contain sets of aquatic systems with similar patterns of hydrologic process, gradient, drainage density, and species distribution. Used to spatially stratify ecoregions according to environmental variables that determine regional patterns of aquatic biodiversity and ecological system characteristics.

Ecological Land Unit (ELU):Mapping units used in large-scale conservation planning projects that are typically defined by two or more environmental variables such as elevation, geological type, and landform (e.g., cliff, stream, summit). Biophysical or environmental analyses combining ELUs with land cover types and satellite imagery can be useful tools for predicting locations of communities or ecological systems when such information is lacking, and capturing ecological variation based upon environmental factors.

Ecological System (ecosystem): Dynamic assemblages of communities that occur together on the landscape at some spatial scale of resolution, are tied together by similar ecological processes, and form a cohesive, distinguishable unit on the ground. Examples are spruce-fir forest, Great Lakes dune and swale complex, Mojave desert riparian shrublands.

Ecoregion: Relatively large unit of land and water covering tens of thousands of square miles and sharing common features of vegetation, soil type, climate, flora, and fauna. Ecoregions were defined by Robert Bailey (Bailey et al 1994) as major ecosystems resulting from large-scale predictable patterns of solar radiation and moisture, which in turn affect the kinds of local ecosystems and animals and plant found within.

Element : A term originating from the methodology of the Natural Heritage Network that refers to species, communities, and other entities (e.g., migratory bird stopovers) of biodiversity that serve as both conservation targets and as units for organizing and tracking information.

Element Occurrence (EO) : A term originating from methodology of the Natural Heritage Network that refers to a unit of land or water on which a population of a species or example of an ecological community occurs. For communities, these EOs represent a defined area that contains a characteristic species composition and structure.

Endangered Species: A species that is federally listed or proposed for listing as Endangered by the U.S. Fish and Wildlife Service under the Endangered Species Act.

Endemic: Species that are restricted to an ecoregion (or a small geographic area within an ecoregion), depend entirely on a single area for survival, and are therefore often more vulnerable.

Feasibility: A principle used in ecoregional planning to select Action Sites by evaluating the staff capacity of TNC and partners to abate threats, the probability of success, and the financial costs of implementation.

Fine Filter Approach: To ensure that the coarse filter–fine filter strategy adequately captures all viable, native species and ecological communities, ecoregional planning teams also target species that cannot be reliably conserved through the coarse-filter approach and may require individual attention through the fine filter approach. Wide-ranging, very rare, extremely localized, narrowly endemic, or keystone species are all likely to need fine-filter strategies.

Floristics: Essentially synonymous with species composition, referring to levels of a vegetation classification that are defined by the species or floristic composition as contrasted with physiognomic features that are also often used to classify vegetation.

Fragmentation: Process by which habitats are increasingly subdivided into smaller units, resulting in their increased insularity as well as losses of total habitat area. Fragmentation may be caused by humans (such as development of a road) or by natural processes (such as a tornado).

GAP (National Gap Analysis Program): Gap analysis is a scientific method for identifying the degree to which native animal species and natural communities are represented in our present-day mix of conservation lands. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of ordinary species (those not threatened with extinction or naturally rare) and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions.

GIS (Geographic Information System): A computerized system of organizing and analyzing any spatial array of data and information.

Global Rank: A numerical assessment of a biological element's relative imperilment and conservation status across its range of distribution ranging from G1 (critically imperiled) to G5 (secure). Assigned by the Natural Heritage Network, global ranks for communities are determined primarily by the number of occurrences and total area of coverage (communities only), modified by other factors such as condition, historic trend in distribution or condition, vulnerability, and threats.

Goal: see Conservation Goal.

Habitat: The place or type of site where species and species assemblages are typically found and/or are successfully reproducing. In addition, marine communities and systems are referred to as habitats. They are named according to the features that provide the underlying structural basis for the community.

Heritage Inventory: A term used loosely to describe the efforts of the Network of Natural Heritage Programs and Conservation Data Centers to inventory geographic areas for occurrences of elements of biodiversity, or to describe the standardized methodologies used by Heritage Programs to store and manage data collected by inventory efforts.

Heritage: A term used loosely to describe the Network of Natural Heritage Programs and Conservation Data Centers or to describe the standardized methodologies used by these programs.

Herptile: A term encompassing reptiles and amphibians.

Imperiled Species: Species which have a global rank of G1–G2 assigned by Natural Heritage Programs or Conservation Data Centers. Regularly reviewed and updated by experts, these ranks take into account number of occurrences, quality and condition of occurrences, population size, range of distribution, threats and protection status.

Indicator Species: A species used as a gauge for the condition of a particular habitat, community, or ecosystem. A characteristic or surrogate species for a community or ecosystem.

Indigenous: A species that is naturally occurring in a given area and elsewhere.

Integration: A portfolio assembly principle where sites that contain high-quality occurrences of both aquatic and terrestrial targets are given priority.

Irreplaceable: The single most outstanding example of a target species, community, or system, or a population that is critical to a species remaining extant and not going extinct.

Keystone Species: A species whose impacts on its community or ecosystem are large; much larger than would be expected from its abundance.

Landscape: A heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout.

Large Patch: Communities that form large areas of interrupted cover. Individual occurrences of this community patch type typically range in size from 50 to 2,000 hectares. Large patch communities are associated with environmental conditions that are more specific than those of matrix communities, and that are less common or less extensive in the landscape. Like matrix communities, large-patch communities are also influenced by large-scale processes, but these tend to be modified by specific site features that influence the community.

Legacies (or Biological Legacies): Features of an ecosystem that include vegetation structure and all the accumulating organic materials that stabilize a system and link it historically to a place. These features, collectively termed biological legacies, include coarse woody debris, seed banks, soil nutrient reservoirs and extensive fungal networks — essentially the by-products of previous or current residents.

Linear Communities : Communities that occur as linear strips are often, but not always, transition zones between terrestrial and aquatic systems. Examples include coastal beach strands, bedrock lakeshores, and narrow riparian communities. Similar to small patch communities, linear communities occur in very specific conditions, and the aggregate of all linear communities covers, or historically covered, only a small percentage of the natural vegetation of the ecoregion. They also tend to support a specific and restricted set of associated flora and fauna. Linear communities differ from small patch communities in that both local scale and large-scale processes strongly influence community structure and function.

Macrohabitats: Macrohabitats are the finest-scale biophysical classification unit used as conservation targets. Examples are lakes and stream/river segments that are delineated, mapped, and classified according to the environmental factors that determine the types and distributions of aquatic species assemblages.

Matrix-forming (or Matrix Community) : Communities that form extensive and contiguous cover may be categorized as matrix (or matrix-forming) community types. Matrix communities occur on the most extensive landforms and typically have wide ecological tolerances. They may be characterized by a complex mosaic of successional stages resulting from characteristic disturbance processes (e.g. New England northern hardwood-conifer forests). Individual occurrences of the matrix type typically range in size from 2000 to 500,000 hectares. In a typical ecoregion, the aggregate of all matrix communities covers, or historically covered, as much as 75-80% of the natural vegetation of the ecoregion. Matrix community types are often influenced by large-scale processes (e.g., climate patterns, fire), and are important habitat for wide-ranging or large area-dependent fauna, such as large herbivores or birds.

Metadata: Metadata documents the content, source, reliability, and other characteristics of data. Federal standards for spatial metadata (from the FGDC, or Federal Geographic Data Committee) are incorporated in the GIS tools used for ecoregional planning in TNC.

Minimum Dynamic Area : The area needed to insure survival or re-colonization of a site following a natural disturbance that removes most or all individuals. This is determined by the ability of some number of individuals or patches to survive, and the size and severity of stochastic (random) events.

Mosaic : An interconnected patchwork of distinct vegetation types.

Native: Those species and communities that were not introduced accidentally or purposefully by people but that are found naturally in an area. Native communities are those characterized by native species and maintained by natural processes. Native includes both endemic and indigenous species.

Network of Conservation Sites: A reserve system connecting multiple nodes and corridors into a landscape that allows material and energy to flow among the various components.

Occurrence: Spatially referenced examples of species, communities, or ecological systems. May be equivalent to Heritage Element Occurrences, or may be more loosely defined locations delineated through 1) the definition and mapping of other spatial data or 2) the identification of areas by experts.

Patch Community: Communities nested within matrix communities and maintained primarily by specific environmental features rather than disturbance processes.

Population Viability Analysis (PVA): A collection of quantitative tools and methods for predicting the likely future status (e.g., likelihood of extinction or persistence) of a population or collection of populations of conservation concern.

Portfolio: The suite or network of areas or natural reserves within an ecoregion that would collectively conserve the native species and communities of the ecoregion. Equivalent to the collection of all conservation targets selected for the portfolio (see Target).

Portfolio Occurrence: see Occurrence.

Potamodromous: Refers to migratory fish species that move entirely within freshwater. See also Diadromous, Catadromous, Anadromous, Amphidromous.

Rangewide: Referring to the entire distribution of a species, community, or ecological system.

Rapid Ecological Assessment (REA): Technique for using remote sensing information combined with on-the-ground selected biological surveys to relatively quickly assess the presence and quality of conservation targets, especially at the community and ecosystem level.

Representativeness: Captures multiple examples of all conservation targets across the diversity of environmental gradients appropriate to the ecoregion (e.g., ecoregional section or subsection, ecological land unit (ELU), or some other physical gradient).

Section : Areas of similar physiography within an ecoregional province; a hierarchical level within the USDA Forest Service ECOMAP framework for mapping and classifying ecosystems at multiple geographic scales.

Shifting Mosaic: An interconnected patchwork of distinct vegetation types that may shift across the land surface as a result of dynamic ecosystem processes, such as periodic wildfire or flooding.

Site (or Conservation Site, or Portfolio Site) : Areas that are defined by the presence of conservation targets, are the focus of conservation action, and are the locus for measuring conservation success.

SLOSS : Acronym standing for “single large or several small” referring to a long-running debate in ecology and conservation biology as to whether it is more effective for biodiversity conservation to have a single large reserve or several small reserves.

Small Patch: Communities that form small, discrete areas of vegetation cover. Individual occurrences of this community type typically range in size from 1 to 50 hectares. Small patch communities occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. The specialized conditions of small patch communities, however, are often dependent on the maintenance of ecological processes in the surrounding matrix and large patch communities. In many ecoregions, small patch communities contain a disproportionately large percentage of the total flora, and also support a specific and restricted set of associated fauna (e.g., invertebrates or amphibians and reptiles) dependent on specialized conditions.

Spatial Pattern: Within an ecoregion, natural terrestrial communities may be categorized into three functional groups on the basis of their current or historical patterns of occurrence, as correlated with the distribution and extent of landscape features and ecological processes. These groups are identified as matrix communities, large patch communities, and small patch communities.

Stratification: A hierarchical division of an ecoregion into nested, progressively smaller geographic units. Spatial stratification is used to represent each conservation target across its range of variation (in internal composition and landscape setting) within the ecoregion, to ensure long-term viability of the type by buffering against degradation in one portion of its range, and to allow for possible geographic variation.

Stream Order: A hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Two first orders flow together to make a second order; two second orders combine to make a third-order stream.

Stress: Something which impairs or degrades the size, condition, or landscape context of a conservation target, resulting in reduced viability.

Subsection : Areas of similar geologic substrates, soils and vegetation within an ecoregional section; a level within the USDA Forest Service ECOMAP framework for mapping and classifying ecosystems at multiple geographic scales.

Surrogate: In conservation planning, surrogates are generally referred to as any conservation target being used to capture or represent targets or elements of biological diversity (both known and unknown) that occur at finer scales of spatial resolution or finer levels of biological organization. For example, communities and ecological systems (coarse filters) are often labeled as surrogate measures of biodiversity as they are intended to represent the many species that occur within these types of targets.

Target: An element of biodiversity selected as a focus for conservation planning or action. The two principal types of targets in Conservancy planning projects are species and ecological communities or ecosystems.

Terrestrial Ecological Systems (ecosystems): Dynamic spatial assemblages of ecological communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes (e.g., fire, hydrology), underlying environmental features (e.g., soils, geology) or environmental gradients (e.g., elevation, hydrologically-related zones); and 3) form a robust, cohesive, and distinguishable unit on the ground. Ecological systems are characterized by both biotic and abiotic (environmental) components.

Threatened Species: Species federally listed or proposed for listing as Threatened by the U.S. Fish and Wildlife Service under the Endangered Species Act.

Threat: The combined concept of ecological stresses to a target and the sources of that stress to the target.

Viability: The ability of a species to persist for many generations or a community to persist over some time period. An assessment of viability will often focus on the minimum area and number of examples or occurrences necessary for persistence. However, conservation goals should not be restricted to the minimum but rather should extend to the size, distribution and number of occurrences necessary for a community to support its full complement of native species.

Lower New England/Northern Piedmont Ecoregion

Target Species List

Vertebrates (22 Species: 8 Primary Targets, 14 Secondary Targets)

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
AFCAA01010	Primary	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3
AFCAA01040	Primary	ACIPENSER OXYRINCHUS	ATLANTIC STURGEON	G3
AFCQC01060	Primary	AMMOCRYPTA PELLUCIDA	EASTERN SAND DARTER	G3
ARAAD02040	Primary	CLEMMYS MUHLENBERGII	BOG TURTLE	G4
ARADE02040	Primary	CROTALUS HORRIDUS	TIMBER RATTLESNAKE	G4
AMACC01130	Primary	MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS	G4
AMACC01100	Primary	MYOTIS SODALIS	INDIANA OR SOCIAL MYOTIS	G2
AMAFF08100	Primary	NEOTOMA MAGISTER	ALLEGHENY WOODRAT	G3G4

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
ABPBJ18120	Secondary	CATHARUS BICKNELLI	BICKNELL'S THRUSH	G4
ARAAD02020	Secondary	CLEMMYS INSCULPTA	WOOD TURTLE	G4
ABPBX03050	Secondary	DENDROICA CAERULESCENS	BLACK-THROATED BLUE WARBLER	G5
ABPBX03240	Secondary	DENDROICA CERULEA	CERULEAN WARBLER	G4
ABPBX03190	Secondary	DENDROICA DISCOLOR	PRAIRIE WARBLER	G5
ARAAD04010	Secondary	EMYDOIDEA BLANDINGII	BLANDING'S TURTLE	G4
ABPBX08010	Secondary	HELMITHEROS VERMIVORUS	WORM-EATING WARBLER	G5
ABPJ19010	Secondary	HYLCOCICHLA MUSTLENIA	WOOD THRUSH	G5
ABPBX11010	Secondary	OPORORNIS FORMOSUS	KENTUCKY WARBLER	G5
ABPBX07010	Secondary	PROTONOTARIA CITREA	PROTHONOTARY WARBLER	G5
ABPBX10030	Secondary	SEIURUS MOTACILLA	LOUISIANA WATERTHRUSH	G5
AMAEB01050	Secondary	SYLVILAGUS TRANSITIONALIS	NEW ENGLAND COTTONTAIL	G4
ABPBX01030	Secondary	VERMIVORA CHRYSOPTERA	GOLDEN-WINGED WARBLER	G4
ABPBX01020	Secondary	VERMIVORA PINUS	BLUE-WINGED WARBLER	G5

Lower New England/Northern Piedmont Ecoregion

Target Species List

Invertebrates (81 Species, 57 Primary Targets, 24 Secondary Targets)

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
IILEYAQ180	Primary	ACRONICTA ALBARUFA	BARRENS DAGGER MOTH	G3G4
IMBIV02030	Primary	ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	G1G2
IMBIV02100	Primary	ALASMIDONTA VARICOSA	BROOK FLOATER	G3G4
IILEYBY082	Primary	AMPHIPOEA EREPTA RYENSIS	A NOCTUID MOTH	GUT1Q
ICMAL01010	Primary	CAECIDOTEA PRICEI	PRICE'S CAVE ISOPOD	G3G4
IILEPH2020	Primary	CALEPHELIS BOREALIS	NORTHERN METALMARK	G3G4
IILEPE2220	Primary	CALLOPHRYS IRUS	FROSTED ELFIN	G3G4
IILEY8921	Primary	CATOCOLA HERODIAS GERHARDI	HERODIAS UNDERWING	G3T3
IILEY89911	Primary	CATOCALA PRETIOSA PRETIOSA		G4T2T3
IILEYFM010	Primary	CHAETAGLAEA CERATA	A NOCTUID MOTH	G3G4
IICOL02070	Primary	CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	G3G4
IICOL02060	Primary	CICINDELA MARGINIPENNIS	COBBLESTONE TIGER BEETLE	G2G3
IICOL02030	Primary	CICINDELA PURITANA	PURITAN TIGER BEETLE	G1G2
IMGASF9140	Primary	CINCINNATIA WINKLEYI	NEW ENGLAND SILTSNAIL	G2G3
ICMAL0606	Primary	CRANGONYX ABERRANS	MYSTIC AMPHIPOD	G3
ICMAL06010	Primary	CRANGONYX DEAROLFI	PENNSYLVANIA CAVE AMPHIPOD	G2G3
IIODO71090	Primary	ENALLAGMA PICTUM	SCARLET BLUET	G3
IIODO71030	Primary	ENALLAGMA RECURVATUM	PINE BARRENS BLUET	G3
IILEP37171	Primary	ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	G5T2T3
ICBRA04030	Primary	EULIMNADIA STONINGTONENSIS	A CLAM SHRIMP	G?
IMGASG5100	Primary	FONTIGENS BOTTIMERI	APPALACHIAN SPRINGSNAIL	G3
IIODO08380	Primary	GOMPHUS QUADRICOLOR	RAPIDS CLUBTAIL	G3G4
IIODO08210	Primary	GOMPHUS VENTRICOSUS	SKILLET CLUBTAIL	G3
IILEX0W020	Primary	HEMARIS GRACILIS	GRACEFUL CLEARWING	G3G4
IILEW0M041	Primary	HEMILEUCA MAIA MAIA	COASTAL BARRENS BUCKMOTH	G4T2T3
IILEW0M043	Primary	HEMILEUCA MAIA SSP 3	INLAND BARRENS BUCKMOTH	G4T1T2
IILEW0MX20	Primary	HEMILEUCA SP 2	SCHWEITZER'S BUCKMOTH	G1Q
IILEU09X10	Primary	ITAME SP 1	BARRENS ITAME (cf I. INEXTRICATA)	G3
IMBIV21050	Primary	LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	G3G4
IIODO10010	Primary	LANTHUS PARVULUS	NORTHERN PYGMY CLUBTAIL	G4
IMBIV22060	Primary	LASMIGONA SUBVIRIDIS	GREEN FLOATER	G3
IICOL41010	Primary	LORDITHON NIGER	BLACK LORDITHON ROVE BEETLE	G1
IILEPG5021	Primary	LYCAEIDES MELISSA SAMUELIS	KARNER BLUE	G5T2
IILEU3C110	Primary	METARRANTHIS APICIARIA	BARRENS METARRANTHIS MOTH	GU
IILEU3C100	Primary	METARRANTHIS PILOSARIA	COASTAL SWAMP METARRANTHIS	G3G4
IIODO12020	Primary	OPHIOGOMPHUS ANOMALUS	EXTRA-STRIPED SNAKETAIL	G3
IIODO12040	Primary	OPHIOGOMPHUS ASPERSUS	BROOK SNAKETAIL	G3G4
IIODO12090	Primary	OPHIOGOMPHUS HOWEI	PYGMY SNAKETAIL	G3
IPTUR10010	Primary	POLYCELIS REMOTA	SUNDERLAND SPRING PLANARIAN	G1
IILEYFN010	Primary	PSECTRAGLAEA CARNOSA	PINK SALLOW	G3
IILEP38090	Primary	PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	G2
IIODO32100	Primary	SOMATOCHLORA GEORGIANA	COPPERY EMERALAD	G3G4
IIODO32130	Primary	SOMATOCHLORA INCURVATA	INCURVATE EMERALD	G4
IILEPJ6040	Primary	SPEYERIA IDALIA	REGAL FRITILLARY	G3
IPTUR04050	Primary	SPHALLOPLANA PRICEI	REFTON CAVE PLANARIAN	G1G3
IZSPN06040	Primary	SPONGILLA ASPINOSA	SMOOTH BRANCHED SPONGE	G2G3
ICMAL05690	Primary	STYGOBROMUS BOREALIS	TACONIC CAVE AMPHIPOD	G3G4
ICMAL05630	Primary	STYGOBROMUS HAYI	HAY'S SPRING AMPHIPOD	G1G2
ICMAL05100	Primary	STYGOBROMUS KENKI	ROCK CREEK GROUNDWATER AMPHIPOD	G1G3
ICMAL05030	Primary	STYGOBROMUS PIZZINII	PIZZINI'S CAVE AMPHIPOD	G2G4
ICMAL05041	Primary	STYGOBROMUS TENUIS TENUIS	PIEDMONT GROUNDWATER AMPHIPOD	G4G5T2
IIODO80010	Primary	STYLURUS AMNICOLA	RIVERINE CLUBTAIL	G3
IIODO80090	Primary	STYLURUS SCUDDERI	ZEBRA CLUBTAIL	G4
IIODO34010	Primary	WILLIAMSONIA FLETCHERI	EBONY BOGHAUNTER	G3G4
IIODO34020	Primary	WILLIAMSONIA LINTNERI	RINGED BOGHAUNTER	G2
IILEY7P260	Primary	ZALE CUREMA	A NOCTUID MOTH	G3G4
IILEY7PX10	Primary	ZALE SP 1	PINE BARRENS ZALE	G3Q

Invertebrates (continued)

Lower New England/Northern Piedmont Ecoregion

Target Species List

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
IIODO14110	Secondary	AESHNA MUTATA	SPATTERDOCK DARNER	G3G4
IILEYJ8060	Secondary	ANARTA LUTEOLA		G4
IILEPA6050	Secondary	ANTHOCHARIS MIDEA	FALCATE ORANGETIP	G5
IILEPE2140	Secondary	CALLOPHRYS HESSELI	HESSEL'S HAIRSTREAK	G3G4
IILEPE2260	Secondary	CALLOPHRYS LANORAIEENSIS	BOG ELFIN	G3G4
IIODO65030	Secondary	CALOPTERYX AMATA	SUPERB JEWELWING	G4
IILEY9S010	Secondary	CERMA CORA	BIRD DROPPING MOTH	G3G4
IILEPJ9140	Secondary	CHLOSYNE NYCTEIS	SILVERY CHECKERSPOT	G5
IICOLO2200	Secondary	CICINDELA PURPUREA	A TIGER BEETLE	G5
IIODO03040	Secondary	CICINDELA TRANQUEBARICA	A TIGER BEETLE	G5
IIODO03040	Secondary	CORDULEGASTER ERRONEA	TIGER SPIKETAIL	G4
IIODO71020	Secondary	ENALLAGMA LATERALE	NEW ENGLAND BLUET	G3
IILEP37140	Secondary	ERYNNIS LUCILIUS	COLUMBINE DUSKYWING	G4
IILEP37100	Secondary	ERYNNIS MARTIALIS	MOTTLED DUSKYWING	G3G4
IIODO08270	Secondary	GOMPHUS DESCRIPTUS	HARPOON CLUBTAIL	G4
IILEY2R050	Secondary	GRAMMIA SPECIOSA	BOG TIGER MOTH	G4G5
IILEU0P020	Secondary	HYPOMECIS BUCHHOLZARIA	BUCHHOLZ'S GRAY	G3G4
IMBIV21160	Secondary	LAMPSILIS RADIATA	EASTERN LAMPMUSSEL	G5
IMBIV24030	Secondary	LEPTODEA OCHRACEA	TIDEWATER MUCKET	G4
IMBIV26010	Secondary	LIGUMIA NASUTA	EASTERN PONDMUSSEL	G4G5
ICBRA05010	Secondary	LIMNADIA LENTICULARIS	AMERICAN CLAM SHRIMP	G4G5
IILEYC0300	Secondary	PAPAIPEMA APPASSIONATA	PITCHER PLANT BORER MOTH	G4
IILEYC0020	Secondary	PAPAIPEMA DUOVATA	GOLDENROD STEM BORDER	G4
IILEYC0X20	Secondary	PAPAIPEMA SP 2	OSTRICH FERN BORER	G2G4

Appendix 1

Lower New England/Northern Piedmont Ecoregion

Target Species List

Vascular Plants: (89 Species, 42 Primary Targets, 47 Secondary Targets)

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
PDSCR01010	Primary	AGALINIS ACUTA	SANDPLAIN GERARDIA	G1
PDSCR01130	Primary	AGALINIS AURICULATA	EARLEAF FOXGLOVE	G3
PDBRA061D0	Primary	ARABIS PATENS	SPREADING ROCKCRESS	G3
PDAST0T0T0	Primary	ASTER DEPAUPERATUS	SERPENTINE ASTER	G2
PDFAB0F7P4	Primary	ASTRAGALUS ROBBINSII VAR JESUPII	JESUP'S MILK-VETCH	G5T1
PDAST18070	Primary	BIDENS BIDENTOIDES	MARYLAND BUR-MARIGOLD	G3
PDAST180M0	Primary	BIDENS EATONII	EATON'S BEGGAR-TICKS	G2
PDBRA0K0L0	Primary	CARDAMINE LONGII	LONG'S BITTER-CRESS	G3Q
PMCYP031K0	Primary	CAREX BARRATTII	BARRATT'S SEDGE	G3G4
PMCYP037T0	Primary	CAREX LUPULIFORMIS	FALSE HOP SEDGE	G3G4
PMCYP03AW0	Primary	CAREX POLYMORPHA	VARIABLE SEDGE	G3
PMCYP03C60	Primary	CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	G3
PMCYP03ES0	Primary	CAREX WIEGANDII	WIEGAND'S SEDGE	G3
PDCAR0605B	Primary	CERASTIUM ARVENSE VAR VILLOSISSIMUM	GOAT HILL CHICKWEED	G5T1Q
PDAST2L0T0	Primary	COREOPSIS ROSEA	ROSE COREOPSIS	G3
PDBOR0B081	Primary	CYNOGLOSSUM VIRGINIANUM VAR BOREALE	NORTHERN WILD COMFREY	G5T4
PMORC0Q020	Primary	CYPRIPEDIUM ARIETINUM	RAM'S-HEAD LADY'S-SLIPPER	G3
PMALI02050	Primary	ECHINODORUS PARVULUS	AMERICAN DWARF BURHEAD	G3Q
PMERI01070	Primary	ERIOCAULON PARKERI	PARKER'S PIPEWORT	G3
PDEUP0Q1T0	Primary	EUPHORBIA PURPUREA	GLADE SPURGE	G3
PDASTDX010	Primary	HASTEOLA SUAVEOLENS	SWEET-SCENTED INDIAN-PLANTAIN	G3G4
PMLIL10010	Primary	HELONIAS BULLATA	SWAMP-PINK	G3
PDCLU03010	Primary	HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3
PPISO01030	Primary	ISOETES EATONII	EATON'S QUILLWORT	G1Q
PMORC1F010	Primary	ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	G2G3
PDAST5X0Q2	Primary	LIATRIS SCARIOSA VAR NOVAE-ANGLIAE	NORTHERN BLAZING-STAR	G3Q
PMORC1R0N0	Primary	MALAXIS BAYARDII	BAYARD'S MALAXIS	G2?
PDHYD0C530	Primary	PHACELIA COVILLEI	BLUE SCORPION-WEED	G2?Q
PMPOA4Z1W0	Primary	POA PALUDIGENA	BOG BLUEGRASS	G3
PDPLM0E0L0	Primary	POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	G3
PMPOT03050	Primary	POTAMOGETON CONFERVOIDES	ALGAE-LIKE PONDWEED	G3G4
PMPOT030F0	Primary	POTAMOGETON HILLII	HILL'S PONDWEED	G3
PMPOT03170	Primary	POTAMOGETON OGDENII	OGDEN'S PONDWEED	G1
PDLAM1N030	Primary	PYCNANTHEMUM CLINOPODIOIDES	BASIL MOUNTAIN-MINT	G2
PDLAM1N0G0	Primary	PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	G2
PDROS1K540	Primary	RUBUS ORARIUS	BLACKBERRY	G3?Q
PMCYP0Q030	Primary	SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	G3
PMCYP0Q0Y0	Primary	SCIRPUS LONGII	LONG'S BULRUSH	G2
PMCYP0R0K0	Primary	SCLERIA RETICULARIS	RETICULATED NUTRUSH	G3G4
PDMAL100C0	Primary	SIDA HERMAPHRODITA	VIRGINIA MALLOW	G2
PPHYM020V0	Primary	TRICHOMANES INTRICATUM	A FILMY-FERN	G3G4
PDVIT040J0	Primary	VITIS RUPESTRIS	ROCK GRAPE	G3

Lower New England/Northern Piedmont Ecoregion

Target Species List

Vascular Plants (continued)

ELCODE	TARGET	GNAME	GCOMNAME	GRANK
PMORC04010	Secondary	ARETHUSA BULBOSA	SWAMP-PINK	G4
PDBET020H0	Secondary	BETULA PUMILA	SWAMP BIRCH	G5
PDAST1E010	Secondary	BOLTONIA ASTEROIDES	ASTER-LIKE BOLTONIA	G5T?
PDCON040G0	Secondary	CALYSTEGIA SPITHAMAEA	LOW BINDWEED	G4G5
PMCYP032U0	Secondary	CAREX CHORDORRHIZA	CREEPING SEDGE	G5
PMCYP03360	Secondary	CAREX CRAWEI	CRAWE SEDGE	G5
PMCYP03520	Secondary	CAREX GARBERI	ELK SEDGE	G4T3Q
PMCYP03870	Secondary	CAREX MEADII	MEAD'S SEDGE	G5
PMCYP03BK0	Secondary	CAREX RICHARDSONII	RICHARDSON SEDGE	G4
PMCYP03C80	Secondary	CAREX SCIRPOIDEA	BULRUSH SEDGE	G5
PDSCR0D0J0	Secondary	CASTILLEJA COCCINEA	SCARLET INDIAN-PAINTBRUSH	G5
PMLIL0F010	Secondary	CHAMAELIRIUM LUTEUM	DEVIL'S-BIT	G5
PMCYP061L0	Secondary	CYPERUS HOUGHTONII	HOUGHTON'S UMBRELLA-SEDGE	G4?
PMCYP090N0	Secondary	ELEOCHARIS EQUISETOIDES	HORSE-TAIL SPIKERUSH	G4
PMCYP091H1	Secondary	ELEOCHARIS PAUCIFLORA VAR FERNALDII	FEW-FLOWERED RUSH	G5T?
PDRAN0G010	Secondary	ENEMION BITERNATUM	FALSE RUE-ANEMONE	G5
PDGEN07060	Secondary	GENTIANELLA QUINQUEFOLIA	STIFF GENTIAN	G5
PDPRI06010	Secondary	HOTTONIA INFLATA	FEATHERFOIL	G4
PDRAN0F010	Secondary	HYDRASTIS CANADENSIS	GOLDEN-SEAL	G4
PPISO010Q0	Secondary	ISOETES ACADENSIS	ACADIAN QUILLWORT	G3?
PGCUP05070	Secondary	JUNIPERUS HORIZONTALIS	CREEPING JUNIPER	G5
PMORC1M030	Secondary	LIPARIS LILIIFOLIA	LARGE TWAYBLADE	G5
PMCYP0H040	Secondary	LIPOCARPHA MICRANTHA	DWARF BULRUSH	G4
PDONA0B0M0	Secondary	LUDWIGIA POLYCARPA	MANY-FRUIT FALSE-LOOSESTRIFE	G4
PMPOA480B0	Secondary	MUHLENBERGIA CAPILLARIS	LONG-AWN HAIRGRASS	G5
PDBOR0S040	Secondary	ONOSMODIUM VIRGINIANUM	VIRGINIA FALSE-GROMWELL	G4
PDCAR0L020	Secondary	PARONYCHIA ARGYROCOMA	SILVERLING	G4
PDSCR1K0M0	Secondary	PEDICULARIS LANCEOLATA	SWAMP LOUSEWORT	G5
PDPLM0D1J0	Secondary	PHLOX PILOSA	DOWNY PHLOX	G5
PDEUP13040	Secondary	PHYLLANTHUS CAROLINIENSIS	CAROLINA LEAF-FLOWER	G5
PDPLN02090	Secondary	PLANTAGO CORDATA	HEART-LEAVED PLANTAIN	G4
PDPGN0L0X0	Secondary	POLYGONUM DOUGLASII	DOUGLAS KNOTWEED	G5
PMCYP0N070	Secondary	RHYNCHOSPORA CAPILLACEA	HORNED BEAKRUSH	G5
PMCYP0N170	Secondary	RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4
PDROS1J012	Secondary	ROSA ACICULARIS SSP SAYI	PRICKLY ROSE	G5
PDAST8E010	Secondary	SCLEROLEPIS UNIFLORA	ONE-FLOWER SCLEROLEPIS	G4
PDAST8P1F0	Secondary	SOLIDAGO PTARMICOIDES	PRAIRIE GOLDENROD	G5
PDAST8P2U4	Secondary	SOLIDAGO SIMPLEX VAR RACEMOSA	LAKE ONTARIO GOLDENROD	G5T4?
PMPOA5V0L0	Secondary	SPOROBOLUS NEGLECTUS	SMALL DROPSEED	G5
PMORC2F050	Secondary	TRIPHORA TRIANTHOPHORA	NODDING POGONIA	G4
PDRAN0P020	Secondary	TROLLIUS LAXUS	SPREADING GLOBEFLOWER	G4T3Q
PDLNT020K0	Secondary	UTRICULARIA RESUPINATA	NORTHEASTERN BLADDERWORT	G4
PDVAL030A0	Secondary	VALERIANA PAUCIFLORA	VALERIAN	G4
PDVAL030J0	Secondary	VALERIANA ULIGINOSA	MARSH VALERIAN	G4Q
PDVER0N0W0	Secondary	VERBENA SIMPLEX	NARROW-LEAVED VERVAIN	G5
PDVIO04080	Secondary	VIOLA BRITTONIANA	COAST VIOLET	G4G5
PMLEM04010	Secondary	WOFFIELLA GLADIATA	SWORD BOGMAT	G5

Lower New England/Northern Piedmont Ecoregion
Target Species Listed as Federally Endangered or Threatened

GNAME	GCOMNAME	USESA*	USESA DATE*
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	LE	67-03-11
ACIPENSER OXYRINCHUS	ATLANTIC STURGEON	(LT-C)	N/A
CLEMMYS MUHLENBERGII	BOG TURTLE	(LT-T(S/A))	N/A
MYOTIS SODALIS	INDIANA OR SOCIAL MYOTIS	LE	67-03-11

GNAME	GCOMNAME	USESA*	USESA DATE*
ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	LE	90-03-14
CICINDELA PURITANA	PURITAN TIGER BEETLE	LT	90-08-07
LYCAEIDES MELISSA SAMUELIS	KARNER BLUE	LE	92-12-14
STYGOBROMUS HAYI	HAY'S SPRING AMPHIPOD	LE	82-02-05

GNAME	GCOMNAME	USESA*	USESA DATE*
AGALINIS ACUTA	SANDPLAIN GERARDIA	LE	88-09-07
ASTRAGALUS ROBBINSII VAR JESUPII	JESUP'S MILK-VETCH	LE	87-06-05
HELONIAS BULLATA	SWAMP-PINK	LT	88-09-09
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	LT	94-10-06
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	LE	91-05-07

*See **Terms Sheet** for a brief explanation of fields and listing codes.

KEY TO TERMS OF FEDERALLY LISTED SPECIES	
C	Candidate for listing
E(S/A)	Treat as endangered because of simililarity of appearance
LE	Listed endangered
LT	Listed threatened
LELT	Listed endangered in part of range: threatened in the remaining part
PE	Proposed endangered
PEPT	Proposed endangered in part of range; proposed threatened in the remaining part
(PS)	Status in only a portion of the species range
PT	Proposed threatened
T(S/A)	Treat as threatened because of simililarity of appearance
USESA	Federal status of an element
USESA DATE	Date of notification of the status in the Federal Register
XE	Essential experimental population
XN	Nonessential experimental

Lower New England/Northern Piedmont Ecoregion

Viable Primary Invertebrate Target Species
Distribution and Goals

GNAME	DISTRIBUTION	GOAL	SUBSECTION #221Ae	221Af	221Ag	221Ah	221Ai	221Al	221Am	221Ba	221Bb	221Bc	221Da	221Db	221Dc	M212Bb	M212Bc	M212Bd	M212Cb	M212Cc	221Ak*	232Ac*	M212De*	Grand Total Accepted EOs
ACRONICTA ALBARUFA	L	10 to 20										1												**1**
ALASMIDONTA HETERODON	W	5 to 10		1						1						10		1						**13**
ALASMIDONTA VARICOSA	W	5 to 10					6	3		1							2			2				**14**
AMPHIPOEA EREPTA RYENSIS	R	20	1																					**1**
CAECIDOTEA PRICEI	L	10 to 20							1				2											**3**
CALEPHELIS BOREALIS	L	10 to 20	5							5														**10**
CALLOPHRYS IRUS	L	10 to 20			7		2		1			11		1										**22**
CATOCALA HERODIAS GERHARDI	P	5 to 10																						**0**
CATOCALA PRETIOSA PRETIOSA	L	10 to 20																						**0**
CHAETAGLAEA CERATA	L	10 to 20										1												**1**
CICINDELA ANCOCISCONENSIS	L	10 to 20																		1				**1**
CICINDELA MARGINIPENNIS	L	10 to 20														8								**8**
CICINDELA PURITANA	L	10 to 20		3																				**3**
CINCINNATIA WINKLEYI	W	5 to 10																						**0**
CRANGONYX ABERRANS	L	10 to 20																						**0**
CRANGONYX DEAROLFI	L	10 to 20																						**0**
ENALLAGMA PICTUM	L/P	10																						**0**
ENALLAGMA RECURVATUM	L/P	10			6																			**6**
ERYNNIS PERSIUS PERSIUS	L/P	10			1		2																	**3**
EULIMNADIA STONINGTONENSIS	R	20	1																					**1**
FONTIGENS BOTTIMERI	R	30												3										**3**
GOMPHUS QUADRICOLOR	L	10 to 20								1														**1**
GOMPHUS VENTRICOSUS	W	5 to 10																						**0**
HERMARIS GRACILIS	R	30																						**0**
HEMILEUCA MAIA MAIA	L	10 to 20			2																			**2**
HEMILEUCA MAIA SSP 3	R	30						2				3												**5**
HEMILEUCA SP 2	P	N/A																						**0**
ITAME SP 1	L	10 to 20						1				1												**2**
LAMPSILIS CARIOSA	L/W	10											2									1		**3**
LANTHUS PARVULUS	L	10 to 20																						**0**
LASMIGONA SUBVIRIDIS	W	5 to 10																						**0**
LORDITHON NIGER	R	20			1																			**1**
LYCAEIDES MELISSA SAMUELIS	W	5 to 10										50												**50**
METARRANTHIS APICIARIA	R/L	20 to 30																						**0**
METARRANTHIS PILOSARIA	L	10 to 20			2																			**2**
OPHIOGOMPHUS ANOMALUS	L/W	10					1	6															1	**8**
OPHIOGOMPHUS ASPERSUS	W	5 to 10			2					1	1													**4**
OPHIOGOMPHUS HOWEI	L/W	10						8															1	**9**
POLYCELIS REMOTA	R	20																						**0**
PSECTRAGLAEA CARNOSA	L	10 to 20																						**0**
PYRGUS WYANDOT	L	10 to 20																						**0**
SOMATOCHLORA GEORGIANA	W	5 to 10																						**0**
SOMATOCHLORA INCURVATA	L	10 to 20																						**0**

***Targets in subsections adjacent to LNE/NP ecoregion.**

Lower New England/Northern Piedmont Ecoregion

Viable Primary Invertebrate Target Species
Distribution and Goals

GNAME	DISTRIBUTION	GOAL	SUBSECTION #221Ae	221Af	221Ag	221Ah	221Ai	221Al	221Am	221Ba	221Bb	221Bc	221Da	221Db	221Dc	M212Bb	M212Bc	M212Bd	M212Cb	M212Cc	221Ak*	232Ac*	M212De*	Grand Total Accepted EOs
SPEYERIA IDALIA	L	10 to 20																						**0**
SPHALLOPLANA PRICEI	L	10 to 20											1											**1**
SPONGILLA ASPINOSA	L	10 to 20																						**0**
STYGOBROMUS BOREALIS	R	30																						**0**
STYGOBROMUS HAYI	R	20												2										**2**
STYGOBROMUS KENKI	R	20												2										**2**
STYGOBROMUS PIZZINII	L	10 to 20											3											**3**
STYGOBROMUS TENUIS TENUIS	R	30												1										**1**
STYLURUS AMNICOLA	W	5 to 10																						**0**
STYLURUS SCUDDERI	P	5 to 10																						**0**
WILLIAMSONIA FLETCHERI	W	5 to 10					4	4													1			**9**
WILLIAMSONIA LINTNERI	L/W	10			13	1	5	1													1			**21**
ZALE CUREMA	R	30			2									2										**4**
ZALE SP 1	R	30			1		1	1																**3**
Grand Total			**7**	**4**	**37**	**1**	**21**	**26**	**2**	**9**	**1**	**67**	**8**	**11**	**0**	**18**	**2**	**1**	**0**	**3**	**2**	**1**	**2**	**223**
* = subsection is part of an adjoining ecoregion. EO captured by GIS buffer analysis of EOs close to the LNE-NP boundary.																								

Lower New England/Northern Piedmont Ecoregion

Viable Primary Plant Target Species

Distribution and Goals

GNAME	DISTRIBUTION	GOAL	SUBSECTION # 221Ae	221Af	221Ag	221Ah	221Ai	221Al	221Am	221Ba	221Bb	221Bc	221Da	221Db	221Dc	M212Bb	M212Bc	M212Bd	M212Cb	M212Cc	Grand Total Accepted EOs
AGALINIS ACUTA	L	10 to 20			2									1							**3**
AGALINIS AURICULATA	P	5 to 10							1												**1**
ARABIS PATENS	P	5 to 10											1								**1**
ASTER DEPAUPERATUS	L/P	20												14							**14**
ASTRAGALUS ROBBINSII VAR JESUPII	L	10 to 20														3					**3**
BIDENS BIDENTOIDES	P/L	5 to 10								3		13									**16**
BIDENS EATONII	L	10 to20			2																**2**
CARDAMINE LONGII	L	10 to 20	3									2									**5**
CAREX BARRATTII	P	5 to 10		2																	**2**
CAREX LUPULIFORMIS	W	5 to 10	5							1		2		2							**10**
CAREX POLYMORPHA	L	10 to 20			2		1														**3**
CAREX SCHWEINITZII	W	5 to 10	1																7		**8**
CAREX WIEGANDII	W	5 to 10				1															**1**
CERASTIUM ARVENSE VAR VILLOSISSIMUM	W	5 to 10												1							**1**
COREOPSIS ROSEA	W	5 to 10			1																**1**
CYNOGLOSSUM VIRGINIANUM VAR BOREALE	P	5 to 10										1									**1**
CYPRIPEDIUM ARIETINUM	W	5 to 10		1				3			1										**5**
ECHINODORUS PARVULUS	W	5 to 10		1																	**1**
ERIOCAULON PARKERI	W	5 to 10			2																**2**
EUPHORBIA PURPUREA	L	10 to 20												3							**3**
HASTEOLA SUAVEOLENS	W	5 to 10												4							**4**
HELONIAS BULLATA	P	10 to 20	1						1					1							**3**
HYPERICUM ADPRESSUM	W	5 to 10			1																**1**
ISOTRIA EATONII	W	5 to 10																			**0**
ISOTRIA MEDEOLOIDES	W	5 to 10				1	5	11										1			**18**
LIATRIS SCARIOSA VAR NOVAE-ANGLIAE	L	10 to 20	4																		**4**
MALAXIS BAYARDII	L	10 to 20										1									**1**
PHACELIA COVILLEI	W	5 to 10												5							**5**
POA PALUDIGENA	W	5 to 10							1				5								**6**
POLEMONIUM VANBRUNTIAE	P	10 to 20																			**0**
POTAMOTGETON CONFERVOIDES	L	10 to 20																			**0**
POTAMOGETON HILLII	L	10 to 20									1	1				1			9		**12**
POTAMOGETON OGDENII	R	20	1								1					1			1		**4**
PYCNANTHEMUM CLINOPODIOIDES	R	20	1												1						**2**
PYCNANTHEMUM TORREI	W	5 to 10		1										3	1						**5**
RUBUS ORARIUS	W	5 to 10								1											**1**
SCIRPUS ANCISTROCHAETUS	L	10 to 20														5	1			4	**10**
SCIRPUS LONGII	L	10 to 20					1	8													**9**
SCLERIA RETICULARIS	W	5 to 10					1						1	4							**6**
SIDA HERMAPHRODITA	P	10 to 20												3							**3**
TRICHOMANES INTRICATUM	P	5 to 10	1																		**1**
VITIS RUPESTRIS	P	10 to 20												1							**1**
Grand Total			**17**	**5**	**10**	**2**	**8**	**22**	**3**	**5**	**3**	**20**	**7**	**42**	**2**	**10**	**1**	**1**	**17**	**4**	**179**

Lower New England/Northern Piedmont Ecoregion

Viable Primary Vertebrate Target Species
Distribution and Goals

GNAME	DISTRIBUTION	GOAL	SUBSECTION # 221Ae	221Af	221Ag	221Ah	221Ai	221Al	221Am	221Ba	221Bb	221Bc	221Da	221Db	221Dc	M212Bb	M212Bc	M212Bd	M212Cb	M221Cc	Grand Total Accepted EOs
ACIPENSER BREVIROSTRUM	W	5 to 10		2	1					2											**5**
ACIPENSER OXYRINCHUS	W	5 to 10																			**0**
AMMOCRYPTA PELLUCIDA	P	5 to 10										3									**3**
CLEMMYS MUHLENBERGII	W	5 to 10	15						1	9	3		2	26					5		**61**
CROTALUS HORRIDUS	W	5 to 10	11	1						5	1	2							3		**23**
MYOTIS LEIBII	W	5 to 10								2											**2**
MYOTIS SODALIS	P	5								1											**1**
NEOTOMA MAGISTER	W	5 to 10	1																		**1**
Grand Total			**27**	**3**	**1**	**0**	**0**	**0**	**1**	**19**	**4**	**5**	**2**	**26**	**0**	**0**	**0**	**0**	**8**	**0**	**96**

Lower New England/Northern Piedmont Ecoregion

Primary Invertebrate Target Species
Viability and Subsection Distribution
Appendix 1

SUBSECTION #	221Ae		221Ae Total	221Af			221Af Total	221Ag			221Ag Total	221Ah			221Ah Total	221Ai			221Ai Total	221Al			221Al Total	221Am			221Am Total
GNAME VIABILITY	Y	N		M	Y	N		M	Y	N		M	Y	N		M	Y	N		M	Y	N		M	Y	N	
ACRONICTA ALBARUFA																											
ALASMIDONTA HETERODON					1	5	6							1	1												
ALASMIDONTA VARICOSA		1	1			1	1			2	2	1			1		6	11	17		3	1	4				
AMPHIPOEA EREPTA RYENSIS	1		1																								
CAECIDOTEA PRICEI																									1		1
CALEPHELIS BOREALIS	5		5																								
CALLOPHRYS IRUS								2	7		9						2	3	5						1		1
CATOCALA HERODIAS GERHARDI																											
CATOCALA PRETIOSA PRETIOSA																											
CHAETAGLAEA CERATA																1			1								
CICINDELA ANCOCISCONENSIS																											
CICINDELA MARGINIPENNIS																											
CICINDELA PURITANA				1	3	2	6																				
CINCINNATIA WINKLEYI																											
CRANGONYX ABERRANS																											
CRANGONYX DEAROLFI																											
ENALLAGMA PICTUM																											
ENALLAGMA RECURVATUM								1	6		7																
ERYNNIS PERSIUS PERSIUS									1		1					1	2	1	4								
EULIMNADIA STONINGTONENSIS	1		1																								
FONTIGENS BOTTIMERI																											
GOMPHUS QUADRICOLOR																											
GOMPHUS VENTRICOSUS																											
HEMARIS GRACILIS																3			3								
HEMILEUCA MAIA MAIA								1	2		3																
HEMILEUCA MAIA SSP 3																					2		2				
HEMILEUCA SP 2																											
ITAME SP 1																				1	1		2				
LAMPSILIS CARIOSA				2			2																	1		1	2
LANTHUS PARVULUS																											
LASMIGONA SUBVIRIDIS																											
LORDITHON NIGER									1		1																
LYCAEIDES MELISSA SAMUELIS																2		1	3								
METARRANTHIS APICIARIA																1		1	2								
METARRANTHIS PILOSARIA								1	2		3																
OPHIOGOMPHUS ANOMALUS																	1		1		6		6				
OPHIOGOMPHUS ASPERSUS									2		2													2			2
OPHIOGOMPHUS HOWEI																					8		8				
POLYCELIS REMOTA				2			2																				
PSECTRAGLAEA CARNOSA																											
PYRGUS WYANDOT																											
SOMATOCHLORA GEORGIANA																											
SOMATOCHLORA INCURVATA																											
SPEYERIA IDALIA																											
SPHALLOPLANA PRICEI																											
STYGOBROMUS BOREALIS																											
STYGOBROMUS HAYI																											
STYGOBROMUS KENKI																											
STYGOBROMUS PIZZINII																											
STYGOBROMUS TENUIS TENUIS																											
STYLURUS AMNICOLOR																											
STYLURUS SCUDDERI								1			1																
WILLIAMSONIA FLETCHERI																	4		4		4		4				
WILLIAMSONIA LINTNERI								4	13	4	21	1	1		2	5	5		10		1		1				
ZALE CUREMA						1	1	1	2		3					1			1								
ZALE SP 1									1		1						1		1	1	1		2				
Grand Total	7	1	8	5	4	9	18	11	37	6	54	2	1	1	4	14	21	17	52	2	26	1	29	3	2	1	6

SUBSECTION #	221Ba			221Ba Total	221Bb	221Bb Total	221Bc			221Bc Total	221Da			221Da Total	221Db			221Db Total	212Dc Total
GNAME VIABILITY	M	Y	N		Y		M	Y	N		M	Y	N		M	Y	N		
ACRONICTA ALBARUFA								1		1									
ALASMIDONTA HETERODON		1		1															
ALASMIDONTA VARICOSA	1	1		2							1		10	11	1		2	3	
AMPHIPOEA EREPTA RYENSIS																			
CAECIDOTEA PRICEI											2	2	5	9					
CALEPHELIS BOREALIS	2	5	1	8															
CALLOPHRYS IRUS								11	3	14	1			1		1	1	2	
CATOCALA HERODIAS GERHARDI																			
CATOCALA PRETIOSA PRETIOSA																			
CHAETAGLAEA CERATA							1	1		2									
CICINDELA ANCOCISCONENSIS																			
CICINDELA MARGINIPENNIS																			
CICINDELA PURITANA																			
CINCINNATIA WINKLEYI																			
CRANGONYX ABERRANS																			
CRANGONYX DEAROLFI											1			1					
ENALLAGMA PICTUM																			
ENALLAGMA RECURVATUM																			
ERYNNIS PERSIUS PERSIUS																			
EULIMNADIA STONINGTONENSIS																			
FONTIGENS BOTTIMERI																3		3	
GOMPHUS QUADRICOLOR		1		1															
GOMPHUS VENTRICOSUS																			
HEMARIS GRACILIS																			
HEMILEUCA MAIA MAIA																			
HEMILEUCA MAIA SSP 3								3		3									
HEMILEUCA SP 2																			
ITAME SP 1								1		1									
LAMPSILIS CARIOSA											13	2	3	18					
LANTHUS PARVULUS																			
LASMIGONA SUBVIRIDIS													2	2			1	1	
LORDITHON NIGER																			
LYCAEIDES MELISSA SAMUELIS							38	50	4	92									
METARRANTHIS APICIARIA																			
METARRANTHIS PILOSARIA																			
OPHIOGOMPHUS ANOMALUS																			
OPHIOGOMPHUS ASPERSUS		1		1	1	1													
OPHIOGOMPHUS HOWEI																			
POLYCELIS REMOTA																			
PSECTRAGLAEA CARNOSA																			
PYRGUS WYANDOT																			
SOMATOCHLORA GEORGIANA																			
SOMATOCHLORA INCURVATA																			
SPEYERIA IDALIA											1			1			4	4	
SPHALLOPLANA PRICEI												1		1					
STYGOBROMUS BOREALIS																			
STYGOBROMUS HAYI																2		2	
STYGOBROMUS KENKI																2		2	
STYGOBROMUS PIZZINII											3	3		6	2		1	3	
STYGOBROMUS TENUIS TENUIS															1	1		2	
STYLURUS AMNICOLOR																			
STYLURUS SCUDDERI																			
WILLIAMSONIA FLETCHERI																			
WILLIAMSONIA LINTNERI																			
ZALE CUREMA																2		2	
ZALE SP 1																			
Grand Total	3	9	1	13	1	1	39	67	7	113	22	8	20	50	4	11	9	24	

SUBSECTION #	M212Bb		M212Bb Total	M212Bc		M212Bc Total	M212Bd			M212Bd Total	M212Cb	M212Cb Total	M212Cc			M212Cc Total	221Ad*	221Ad Total*	221Ak*	221Ak Total*	232Ac*		232Ac Total*	M212De*	M212De Total*	Grand Total of All EOs
GNAME VIABILITY	Y	N		Y	N		M	Y	N		M		M	Y	N		M		Y		Y	N		Y		
ACRONICTA ALBARUFA																										1
ALASMIDONTA HETERODON	10	2	12					1	1	2																22
ALASMIDONTA VARICOSA		1	1	2	1	3	1		2	3			1	2	4	7										56
AMPHIPOEA EREPTA RYENSIS																										1
CAECIDOTEA PRICEI																										10
CALEPHELIS BOREALIS																										13
CALLOPHRYS IRUS																	1	1								33
CATOCALA HERODIAS GERHARDI																										0
CATOCALA PRETIOSA PRETIOSA																										0
CHAETAGLAEA CERATA					1	1																				4
CICINDELA ANCOCISCONENSIS														1		1										1
CICINDELA MARGINIPENNIS	8	1	9																							9
CICINDELA PURITANA																										6
CINCINNATIA WINKLEYI																										0
CRANGONYX ABERRANS																										0
CRANGONYX DEAROLFI																										1
ENALLAGMA PICTUM																										0
ENALLAGMA RECURVATUM																										7
ERYNNIS PERSIUS PERSIUS																										5
EULIMNADIA STONINGTONENSIS																										1
FONTIGENS BOTTIMERI																										3
GOMPHUS QUADRICOLOR																										1
GOMPHUS VENTRICOSUS																										0
HEMARIS GRACILIS																										3
HEMILEUCA MAIA MAIA																										3
HEMILEUCA MAIA SSP 3																										5
HEMILEUCA SP 2																										0
ITAME SP 1																										3
LAMPSILIS CARIOSA																					1	1	2			24
LANTHUS PARVULUS																										0
LASMIGONA SUBVIRIDIS																										3
LORDITHON NIGER																										1
LYCAEIDES MELISSA SAMUELIS																										95
METARRANTHIS APICIARIA																										2
METARRANTHIS PILOSARIA																										3
OPHIOGOMPHUS ANOMALUS																								1	1	8
OPHIOGOMPHUS ASPERSUS																										6
OPHIOGOMPHUS HOWEI																								1	1	9
POLYCELIS REMOTA																										2
PSECTRAGLAEA CARNOSA																										0
PYRGUS WYANDOT																										0
SOMATOCHLORA GEORGIANA																										0
SOMATOCHLORA INCURVATA																										0
SPEYERIA IDALIA																										5
SPHALLOPLANA PRICEI																										1
STYGOBROMUS BOREALIS																										0
STYGOBROMUS HAYI																										2
STYGOBROMUS KENKI																										2
STYGOBROMUS PIZZINII																										9
STYGOBROMUS TENUIS TENUIS											2	2														4
STYLURUS AMNICOLOR																										0
STYLURUS SCUDDERI																										1
WILLIAMSONIA FLETCHERI																			1	1						9
WILLIAMSONIA LINTNERI																			1	1						35
ZALE CUREMA																										7
ZALE SP 1																										4
Grand Total	18	4	22	2	2	4	1	1	3	5	2	2	1	3	4	8	1	1	2	2	1	1	2	2	2	420

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***Targets in subsections adjacent to LNE-NP ecoregion.**

Appendix 1.

Lower New England/Northern Piedmont Ecoregion

Primary Plant Target Species

Viability and Subsection Distribution

SUBSECTION #	221Ae			221Ae Total	221Af			221Af Total	221Ag		221Ag Total	221Ah	221Ah Total	221Ai			221Ai Total
GNAME / VIABILITY	M	Y	N		M	Y	N		Y	N		Y		M	Y	N	
AGALINIS ACUTA									2		2						
AGALINIS AURICULATA																	
ARABIS PATENS																	
ASTER DEPAUPERATUS																	
ASTRAGALUS ROBBINSII VAR JESUPII																	
BIDENS BIDENTOIDES																	
BIDENS EATONII									2		2						
CARDAMINE LONGII		3	1	4													
CAREX BARRATTII						2		2									
CAREX LUPULIFORMIS		5	2	7													
CAREX POLYMORPHA			1	1					2	1	3				1		1
CAREX SCHWEINITZII		1	1	2													
CAREX WIEGANDII												1	1				
CERASTIUM ARVENSE VAR VILLOSISSIMUM																	
COREOPSIS ROSEA									1	4	5						
CYNOGLOSSUM VIRGINIANUM VAR BOREALE																	
CYPRIPEDIUM ARIETINUM						1		1									
ECHINODORUS PARVULUS						1		1									
ERIOCAULON PARKERI									2		2						
EUPHORBIA PURPUREA																	
HASTEOLA SUAVEOLENS																	
HELONIAS BULLATA		1		1													
HYPERICUM ADPRESSUM									1		1						
ISOTRIA EATONII																	
ISOTRIA MEDEOLOIDES	1		1	2	1		1	2		2	2	1	1		5	12	17
LIATRIS SCARIOSA VAR NOVAE-AN(		4	1	5						2	2			2		3	5
MALAXIS BAYARDII																	
PHACELIA COVILLEI																	
POA PALUDIGENA																	
POLEMONIUM VANBRUNTIAE																	
POTAMOGETON CONFERVOIDES							1	1									
POTAMOGETON HILLII			2	2													
POTAMOGETON OGDENII		1		1													
PYCNANTHEMUM CLINOPODIOIDES		1	1	2			1	1								1	1
PYCNANTHEMUM TORREI			2	2		1		1									
RUBUS ORARIUS																	
SCIRPUS ANCISTROCHAETUS							1	1									
SCIRPUS LONGII															1	1	2
SCLERIA RETICULARIS										1	1				1		1
SIDA HERMAPHRODITA																	
TRICHOMANES INTRICATUM		1		1													
VITIS RUPESTRIS																	
Grand Total	**1**	**17**	**12**	**30**	**1**	**5**	**4**	**10**	**10**	**10**	**20**	**2**	**2**	**2**	**8**	**17**	**27**

SUBSECTION #	221Al			221Al Total	221Am		221Am Total	221Ba			221Ba Total	221Bb	221Bb Total	221Bc		221Bc Total	221Da		221Da Total
GNAME / VIABILITY	M	Y	N		Y	N		M	Y	N		Y		Y	N		M	Y	
AGALINIS ACUTA																			
AGALINIS AURICULATA					1		1										1		1
ARABIS PATENS																		1	1
ASTER DEPAUPERATUS																			
ASTRAGALUS ROBBINSII VAR JESUPII																			
BIDENS BIDENTOIDES									3	3	6			13	8	21			
BIDENS EATONII																			
CARDAMINE LONGII														2	1	3			
CAREX BARRATTII																			
CAREX LUPULIFORMIS								1	1	1	3			2	1	3			
CAREX POLYMORPHA						2	2												
CAREX SCHWEINITZII																			
CAREX WIEGANDII																			
CERASTIUM ARVENSE VAR VILLOSISSIMUM																			
COREOPSIS ROSEA																			
CYNOGLOSSUM VIRGINIANUM VAR BOREALE														1		1			
CYPRIPEDIUM ARIETINUM		3	1	4								1	1						
ECHINODORUS PARVULUS																			
ERIOCAULON PARKERI																			
EUPHORBIA PURPUREA																			
HASTEOLA SUAVEOLENS																			
HELONIAS BULLATA					1		1												
HYPERICUM ADPRESSUM																			
ISOTRIA EATONII																			
ISOTRIA MEDEOLOIDES	2	11	35	48															
LIATRIS SCARIOSA VAR NOVAE-AN(																			
MALAXIS BAYARDII														1		1			
PHACELIA COVILLEI																			
POA PALUDIGENA					1	1	2								1	1		5	5
POLEMONIUM VANBRUNTIAE																			
POTAMOGETON CONFERVOIDES	2			2															
POTAMOGETON HILLII												1	1	1		1			
POTAMOGETON OGDENII												1	1						
PYCNANTHEMUM CLINOPODIOIDES																			
PYCNANTHEMUM TORREI																			
RUBUS ORARIUS									1		1								
SCIRPUS ANCISTROCHAETUS																			
SCIRPUS LONGII		8	1	9															
SCLERIA RETICULARIS																		1	1
SIDA HERMAPHRODITA																			
TRICHOMANES INTRICATUM																			
VITIS RUPESTRIS																			
Grand Total	**4**	**22**	**37**	**63**	**3**	**3**	**6**	**1**	**5**	**4**	**10**	**3**	**3**	**20**	**11**	**31**	**1**	**7**	**8**

SUBSECTION #	221Db			221Db Total	221Dc			221Dc Total	M212Bb		M212Bb Total	M212Bc		M212Bc Total	M212Bd		M212Bd Total	M212Cb			M212Cb Total	M212Cc		M212Cc Total	Grand Total of All EOs
GNAME / VIABILITY	M	Y	N		M	Y	N		M	Y		Y	N		Y	N		M	Y	N		Y	N		
AGALINIS ACUTA		1		1																					3
AGALINIS AURICULATA																									2
ARABIS PATENS																									1
ASTER DEPAUPERATUS	1	14	7	22																					22
ASTRAGALUS ROBBINSII VAR JESUPII										3	3														3
BIDENS BIDENTOIDES																									27
BIDENS EATONII																									2
CARDAMINE LONGII																									7
CAREX BARRATTII																									2
CAREX LUPULIFORMIS		2		2																					15
CAREX POLYMORPHA																									7
CAREX SCHWEINITZII																		3	7	4	14				16
CAREX WIEGANDII																									1
CERASTIUM ARVENSE VAR VILLOSISSIMUM		1		1																					1
COREOPSIS ROSEA																									5
CYNOGLOSSUM VIRGINIANUM VAR BOREALE																									1
CYPRIPEDIUM ARIETINUM																									6
ECHINODORUS PARVULUS																									1
ERIOCAULON PARKERI																									2
EUPHORBIA PURPUREA	1	3		4																					4
HASTEOLA SUAVEOLENS		4	4	8																					8
HELONIAS BULLATA		1		1																					3
HYPERICUM ADPRESSUM																									1
ISOTRIA EATONII																									0
ISOTRIA MEDEOLOIDES															1	1	2								74
LIATRIS SCARIOSA VAR NOVAE-AN(																									12
MALAXIS BAYARDII																									1
PHACELIA COVILLEI		5	2	7																					7
POA PALUDIGENA			1	1																					9
POLEMONIUM VANBRUNTIAE	1		1	2																					2
POTAMOGETON CONFERVOIDES																				1	1				4
POTAMOGETON HILLII										1	1								9	6	15				20
POTAMOGETON OGDENII										1	1							1	1		2				5
PYCNANTHEMUM CLINOPODIOIDES						1	1	2																	6
PYCNANTHEMUM TORREI		3	2	5	1	1	1	3																	11
RUBUS ORARIUS																									1
SCIRPUS ANCISTROCHAETUS									2	5	7	1	1	2								4	1	5	15
SCIRPUS LONGII																									11
SCLERIA RETICULARIS		4		4																					7
SIDA HERMAPHRODITA	3	3	1	7																					7
TRICHOMANES INTRICATUM																							1	1	2
VITIS RUPESTRIS		1	1	2																					2
Grand Total	**6**	**42**	**19**	**67**	**1**	**2**	**2**	**5**	**2**	**10**	**12**	**1**	**1**	**2**	**1**	**1**	**2**	**4**	**17**	**11**	**32**	**4**	**2**	**6**	**336**

Lower New England/Northern Piedmont Ecoregion

Primary Vertebrate Target Species
Viability and Subsection Distribution
DRAFT 9\20\00 CONFIDENTIAL

SUBSECTION #	221Ae			221Ae Total	221Af			221Af Total	221Ag		221Ag Total	221 Ah Total	221Ai		221Ai Total	221Al Total	221Am			221Am Total	221Ba			221Ba Total	221Bb		221Bb Total	221Bc			221Bc Total	221Da			221Da Total	221Db			221Db Total	221Dc	221Dc Total	M212Bb	M212Bb Total	M212Bc Total	221Bd	221Bd Total	M212Cb		M212Cb Total	M212Cc	M212Cc Total	M221Da*	M221Da Total*	Grand Total of All EOs
GNAME VIABILITY	**M**	**Y**	**N**		**M**	**Y**	**N**		**Y**	**N**			**M**	**N**			**M**	**Y**	**N**		**M**	**Y**	**N**		**Y**	**N**		**M**	**Y**	**N**		**M**	**Y**	**N**		**M**	**Y**	**N**		**N**		**N**			**N**		**Y**	**N**		**N**		**N**		
ACIPENSER BREVIROSTRUM			1	1		2		2	1		1											2	1	3						2	2	2			2			1	1															12
ACIPENSER OXYRINCHUS			1	1			2	2																														1	1															4
AMMOCRYPTA PELLUCIDA																													3		3																							3
CLEMMYS MUHLENBERGII	10	15	30	55													7	1	22	30	4	9	19	32	3		3					4	2	16	22	1	26	78	105	2	2						5	1	6	1	1			256
CROTALUS HORRIDUS	8	11	19	38	1	1		2					2	1	3							5	2	7	1	2	3		2	1	3									2	2	1	1		1	1	3	1	4					64
MYOTIS LEIBII			2	2																		2	1	3				1		1	2																	4	4					11
MYOTIS SODALIS	4			4						2	2											1		1				1			1																	1	1					9
NEOTOMA MAGISTER		1	1	2																			2	2																					1	1						1	1	6
Grand Total	22	27	54	103	1	3	2	6	1	2	3	0	2	1	3	0	7	1	22	30	4	19	25	48	4	2	6	2	5	4	11	6	2	16	24	1	26	80	107	4	4	1	1	0	2	2	8	7	15	1	1	1	1	365

***Targets in subsections adjacent to the LNE/NP ecoregion**.

Lower New England\Northern Piedmont

Primary Invertebrate Species

Progress towards Goals

GNAME	GCOMNAME	DISTRIBUTION	GOAL	# of Eos	# ACCEPTED by Expert Team	# ACCEPTED into the Portfolio	GOAL MET
ACRONICTA ALBARUFA	BARRENS DAGGER MOTH	L	10 to 20	1	1	1	No
ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	W	5 to 10	22	13	13	**Yes**
ALASMIDONTA VARICOSA	BROOK FLOATER	W	5 to 10	56	14	12	**Yes**
AMPHIPOEA EREPTA RYENSIS	A NOCTUID MOTH	R	20	1	1	0	No
CAECIDOTEA PRICEI	PRICE'S CAVE ISOPOD	L	10 to 20	10	3	1	No
CALEPHELIS BOREALIS	NORTHERN METALMARK	L	10 to 20	13	10	10	**Yes**
CALLOPHRYS IRUS	FROSTED ELFIN	L	10 to 20	33	22	22	**Yes**
CATOCALA HERODIAS GERHARDI	HERODIAS UNDERWING	P	5 to 10	0	0	0	No
CATOCALA PRETIOSA PRETIOSA		L	10 to 20	0	0	0	No
CHAETAGLAEA CERATA	A NOCTUID MOTH	L	10 to 20	4	1	1	No
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	L	10 to 20	1	1	1	No
CICINDELA MARGINIPENNIS	COBBLESTONE TIGER BEETLE	L	10 to 20	9	8	8	No
CICINDELA PURITANA	PURITAN TIGER BEETLE	L	10 to 20	6	3	3	No
CINCINNATIA WINKLEYI	NEW ENGLAND SILTSNAIL	W	5 to 10	0	0	0	No
CRANGONYX ABERRANS	MYSTIC RIVER AMPHIPOD	L	10 to 20	0	0	0	No
CRANGONYX DEAROLFI	PENNSYLVANIA CAVE AMPHIPOD	L	10 to 20	1	0	0	No
ENALLAGMA PICTUM	SCARLET BLUE	L/P	10	0	0	0	No
ENALLAGMA RECURVATUM	PINE BARRENS BLUET	L/P	10	7	6	6	No
ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	L/P	10	5	3	3	No
EULIMNADIA STONINGTONENSIS	A CLAM SHRIMP	R	20	1	1	1	No
FONTIGENS BOTTIMERI	APPALACHIAN SPRINGSNAIL	R	30	3	3	3	No
GOMPHUS QUADRICOLOR	RAPIDS CLUBTAIL	L	10 to 20	1	1	0	No
GOMPHUS VENTRICOSUS	SKILLET CLUBTAIL	W	5 to 10	0	0	0	No
HEMARIS GRACILIS	GRACEFUL CLEARWING	R	30	3	0	0	No
HEMILEUCA MAIA MAIA	COASTAL BARRENS BUCKMOTH	L	10 to 20	3	2	2	No
HEMILEUCA MAIA SSP 3	INLAND BARRENS BUCKMOTH	R	30	5	5	5	No
HEMILEUCA SP2	SCHWEITZER'S BUCKMOTH	P	N/A	0	0	0	No
ITAME SP 1	BARRENS ITAME (cf I. INEXTRICATA)	L	10 to 20	3	2	2	No
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	L/W	10	24	3	3	No
LANTHUS PARVULUS	NORTHERN PYGMY CLUBTAIL	L	10 to 20	0	0	0	No
LASMIGONA SUBVIRIDIS	GREEN FLOATER	W	5 to 10	3	0	0	No
LORDITHON NIGER	BLACK LORDITHON ROVE BEETLE	R	20	1	1	1	No
LYCAEIDES MELISSA SAMUELIS	KARNER BLUE	W	5 to 10	95	50	50	**Yes**
METARRANTHIS APICIARIA	BARRENS METARRANTHIS MOTH	R/L	20 to 30	2	0	0	No
METARRANTHIS PILOSARIA	COASTAL SWAMP METARRANTHIS	L	10 to 20	3	2	2	No
OPHIOGOMPHUS ANOMALUS	EXTRA-STRIPED SNAKETAIL	L/W	10	8	8	8	No
OPHIOGOMPHUS ASPERSUS	BROOK SNAKETAIL	W	5 to 10	6	4	3	No
OPHIOGOMPHUS HOWEI	PYGMY SNAKETAIL	L/W	10	9	9	9	No
POLYCELIS REMOTA	SUNDERLAND SPRING PLANARIAN	R	20	2	0	0	No
PSECTRAGLAEA CARNOSA	PINK SALLOW	L	10 to 20	0	0	0	No
PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	L	10 to 20	0	0	0	No
SOMATOCHLORAR GEORGIANA	COPPERY EMERALD	W	5 to 10	0	0	0	No
SOMATOCHLORA INCURVATA	INCURVATE EMERALD	L	10 to 20	0	0	0	No
SPEYERIA IDALIA	REGAL FRITILLARY	L	10 to 20	5	0	0	No
SPHALLOPLANA PRICEI	REFTON CAVE PLANARIAN	L	10 to 20	1	1	0	No
SPONGILLA ASPINOSA	SMOOTH BRANCHED SPONGE	L	10 to 20	0	0	0	No
STYGOBROMUS BOREALIS	TACONIC CAVE AMPHIPOD	R	30	0	0	0	No
STYGOBROMUS HAYI	HAY'S SPRING AMPHIPOD	R	20	2	2	2	No
STYGOBROMUS KENKI	ROCK CREEK GROUNDWATER AMPHIPOD	R	20	2	2	2	No
STYGOBROMUS PIZZINII	PIZZINI'S CAVE AMPHIPOD	L	10 to 20	9	3	1	No
STYGOBROMUS TENUIS TENUIS	PIEDMONT GROUNDWATER AMPHIPOD	R	30	4	1	1	No
STYLURUS AMNICOLA	RIVERINE CLUBTAIL	W	5 to 10	0	0	0	No
STYLURUS SCUDDERI	ZEBRA CLUBTAIL	P	5 to 10	1	0	0	No
WILLIAMSONIA FLETCHERI	EBONY BOGHAUNTER	W	5 to 10	9	9	9	**Yes**
WILLIAMSONIA LINTNERI	RINGED BOGHAUNTER	L/W	10	35	21	21	**Yes**
ZALE CUREMA	A NOCTUID MOTH	R	30	7	4	4	No
ZALE SP 1	PINE BARRENS ZALE	R	30	4	3	3	No
Grand Total				**420**	**223**	**213**	**7 Yes**
							50 No

Lower New England\Northern Piedmont

Primary Vertebrate Species

Progress towards Goals

GNAME	GCOMNAME	DISTRIBUTION	GOAL	# of Eos	# ACCEPTED by Expert Team	# ACCEPTED into the Portfolio	GOAL MET
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	W	5 to 10	12	5	3	No
ACIPENSER OXYRINCHUS	ATLANTIC STURGEON	W	5 to 10	4	0	0	No
AMMOCRYPTA PELLUCIDA	EASTERN SAND DARTER	P	5 to 10	3	3	2	No
CLEMMYS MUHLENBERGII	BOG TURTLE	W	5 to 10	256	61	47	**Yes**
CROTALUS HORRIDUS	TIMBER RATTLESNAKE	W	5 to 10	64	23	21	**Yes**
MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS	W	5 to 10	11	2	1	No
MYOTIS SODALIS	INDIANA OR SOCIAL MYOTIS	P	5	9	1	1	No
NEOTOMA MAGISTER	ALLEGHENY WOODRAT	W	5 to 10	6	1	1	No
Grand Total				**365**	**96**	**76**	**2 Yes**
							6 No

Lower New England\Northern Piedmont Ecoregion
Primary Vascular Plant Species
Progress towards Goals

GNAME	GCOMNAME	DISTRIBUTION	GOAL	# of Eos	# ACCEPTED by Expert Team	# ACCEPTED into the Portfolio	GOAL MET
AGALINIS ACUTA	SANDPLAIN GERARDIA	L	10 to 20	3	3	3	No
AGALINIS AURICULATA	EARLEAF FOXGLOVE	P	5 to 10	2	1	0	No
ARABIS PATENS	SPREADING ROCKCRESS	P	5 to 10	1	1	1	No
ASTER DEPAUPERATUS	SERPENTINE ASTER	L/P	20	22	14	13	No
ASTRAGALUS ROBBINSII VAR JESUPII	JESUP'S MILK-VETCH	L	10 to 20	3	3	3	No
BIDENS BIDENTOIDES	MARYLAND BUR-MARIGOLD	P/L	5 to 10	27	16	7	**Yes**
BIDENS EATONII	EATON'S BEGGAR-TICKS	L	10 to20	2	2	2	No
CARDAMINE LONGII	LONG'S BITTER-CRESS	L	10 to 20	7	5	2	No
CAREX BARRATTII	BARRATT'S SEDGE	P	5 to 10	2	2	2	No
CAREX LUPULIFORMIS	FALSE HOP SEDGE	W	5 to 10	15	10	7	**Yes**
CAREX POLYMORPHA	VARIABLE SEDGE	L	10 to 20	7	3	3	No
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	W	5 to 10	16	8	6	**Yes**
CAREX WIEGANDII	WIEGAND'S SEDGE	W	5 to 10	1	1	1	No
CERASTIUM ARVENSE VAR VILLOSISSIMUM	GOAT HILL CHICKWEED	W	5 to 10	1	1	1	No
COREOPSIS ROSEA	ROSE COREOPSIS	W	5 to 10	5	1	1	No
CYNOGLOSSUM VIRGINIANUM VAR BOREALE	NORTHERN WILD COMFREY	P	5 to 10	1	1	1	No
CYPRIPEDIUM ARIETINUM	RAM'S-HEAD LADY'S-SLIPPER	W	5 to 10	6	5	5	**Yes**
ECHINODORUS PARVULUS	AMERICAN DWARF BURHEAD	W	5 to 10	1	1	1	No
ERIOCAULON PARKERI	PARKER'S PIPEWORT	W	5 to 10	2	2	2	No
EUPHORBIA PURPUREA	GLADE SPURGE	L	10 to 20	4	3	3	No
HASTEOLA SUAVEOLENS	SWEET-SCENTED INDIAN-PLANTAIN	W	5 to 10	8	4	3	No
HELONIAS BULLATA	SWAMP-PINK	P	10 to 20	3	3	3	No
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	W	5 to 10	1	1	1	No
ISOTRIA EATONII	EATON'S QUILLWORT	W	5 to 10	0	0	0	No
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	W	5 to 10	74	18	15	**Yes**
LIATRIS SCARIOSA VAR NOVAE-ANGLIAE	NORTHERN BLAZING-STAR	L	10 to 20	12	4	4	No
MALAXIS BAYARDII	BAYARD'S MALAXIS	L	10 to 20	1	1	1	No
PHACELIA COVILLEI	BLUE SCORPION-WEED	W	5 to 10	7	5	5	**Yes**
POA PALUDIGENA	BOG BLUEGRASS	W	5 to 10	9	6	6	**Yes**
POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	P	10 to 20	2	0	0	No
POTAMOGETON CONFERVOIDES	ALGAE-LIKE PONDWEED	L	10 to 20	4	0	0	No
POTAMOGETON HILLII	HILL'S PONDWEED	L	10 to 20	20	12	12	**Yes**
POTAMOGETON OGDENII	OGDEN'S PONDWEED	R	20	5	4	4	No
PYCNANTHEMUM CLINOPODIOIDES	BASIL MOUNTAIN-MINT	R	20	6	2	2	No
PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	W	5 to 10	11	5	4	No
RUBUS ORARIUS	BLACKBERRY	W	5 to 10	1	1	1	No
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	L	10 to 20	15	10	10	**Yes**
SCIRPUS LONGII	LONG'S BULRUSH	L	10 to 20	11	9	9	No
SCLERIA RETICULARIS	RETICULATED NUTRUSH	W	5 to 10	7	6	6	**Yes**
SIDA HERMAPHRODITA	VIRGINIA MALLOW	P	10 to 20	7	3	2	No
TRICHOMANES INTRICATUM	A FILMY-FERN	P	5 to 10	2	1	1	No
VITIS RUPESTRIS	ROCK GRAPE	P	10 to 20	2	1	1	No
Grand Total				**336**	**179**	**154**	**10 Yes**
							32 No

Lower New England\Northern Piedmont

Secondary targets with EOs in portfolio and 10-year Action Sites

Scientific Name	No. of EOs in Portfolio Sites	No. of EOs in Portfolio 10 Year Action Sites
CORDULEGASTER ERRONEA	0	0
CYPERUS HOUGHTONII	0	0
DENDROICA CAERULESCENS	0	0
ELEOCHARIS PAUCIFLORA VAR FERNALDII	0	0
ENEMION BITERNATUM	0	0
HOTTONIA INFLATA	0	0
PHLOX PILOSA	0	0
PHYLLANTHUS CAROLINIENSIS	0	0
PROTONOTARIA CITREA	0	0
ROSA ACICULARIS SSP SAYI	0	0
UTRICULARIA RESUPINATA	0	0
VERMIVORA CHRYSOPTERA	0	0
VIOLA BRITTONIANA	0	0
AESHNA MUTATA	1	1
BOLTONIA ASTEROIDES	1	0
CALLOPHRYS LANORAIEENSIS	1	1
CAREX CHORDORRHIZA	1	0
CAREX GARBERI	1	1
ERYNNIS LUCILIUS	1	0
GRAMMIA SPECIOSA	1	0
HELMITHEROS VERMIVORUS	1	0
LAMPSILIS RADIATA	1	1
LIGUMIA NASUTA	1	1
LUDWIGIA POLYCARPA	1	0
MUHLENBERGIA CAPILLARIS	1	0
PAPAIPEMA SP 2	1	1
PLANTAGO CORDATA	1	0
SCLEROLEPIS UNIFLORA	1	0
SPOROBOLUS NEGLECTUS	1	0
VALERIANA ULIGINOSA	1	0
VERBENA SIMPLEX	1	0
ANARTA LUTEOLA	2	2
CERMA CORA	2	1
CHLOSYNE NYCTEIS	2	2
PARONYCHIA ARGYROCOMA	2	2
RHYNCHOSPORA INUNDATA	2	1
VERMIVORA PINUS	2	0
CALLOPHRYS HESSELI	3	2
CALYSTEGIA SPITHAMAEA	3	2
CAREX CRAWEI	3	1
CAREX RICHARDSONII	3	2
ELEOCHARIS EQUISETOIDES	3	2
LIPOCARPHA MICRANTHA	3	3
ONOSMODIUM VIRGINIANUM	3	2
CAREX MEADII	4	3
LEPTODEA OCHRACEA	4	1
LIPARIS LILIIFOLIA	4	2
PAPAIPEMA APPASSIONATA	4	2
SOLIDAGO SIMPLEX VAR RACEMOSA	4	3
VALERIANA PAUCIFLORA	4	4
CAREX SCIRPOIDEA	5	3
JUNIPERUS HORIZONTALIS	5	2
PEDICULARIS LANCEOLATA	5	3
RHYNCHOSPORA CAPILLACEA	5	4
TRIPHORA TRIANTHOPHORA	5	3
DENDROICA CERULEA	6	3
ARETHUSA BULBOSA	7	4
GENTIANELLA QUINQUEFOLIA	7	6
POLYGONUM DOUGLASII	7	4
CASTILLEJA COCCINEA	9	6
HYDRASTIS CANADENSIS	10	1
SOLIDAGO PTARMICOIDES	10	4
BETULA PUMILA	11	6
CHAMAELIRIUM LUTEUM	11	5
ENALLAGMA LATERALE	11	7
EMYDOIDEA BLANDINGII	20	11
CLEMMYS INSCULPTA	22	11

Lower New England\Northern Piedmont

Secondary Targets without Occurrences

LNE Secondary Vertebrate Targets with No EOs

ABPBJ18120	0	Secondary	CATHARUS BICKNELLI	BICKNELL'S THRUSH
ABPBX03190	0	Secondary	DENDROICA DISCOLOR	PRAIRIE WARBLER
ABPJ19010	0	Secondary	HYLCOCICHLA MUSTLENIA	WOOD THRUSH
ABPBX10030	0	Secondary	SEIURUS MOTACILLA	LOUISIANA WATERTHRUSH
AMAEB01050	0	Secondary	SYLVILAGUS TRANSITIONALIS	NEW ENGLAND COTTONTAIL

LNE Secondary Invertebrate Targets with No EOs

IILEPA6050	0	Secondary	ANTHOCHARIS MIDEA	FALCATE ORANGETIP
IIODO65030	0	Secondary	CALOPTERYX AMATA	SUPERB JEWELWING
IICOLO2200	0	Secondary	CICINDELA PURPUREA	A TIGER BEETLE
IIODO03040	0	Secondary	CICINDELA TRANQUEBARICA	A TIGER BEETLE
IILEP37100	0	Secondary	ERYNNIS MARTIALIS	MOTTLED DUSKYWING
IIODO08270	0	Secondary	GOMPHUS DESCRIPTUS	HARPOON CLUBTAIL
IILEU0P020	0	Secondary	HYPOMECIS BUCHHOLZARIA	BUCHHOLZ'S GRAY
ICBRA05010	0	Secondary	LIMNADIA LENTICULARIS	AMERICAN CLAM SHRIMP
IILEYC0020	0	Secondary	PAPAIPEMA DUOVATA	GOLDENROD STEM BORDER

LNE Secondary Vascular Plant Targets with No EOs

PPISO010Q0	0	Secondary	ISOETES ACADENSIS	ACADIAN QUILLWORT
PDRAN0P020	0	Secondary	TROLLIUS LAXUS	SPREADING GLOBEFLOWER
PMLEM04010	0	Secondary	WOFFIELLA GLADIATA	SWORD BOGMAT

Appendix 2.
Lower New England\Northern Piedmont
Priority Bird Species of LNE-NP: Secondary Targets

Species	AI-09	PT-09	**PIF09**	AI-17	PT-17	**PIF17**	AI-27	PT-27	**PIF 27**	**GLOBAL**	Habitat	Comments
Bicknell's Thrush				2	3	**23**	4	3	**24**	**21**	Northern forest, mountain top	important to north, watchlist
Wood Thrush	4	5	**24**	4	2	**21**	5	5	**24**	**20**	Hardwood forest	watchlist
Blue-winged Warbler	5	5	**26**	3	2	**20**	2	3	**20**	**19**	Shrub	
Golden-winged Warbler	2	4	**26**	3	2	**25**	2	3	**25**	**25**	Shrub	watchlist
Black-throated Blue Warbler	2	3	**22**	2	3	**21**	3	2	**21**	**20**	Northern hardwood	high scores in all, important to north, watchlist
Prairie Warbler	3	5	**23**	2	2	**19**	2	3	**20**	**20**	Shrub	watchlist
Cerulean Warbler	2	3	**24**	2	3	**25**				**25**	Swamp/hardwood	high scores, inc in region, watchlist
Prothonotary Warbler	2	3	**21**	2	3	**21**				**21**	Swamp/hardwood	high enough scores, low AI, watchlist
Worm-eating Warbler	3	3	**24**	4	3	**25**				**21**	Hardwood	watchlist
Louisiana Waterthrush	4	3	**23**	4	1	**20**	3	2	**20**	**19**	Hardwood	
Kentucky Warbler	2	3	**21**	2	3	**21**				**19**	Hardwood/shrub	high enough scores low AI, watchlist

Comments:

Bicknell's Thrush and Black-throated Blue Warbler will be priorities in the northern portion of the ecoregion.
Prothonotary Warbler and Kentucky Warbler will be priorities to the south.
Dickcissel, Henslow's Sparrow, and Bobolink, although not appearing on this list because of low population sizes, should be considered a management priority when they occur at priority sites.
DC/MD nominated loggerhead shrike. The loggerhead shrike has a global PIF score is 17. The cutoff criteria for this bird list as 19.

Lower New England\Northern Piedmont

Viable Community Occurrences Grouped by Subregion

Subregion	***So NE Plains***			**Totals**		***NE LNE Plains***		**Totals**		***Hudson River***			**Totals**		***No. Piedmont***				**Total**		***Mountain and Highlands***					**Total**	**GOAL**	**SELECTED**
	221Ae	221Af	221Ag			221Ai	221Al			221Ba	221Bb	221Bc			221Da	221Db	221Dc				M212Bb	M212Bc	M212Bd	M212Cb	M212Cc			
bogs and acidic fens																												
acidic dwarf shrub bog	2		6	8		5	4	9			2		2								1		1	4		6		
acidic dwarf shrub bog: northern							3	3															1			1		
Black spruce -tamarack bog																								1		1		
fen: acidic	8		4	12		2	7	9																3	2	5		
PP bog																												
																											50	56
Calcareous fen																												
fen: calcareous	11			11						4	2		6											2		2		
fen:neutral	2		1	3																				1		1		
																											213	23
Cliff/outcrop																												
cliff:acidic:low-mid elev.	1			6						1			1											1		1		
cliff:calc:high elev.																						2		1		3		
cliff:calc:low-mid elev.	1			6						1	2	7	10								1			1		2		
cliff:neutral:low-mid elev.																						1				1		
riverside outcrop & bluff							1	1								1			1		1	2				3		
traprock outcrop															1		1		2									
outcrop: calc: verylow to mid elev							1	1			1	2	3											3		3		
outcrop:acidic:low-mid							2	2																3	1	4		
outcrop:shale, low to mid elev															1				1									
open talus			1	1								1	1															
talus:neutral:north																												
talus:neutral:south																						2				2		
talus:acidic	4		1	5																	2			1		3		
talus:acidic/subacidic	1	1	1	3																								
																											25	66
Deciduous or mixed woodland																												
PP-heath outwash woodlands							1	1																				
PP-SO outwash woodlands			2	2			7	7				1	1															
PP-SO rocky summit	4			4						2		1	3								1			2		3		
																											28	21
Floodplain forest and woodland																												
Floodplain forest		4		4		3	2	5													2	1	3		1	7		
																											124	16
Marsh and wet meadow																												
marsh	1	1		2		3	1	4				2	2															
																											24	8
Other																												
cave										1			1															
																												1
Palustrine forest and woodland																												
hemlock hardwood swamp	2			2																								
Hemlock swamp											1		1												1	1		
Red maple-NWC swamp																								1		1		
red maple-tamarack calc peat swamp											2	1	3															
Black gum-redmaple swamp						2		2													1					1		
Black spruce swamp																												
NWC conifer swamp											1		1															
seepage forest																						2				2		
seepage swamp: acidic	1			1		1	2	3																				
seepage swamp: calc/neutral	7			7						2			2								2			2		4		
shrub swamp		1		1			1	1				2																
Spruce swamp																								3	1	4		
swamp: acidic			3	3		5	1	6																				
swamp: alluvial		1	1	2								1											1			1		
swamp:acidic																												
																											308	47
Pond and lake																												
pond											1		1									2				2		
pond: alkaline	1			1								1	1															
pond: vernal												2	2															
Lake/lakeshore							1	1																				
pondshore: calcareous																												
pondshore:acidic						4	5	9														1				1		
																											40	18
Ridgetop/rocky summit																												
summit: acid, high elev																						2				2		
summit: acid, low to mid			1	1		3	3	6		1											3	1		3		7		
summit: calc, high elev																						1				1		

summit: subacidic: verylow to low	3	4	1	**8**																							
summit:calc:low-mid elev	2			**2**																							
																										74	28
River and Stream																											
stream: high gradient																											
riverscour bank																											
rivershore grassland																					1			1	**2**		
rivershore: coarse sed						2	9	**11**																			
rivershore: cobble																								3	**3**		
riverside seep																				2					**2**		
seep:neutral																					2				**2**		
																										74	20
Sandplains																											
inland dune							1	**1**																			
sand barren																											
marine beach/shore	1			**1**			2	**2**																			
																										122	4
Serpentine barrens																											
serpentine barren																3			**3**								
																										43	3
Terrestrial conifer forest																											
forest: hemlock																1			**1**								
forest: conifer																											
forest: spruce-fir																					1				**1**		
red pine woodland											2		**2**							1	3		1	1	**6**		
talus:calcareous?										1	1	6															
																										27	10
Terrestrial deciduous forest																											
forest: chestnut oak										1			**1**														
forest: northern hardwood																					1				**1**		
forest: oak	1			**1**		3	4	**7**			5		**5**							3	1		1		**5**		
forest: oak-hickory	1			**1**							3	3	**6**										1		**1**		
forest: oak-hickory: calc	3			**1**		5		**5**		2			**2**														
forest: oak-maple							4	**4**			1		**1**								2	1			**3**		
woodland: calcareous										1		1															
forest: lake plain						1		**1**				1	**1**							1					**1**		
forest: cove	2			**2**		2	1	**3**								2			**3**	4	11		1		**16**		
																										105	71
Terrestrial mixed forest																											
forest: oak-pine																											
forest: pine-hardwood																							1		**1**		
forest: spruce-hardwood																							1		**1**		
																										48	2
Tidal																											
marsh:tidal, brackish	3		1	**4**						1			**1**														
marsh:tidal, fresh	1	1	1	**3**						3		8	**11**														
mudflat:tidal	3		1	**4**						3		8	**11**														
shore: intertidal										2		4	**6**														
swamp: tidal, fresh										2		4															
																										33	40
	70	13	28			44	64			28	24	56			2	7	1			25	40	8	38	11			

Community associations for LNE arranged by group type, subregion, and subsection, with distribution and goals

							No. Piedmont				Reading Prong		Hudson River				So. NE Plains				NE. LNE Plains				Mountain and Highlands				
LNP Major Group	LNP Sub-Group	LNP Scale	LNP Distr	GOAL	ElCode	GnameTrans	221Db	221Da	221Dc		221Am		221Ba	221Bc	221Bb		221Ae	221Af	221Ag		221Ah	221Ai	221Al		M212Cb	M212Cc	M212Bb	M212Bd	M212Bc
Bogs & Acidic Fens		SP	L	13	CEGL006008	Leatherleaf - (Dwarf Huckleberry)- Water Willow / Virginia Chain-fern Dwarf-shrubland	0	0					2	1	2		2	2	2		2	2	2		2	2	2	2	2
Bogs & Acidic Fens		SP	L/W	13	CEGL006394																								
Bogs & Acidic Fens		SP	W	6	CEGL006190	Highbush Blueberry / Peatmoss species Shrubland																							
Bogs & Acidic Fens		SP	W	6	CEGL006302	Leatherleaf / Slender Sedge - Bladderwort species Shrub Herbaceous Vegetation									1										2				
Bogs & Acidic Fens		SP	W	6	CEGL006164	(Smooth Alder, Speckled Alder) / Cinnamon Fern - Peatmoss species Shrubland																							
Bogs & Acidic Fens		SP?	W	6	CEGL006225	Sheep laurel - leatherleaf - (black spruce) / lichen Dwarf-shrubland	0	0	0		0		1	1	2		1	0	1		1	1	2		2	1	0	1	1
Calcareous Fen		SP	L	13	CEGL006356	Shrubby cinquefoil / Limestone beaksedge - Savanna nutrush Shrub Herbaceous Vegetation																							
Calcareous Fen		SP	L/R	25	CEGL006103	Bayberry - Shrubby cinquefoil / Sterile sedge - Yellow sedge Shrub Herbaceous Vegetation	0	0	0		1		1	0	0		1	0	0		0	0	0		0	0	0	0	0
Calcareous Fen		SP	L?	13	CEGL006160	Sweet gale / Woolly-fruit sedge - Ontario lobelia - Alpine cottongrass Shrub Herbaceous Vegetation																							
Calcareous Fen		SP	R	25	CEGL006101	TUFTED HAIRGRASS - SKUNK CABBAGE HERBACEOUS VEGETATION			0		1		1				1												
Calcareous Fen		SP	R	25	CEGL006357	Eastern red cedar / Shrubby cinquefoil / Yellow sedge - Rigid sedge Shrub Herbaceous Vegetation																							
Calcareous Fen		SP	R?	25	CEGL006326	SHRUBBY CINQUEFOIL / STERILE SEDGE - PORCUPINE SEDGE - YELLOW SEDGE SHRUB HERBACEOUS VEGETATION	0	0	0		0																		
Calcareous Fen		SP	R?	25	CEGL006359	Silky dogwood - Hoary willow / Shrubby cinquefoil / Tussock sedge Shrubland							2				2												
Calcareous Fen		SP	R?	25	CEGL006123	DOGWOOD / SEDGES SHRUB HERBACEOUS VEGETATION									1		2								1				
Calcareous Fen		SP	R?	25	CEGL006360	Swamp birch - Poison sumac - Shrubby cinquefoil Shrubland							2	1	2		2								1				
Calcareous Fen		SP	W	6	CEGL006142	Sticky Bog-asphodel - Elk Sedge Herbaceous Vegetation																							
Calcareous Fen		SP	W	6	CEGL006068	Sweet Gale - Shrubby Cinquefoil / Woolly-fruit Sedge - Sawgrass Shrub Herbaceous Vegetation							2		1		2								1				
Cliff/Outcrop		SP	R/L	25	CEGL006104	SERPENTINE MAIDENHAIR FERN - SPLEENWORT - FIELD CHICKWEED SPARSE VEGETATION																							
Deciduous or Mixed Woodland		LP/SP	L/W	9	CEGL006166	Pitch Pine - (Scarlet Oak, Black Oak) / Little Bluestem Woodland											2	2	2		1	2	1		2	1	1	1	1
Deciduous or Mixed Woodland		SP	W	6	CEGL005058	AMERICAN BASSWOOD - WHITE ASH - (SUGAR MAPLE) / GERANIUM SP. WOODLAND																							
Deciduous or Mixed Woodland		SP/LP	L	13	CEGL006320	Red Oak / Eastern Rockcap Fern Woodland	0	0	0				2	0	0		2	2	2		1	2	2		2	1	1	2	2
Floodplain Forest & Woodland		SP	?	0:00	CEGL006001	Silver Maple - American Elm / Sensitive Fern Forest																							
Floodplain Forest & Woodland		SP	?©	0:00	CEGL006042	Silver Maple - American Elm / Eastern Ninebark Forest																							
Floodplain Forest & Woodland		SP	L/R©	25	CEGL006386	Swamp White Oak - Red Maple / Musclewood Forest																							
Floodplain Forest & Woodland		SP	L/W	13	CEGL006114	Sugar Maple / Eastern Waterleaf - Jumpseed Forest																							
Floodplain Forest & Woodland		SP	P	3	CEGL006405	American Basswood - Sugar Maple - Black Maple / Wood Nettle Forest																							

Lower New England\Northern Piedmont

Community Associations arranged by group type, subregion, and subsection with distribution and goals

LNP Major Group	LNP Sub-Group	LNP Scale	LNP Distr	GOAL	ElCode	GnameTrans	221Db	221Da	221Dc		221Am		221Ba	221Bc	221Bb		221Ae	221Af	221Ag		221Ah	221Ai	221Al		M212Cb	M212Cc	M212Bb	M212Bd	M212Bc
Floodplain Forest & Woodland		SP	R?©	25	CEGL006185	Pin Oak - Red Maple / Gray's Sedge - Canada Avens Forest																							
Floodplain Forest & Woodland		SP	W	6	CEGL006176	Silver Maple / False-nettle Forest																							
Floodplain Forest & Woodland		SP/LP	W	6	CEGL006147	Silver Maple - Cottonwood / Ostrich Fern Forest																							
Floodplain Forest & Woodland		SP/LP	W?	6	CEGL006036	Sycamore - Green Ash Forest																							
Floodplain Forest & Woodland		SP?	L	13	CEGL006184	River Birch - Sycamore / Yellow Jewelweed Forest																							
Marsh & Wet Meadow		SP	W	6	CEGL006275	(Softstem Bulrush, Hardstem Bulrush) Eastern Herbaceous Vegetation																							
Marsh & Wet Meadow		SP	W	6	CEGL005174	Canada Reedgrass Eastern Herbaceous Vegetation							1	1	2		1	2	2		2	2	2		2		2	2	2
Marsh & Wet Meadow		SP/LP	W	6	CEGL006153	(Narrowleaf Cattail, Common Cattail) - (Bulrush species) Eastern Herbaceous Vegetation							1	1	2		1								2				
Marsh &Wet Meadow		SP	W	6	CEGL004121	Tussock Sedge Seasonally Flooded Herbaceous Vegetation	2	1					1	1	2		2	1	2		1	1			2	1		1	
Other		SP	W	6	CEGL006193	Golden-saxifrage Herbaceous Vegetation																							
Palustrine Forest & Woodland		LP	L	9	CEGL006189	Atlantic White Cedar / Winterberry Forest	0	0	0		0																		
Palustrine Forest & Woodland		LP	L	9	CEGL006396	Red Maple - (Atlantic White Cedar) / Great Rhododendron Forest	0	0	0		0														0	0	0	0	0
Palustrine Forest & Woodland		LP	L	9	CEGL006207	Atlantic White Cedar - Red Maple Lower New England, Northern Piedmont Forest																							
Palustrine Forest & Woodland		LP	L?	9	CEGL006156	Red Maple - Black Gum / Swamp Azalea - Sweet Pepperbush Forest		2	2		2			0	1		2	2	2		1	2	1		2	1	0	1	0
Palustrine Forest & Woodland		LP	P	3	CEGL006188	Atlantic White Cedar / Inkberry Forest	0	0	0		0		0						1			1			0	0	0	0	0
Palustrine Forest & Woodland		LP	W	5	CEGL006226	Eastern Hemlock - Yellow Birch / Winterberry / Peatmoss spp. Forest																							
Palustrine Forest & Woodland		LP?	L/W	9	CEGL006406	Red Maple - Green Ash, White Ash / Spicebush / Skunk Cabbage Forest		2	2		0		2				2		2										
Palustrine Forest & Woodland		SP	?©	0:00	CEGL006380	Eastern Hemlock - Red Maple - Yellow Birch / Cinnamon Fern Forest																							
Palustrine Forest & Woodland		SP	L	13	CEGL006395	Red maple \ speckled alder - winterberry / royal fern Woodland	0	0	0		0																		
Palustrine Forest & Woodland		SP	L	13	CEGL006364	Atlantic White Cedar - Acer rubrum / Highbush Blueberry / Marsh St. Johnswort Forest																							
Palustrine Forest & Woodland		SP	L	13	CEGL006363	Atlantic White Cedar - Red Spruce / Black Huckleberry / Creeping Snowberry Forest																							
Palustrine Forest & Woodland		SP	L	13	CEGL006321	Atlantic White Cedar / Leatherleaf Woodland											1	1	2		1	2							
Palustrine Forest & Woodland		SP	L	13	CEGL006312	Red Spruce - Balsam Fir / Creeping Teaberry / Peatmoss spp. Forest															2	2	1						
Palustrine Forest & Woodland		SP	L	13	CEGL006311	Red Spruce - Balsam Fir / Magellan Peatmoss Forest																							
Palustrine Forest & Woodland		SP	L/W	5	CEGL006118	Red Maple - Tamarack / Alderleaf Buckthorn Woodland																							
Palustrine Forest & Woodland		SP	L?	13	CEGL006220	Black Ash - Red Maple / Mountain Holly - Highbush Blueberry Forest									2		1	2			1	2	2		2	2	0	2	2
Palustrine Forest & Woodland		SP	L?	13	CEGL006240	Pin Oak - Red Maple / Cinnamon Fern Forest																							

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Palustrine Forest & Woodland		SP	L©	13	CEGL006194	Pitch Pine / Leatherleaf / Peatmoss species Forest	0	0	0	0	0		0	1	1	1	1	1	1	0	0	1	1	1
Palustrine Forest & Woodland		SP	P	3	CEGL006279	Eastern Hemlock / Great Rhododendron / Peatmoss spp. Forest	0	0	1	0	2	0	0	2										
Palustrine Forest & Woodland		SP	P	3	CEGL006110	Sweetgum - Red Maple - Willow Oak / Swamp Fetterbush Forest																		
Palustrine Forest & Woodland		SP	P	3	CEGL006238	Red Maple - Blackgum - Sweetbay Forest																		
Palustrine Forest & Woodland		SP	W	6	CEGL006168	Black Spruce - Larch / Sheep laurel / Sphagnum Forest	0	0	0	0				2		2								
Palustrine Forest & Woodland		SP	W	6	CEGL006241	Swamp White Oak / Highbush Blueberry / Stalkgrain Sedge Forest																		
Palustrine Forest & Woodland		SP	W	6	CEGL006014	Red Maple - Black Gum - Yellow Birch / Sphagnum Forest					0			2	1	1	2	1	1	1	1	2	1	1
Palustrine Forest & Woodland		SP	W?	6	CEGL006007	Northern White Cedar / Stairstep Moss Forest																		
Palustrine Forest & Woodland		SP/LP	L	13	CEGL006355	Atlantic White Cedar / Great Laurel Forest	0	0	1	0				2										
Palustrine Forest & Woodland		SP/LP	L	13	CEGL006078	Atlantic White Cedar - Red Maple - Sweet Bay Forest																		
Palustrine Forest & Woodland		SP/LP	L/W	13	CEGL006198	Red Spruce - Red Maple / Mountain Holly Forest	0	0	0	0				2	0	1	1	2	2	2	2	0	2	2
Palustrine Forest & Woodland		SP/LP	W	6	CEGL006009	Black Ash - Red Maple - (Tamarack) / American Alder-buckthorn Forest					2	1	1	2	2		1	1	1	1	1		1	1
Palustrine Forest & Woodland		SP/LP	W	6	CEGL006119	Red Maple / Tussock Sedge - Sensitive Fern Woodland																		
Palustrine Forest & Woodland		SP/LP	W	6	CEGL002482	WHITE PINE - (RED MAPLE) / ROYAL FERN SPP. FOREST																		
Palustrine Forest & Woodland		SP?	L/P	0:00	CEGL007441	Black Ash - Red Maple Saturated Forest																		
Palustrine Forest & Woodland		SP?	L/P	0:00	CEGL006199	Northern White Cedar - Red Maple / Red-Osier Dogwood Forest																		
**more than one group (Shrub Swamp, Bog & Acidic Fen)		SP	W	6	CEGL003908	Buttonbush Semipermanently Flooded Shrubland					2	1	2	2	2	2	2	2	2	2		2	2	2
Pond & Lake		SP	L	13	CEGL006243	Canary Reedgrass - Matting Rosette Grass Herbaceous Vegetation	0	0	0	0														
Pond & Lake		SP	L/P	0:00	CEGL006300	Virginia Meadowbeauty - Crotalaria Herbaceous Vegetation	0	0	0	0	0									0	0	0		
Pond & Lake		SP	L/P	0:00	CEGL006086	White Waterlily - Robbins Spikerush Herbaceous Vegetation																		
Pond & Lake		SP	L/P	0:00	CEGL006035	Swamp-candles - Threeway Sedge Herbaceous Vegetation																		
Pond & Lake		SP	P	6	CEGL006261	(Blunt Spikerush, Yellow Spikerush) - Seven-angle Pipewort Herbaceous Vegetation																		
Pond & Lake		SP	W	6	CEGL004291	Pickerelweed - Green Arrow-arum Semipermanently Flooded Herbaceous Vegetation					1	1	1	1						1				
Ridgetop/ Rocky Summit		LP	W	5	CEGL006116	Pitch pine / Black chokeberry woodland					2	2	2	2	2	2	1	2	1	2	0	2	2	0
Ridgetop/ Rocky Summit		SP	?©	0:00	CEGL006180	Eastern Red-cedar - Hop Hornbeam / Bristleleaf Sedge Woodland																		
Ridgetop/ Rocky Summit		SP	L	13	CEGL006047	Eastern Red-cedar - Hop Hornbeam / Sideoats Grama Wooded Herbaceous Vegetation																		
Ridgetop/ Rocky Summit		SP	L©	13	CEGL006002	Eastern Redcedar - White Ash / Northern Oatgrass / Canada Bluegrass Woodland			0		0	0	0	2	2	0	0							

Lower New England\Northern Piedmont

Community Associations arranged by group type, subregion, and subsection with distribution and goals

LNP Major Group	LNP Sub-Group	LNP Scale	LNP Distr	GOAL	ElCode	GnameTrans	221Db	221Da	221Dc		221Am		221Ba	221Bc	221Bb		221Ae	221Af	221Ag		221Ah	221Ai	221Al		M212Cb	M212Cc	M212Bb	M212Bd	M212Bc
Ridgetop/ Rocky Summit		SP	P	3	CEGL006093	Northern White Cedar / Prairie Goldenrod Woodland	0	0	0		0		0					0	0		0								
Ridgetop/ Rocky Summit		SP	P	3	CEGL006053	Red Spruce / Northern Lowbush Blueberry - Mountain-cinquefoil Woodland																							
Ridgetop/ Rocky Summit		SP	P/0	3	CEGL004996	(Table Mountain Pine, Pitch Pine) / Bear Oak / Black Huckleberry Woodland																							
Ridgetop/ Rocky Summit		SP	P?	3	CEGL006298	ALPINE BLUEBERRY DWARF-SHRUBLAND	0	0	0		0							0	0		0						0		
Ridgetop/ Rocky Summit		SP	W	6	CEGL005094	LOW SWEET BLUEBERRY DWARF-SHRUBLAND	0	0	0		0						1	0	0		1	1	2		2	2	0	2	2
Ridgetop/ Rocky Summit		SP	W	6	CEGL005101	WHITE PINE - RED OAK / POVERTY GRASS ACID BEDROCK HERBACEOUS VEGETATION																							
Ridgetop/ Rocky Summit		SP/LP	W	6	CEGL006134	Red Oak - Rock Chestnut Oak / Blueberry species / Wavy Hairgrass Woodland							2	2	2		2	2	0		1	2	0		2	0	1	2	0
River & Stream		SP	P/W	3	CEGL006283	Big Bluestem - Panicgrass - Tall Blue Wild Indigo Herbaceous Vegetation																							
River & Stream		SP	R	25	CEGL004284	MOSS PHLOX - STICKY GOLDENROD - BALSAM RAGWORT HERBACEOUS VEGETATION	2	1	0		0		0	0	0		0	0	0		0	0	0		0	0	0	0	0
River & Stream		SP	R	25	CEGL006284	Big Bluestem - Bellflower - Sticky Goldenrod Herbaceous Vegetation																							
River & Stream		SP	W	6	CEGL004286	Common Water-willow Herbaceous Vegetation	2	2			1				0			0	0		0	0	0		0	0	0	0	0
River & Stream		SP	W	6	CEGL004331	Riverweed Herbaceous Vegetation	1	2	1		2						2	2	2		1	2	1				2	1	1
River & Stream		SP	W	6	CEGL006196	American Eelgrass - Clasping-leaf Pondweed Herbaceous Vegetation							2	2	0		2	2	2		1	1	1		1		1	1	1
River & Stream		SP	W	6	CEGL003901	Black Willow Temporarily Flooded Shrubland											2	2	1										
Sandplains		LP	L	9	CEGL006025	Pitch Pine / Scrub Oak / Roundhead Bushclover Woodland								2				2											
Sandplains		SP	L	13	CEGL005046	PITCH PINE / BLUEBERRY SPP. - HUCKLEBERRY WOODLAND	0	0	0		0		0		0		0	2	2		2	1	1		0	0	2	1	
Sandplains		SP	R	25	CEGL006276	Grey Birch / Little Buestem / Stiff Aster Sparse Vegetation	0	0	0		0		0	0	0							1	1		0	0		1	
Sandplains		SP	R	25	CEGL006232	BEACH HEATHER - SILVERLING DWARF-SHRUBLAND	0	0	0		0		0	0	0		0	0	0		0	1	2		0	0	0	0	0
Sandplains		SP	R	25	CEGL006004	White Pine - Grey Birch / Sweetfern / Little Bluestem Woodland	0	0	0		0		0	0	0		0				0	1	1		0	0	1	1	0
Sandplains		SP	R©	25	CEGL006391	Pitch pine - beach heather - golden aster Sparse Vegetation	0	0	0		0		0	0	0		0	0	2		0	1	1		0	0	0	0	0
Sandplains		SP?	L	13	CEGL006203	Pitch Pine / Scrub Oak / Ricegrass Woodland	0	0	0		0		0	0	0		0	0	0		1	2	2		0	0	1	1	
**2 groups(Sandplain & Ridgetop)		SP	W	6	CEGL003883	Bear Oak Shrubland							1	2	1		2	2	0		0	2	2		2	2	0	0	0
Serpentine Barren		LP?	R	18	CEGL006159	Pitch Pine / Little Bluestem - Papillose Nutrush Wooded Herbaceous Vegetation																							
Serpentine Barren		SP	R(s)	25	CEGL006266	Virginia Pine / Blackjack Oak Forest (successional)	2	1	0		0		0	0	0		0	0	0		0	0	0		0	0	0	0	0
Terrestrial Conifer Forest		LP	L	9	CEGL006128	Red Spruce - Balsam Fir - American Mountain-Ash Forest	0	0	0		0		0	0	0		0	0	0		0	1	1		2	1	0	1	1
Terrestrial Conifer Forest		LP	P	3	CEGL006259	Eastern White Pine - Red Pine - Pitch Pine Forest	0	0	0		0																		
Terrestrial Conifer Forest		LP?	P	3	CEGL006273	Red Spruce - Balsam Fir - Paper Birch Forest																			2		0		
Terrestrial Conifer Forest		M	L	*	CEGL006328	White Pine - Hemlock Lower New England, Northern Piedmont Forest	0	0	0		0		0	1	2		2	2	0		1	2	2		2	2	2	2	2
Terrestrial Conifer Forest		SP	P	3	CEGL007119	Virginia Pine - (Pitch Pine, Shortleaf Pine) - (Rock Chestnut Oak) / Hillside Blueberry Forest			0		0		0	0	0		0	0	0		0	0	0		0	0	0	0	0
Terrestrial Conifer Forest		SP	P	3	CEGL006253	Eastern White Pine - Red Pine / Canada Bunchberry Forest											2	1											
Terrestrial Conifer Forest		SP	P	3	CEGL006324	Eastern White Pine - Eastern Hemlock - Red Spruce Forest																							

Lower New England\Northern Piedmont

Community Associations arranged by group type, subregion, and subsection with distribution and goals

LNP Major Group / LNP Sub-Group	LNP Scale	LNP Distr	GOAL	ElCode	GnameTrans	221Db	221Da	221Dc	221Am	221Ba	221Bc	221Bb	221Ae	221Af	221Ag	221Ah	221Ai	221Al	M212Cb	M212Cc	M212Bb	M212Bd	M212Bc
Terrestrial Deciduous Forest	?	P	3	CEGL006237	Sugar Maple - White Ash - American Basswood - Cucumber-tree / Common Black-cohosh Forest			0		0	0	0	0	0	0	0	0	0	0		0	0	0
Terrestrial Deciduous Forest	LP	L	9	CEGL006088	Eastern Hemlock - American Beech Forest																		
Terrestrial Deciduous Forest	LP	L	9	CEGL006236	(Pignut Hickory, Shagbark Hickory) - White Ash - Oak species Central Appalachian Forest								1	2			2	0	2	2	2	2	0
Terrestrial Deciduous Forest	LP	P	3	CEGL006374	Black Oak - Scarlet Oak - Chestnut Oak / Mountain Laurel Forest	0	0								2	2	2						
Terrestrial Deciduous Forest	LP	W	5	CEGL002464	PAPER BIRCH / SUGAR MAPLE - MIXED HARDWOODS FOREST	0	0	0	0	0			0	0	0		2	2	2		2	1	2
Terrestrial Deciduous Forest	LP	W	5	CEGL005008	Sugar Maple - Ash species - American Basswood / Sweet Cicely - Blue Cohosh Forest	0	0	0	0	2	2	2	2	2	1	1	1	1	2	2	2	1	1
Terrestrial Deciduous Forest	LP/M	L	9	CEGL006301	Pignut Hickory, Shagbark Hickory - Hop-hornbeam / Pennsylvania Sedge Forest		1	2	1	2	2	2	2	2	2	2	2		2	2	2	2	
Terrestrial Deciduous Forest	M	L	*	CEGL006375	Scarlet Oak - Black Oak / Sassafras / hillside Blueberry Forest								0	2	2		1	0	0	0	0	0	0
Terrestrial Deciduous Forest	M	L?	*	CEGL006336	White Oak, Red Oak, Black Oak / Flowering Dogwood / Maple-leaved Viburnum Forest	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	0	2	0
Terrestrial Deciduous Forest	M	L?	*	CEGL006173	Red Oak - Sugar Maple - American Beech / Mapleleaf Arrow-wood Forest	0	0			0	2	2	2	2	2	2	2	0	2	2	2	2	0
Terrestrial Deciduous Forest	M	W	*	CEGL006252	Sugar Maple - Yellow Birch - Beech / Hobblebush Forest	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Terrestrial Deciduous Forest	M	W	*	CEGL006125	Northern Red Oak - Sugar Maple - Tuliptree Forest	1	2	2	2	2	0	1	2	0	0	0	0	0	0	0	0	0	0
Terrestrial Deciduous Forest	M	W	*	CEGL006282	(Rock Chestnut Oak, Black Oak) / Black Huckleberry Forest	1	2	2	2	2	2	2	2	2	2	2			2	2	1		
Terrestrial Deciduous Forest	SP	?©	0:00	CEGL006000	Red Oak - Yellow Birch / Cinnamon Fern Forest																		
Terrestrial Deciduous Forest	SP	W	6	CEGL006201	Sugar Maple - Tuliptree - White Ash / Bladdernut Forest	1	1		1														
Terrestrial Deciduous Forest	SP	W	6	CEGL005010	SUGAR MAPLE - CHINQUAPIN OAK FOREST																		
Terrestrial Deciduous Forest	SP?	L?	13	CEGL006020	Sugar Maple - White Ash - Butternut / Bladdernut Forest			1		1			2	2	2	1	1	1	1	1	1	1	1
Terrestrial Deciduous Forest	SP?	W©	6	CEGL006017	Sugar Maple - Chinquapin Oak / Redbud Forest																		
Terrestrial Mixed Forest	LP	L	9	CEGL006129	Eastern Hemlock - Yellow Birch - Red Spruce / Canada Bunchberry Forest	0	0	0	0	0	0	1		0	0	1	1	1	2	2	1	1	2
Terrestrial Mixed Forest	LP	L	9	CEGL006267	Red Spruce - Yellow Birch / Woodfern Forest														2				
Terrestrial Mixed Forest	LP/M	W	5	CEGL006109	Eastern Hemlock - Yellow Birch Lower New England, Northern Piedmont Forest	2	2	1	2	2	1	2	2	2	2	2			2	2	2	2	2
Terrestrial Mixed Forest	M	W	*	CEGL006293	White Pine - Red Oak, Black Oak - American Beech Forest	0	0	0	0			1	2	1	2	2	2	2	2	2	2	2	2
Terrestrial Mixed Forest	M	W?	*	CEGL006290	Pitch Pine - (Black Oak, Rock Chestnut Oak) Lower New England, Northern Piedmont Forest	0	1	0	1				1	2	2	1	2	2			0	0	0
Terrestrial Mixed Forest	SP	P	3	CEGL006206	EASTERN HEMLOCK - YELLOW BIRCH - BLACK CHERRY / GREAT RHODODENDRON FOREST			1	1	1			1	0	0	0	0	0	0	0	0	0	0
Terrestrial Mixed Forest	SP	P/0©	3	CEGL006383	Pitch Pine - (Shortleaf Pine) / (Blackjack Oak, Scrub Oak) / Hillside Blueberry Woodland																		
Terrestrial Mixed Forest	SP/LP	L	13	CEGL006381	Pitch Pine - Scarlet Oak / Bayberry Forest								1	1	1				2				

Lower New England\Northern Piedmont

Community Associations arranged by group type, subregion, and subsection with distribution and goals

LNP Major Group	LNP Sub-Group	LNP Scale	LNP Distr	GOAL	ElCode	GnameTrans	221Db	221Da	221Dc		221Am		221Ba	221Bc	221Bb		221Ae	221Af	221Ag		221Ah	221Ai	221Al		M212Cb	M212Cc	M212Bb	M212Bd	M212Bc
Tidal		SP	P	3	CEGL006337	(SPECKLED ALDER, SMOOTH ALDER) - SILKY DOGWOOD SHRUBLAND											1	2											
Tidal		SP	P/0	3	CEGL006150	Switchgrass Tidal Herbaceous Vegetation																							
Tidal		SP	P/W	3	CEGL006325	Mixed Forbs (High Marsh) Tidal Herbaceous Vegetation																							
Tidal		SP	P/W	3	CEGL004472	Broadleaf Pondlily Tidal Herbaceous Vegetation							2	2	0		1								0				
Tidal		SP	P?	3	CEGL006165	Red Maple - Green Ash / Smartweed species Woodland																							
Tidal		SP	W	6	CEGL004202	Wild Rice Tidal Herbaceous Vegetation							2	2	0		1								0				
Tidal		SP	W	6	CEGL006352	Estuary Pipewort - Dotted Smartweed Herbaceous Vegetation																							
Tidal		SP	W	6	CEGL006080	Water-hemp Tidal Herbaceous Vegetation											1		2			2							

Patch type: M= matrix; LP=large patch; SP=small patch; **Rangewide distribution**: R= Restricted; L= Limited; W= Widespread; P= Peripheral. **Subsection distribution:** 2= known to occur; 1= probably occurs; 0= does not occur. Blank field = No Information.

Appendix 4. **Lower New England\Northern Piedmont**

Matrix Forest Associations within Tier 1 Preferred Sites; preliminary analysis

General Forest Type	Matrix Forest Associations	No.of potential matrix sites characteristic of these types	No. of Tier 1 Preferred Sites chosen for the Portfolio
Central Hardwoods		19	12
	Scarlet Oak - Black Oak - Sassafras Forest		
	Mixed Oak - Flowering Dogwood Forest		
	Chestnut Oak - Mixed Oak Forest		
	Hemlock - Northern Hardwoods Forest		
	Red Oak - Sugar Maple - Tulip Tree Forest		
	Sugar Maple - Yellow Birch - Beech Forest		
	Pitch Pine - Oak Forest		
	White Pine - Hemlock Forest		
	Black Oak - White Oak Forest		
Transitional Hardwoods		38	15
	Red Oak - Sugar Maple Forest		
	Red Oak - White Pine Forest		
	Chestnut Oak - Black Oak Forest		
	Hemlock - Northern Hardwoods Forest		
	Sugar Maple - Yellow Birch - Beech Forest		
	Pitch Pine - Oak Forest		
	Hickory - Ostraya - Sedge Forest		
	White Pine - Hemlock Forest		
	Mixed Oak - Flowering Dogwood Forest		
	Scarlet Oak - Black Oak - Sassafras Forest		
Northern Hardwoods		32	13
	Red Oak - Sugar Maple - Tulip Tree Forest		
	White Pine - Northern Hardwood Forest		
	Hemlock - Northern Hardwoods Forest		
	Sugar Maple - Yellow Birch - Beech Forest		
	Chestnut Oak - Black Oak - huckleberry Forest		
	Pitch Pine - Oak Forest		
	Hickory - Ostraya - Sedge Forest		
	White Pine - Hemlock Forest		
	Mixed Oak - Flowering Dogwood Forest		
	Scarlet Oak - Black Oak - Sassafras Forest		
"Outliers"		4	2
	Blocks largely consisting of water		

Appendix 5

Lower New England\Northern Piedmont
Ecological Land Unit Gap Analysis Summary

ELUs Present in LNE = 371
ELUS Represented in Tier 1 Matrix Sites = 335
ELUS Represented in 10yr Action Matrix Sites = 294
ELUS Represented in the Portfolio = 344
ELUS Represented in the 10Yr Action Portfolio = 311

% ELUS Represented in Tier 1 Matrix Sites = 90.30
% ELUS Represented in 10yr Action Matrix Sites = 79.25
% ELUS Represented in the Portfolio = 92.72
% ELUS Represented in the 10Yr Action Portfolio = 83.83

Ecological Land Unit Detailed Summary: Percent and Acreage of ELU Groups within Portfolio Sites

Summarized ELU Groups	% of LNE	Acres in LNE	% of Tier 1 that is in this ELU Group	Acres of this ELU Group that is in Tier 1	% of Matrix 10yr Action that is in this ELU Group	Acres of ELU Group that is in Matrix 10 yr Action	% of Portfolio that is in this ELU Group	Acres of this ELU Group that is in the Portfolio	% of Portfolio 10yr action that is in this ELU Group	Acres of this ELU Group that is in the Portfolio 10yr Action
Cliff, Upperslope, Summit	**2.56**	**596783**	**6.33**	**134506**	**6.53**	**82039**	**5.95**	**160026**	**6.00**	**87399**
Sideslope or Coves - on Acidic Granitic/Mafic	5.14	1195390	13.26	281932	10.74	134858	11.88	319360	9.71	141489
Sideslope or Coves - on Acidic Sed/Metased	5.56	1294011	11.67	248068	12.29	154351	10.46	281245	11.26	164201
Sideslope or Coves - on Acidic Shale	0.57	133063	0.42	8996	0.41	5185	0.49	13284	0.40	5783
Sideslope or Coves - on Calcareous/mod Calcareous	1.72	400897	2.54	54044	3.42	42943	2.74	73623	3.46	50398
Sideslope or Coves - on Coarse Sedimentary	0.00	461	0.00		0.00		0.00	75	0.00	
Sideslope or Coves - on Ultramafic	0.02	4095	0.02	377	0.00		0.03	754	0.02	356
Sideslopes or Coves Total:	**13.01**	**3027918**	**27.91**	**593417**	**26.87**	**337337**	**25.61**	**688340**	**24.85**	**362226**
Gently Sloping Flat - on Acidic Granitic/Mafic	9.59	2231315	10.82	230074	9.73	122159	10.03	269673	9.10	132643
Gently Sloping Flat - on Acidic Sed/Metased	11.17	2599203	10.18	216377	11.73	147242	9.35	251259	10.81	157557
Gently Sloping Flat - on Acidic Shale	1.81	420562	0.93	19863	0.51	6382	0.97	26118	0.65	9507
Gently Sloping Flat - on Acidic Shale on Ultramafic	0.07	16088	0.02	504	0.01	109	0.18	4842	0.17	2406
Gently Sloping Flat - on Calcareous/Mod Calcareous	3.13	727463	2.31	49114	2.82	35436	2.86	76997	3.25	47360
Gently Sloping Flat - on Coarse Sedimentary	0.08	19760	0.00	29	0.00		0.03	760	0.04	531
Gently Sloping Flats Total:	**25.84**	**6014391**	**24.26**	**515961**	**24.79**	311328	**23.42**	**629649**	**24.01**	**350004**
Dry Flat - Deep Coarse Grained Sediment	7.02	1634526	2.42	51509	2.67	33525	4.54	121975	4.86	70900
Dry Flat - Deep Fine Grained Sediment	2.03	473103	0.21	4417	0.24	3057	0.70	18726	0.57	8374
Dry Flat - Till or Patchy Quarternary on Acidic Granitic	8.58	1995982	7.52	159844	6.84	85929	7.26	195158	6.69	97495
Dry Flat - Till or Patchy Quarternary on Acidic Sedimentary	11.52	2680769	6.15	130755	7.78	97732	5.69	153071	7.11	103612
Dry Flat - Till or Patchy Quarternary on Acidic Shale	3.20	745797	0.87	18568	0.58	7341	0.84	22702	0.61	8903
Dry Flat - Till or Patchy Quarternary on Calcareous	3.64	846230	1.35	28667	1.43	17922	1.87	50131	1.80	26222
Dry Flat - Till or Patchy Quarternary on on Ultramafic	0.09	20121	0.01	188	0.00	21	0.17	4555	0.16	2313
Dry Flats Total:	**36.08**	**8396529**	**18.53**	**393948**	**19.55**	**245526**	**21.07**	**566318**	**21.80**	**317819**
Wet Flat / Slope Bottom	**13.17**	**3064370**	**12.52**	**266144**	**12.30**	**154416**	**13.50**	**362791**	**13.39**	**195236**
Stream/River/Lake/Ocean	**9.33**	**2171792**	**10.46**	**222438**	**9.95**	**124995**	**10.45**	**280819**	**9.96**	**145155**

Appendix 5

Lower New England\Northern Piedmont
Ecological Land Unit Gap Analysis Summary

Ecological Land Unit Detailed Summary: Percent and Acreage of ELU Groups in Natural Land Cover within the Portfolio

Summarized ELU Classes	% of ELU in LNE that is in Natural Cover	Acres of ELU in Natural Cover in LNE	% of ELU in Natural Cover in LNE that is in Tier 1	Acres of ELU in Natural Cover in LNE that is in Tier 1	% of Elu in Natural Cover in LNE that is in Matrix 10yr Action	Acres of ELU in Natural Cover in LNE that is in Matrix 10 yr Action	% of Elu in Natural Cover in LNE that is in the Portfolio	Acres of ELU in Natural Cover in LNE that is in the Portfolio	% of Elu in Natural Cover in LNE that is in the Portfolio 10yr Action	Acres of ELU in Natural Cover in LNE that is in the Portfolio 10yr Action
Cliff, Upperslope, Summit	**94.12**	**561700**	**23.44**	**131683**	**14.29**	**80288**	**27.82**	**156274**	**15.20**	**85382**
Sideslope or Coves - on Acidic Granitic/Mafic	93.11	1113063	24.72	275192	11.78	131119	27.92	310750	12.33	137241
Sideslope or Coves - on Acidic Sed/Metased	89.90	1163264	20.47	238077	12.73	148097	23.06	268193	13.47	156669
Sideslope or Coves - on Acidic Shale	87.40	116292	7.18	8348	4.21	4894	10.62	12353	4.65	5404
Sideslope or Coves - on Calcareous/mod Calcareous	86.13	345290	14.40	49720	11.36	39232	19.20	66302	13.10	45237
Sideslope or Coves - on Coarse Sedimentary	71.83	331	2.45	8	0.00		15.69	52	0.00	
Sideslope or Coves - on Ultramafic	91.35	3741	9.99	374	4.69	175	19.37	724	9.21	344
Sideslopes and Coves Total:	**90.56**	**2741982**	**20.85**	**571719**	**11.80**	**323517**	**24.01**	**658374**	**12.58**	**344895**
Gently Sloping Flat - on Acidic Granitic/Mafic	77.48	1728752	12.36	213755	6.51	112554	14.23	246027	7.01	121142
Gently Sloping Flat - on Acidic Sed/Metased	63.58	1652564	11.77	194550	8.14	134465	13.19	217974	8.50	140490
Gently Sloping Flat - on Acidic Shale	57.51	241870	5.99	14478	1.49	3598	7.77	18799	2.28	5511
Gently Sloping Flat - on Acidic Shale on Ultramafic	62.11	9991	3.82	382	1.01	101	36.34	3630	18.29	1827
Gently Sloping Flat - on Calcareous/Mod Calcareous	62.86	457308	8.82	40327	6.39	29200	12.94	59190	8.02	36675
Gently Sloping Flat - on Coarse Sedimentary	42.69	8435	0.17	15	0.00		5.66	478	4.81	406
Gently Sloping Flats Total	**68.15**	**4098921**	**11.31**	**463507**	**6.83**	279917	**13.32**	**546098**	**7.47**	**306052**
Dry Flat - Deep Coarse Grained Sediment	50.04	817898	5.23	42758	3.45	28233	10.84	88656	6.63	54257
Dry Flat - Deep Fine Grained Sediment	38.55	182382	1.15	2094	0.76	1389	5.04	9199	2.20	4004
Dry Flat - Till or Patchy Quarternary on Acidic Granitic	69.04	1377949	10.65	146768	5.72	78751	12.72	175272	6.43	88642
Dry Flat - Till or Patchy Quarternary on Acidic Sedimentary	46.87	1256584	8.97	112773	6.78	85143	9.96	125125	6.98	87726
Dry Flat - Till or Patchy Quarternary on Acidic Shale	37.34	278517	3.99	11107	0.93	2586	5.03	14015	1.23	3423
Dry Flat - Till or Patchy Quarternary on Calcareous	43.30	366408	5.99	21932	3.77	13820	9.82	35996	5.22	19116
Dry Flat - Till or Patchy Quarternary on on Ultramafic	44.51	8957	1.52	136	0.22	19	29.92	2680	13.76	1233
Dry Flat Total:	**51.08**	**4288696**	**7.87**	**337569**	**4.90**	**209941**	**10.51**	**450944**	**6.03**	**258399**
Wet Flat / Slope Bottom	**67.75**	**2076141**	**11.40**	**236758**	**6.55**	**136049**	**15.09**	**313279**	**8.08**	**167757**
Stream/River/Lake/Ocean	**81.65**	**1773260**	**11.84**	**209969**	**6.61**	**117201**	**14.79**	**262187**	**7.61**	**134883**

*** Please remember that these values are estimates based on 90m ELU cells and 30m land cover cell intersections.**

Although the data can show general patternsn, some categories such as streams/rivers/lakes/ocean acreage in natural coverage may be hard to interpret due to the resolution difference in the input datasets. For example, in the ELUs all water features are represented as 90m cells (even if the width of the stream was less than 90m across). Therefore, the area of water is overestimated and when 30m landcover is intersected with these 90m cells, some of the agriculture or developed 30m cells intersect water ELUS causing us to report water in non-natural cover. Although this combination of non-natural cover water should not exist, it does show us that there is development very near the water features

Lower New England\Northern Piedmont

Matrix Sites by their Ecological Land Unit Group

ELUGROUP	NAME	TIER	PORTFOLIO	ACRES	STATE	MUIDS
1	French Creek East/Pine Swamp	1	Y-10-Yr. Action Site	43648.28	PA	221Da
1	Swartswood Block	1	Y-Partner Lead	71199.72	NJ	221Ba
1	Furnace Hills	2	Alternate Site	34020.51	PA	221Da
2a	Wood River Barrens/Pachaug	1	Y-10-Yr. Action Site	45719.30	RI/CT	221Ag
2a	Saugatuck Forest	1	Y-10-Yr. Action Site	15331.91	CT	221Ae
2a	Pawtauckaway	1	Y-TNC Lead	28659.11	NH	221Ai
2a	Arcadia Pond - South Pachaug, CT	2	Alternate Site	21440.93	CT	221Ag
2a	North Pachaug (Mt. Misery)	2	Alternate Site	20407.40	CT	221Ag
2a	Arcadia Ponds	2	Alternate Site	22095.55	CT/RI	221Ag
2b	Pleasant Mountain	1	Y-10-Yr. Action Site	53020.88	ME	221Al
2b	Meshomasic State Forest	1	Y-10-Yr. Action Site	40123.82	CT	221Ag / 221Af
2b	Kezar River	2	Alternate Site	35645.19	ME	221Al
3a	Sourland Mountains	1	Y-10-Yr. Action Site	29956.43	NJ	221Da
3a	Lower Patapsco River	2	Alternate Site	19953.56	MD	221Db
3b	Shaupeneak	1	Y-Partner Lead	25933.80	NY	221Ba
3b	Pretty Boy/Hereford	1	Y-Partner Lead	26147.62	MD	221Db
4a	Big Kitty/Whately	1	Y-10-Yr. Action Site	41621.99	MA	221Ae / 221Af
4a	Tekoa	1	Y-10-Yr. Action Site	25243.34	MA	221Ae / 221Af
4a	Bomoseen	1	Y-10-Yr. Action Site	22829.83	VT	221Bb
4a	Macedonia Brook	1	Y-10-Yr. Action Site	37003.33	CT/NY	221Ae
4a	New Marlborough	2	Alternate Site	109495.90	MA/CT	M212Cc
4a	Barkhamstead/Granville (N/S)	2	Alternate Site	117598.64	CT/MA	221Ae
4a	Westhampton	2	Alternate Site	31899.28	MA	221Ae
4a	Putney Mountain	2	Alternate Site	30800.63	VT	M212Cc
4a	Mid-Dutchess	2	Alternate Site	28730.09	NY	221Ae
4b	Surrey Mountain	1	Y-10-Yr. Action Site	32472.55	NH	M212Bc
4b	Canaan Mountain	1	Y-10-Yr. Action Site	41936.56	CT	221Ae
4b	Pine River	1	Y-10-Yr. Action Site	68540.96	NH/ME	221Al
4b	Warwick	1	Y-Partner Lead	77198.45	MA/NH	M212Bd
4b	Wendell	2	Alternate Site	45080.76	MA	221Ah
4b	Burnt Meadow Brook	2	Alternate Site	46345.63	ME/NH	221Al
4b	White Hollow	2	Alternate Site	14627.35	CT	221Ae
4b	Cornish	2	Alternate Site	47370.70	NH	M212Bb
4b	Merry Meeting Lakes	2	Alternate Site	49737.68	NH	221Al
4b	Minks	2	Alternate Site	26796.73	NH	M212Bd / 221Ai
4b	Francestown	2	Alternate Site	38034.63	NH	M212Bd
4b	Mohawk	2	Alternate Site	15601.64	CT	221Ae
5	Harriman	1	Y-Partner Lead	47585.10	NY	221Ae
5	Waywayanda	1	Y-Partner Lead	36306.14	NJ/NY	221Ae
5	Ringwood	1	Y-Partner Lead	18982.55	NY/NJ	221Ae
5	Sparta Mountain	2	Alternate Site	31482.61	NJ	221Ae
5	Hudson Highland	2	Alternate Site	51401.87	NY	221Ae
5	West Point/Black Rock	2	Alternate Site	16383.44	NY	221Ae
6a	Pisgah	1	Y-10-Yr. Action Site	38330.84	NH	M212Bd
6a	Yale-Myers Forest	1	Y-10-Yr. Action Site	33315.36	CT/MA	221Ag / 221Ah
6a	Royalston	1	Y-Partner Lead	64324.07	MA/NH	M212Bd
6a	Silver Lake	1	Y-TNC Lead	22675.60	NH	221Al
6a	Gunstock	2	Alternate Site	40480.94	NH	221Al
6a	Bear Brook	2	Alternate Site	51926.86	NH	221Ai
6a	Scott Mountain	2	Alternate Site	16733.23	NH	M212Bd
6a	Rhododendron	2	Alternate Site	18067.71	NH	M212Bd

Lower New England\Northern Piedmont
Matrix Sites by their Ecological Land Unit Group

6a	Blue Hills	2	Alternate Site	43940.31	NH	221Al
6b	Otis	1	Y-10-Yr. Action Site	20875.16	MA	M212Cc
6b	Super Sanctuary/Nubanuset Willard	1	Y-10-Yr. Action Site	54932.18	NH	M212Bc
6b	Lake George/S. Bay	1	Y-10-Yr. Action Site	154881.61	NY	221Bc
6b	Franklin Falls	1	Y-Partner Lead	25414.95	NH	M212Bc
6b	Plymouth	2	Alternate Site	33589.32	NH	M212Bc
6b	Ragged Mountain	2	Alternate Site	41219.18	NH	M212Bc
6b	Unity	2	Alternate Site	93495.67	NH	M212Bc
6b	Lyneborough	2	Alternate Site	54568.71	NH	M212Bd
6b	Wapack	2	Alternate Site	37324.83	NH	M212Bd
7a	Middlefield - Peru	1	Y-10-Yr. Action Site	107420.82	MA	M212Cc
7a	Andora	1	Y-10-Yr. Action Site	70256.12	NH	M212Bc
7a	Mt. Cardigan	1	Y-Partner Lead	99795.56	NH	M212Bc
7a	Glebe Mountain	1	Y-TNC Lead	23811.47	VT	M212Cc
7a	Mohawk Trail South	2	Alternate Site	76498.97	MA	M212Cc
7a	Beartown	2	Alternate Site	49805.38	MA	M212Cc
7a	Gile State Forest	2	Alternate Site	94084.65	NH	M212Bc
7a	Stiles Brook	2	Alternate Site	37557.41	VT	M212Cc
7b	Ossipee Mountains	1	Y-Partner Lead	58851.91	NH	221Al
7b	Kearsarge	2	Alternate Site	45509.42	NH	M212Bd / 221Ai
8	October Mountain	1	Y-10-Yr. Action Site	49386.57	MA	M212Cc
8	Mascoma	1	Y-Partner Lead	121358.25	NH	M212Bc
8	Moosilauke	2	Alternate Site	53293.26	NH	M212Bc
8	Chalet WMA	2	Alternate Site	21679.14	MA	M212Cc
8	Windsor	2	Alternate Site	30242.10	MA	M212Cc
8	Schateaguey	2	Alternate Site	63138.12	VT	M212Cc
8	Arthur Davis	2	Alternate Site	33916.89	VT	M212Cc
8	Smokeshire	2	Alternate Site	28474.45	VT	M212Cc
8	Dovertown Forest	2	Alternate Site	47799.13	VT	M212Cc
8	Monadnock	2	Alternate Site	18220.42	NH	M212Bc
8	Pillsbury	2	Alternate Site	78014.78	NH	M212Bd / M212Bc
9	Mt. Washington - Mt. Riga	1	Y-10-Yr. Action Site	47490.89	MA/CT/NY	M212Cb
9	Equinox	1	Y-10-Yr. Action Site	71682.89	VT/NY	M212Cb
9	Northern Taconic/Berlin Mountain	1	Y-10-Yr. Action Site	34842.69	NY/MA	M212Cb
9	Blueberry Hill	1	Y-TNC Lead	20679.10	VT	M212Cb
9	Bird Mountain	2	Alternate Site	23504.41	VT	M212Cb
9	Mt. Greylock	2	Alternate Site	33581.58	MA	M212Cb
9	Dorset Peak	2	Alternate Site	50374.65	VT	M212Cb
9	Grass Mountain	2	Alternate Site	43248.28	VT/NY	M212Cb
10	Rensselaer Plateau Central	1	Y-10-Yr. Action Site	75020.92	NY	M212Cb
10	Rensselaer Plateau North	2	Alternate Site	29573.84	NY	M212Cb
10	Rensselaer Plateau South	2	Alternate Site	27108.51	NY	M212Cb
Outliers	Lock Raven	1	Y-Partner Lead	13652.19	MD	221Db
Outliers	Quabbin	1	Y-Partner Lead	88021.45	MA	221Ah

Appendix 6.
Lower New England\Northern Piedmont
The Seven Major LNE-NP Ecological Drainage Units

Group1 : Potomac/Susquehanna basins: Distinguished by zoogeographic differences with other areas (Maxwell et al. 1995, Hocutt and Wiley, 1986).

Major Systems:
1) Lower Susquehanna from Harrisburg to Chesapeake Bay – a big river with complex upstream influences from glaciated mountains.
2) Monaccy Creek and Upper Susquehanna tribs – small to moderate systems flowing over sandstone with low/moderate base flow
3) Rock Creek, Patapsco/Gunpowder/Patuxent Rivers, and lower Susquehanna tributaries –small to moderate, flashy systems flowing over complex geology comprised mostly of gneiss and ultramafics.

Group 2 : Merrimac/Saco Basins: Distinguished because of zoogeographic differences with other areas (Maxwell et al. 1995, Hocutt and Wiley, 1986).

Major Systems:
1) Merrimac/Saco/Androscoggin – big rivers originating in mountains (steep gradients flowing over granite/quartzite/schist bedrock and thin till), flowing to more moderate gradients similar to below
2) Ipswich/Charles/Nashua/Salmon – generally low gradient systems flowing over thin till. Spring peak flows and fall low flows.

Group 3 : Poultney River and Otter Creek Headwaters: Should be included in Northern Appalachian Ecoregional Plan. Distinguished because of zoogeographic differences with other areas (Maxwell et al. 1995, Hocutt and Wiley, 1986).

Major Systems:
1) Small area of headwaters to the Poultney, Mettawee, and Otter Creek - thin till over shales and meta-sedimentary bedrock. Small and moderate streams that are low-to-moderate gradient, with some lakes and wetlands.

Group 4 : Hudson drainage – through 221B(a,b,d): Distinguished because of physiographic, climatic, and geologic differences.

Major systems:
1) Hudson and Mohawk - Large rivers in valleys of loamy till over shale and limestone.
Tributary systems in same setting.
2) Batten Kill, Hoosic River – originating in low Taconic Mountains, sandy till over meta-sedimentary / limestone and flowing into Hudson Valley. Tributaries originating in low Catskill Mountains on loamy till/outwash over shale/sandstone and flowing into Hudson Valley

Group 5 : Delaware / NJ Drainage – through 221D: Distinguished because of physiographic, climatic, geologic differences.

Major Systems:
1) Delaware – large river flowing over sandstone; complex upstream influences from glaciated mountains
2) Skuykill/Lehigh Rivers – small to medium rivers originating in low mountains, ridge and valley with carbonate sandstones, then flowing over sandstone, and finally a complex geology comprised mostly of gneiss and ultramafics (serpentine) before flowing into the Delaware.
3) Brandywine, Chester, etc – small rivers flowing first through sandstone and then through a complex geology comprised mostly of gneiss and ultramafics (serpentine) before flowing into the Delaware.
4) Raritan – medium river originating on granitic gneiss then flowing over sandstone before flowing into ocean
5) Passaic – 221Dc – medium river flowing through loamy till over shale into ocean

Appendix 6.
Lower New England\Northern Piedmont
<u>The Seven Major LNE-NP Ecological Drainage Units</u>

Group 6 : Lower Connecticut Drainages: Distinguished because of physiographic, climatic, geologic differences.

<u>Major Systems</u>:
1) Connecticut – large river flowing through broad glacial valley (with many deposits)over sedimentary/volcanic bedrock
2) Croton, Naugatuck, Quinnipiac, Thames, and other coastal streams) – low gradient, small and medium rivers flowing through hills over sandy to coarse till over granite-schist-gneiss and into ocean
3) Housatonic, Farmington, Westfield – medium rivers originating in low mountains (till and outwash over meta-sedimentary bedrock) with moderate gradients and flowing into lower gradient hills over sandy to coarse till over granite-schist-gneiss and into ocean

Group 7 : Upper Connecticut drainages (M212): Distinguished because of physiographic climatic, geologic differences.

<u>Major Systems</u>:
1) Connecticut – large river flowing through glaciated high hills of lake silts and kame gravel over meta-sedimentary bedrock
2) Deerfield, Gree, West, While, Cold, Ashuelot, Millers – Tributaries to large rivers flowing through low mountains of sandy loam till over various bedrock.

To identify and map aquatic macrohabitats a conceptual model was first developed an aquatics team led by Greg Podnisinski. The team identified key variables for aquatic diversity in the ecoregion and spatial approximation of these variables were then derived from available GIS layers (e.g. 90 m digital elevation models, RF3 and DLG hydrologic features, State geologic maps). For streams the key variables consisted of stream size, acidity, stability, gradient, and downstream connectivity. Each of these components was subdivided into a small number (1 to 5) of classes and when these classes were intersected to produce 400 (4 x 2 x 2 x 5 x 5) possible stream types such as “small, calcareous, stable, low gradient stream connected to another small stream” . For lakes, the key variables consisted of size, acidity class, naturalness, shoreline type, connectivity class, and network placement class. When these classes were intersected it produced 720 (4 x 2 x 2 x 3 x 3 x 5) possible lake types such as “ large, acidic, natural, round lake with outlets connected to a medium size stream”. The macrohabitats were then mapped and used to described the aquatic features found within a given watershed.

Appendix 6.

Lower New England \ Northern Piedmont

Final LNE-NP Aquatic Macrohabitat Classification

Streams

Stream macrohabitats will be defined based upon the concatenation of values for the following five variables:

Size

1 - headwater (link 1-5)
2 - creek (link 6-30)
3 - small river (link 31-450)
4 - large river (link >450)

Hydrologic regime

1 – unstable (elaborate rules based on watershed geology and stream size)
2 – stable (elaborate rules based on watershed geology and stream size)

Chemistry

1 – calcareous/neutral (elaborate rules based on watershed geology and stream size)
2 – acidic (elaborate rules based on watershed geology and stream size)

Downstream connectivity

1 – headwater/creek (link 1 – 30)
2 – small river (link 31 – 450)
3 – large river (link 451 and greater)
4 – lake/wetland
5 – coastal

Gradient

1 – <0.005
2 – 0.005 - <0.02
3 – 0.02 – < 0.04
4 – 0.04 – 0.1
5 - >0.01

Let's go with this for now and see how it plays out – we may group 1 and 2 together and 4 and 5 together.

Lakes

Lake macrohabitats will be defined based upon the concatenation of values for the following five variables:

Natural (vs. impoundment)

1 – natural
2 – impoundment

General water chemistry (inferred from local geology)

1 – calcareous/neutral

2 – acidic

Size

1 – 1 - 10 ha
2 – 11 – 100 ha
3 – 101 – 1000 ha
4 - >1000 ha

Shoreline complexity

Four classes, (round , elongate, complex, very complex), based upon Shoreline Complexity Index, will be used. Class intervals will be the same as used in Great Lakes Pilot Project.

$$\text{Shoreline Complexity } Index = \frac{Perimeter}{2\sqrt{\Pi * Area}}$$

1 – round = .97-1.02
2 – elongate = 1.03 – 2.03
3 – complex = 2.04 – 4.00
4 – very complex = >4.00

Network position

Hydrologic regime inferred from GIS flow accumulation model (low, moderate and high) and connectivity (unconnected, outlet only, inlets and outlets). Ranges for flow accumulation categories will be assigned after flow accumulation analysis has been completed and the statistical distribution of data examined. Nine combinations are possible as follows:

	Flow Accumulation	Connectivity
1.	a. Low	Unconnected
	b. Low	Outlet Only
	c. Low	Inlet and Outlet
2.	a. Moderate	Unconnected
	b. Moderate	Outlet Only
	c. Moderate	Inlet and Outlet
3.	a. High	Unconnected
	b. High	Outlet Only
	c. High	Inlet and Outlet

Elevation

This variable may be useful... we can do this pretty easily, so let's just get an absolute number and use later if necessary.

APPENDIX 7--PLANNING TEAMS

The planning process involved the Eastern Resource Office, thirteen Nature Conservancy Chapter offices, and thirteen Natural Heritage offices. The group established a Core Team to direct the overall progress of the plan and a number of Expert Teams to address particular taxonomic and ecological dimensions of the project.

Core Team
Henry Barbour, Director of Conservation Science, MA Chapter (Lead)
Mark Anderson, Director of Eastern Conservation Science\Regional Ecologist, ERO (Co-leader)
Wayne Klockner, State Director, MA Chapter: (Sponsor)
Joshua Royte, Conservation Planner, ME Chapter
Don Cameron, Botanist, Maine Natural Areas Program
Doug Bechtel, Assistant Director of Science and Stewardship, NH Chapter
Dan Sperduto, Ecologist, New Hampshire Natural Heritage Inventory
Ana Ruesink, Site Conservation Planner, VT Chapter
Eric Sorenson, Ecologist, Vermont Nongame and Natural Heritage Program
Frank Lowenstein, Geoffrey Hughes Berkshire Taconic Landscape Program Director, MAFO
Judy Preston, Director of Science and Stewardship, CT Chapter
Nancy Murray, Director, Connecticut Natural Diversity Database
Laura Flynn, formerly Director of Science and Stewardship, Lower Hudson Chapter
Maria Trabka, formerly Director of Science and Stewardship, Eastern New York Chapter
Tony Wilkinson, Director of Conservation Programs, Combined NY Chapters – replaced Laura and Maria
Andy Finton, Associate Ecologist, New York Natural Heritage Program
Anne Heasley, Assistant State Director for Conservation Programs, NJ Chapter
Tom Breden, Coordinator, New Jersey Natural Heritage Program
Mark Zankel, Director of Science and Stewardship, DE Chapter
Gregory Eckert, Director of Science and Stewardship, PA Chapter
Greg Podniesinski, Ecologist, PA Natural Diversity Inventory East
Stephanie Flack, Conservation Planner, MD Chapter
Olin Allen, formerly District of Columbia Natural Heritage Program
Judy Dunscomb, Director of Science and Stewardship, VA Chapter

Terrestrial Communities Expert Team
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Mark Anderson, Director of Conservation\Regional Ecologist, ERO: (Co-leader)
Sue Gawler, Maine Natural Areas Program
Dan Sperduto and Bill Nichols, New Hampshire Natural Heritage Inventory
Eric Sorenson,Vermont Nongame & Natural Heritage Program
Pat Swain and Jennifer Kearsley, Massachusetts Natural Heritage & Endangered Species Program
Sally Shaw ,The Nature Conservancy , Massachusetts Chapter
Ken Metzler, Connecticut Natural Diversity Database
Andy Finton, Ecologist, New York Natural Heritage Program
Tom Breden, Yvette Alger, Kathleen Strakosch Walz, New Jersey Natural Heritage Program
Tony Davis and Greg Podniesinski, Pennsylvania Natural Diversity Inventory – East

Jean Fike, Pennsylvania Natural Diversity Inventory – Central
Ashton Berdine, Maryland Natural Heritage Program
Rick Enser, Rhode Island Natural Heritage
Liz Thompson, TNC Vermont Chapter
Carol Reschke, formerly NY Heritage
Bob Zaremba, former Director of NY Conservation Science, now Conservation Ecologist, ERO

Plant Expert Team
Joshua Royte, Conservation Planner, ME: (Team Leader)
William Brumback, Director, New England Plant Conservation Program,
New England Wildflower Society
Chris Frye, State Botanist, Maryland Dept. of Natural Resources Wildlife and Heritage Division
Ann Rhoads, Ph. D., Director, Pennsylvania Flora Project, Morris Arboretum, University of PA
Gregory E. Eckert, PhD., formerly Director, Science and Stewardship, PA Chapter

Vertebrate and Invertebrate Expert Team
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Larry Master, Chief Zoologist, HO - ERO
Geoff Hammerson, Zoologist, HO-ERO/Wesleyan University
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Ginger Carpenter, Director of Science and Stewardship, RI Chapter
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Dale Schweitzer, TNC Invertebrate Zoologist, NJ
Jane O'Donnell, Natural Heritage Zoologist, CT DEP
Dave Wagner, Professor of Entomology, University of Connecticut
Andrew Milliken, Senior Biologist, US Fish and Wildlife Service
Alison Whitlock, Biologist, US Fish and Wildlife Service
Tom Savoy, Fisheries Biologist, Connecticut DEP Fisheries
Olin Allen, District of Columbia Natural Heritage Program
Scott Smith, Zoologist, Maryland Department of Natural Resources
Jim McCann, Zoologist, Maryland Department of Natural Resources
Dan Feller, Zoologist, Maryland Department of Natural Resources
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Lise Hanners, Den Preserve Assistant, CT Chapter
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GIS and Data Management
Arlene Olivero, GIS Analyst, ERO
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Meredith Hammon, Administrative Coordinator, ERO

Additional expert advice and assistance provided by:
Greg Low, Vice President for U.S. Conservation, HO
John Cook, Northeast Regional Director, ERO
Steve Buttrich, former Director of Eastern Conservation Science
Bob Zaremba, former Director of NY Conservation Science, now Conservation Ecologist, ERO
Diane Vosick, former Conservation Science, HO
Meg Connerton, Office Manager, MA Chapter

Lower New England GIS Data Sources

Transportation: Macon USA TIGER Transportation 1994 1:100K.
Minor Road Bounded Blocks are based on primary highways, primary roads, secondary roads, local roads, railroads, utility lines, and major streams and shorelines from Macon USA TIGER 1994 1:100K.
Major Road Bounded Blocks are based on primary highways, primary roads, and secondary roads from Macon USA TIGER 1994 1:100K with major road class updates from Geographic Data Technology (GDT) 1997.
Transportation Feature Types
1. Primary highway with limited access: Interstate highways and some toll highways. Distinguished by the presence of interchanges, access ramps, and opposing traffic lanes separated by a median strip.
2. Primary road without limited access: Nationally and regionally important highways that do not have limited access. Mostly US highways but may include some state and county highways that connect larger cities May be divided or undivided and have multilane or single lane characteristics.
3. Secondary and connecting road: Mostly state highways that connect smaller towns. Must be concrete or asphalt and are usually undivided with single-lane characteristics.
4. Local, neighborhood, and rural road: Used for local traffic and usually have a single lane or traffic in each direction. Includes paved and unpaved roads.
5. Waterbodies: Lakes and wide rivers.
6. Railroads
7. Major Utility Lines: Pipelines or Powerlines
8. Airport runways, permanent fences, ski lifts
9. Vehicle and non-Vehicle Trails

Potential Matrix Sites:

For states in Lower New England (ME, NH, VT, NY, MA, CT, RI):
Potential matrix sites are major road bounded blocks which met one of the following criteria
1. Contain >= one 10,000 acre local road bounded block,
2. Area of block is >= 5,000 acres with >= 75% natural land cover **AND**
   a. Contains >= 20,000 acres of natural land cover OR
   b. Contains (>= 80% natural land cover) and (>= one 2,000 acre local road bounded block) and (managed area >= 20% or >= 4,000 acres)

For states in the Piedmont (NJ, PA, MD, VA, DE, DC):
Potential matrix sites are all major road bounded blocks > 5,000 acres with > 55% natural land cover.

Managed Areas: Includes all managed lands with a conservation purpose, along with other large state or federally managed lands greater than 500 acres. Sources include:
PA - PA DEP 1:24K. State, county, federal, & private 1999.
MD - MD DNR 1:24K. State, county, federal, & private 1999.
DE DNREC Protected Lands 1:24K 1999.
NJ DEP Natural and Historic Resources 1:24K 1999.
VA - VA DCR 1:24K; VA Heritage 1:24K; VA DIGF 1:24K 1999.
NY and Northern Forest Conservation Lands Coverage by TNC/Sweet Water Trust 9/98, scales vary
MassGIS Open Space 1998, 1:24k.
CT Managed Area coverage from Federal, State, Municipal, and Private coverages from CT DEP, various scales
RI Protected Land RIGIS open space coverages 1999, various scales.
UCSB MAD 1:250K. Major federal & state lands; and USFWS National Wildlife Refuges, various scales.

Land cover: EPA/USGS/Hughes MRLC 30 meter classified Landsat TM imagery. Omage dates 1991-1993. Draft for New England.

Ecoregion boundaries and Subsections: TNC Eastern Conservation Science, based on USFS (Keys et al.) subsections and Natural Heritage Program data 1:1M.

Bibiliography

Element Occurrences: All primary and secondary LNE target species and all communities that occur within the LNE Ecoregion. Provided by State Heritage programs.

Waterbodies: USGS National Hydrography Dataset 2000.

Streams (single line): EPA Reach File 3 (RF3) 1:100K.

Dams: U.S. Army Corps of Engineers 1998 National Inventory of Dams from EPA Basins dataset 1999.

Cultural and Natural Features: USGS Geographic Names Information System (GNIS) database 1998.

Political boundaries: ESRI ArcData 1:100K 1998.

Elevation: From USGS 1:250k Digital Elevation Model (90m).

Landforms: Landforms were modeled using land position, slope, and relative moisture from UGS 1:250k DEM. Wetlands from the 1991-1993 EPA MRLC 30m classified Landsat TM imagery Draft for New England dataset were also integrated into the wet flat landform feature. Lakes and wide river polygons and streams are from the National Hydrography Dataset 1:100k. Surficial sediments were integrated into the dry flats and gently sloping flat landform classes. Created by TNC Eastern Conservation Science, 1999.

Surficial Geology: from USGS DDS-38 Digital Representation of a Map Showing the Thickness and Character of Quaternary Sediments in the Glaciated United States East of the Rocky Mountains. 1:1M 1998.

Bedrock Geology: Formations classified into simplified 8 categories by TNC Eastern Conservation Science.
Maine: Digital map based on Osberg,P.H., Hussey,A.M.,II, and Boone,G.M., 1985, Bedrock Geologic Map of Maine, 1985, scale 1:500:000.
Maryland: 1968 Geologic Map of Maryland (blueline). 1:250,000 scale. Maryland Geological Survey; compiled and edited by Cleaves, E.T., J. Edwards, Jr., and Glaser, J.D.; supervised by K.N. Weaver.
Massachusetts and Connecticut: MA data compiled by USGS-WRD Connecticut River NAWQA (1:125,000) and USGS - New England Coastal NAWQA (1:250,000).The USGS is the originator of dataset. Based on Zen, E-an, Goldsmith, Richard, Ratcliff, N.L., Robinson, Peter, and Stanley, R.S., [compilers], 1983, Bedrock geologic map of Massachusetts: U.S. Geological Survey, 3 map sheets, scale 1:250,000.
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New Jersey: Digital version originated from 3 USGS and NJ Geological Survey 1:100,000 scale sheets; Northern, Central and Southern NJ.
New York: NY State Geological Survey, 1:250,000.
Pennsylvania: Geologic Map of Pennsylvania, 1980, 1:250,000 scale. (Berg et al.) PASDA distributed.
Rhode Island: RI data compiled and USGS - WRD - New England Coastal NAWQA (1:250,000). Hermes, O.D., Gromet, L.P., and Murrey, D.P. (compilers), 1994, Bedrock geologic map of Rhode Island:
Kingston, R.I., University of Rhode Island, Rhode Island Map Series No. 1, scale 1:100,000.
Vermont: Digital map based on Doll,C.G., Cady,W.M., Thompson,J.B.,Jr., and Billings,M.P., 1961, Centennial geologic map of *Vermont:* Vermont Geological Survey, scale 1:250,000. Geologic classes grouped by VTGS 1998.
Virginia: Berquist, C.R., Jr., and Uschner, N. E., 1999, Spatial data of the digital geologic map of Virginia: VA Div. of Mineral Res. Digital Pub. 14B. Based on 1993, Geologic map of Virginia: Virginia Division of Mineral Resources, scale 1:500,000.
USGS-WRD: NEW ENGLAND COASTAL NAWQA LITHOLOGY: The USGS is the originator of dataset. The original sources of data were the individual Bedrock maps produced for each state: New Hampshire, Massachusetts, Maine, and Rhode Island. The references for the state bedrock maps are as follows: Lyons, J.B., Bothner, W.A., Moench, R.H., and Thompson, J.B., Jr., eds., 1997, Bedrock geologic map of New Hampshire: U.S. Geological Survey, 2 map sheets, scale 1:250,000 Zen, E-an, Goldsmith, Richard, Ratcliff, N.L., Robinson, Peter, and Stanley, R.S., [compilers], 1983, Bedrock geologic map of Massachusetts: U.S. Geological Survey, 3 map sheets, scale 1:250,000 Osberg, P.H., Hussey, A.M., and Boone, G.M., eds., 1985, Bedrock geologic map of Maine: Maine Geological Survey, Department of Conservation, 1 sheet, scale 1:500,000 Hermes, O.D., Gromet, L.P., and Murrey,

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USGS-WRD: CONNECTICUT RIVER NAWQA LITHOLOGY: The USGS is the originator of dataset. The original sources of data were the individual Bedrock maps produced for each state. Scale 1:125,000 1997.

Ecological Land Units: Combination of elevation, landform, bedrock geology, and surficial geology grids. See lneelu.doc for more information regarding the development and use of this dataset. Created by TNC Eastern Conservation Scinec, 1999.

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