

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 and GIS Manager; 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. David Hunt led and authored the aquatic features analyses. Mark Anderson substantially wrote or reworked all other methodologies sections. Susan Bernstein edited and compiled all sections.

STL Planning Team and Working Groups

Core Team

Liz Thompson, Team Leader

Bob Zaremba, former Team Leader

Ana Ruesink, former Team Leader and Botany Working Group Leader

Paul Novak, Zoology Working Group Leader

Eric Sorenson, Terrestrial Communities Working Group Leader

David Hunt, Aquatic Working Group Leader

Mark Anderson, Eastern Conservation Science Director and Matrix Features Working Group Leader

Bob Klein, Project Sponsor

* Thompson, E., M.G. Anderson et al. 2003. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, MA

Botany Working Group

Ana Ruesink, Working Group Leader
Bob Popp
Louise Gratton

Zoology Working Group

Paul Novak, Working Group Leader
Kathy Schneider, former Working Group Leader
Mark Ferguson
Sandy Bonanno
Ana Ruesink

Terrestrial Communities Working Group

Eric Sorenson, Working Group Leader
David Hunt
Mark Anderson
Bob Zaremba

Aquatic Features Working Group

David Hunt , Working Group Leader
Mark Anderson, Leader for work originating at TNC Eastern Conservation Science
Eric Sorenson
Arlene Olivero
Cooperators: Mark Bryer, Sandy Bonanno, Bob Zaremba, Liz Thompson, Bill Brown, Greg Edinger, Judy Ross, Susan Warren, Steve Fiske, Rich Langdon, Mark Fitzgerald, Gerry Smith, Jonathan Higgins, Paul Novak, Kathy Schneider.

Matrix Features Working Group

Mark Anderson, Working Group Leader
Liz Thompson
Bob Zaremba
Charles Ferree
Ana Ruesink
Eric Sorenson
David Hunt
Sandy Bonanno
Bill Brown
Chris Maron
Jim Howe
Louise Gratton
Ann Johnson

Other Participants in All-Team Meetings

Michael Carr
Mary Droege

John Roe
David Klein
Andy Beers
John Riley
Ann Werner
Heather Potter
Tom Brown

A CONSERVATION VISION FOR THE ST. LAWRENCE – CHAMPLAIN VALLEY ECOREGION

The St. Lawrence – Champlain Valley Ecoregion is a diverse and beautiful place, with vast stretches of fertile land, rich woodlands, vibrant wetlands, dramatic cliffs, one of the continent's largest rivers, the St. Lawrence, and the continent's sixth largest lake, Lake Champlain. The ecoregion hosts a number of endemic species as well as more widespread species at the edges of their ranges. It provides critical habitat for migratory birds, breeding grassland birds, and wintering raptors.

Because of its fertile soils, relatively mild climate, and stunning scenery, the ecoregion has been used by humans for at least 10,000 years, and very heavily for the last 300 of these. Some of the species that once occurred in the ecoregion have been extirpated, either throughout the east or in the ecoregion alone. Others are in decline or otherwise vulnerable. The upland and wetland natural communities of the region have been reduced in many cases to small, isolated fragments that harbor exotic species and have lost much of their integrity. The lakes, ponds, rivers, and streams that define this ecoregion are compromised by pollution and damming. Conservation of this region's biological diversity will be a challenge.

We identified several key threats to the biological diversity of the ecoregion: water flow manipulation, landscape fragmentation, invasive exotic species, intensive agriculture, intensive forestry, a weak conservation ethic in the human population overall, and pollution of all kinds. Abating these threats will require creative approaches and hard work. Restoration of ecological systems and their component species will be vital to success in conserving both the uplands and the aquatic features of the ecoregion. Influencing public policy in the areas of water management, agriculture, forestry, and transportation will be crucial. Deep and committed partnerships in all these endeavors will be more important than ever if we wish to be successful in achieving our goals.

We envision an ecoregion that, 100 years from today, supports intact and viable terrestrial and aquatic systems along with all their native species, and healthy human communities that work to maintain the natural integrity of the region.

PARTICIPANTS IN THE PLANNING PROCESS

Core Team

Liz Thompson, Team Leader
Bob Zaremba, former Team Leader
Ana Ruesink, former Team Leader and Botany Working Group Leader
Paul Novak, Zoology Working Group Leader
Eric Sorenson, Terrestrial Communities Working Group Leader
David Hunt, Aquatic Working Group Leader
Mark Anderson, Eastern Conservation Science Director and Matrix Features
Working Group Leader
Bob Klein, Project Sponsor

Botany Working Group

Ana Ruesink, Working Group Leader
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Louise Gratton

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Sandy Bonanno
Ana Ruesink

Terrestrial Communities Working Group

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David Hunt
Mark Anderson
Bob Zaremba

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David Hunt , Working Group Leader
Mark Anderson, Leader for work originating at TNC Eastern Conservation Science
Eric Sorenson
Arlene Olivero
Cooperators: Mark Bryer, Sandy Bonanno, Bob Zaremba, Liz Thompson, Bill
Brown, Greg Edinger, Judy Ross, Susan Warren, Steve Fiske, Rich Langdon, Mark
Fitzgerald, Gerry Smith, Jonathan Higgins, Paul Novak, Kathy Schneider.

Matrix Features Working Group

Mark Anderson, Working Group Leader
Liz Thompson
Bob Zaremba
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Ana Ruesink

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Ann Johnson

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INTRODUCTION TO THE ST. LAWRENCE – CHAMPLAIN VALLEY ECOREGION*

Ecological Description

Bordered on the northern edge by the Canadian Shield, the St. Lawrence Valley carries water from the Great Lakes eastward to the Atlantic Ocean. The St. Lawrence River is one of the greatest waterways in North America, draining the entire Great Lakes system, emptying water that originated as far as the forests in Minnesota and collecting from its vast watershed until discharging almost 230,000 cubic feet (6,515 cubic meters) per second into the Atlantic at the eastern boundary of the ecoregion.

At the western edge of the ecoregion, the St. Lawrence Valley begins where Lake Ontario narrows to form the St. Lawrence River. Here, the channel widens and the water flows through the Thousand Islands between Ontario and New York State. Just before reaching the city of Montreal, the Ottawa River joins the St. Lawrence. The Ottawa River is bound on its north by the Canadian Shield, but the vast plain on the southern side stays at a low elevation until the flat expanse reaches the northern edge of the St. Lawrence River. Although this area of low-lying land, made up of low-elevation forests, agricultural fields, estuaries, rivers, and streams, is currently part of the Great Lakes Ecoregion, in time, it would be logical to add it to the St. Lawrence – Champlain Valley Ecoregion. From Montreal, the St. Lawrence River flows at near-sea-level elevation. From Trois-Rivieres downstream, it is affected by ocean tides.

To the west, the ecoregion follows the western edge of the Adirondacks in a southward-stretching area of low-lying land that wraps around the Tug Hill Plateau. The other southern extension of the ecoregion is the Lake Champlain Valley that lies between New York State and Vermont. From the peaks of the Green Mountains or the Adirondacks, one sees breathtaking views of the low-lying valley of Lake Champlain, the expansive body of water, the flat agricultural lands that border the lake, the foothills and the mountains in the distance. The narrow valley has the longest growing season in the region and is highly productive agriculturally. Because of the historical importance of the lake as commercial highway, a number of the region's largest populations centers lie on the shores of Lake Champlain. The largest cities on the New York side of the lake include Ticonderoga at the southern tip and Plattsburgh at the northern end of the lake. In Vermont, the population centers are primarily focused in Burlington, Winooski, Essex Junction and St. Albans.

In 1998, The Nature Conservancy identified the St. Lawrence – Champlain Valley Ecoregion as distinct from the larger Great Lakes Ecoregion, of which it had formerly been a part, based on the area's unique patterns of vegetation, climate, hydrology and a more complete consideration of the Canadian portion. From mountain streams to the deltas and marshes that line the shores of the St. Lawrence River and Lake Champlain, this ecoregion is defined in a large part by the waters flowing through it and the relationship between the aquatic features and the land. The region is set apart from the

* Thompson, E., M.G. Anderson et al. 2003. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, MA

landscape around it because of its low elevation, soil types, topography, plant communities, climate, and endemic species.

The landscape that makes up the ecoregion is defined by natural and human processes. Glacial activity resulted in changes to the topography, the soils and aquatic processes. Today, the rich agricultural lands in the area lie on highly productive alkaline soils that are made up of glacial lake and marine sediments. The cliffs, wetlands and remnant forests that can be found along the shores of the waterways and into the foothills provide critical habitat to migratory birds and other species ranging from common to rare. Many of the species located in the St. Lawrence – Champlain Valley ecoregion are under threat as a result of human activities. Past land uses include mining, tanneries, logging, agriculture, factories, and mill ponds. These have all had a dramatic and lasting impact on the ecoregion. Today, additional threats include invasive exotic species, altered hydrologic systems, byproducts of agricultural practices (chemicals, nutrients, and sediments), land conversion, and urban sprawl, all of which endanger the biodiversity found here.

Geography

The 18,338 square miles of the St. Lawrence – Champlain Valley ecoregion include portions of two states, New York and Vermont, and the Canadian province of Québec. Almost 24% of the land included in the ecoregion is located in New York, 9.9% is located in Vermont, and 66.3% is located in Québec. The landscape encompassed by the ecoregion is comprised of lowlands surrounding two prominent bodies of water, the St. Lawrence River and Lake Champlain.

The ecoregion falls entirely within the Laurentian Mixed Forest Province of the U.S. Forest Service (199_). Within this physiographic scheme, the region includes the St. Lawrence Glacial Marine Plain, the St. Lawrence Till Plain, the Champlain Glacial Lake and Marine Plain, the Champlain Hills and the St. Lawrence Glacial Lake Plain.

Some of the many interesting features of the St. Lawrence – Champlain Valley ecoregion include the following:

- The St. Lawrence River is one of the major waterways of North America, extending 760 miles (1,224 km) from Lake Ontario to the Gulf of St. Lawrence north of the Gaspé Peninsula, and draining the entire Great Lakes system.
- Lake Champlain is roughly 490 square miles and up to 400 feet deep. It is sometimes referred to as the sixth Great Lake.
- Open water makes up 9.5 percent of the U.S. portion of the ecoregion and 0.8 percent of the Québec portion of the ecoregion.
- The ecoregion provides critical habitat for migratory birds, breeding grassland birds and also for wintering raptors including bald eagles, hawks, and owls.
- The region is an important regional flyway that provides stopover habitat for migratory forest land birds.
- Montréal, Québec is the largest population center in the ecoregion, with a population of about 3.5 million people in the metropolitan area.
- Burlington is the largest population center in Vermont, with a regional population of about 120,000.

- Plattsburgh is the largest population center in the New York portion of the ecoregion with a population of about 30,000 people

Geology and topography

The St. Lawrence River Valley and the Lake Champlain Valley stand out from the land that surrounds them. The land is primarily flat as a result of the underlying bedrock, the weight of ancient glaciers, and the shifting levels of the water that filled the valleys. Elevations in the Champlain Valley range from 95 feet above sea level on the shores of the lake to 1,800 feet in the foothills of eastern Franklin and Chittenden counties. The elevations of the land surrounding the St. Lawrence River are slightly lower than those surrounding Lake Champlain. Elevations in the St. Lawrence Valley range from very low elevations along the drainages of the St. Lawrence to sea level as it empties into the ocean. The surrounding low slopes range in elevation from 80-180 feet. The foothills surrounding these slopes range from 590-1,200 feet before rising into the bordering Adirondacks, Green Mountains and the Canadian Shield.

This ecoregion has some of the oldest rocks in the northeast. Ordovician limestones, dolomites, and shales, the prominent rocks in the region, are often filled with fossil trilobites, snails, corals and algae that provide evidence of the marine environment which once existed here. These rocks and the processes that have shaped them give the area much of its character. Thrust faults created during the Taconic Orogeny have left behind cliffs and steep slopes that provide specialized habitats like rock outcrops and talus.

In very recent times, at least geologically speaking, glaciers transformed these valleys, as they did all of North America. Following the retreat of glaciers from the region, which occurred roughly 13,500 years ago, the valleys were filled with fresh water. Lake Champlain went through a transition from the glacial fresh water of Lake Vermont to the brackish Champlain Sea as seawater entered the valley from the Atlantic by way of the St. Lawrence River. Changes brought by the glaciers left lasting effects in the St. Lawrence Valley in the form of marine plains and rolling, low, parallel ridges. The streams, rivers and lakes that fed these bodies of water carried huge loads of sediments which they deposited as they emptied into Lake Vermont, the Champlain Sea, and the St. Lawrence River. The resulting formations of deltas and beaches deposited by post-glacial lakes and seas and also by the rivers that emptied into these bodies of water account for the gravels, sands, fine silts, and clays that occupy much of the region today. In fact, it was the flooding of these basins by lake and sea, and the movement of sediments in the valleys, which had more of an effect on the soils found in this ecoregion than any other factor. Most soils throughout the ecoregion developed in post-glacial lake and marine deposits of gravel, sand, and clay.

The nearly level clay plains that occupy much of the low-lying land in the ecoregion are incised by streams and pockmarked by small lakes, ponds, and wetlands. The soils here have naturally poor drainage because of the fine clay particles. The lowest elevations of the Champlain Valley are made up of clay soils. This wet, sticky clay, although hard to plow in the spring, makes for highly productive agricultural lands. The well-drained deltaic sands of the valley are also very flat and divided by occasional stream channels that have caused locally steep topography in certain areas. The soils in the region's foothills were not as affected by the water bodies as the lower elevations. Instead, they

were scoured by retreating glaciers that left a layer of glacial till over the bedrock. The soils in the St. Lawrence Valley are made up primarily of marine clays that resulted from an influx of seawater at the end of the glacial period.

Climate

Overall, the St. Lawrence – Champlain Valley ecoregion has a temperate climate that accounts for warm to hot summer temperatures and cold winters. Water plays a central role in the climate of this ecoregion. Both the St. Lawrence River and Lake Champlain have a moderating affect on temperatures within the region. Summer temperatures tend to be higher in the valleys than in surrounding areas, with an average July temperature in the St. Lawrence River Valley of 69°F and upwards of 70°F in the Champlain Valley. Winter temperatures in the ecoregion also tend to be higher than in surrounding areas. In January, the average temperature around the St. Lawrence River Valley is 13°F, while the average temperature in the Champlain Valley is 19°F. Latitude and elevation also affect temperature. Low winter temperatures are primarily a result of the region's latitude, while warm summer temperatures are primarily a result of low elevation.

The St. Lawrence – Champlain Valley ecoregion tends to be warm and dry. Average annual precipitation ranges from 28 inches in the valleys to 38 inches or more in the foothills. In contrast, the highest parts of the adjacent Green Mountains get over 70 inches of precipitation in the average year and the Adirondacks get over 40 inches per year.

The growing season in this area generally lasts from 120 to 140 days, but increases to about 160 days in a narrow belt around Lake Champlain, where the growing season is very similar to parts of the southern Connecticut River Valley. Vermonters and New Yorkers who farm in the Champlain Valley refer to the area as the “banana belt.” Although some warm-climate crops are grown successfully here, the growing season doesn't actually provide enough warm weather for bananas to grow.

Vegetation

Pre-settlement forest data derived from early town boundary surveys shed some light on what trees once grew in the ecoregion. According to these accounts in the Champlain and St. Lawrence valleys, the forests on the clayplain (flat regions of fine-grain surficial deposits) were variously dominated by red maple, beech, hemlock, swamp white oak, bur oak, white oak, white ash, and shagbark hickory. In the sandplains, evidence suggests that black oak, red oak, white pine, pitch pine, and red maple were common. Today, in the remnant patches of clayplain and sandplain forests, these are still the dominant species. Near Lake Champlain, on the calcareous soils occurring over limestone and dolomite, the prevailing species included northern white cedar, shagbark hickory, oaks, and maples. The glacial till soils in the foothills surrounding the valley supported upland northern hardwood forests. Evidence suggests that oaks were probably present in much lower numbers than can be seen today and that they grew mainly in the driest sites.

The early surveys are our only glimpse into the pre-settlement forest, because most of the lowlands of the ecoregion have been converted to agricultural use. With their warm climates and fertile, nearly stone-free soils, both the Champlain Valley and the St. Lawrence River Valley were ideal for early settlement and farming. Beginning in the late

18th century, settlers cleared the forests of the region, draining the lowlands, and planting crops. Today, small remnants of characteristic natural communities that once dominated the ecoregion include clayplain forests and sandplain forests.

Biodiversity and endemism

As temperatures warmed following the last glaciation, an unusual landscape was left behind. The barren lowlands were free of ice earlier than the surrounding mountains and species from the south began moving northward to fill the ice-free areas. The plants and animals that colonized the region evolved over time, leading to a small but distinct set of endemic, or strictly localized, species and subspecies, such as Champlain beachgrass.

Rare species (including these few endemic species along with species that occur elsewhere) in the region include Champlain beach grass (*Ammophila champlainensis*), lake sturgeon (*Acipenser fulvescens*), and eastern spiny soft shell turtle (*Apalone spinifera*). Other species requiring special focus because of their rarity are Blandings turtle (*Emydoidea blandingi*), Indiana bat (*Myotis sodalis*), small-footed myotis (*Myotis leibii*), and elusive clubtail (*Stylurus notatus*). In addition to the lake sturgeon, fish species like the Eastern sand-darter (*Ammocrypta pellucida*), the copper red horse (*Moxostoma hubbsi*), and the greater red horse (*Moxostoma valenciennesa*) are declining in the rivers and streams within the ecoregion. Birds that have been listed as targets for protection include species that are important regionally, are threatened, or have numbers that are currently declining. Some of these birds include the boblink (*Dolichonyx oryzivorus*), bank swallow (*Riparia riparia*), Cerulean warbler (*Dendroica cerulea*), upland sandpiper (*Bartramia longicauda*) and Henslow's sparrow (*Ammodramus henslowii*). Grassland areas, along with marshes and swamps are particularly important areas for these birds. Some of the twelve plant species that are either endemic or threatened and have been listed as primary targets include Eaton's beggar-ticks (*Bidens eatonii*), rugulose grape-fern (*Botrychium rugulosum*), ram's-head lady's-slipper (*Cypripedium arietinum*), and Victorin's gentian (*Gentianopsis victorinii*).

Land Use Trends and Current Threats

Humans have occupied the St. Lawrence and Champlain Valleys for at least 10,000 years, adapting their way of life to a changing environment. Initially, people lived in small, nomadic groups and then later lived in larger settlements. Historically, the area was within the Iroquois Tribal Territory. European exploration of the area began in the 17th century with explorers, then fur traders and settlers in the 18th century. Initial changes brought on by settlement were the reduction of certain species to support the fur trade, like beavers and fishers that were essentially hunted to extinction in the region. The significant change the settlers brought to the landscape was the amount of forest they cleared for agriculture and sheep pasture. By 1830, 75% of the area had been cleared, but by 1850, many of these farms had been abandoned as residents moved west in search of more productive soils. The forests that have regrown in these areas have been repeatedly harvested throughout subsequent years and the trees that stand today in remnant patches are commonly third or fourth successions of growth.

Today, the human threats facing the ecoregion are somewhat different than they have been historically. The most significant of these threats stems from commercial and residential development, and agricultural runoff, which have lead to problems with water

quality, air quality, habitat reduction, and fragmentation. Other human-caused changes to the landscape include fire suppression and the subsequent loss of trees relying on fire to reproduce. Additionally there has been an influx of invasive species some of which pose potential problems to the native species in the ecoregion. While only about 6 percent of the land in the ecoregion is used for urban development, the roughly 5 million people who live within these valleys have dramatic impacts on the landscape. The largest population centers within the ecoregion lie in Canada. They are Montréal, Ottawa, and Québec, with about 3.5 million, 1,065,000, and 700,000 respectively. In Vermont, the largest population centers are Burlington and St. Albans with 120,000 and 13,000. In New York State the primary population centers are Plattsburgh, Watertown, and Ticonderoga with populations of 30,000, 26,700, and 5,000.

Other threats come from a variety of sources, some of them indirectly from humans. Insect and disease disturbances have occurred in the form of Dutch elm disease, chestnut blight (both of these introduced from Asia), gypsy moth (introduced from Europe), beech bark disease, false pine budworm, and butternut canker. Within the ecoregion, periodic outbreaks of insects and diseases have devastated thousands of forested acres. Some of these cycles occur naturally; others result from human introductions of pathogens. Some of the prominent trees in our forest communities have been nearly eliminated by these natural and introduced causes.

PORTFOLIO SUMMARY*

The portfolio contains 28 **plant** populations in the United States portion of the ecoregion and 34 sites in the Québec portion. For primary **animal** targets, the portfolio identifies the following viable occurrences and their surrounding survey site: 6 grassland breeding bird sites, 5 sites for bats (three are hibernacula, two are maternity sites), 19 sites for fish, 3 sites for reptiles, 8 sites for insects, and 21 sites for mussels.

The portfolio contains 456 **terrestrial community** examples, including 9 lakes, 243 palustrine (wetland) communities, and 204 terrestrial (upland) communities. 125 **aquatic features**, ranging in size from huge systems such as the St. Lawrence River and Lake Champlain, to small features such as ponds, are included in the portfolio.

Finally, 17 Preferred (Tier 1) **matrix forest** blocks, three of which were subsequently combined into one, were selected for the final portfolio

In summary, the full portfolio for the United States portion of the St. Lawrence – Champlain Valley Ecoregion includes:

28 occurrences of primary plant targets
62 occurrences of primary animal targets (including grassland bird breeding sites and Indiana bat maternity sites)
456 occurrences of primary terrestrial community targets
125 primary target aquatic features
15 final Preferred (Tier 1) matrix blocks

These primary targets are found within a total of 15 *matrix blocks*, large landscape-scale areas ranging in size from 6,700 to 91,000 acres and 51 other areas (so-called “standard sites”), ranging in size from less than an acre to thousands of acres.

The size of matrix blocks is measured as the area that is delineated by fragmenting features such as roads and powerlines. The size of the standard sites is measured as the area that contains the target population, breeding area, or natural community. Conservation of these areas may require action in an area larger than the size of the site, or may be achieved by action in an area much smaller than the size of the site. In some cases, conservation will be accomplished by actions outside the site itself. Conservation actions will be determined through conservation area planning.

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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

* 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.

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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 concern:	Ranked G3-G5 by Natural Heritage Programs/Conservation Data Centers, but match one or more of the following criteria:
<i>Declining species</i>	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.
<i>Endemic species</i>	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.
<i>Disjunct species</i>	Have populations that are geographically isolated from other populations.
<i>Peripheral species</i>	Are more widely distributed in other ecoregions but have populations in this ecoregion at the edge of their geographical range.
<i>Vulnerable species</i>	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).
<i>Focal species</i>	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: <i>Keystone species:</i> 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. <i>Wide-ranging species:</i> 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 subsection² 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

Setting conservation goals for plant targets

The group set numerical conservation goals for the primary target species based on their rarity and distribution as shown in the table below. These numbers are initial minima. The conservation biology literature suggests that five occurrences of a rare species will not ensure its survival long term, but if we can conserve five while we work to determine the real number needed we will be making progress in the right direction. We will need to reassess these goals.

Distribution	G1	G2	G3
Restricted (R)	5	20	30
Limited (L)	5	10	10
Widespread (W)	5	5	5
Peripheral (P)	NA	5	5

Setting conservation goals for animal targets

The group set numerical and distributional goals for primary target species, as follows:

For G1 and G2 species

- Include all viable occurrences found within the ecoregion in the portfolio. In addition, include any occurrences not currently considered viable, but for which the potential exists for restoring them to a viable condition.
- The number of sites will not be specified. In many cases there are fewer than five occurrences within the ecoregion, there may never have been more, and increasing the number will be difficult. For this iteration of the plan, we will seek to protect what exists now and improve or restore others where they have been or where they are hanging on.
- Justification: These species are truly globally extremely rare. By definition, there will likely be no more than 20 occurrences in the ecoregion and, unless the species is restricted to the ecoregion, there will not be anywhere close to that many. Conserving all viable occurrences and restoring any that may be restorable seems to be a very reasonable goal. We recognize that this does not provide clear guidance on when to “give up” on a species but we are not confident or in agreement on what guidance to provide (more work needed on this question).

For G3, G4, and G5 species

- Follow guidelines in Lower New England ecoregional plan, and modified by St. Lawrence – Champlain Valley plant team. These are minimum numbers to include in the portfolio. All occurrences selected must be viable (ranked A-C).

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for species. Based on Thompson, E. et al. 2002. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Ideally, occurrences would span the various subsections although A-ranked occurrences should probably be chosen over C-ranked occurrences without regard to subsection.

For grassland birds

- No number, distribution or viability criteria was set – although 6 proposed sites were identified – this needs discussion

The group set distributional goals as follows:

Restricted species – include 30 sites/meta-populations
Limited species – include 20 sites/meta-populations
Widespread species – include 5 sites/meta-populations
Peripheral species – include 5 sites/meta-populations
Disjunct species – include 5 sites/meta-populations

Portfolio Results for Plants

Although this plan treats only the U.S. portion of the ecoregion comprehensively, the botany working group was unique in that they analyzed data from both the United States and Québec. They took the following steps toward selecting portfolio sites.

The group reviewed all G1 to G3 species (including G3G4 species, and T1 or T2 species) known from the ecoregion. This involved checking on recent work on the taxonomy and nomenclature of each to ensure that the rare taxon is still recognized and that we are using the correct name.

They then reviewed all other vulnerable plant species in the region, including

- significant disjuncts (populations that are isolated enough from the species' main range that genetic exchange is unlikely);
- populations with unique genetic variation or occurring in a unique ecological context;
- populations at the far edges of their species range; and
- ecoregion endemics known to be vulnerable and in decline.

The group then selected 45 target species that met either rarity or vulnerability criteria. Of these, **twelve** are primary targets (G1 through G3G4 species with known EOs in the ecoregion). Three are provisional primary targets (globally rare species with taxonomic questions). In this plan these three are treated as secondary targets. Thirty are secondary targets (state-or province-rare species that warrant protection based on distribution – all are at the edges of their ranges and may be vulnerable for other reasons). All primary and secondary targets are listed in Appendix A, and more detailed information is provided in the Supporting Documents.

Five of the twelve primary targets have the minimum number of occurrences to meet these numerical conservation goals. The group also set a distributional goal of one occurrence in each subsection in which the species naturally occurs. Three of the twelve primary target species met the distributional goals. Occurrences of the primary target species that met the viability criteria were selected for inclusion in the portfolio.

Summary of portfolio for plants

The portfolio contains 28 sites in the United States portion of the ecoregion and 34 sites in the Québec portion.

Portfolio Results for Animals

The zoology working group encompassed avian, mammal, fish, herptiles and macro invertebrate targets. Some targets (particularly bird species or suites) were allocated to secondary target status if a review of habitat relationships and ecosystem targets suggested they would be conserved by ecosystem protection of critical breeding habitat. Others (e.g. grassland bird) were elevated to primary targets if no natural ecosystem type was identified that corresponded with their habitat needs.

The group selected 23 targets, including

- G1-G3 species (G3-G4 included) and
- G4 and G5 species of selected taxonomic groups with disjunct populations in this ecoregion.
- One avian habitat suite comprised of several grassland breeding birds

In addition, the group selected 32 secondary target species which should be factored into site conservation planning. These species include those which are actively tracked by at least one of the two states in the ecoregion and are also listed as endangered, threatened, or of special concern by at least one of the two states. Many of the amphibian and reptile species on this list are either at the northern or eastern limits of their ranges.

Bird targets were chosen based on list in Draft Version 1.5 of the Partners In Flight (PIF) Landbird Conservation Plan: St. Lawrence Plain Physiographic Area 18 and North American Bird Conservation Initiative (NABCI) Bird Conservation Region (BCR) 13 (Lower Great Lakes/St. Lawrence Plain) listing. This approach is based on recommendations of The Nature Conservancy (TNC) Wings of America Program Geography of Hope document regarding incorporating Birds as Ecoregional Planning Conservation Targets. It is also consistent with the Great Lakes Ecoregional Plan, which originally included some of this ecoregion.

All species listed in PIF Area 18 are grouped into **suites of species** that utilize similar habitat (following groupings in PIF plan). The suite of species is the target. At this time we will probably need to restrict selection of sites largely to breeding sites with a few exceptions.

One habitat suite, grassland species, was identified as a primary target. Three were identified as secondary targets. These are shrub-early successional species; riparian-deciduous and mixed forest species; and freshwater wetland, lakeshore, and river species.

In addition, a number of individual species were chosen as secondary targets.

The group assessed the viability of each occurrence (population) of each primary target species based on population size, condition, evidence of reproduction, condition of the habitat, and expert opinion. Additionally six sites were identified for the grassland bird species suite based on expert opinion; these were considered provisionally viable and are included in the portfolio. Further work is needed to define the characteristics of a viable grassland breeding site.

All sites for animal targets that were considered viable were included in the portfolio.

Summary of portfolio for animals

The portfolio identifies the following viable occurrences and their surrounding survey site for primary targets: six grassland breeding bird sites, five sites for bats (three are hibernacula, two are maternity sites), 19 sites for fish, 3 sites for reptiles, 8 sites for insects, and 21 sites for mussels.

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 (NVC²), 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 ELUs³ 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 (700K)	M212D (5.9M)	M212A (6.8M)	M212C M212B (3.4M)	M212Aa,b 212Aa (5.3M)	212A,B 212C,D (6.9M)	212C 212D (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 a sample of 1300 patch-forming ecosystem occurrences we calculated *10 times 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	Woodland	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 from 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+

Sample Page

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 terrestrial communities working group began by comparing New York and Vermont community classifications with TNC's National Vegetation Classification (NVC). This resulted in a crosswalked list of 127 community types known or expected to occur in the ecoregion.

Communities were then assigned to distribution and scale classes, and also identified communities that tend to occur together in groups, which may therefore require special conservation attention. For all New York and Vermont community occurrences in the ecoregion, NVC association names and codes were applied, and the group assessed each occurrence for size, current condition, and landscape quality, the latter both from expert opinion and GIS analyses. With this information, they made assessments of viability, likelihood of persistence, and whether the occurrence was large enough to support associated species.

The group adopted the numerical and distribution goals developed for the Northern Appalachians Ecoregional plan (see below). They have not currently assessed whether goals were met, but initial review suggests that in most cases they were not. However, during the selection of 10-year action sites steps were taken to ensure that each community was represented at least once in the list of sites to be worked on in the next ten years.

	Minimum Primary Target Occurrences	
Minimum Stratification Level	Large Patch (4)	Small Patch (5)
Restricted (4)	16	20
Limited (2)	8	10
Widespread (1)	4	5
Peripheral (1)	4	5

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for terrestrial communities and systems. Based on Thompson, E. et al. 2002. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Summary of Portfolio for Terrestrial Communities

The portfolio contains 456 community occurrences, including nine lakes, 243 palustrine (wetland) communities, and 204 terrestrial (upland) communities. (Note: the ecological stratification scheme is incomplete until Quebec is fully incorporated into the planning.)

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

* 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 forest⁴. 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” rule⁶.

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 population⁷ 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 is 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.

Scaling factors for Matrix Forest Systems in the High Allegheny ecoregion.

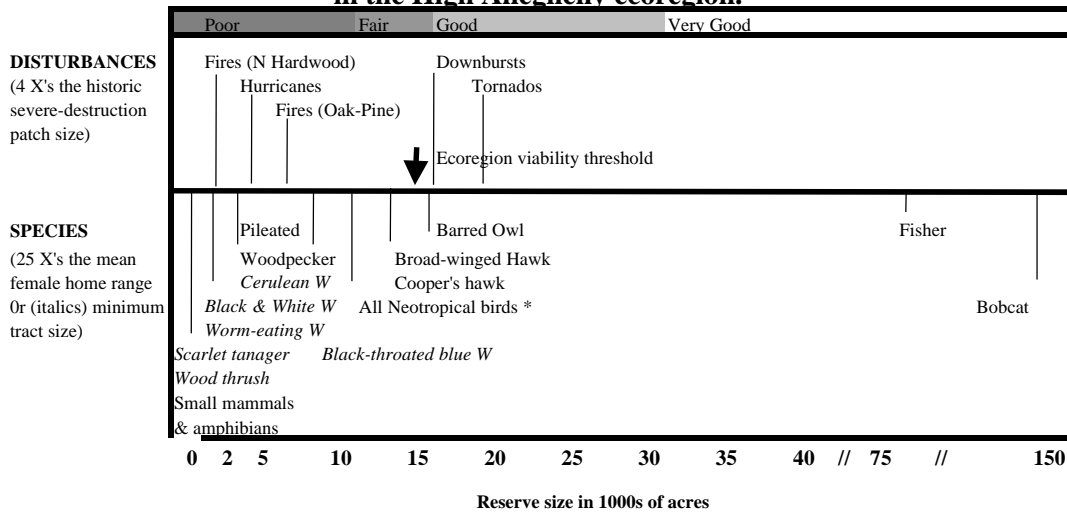


Figure MAT1. Scaling factors for matrix forest systems in the High Allegheny Ecoregion. Note: Fisher and bobcat are included in the figure for context; they were not considered to be interior-forest-requiring species.

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. *Composition* 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 jays¹⁹). 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

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 legacies²⁶ 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 programs³³ 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 classified³⁸ 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 occurrences³⁹ 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
	<i>ELU Group A</i>	<i>ELU Group B</i>
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 reports⁴⁰ 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.

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.

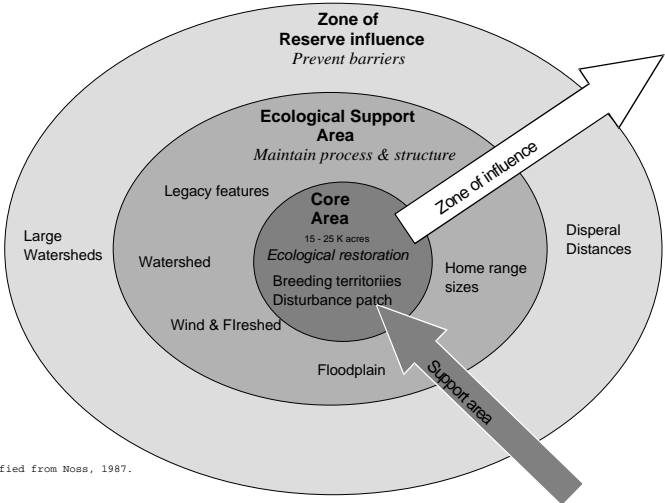
Some TNC ecoregional plans have developed baseline percentages for each matrix system target, such as 10% of the existing cover. We examined these methodologies but did not find them suitable for the Northeast. One reason is that the existing cover is not representative of the historic cover. Diminishing 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



Modified from Noss, 1987.

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
NAME: Merry Meeting Lakes
STATE/S: NH

RANK: Y
SUBSECTION: 221A1 Sebago-Ossipee Hills and Plains

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 community, 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: 96 %

Natural Cover:	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*

Matrix forest systems in the St Lawrence – Champlain Valley ecoregion are comprised of a handful of dominant forest community types including three that dominate in the United States portion of the ecoregion. These three are sugar maple-beech-yellow birch northern hardwood forests, sugar maple-basswood-white ash rich northern hardwood forests (some of which may be transitional to more southern forests and therefore contain significant components of hickory, white pine, and oaks), and oak-dominated clay plain forests. In addition, floodplain forests are locally dominant in the Lac St. Pierre section of the St. Lawrence River. Included in the definition of matrix forest systems are also all the early and mid-successional stages of these forest types, such as aspen-birch forest. Descriptions and technical names of all matrix forest types as well as the 123 other forested and non forested community types are available in the St. Lawrence – Champlain Valley community classification booklet (Sorenson et al., in prep.) being developed by the Heritage Ecologists in the participating states and region.

Modifications to Standard Method

To identify the minimum size needs for associated species we first developed a list of species associated with the dominant forest systems in the St. Lawrence – Champlain Valley ecoregion. Subsequently we narrowed the list down to those species dependent on forest interior for breeding. Examples of those species include year-round residents preferring large tracts of old forests, e.g. pine marten (*Martes americana*) and northern goshawk (*Accipiter gentilis*) as well as forest breeding neotropical migrants such as black-and-white warbler (*Mniotilta varia*), Canada warbler (*Wilsonia canadensis*), eastern wood-peewee (*Contopus virens*), veery (*Catharus fuscescens*), wood thrush (*Hylocichla mustelina*), black-throated blue warbler (*Dendroica caerulescens*), ovenbird (*Seiurus aurocapillus*), scarlet tanager (*Piranga olivacea*), and red-shouldered hawk (*Buteo lineatus*) (Figure 1). Using literature and expert opinion we then developed an estimate of acreage needs for 25 female breeding territories of each species and/or acreage to meet any area needs that have been demonstrated for individual species.

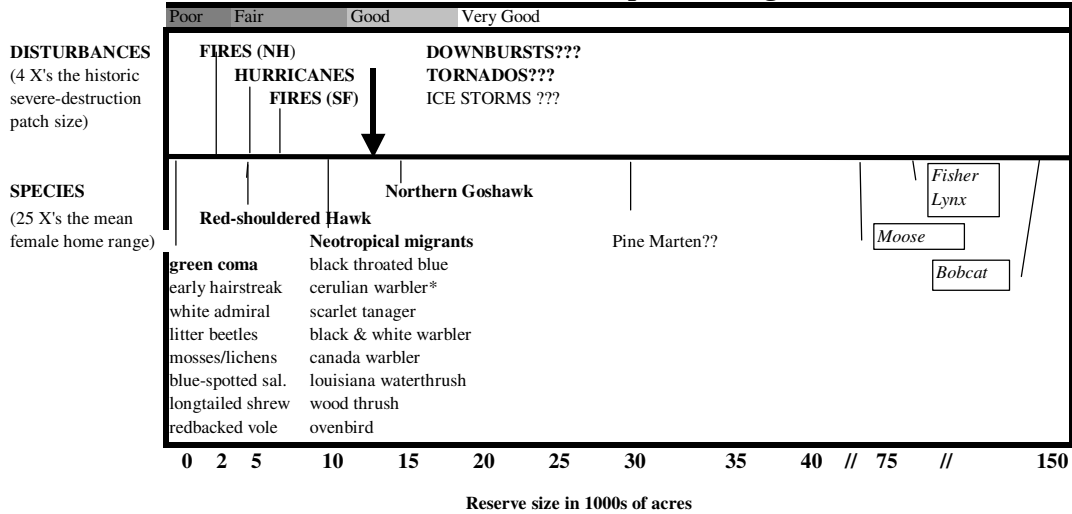
Wide ranging species and top carnivores (e.g. lynx, bobcat, cougar, wolf, bear, moose) that benefit from forest interior conditions but require a broader range of habitats and conditions for survival were considered but not explicitly included in the scaling of the forest area requirements. The needs of each of these species are being addressed in a species-specific way through a combination of core areas, networks and connecting lands.

To set a critical size threshold for matrix forest systems, we combined the minimum dynamic area for disturbances with acreage needs of forest interior dependent fauna onto a single linear axis for STL (Figure 1). Using figure 1 we set our minimum size threshold at 10,000 acres.

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for matrix-forming ecosystems. Based on Thompson, E. et al. 2002. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Scaling factors and Reserve size for Matrix forests in the St Lawrence -Lake Champlain ecoregion

draft: M. Anderson 2001



Factors to the left of the arrow should be encompassed by a 12,000 acre reserve
 NH = N. hardwoods SF = Spruce-fir
 *PIF shrub or early successional species include blue-winged, golden winged, prairie and mourning warbler

Neotropical estimates based on Robbins et al. 1989, see text for full explanation]
 Freemark (1996) list of area sensitive birds:

Figure 1. Scaling factors and reserve size for matrix forests in the STL ecoregion

Portfolio Results for Matrix Forests

Following the standard methodology for identifying and selecting matrix forest block examples resulted in the selection of 17 Preferred (Tier 1) matrix blocks and 13 Alternate (Tier 2) blocks. The blocks are listed in Appendix E. In that table, information is included about seven blocks that were eliminated during the December 2001 review meeting. Subsequently, three of the blocks (317, 318, 319) were combined into one, making 15 Preferred matrix forest examples for the final portfolio.

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 Fund¹ 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

* 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 habitats⁶ 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 exists 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 ecosystems⁸
- Although aquatic habitats are continuous, we can make reasonable generalizations about discrete patterns in habitat use and boundaries distinguishing major transitions⁹
- 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

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:

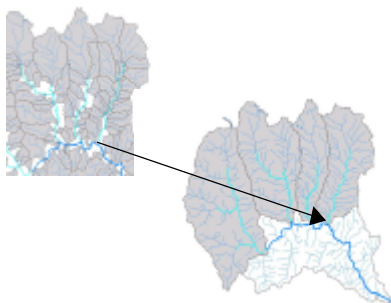
Table 1: Generalized Stream Size and Community Relationships

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.

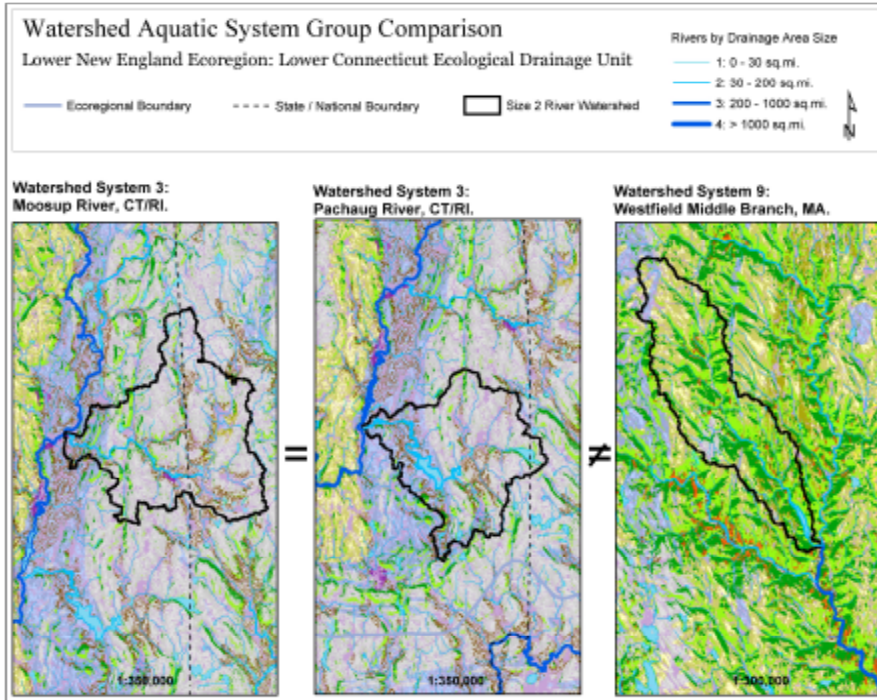


Figure 2: Watershed Aquatic System Group Comparison

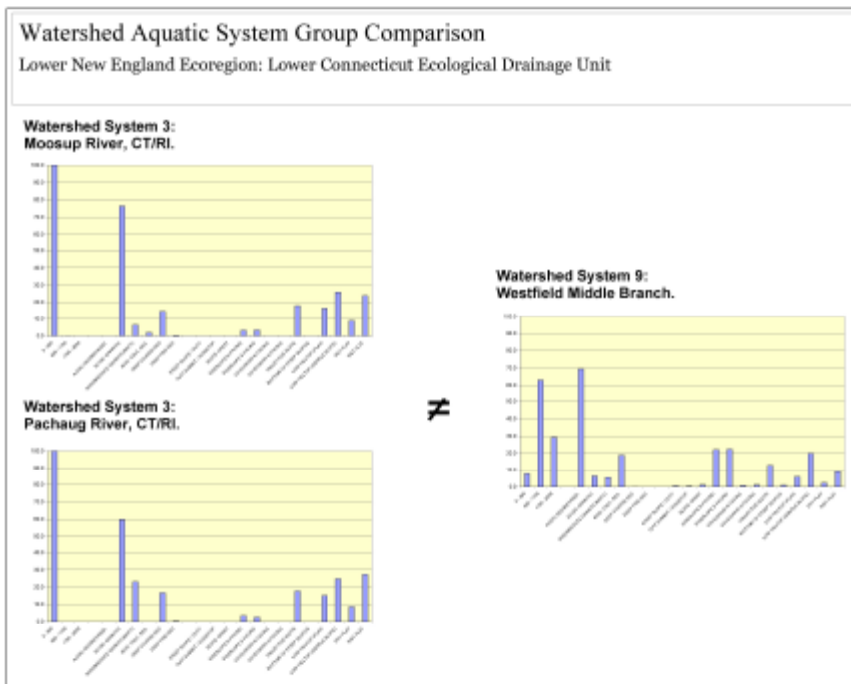


Figure 3: Watershed Aquatic System Component Summary

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 connectivity¹⁵. 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 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

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 aquatic 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 <i>conditionally</i> 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

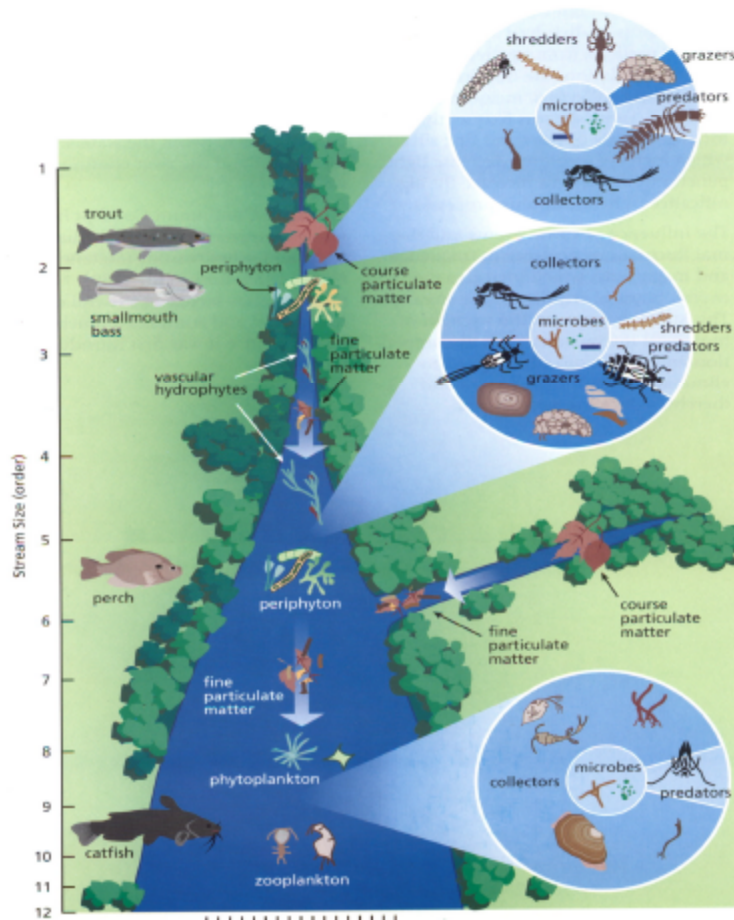


Figure 1: River Continuum in Size

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 (<i>Parapsyche</i> , <i>Palegapetus</i>)-Stoneflies (<i>Capniidae</i>)-Non-biting midges (<i>Eukiefferella</i>), Mayflies (<i>Eurylophella</i>).Other preferential taxa Caddisflies?(<i>Symphitopsyche</i>), Stoneflies (<i>Leuctridae</i> , <i>Taenionema</i> , <i>Chloroperlidae</i> , <i>Peltoperla</i>), Water strider (pools). Possible taxa Alder flies, Beetles (<i>Psephenidae</i>), Mollusca (<i>Elliptio</i>), Mayflies (<i>Heptagenidae</i>).		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, <i>acid intolerant</i> bryophytes, non vegetated areas Macroinverts: circumneutral , <i>acid intolerant</i> leaf shredders: Mayflies (<i>Rithrogenia</i>)-Caddisflies (<i>Symphitopsyche</i> ?, <i>Glossosoma</i>)-Flies (<i>Simulium</i> , <i>Antocha</i>) Stoneflies (<i>Peltoperla</i> , <i>Chloroperlidae</i> , <i>Malikrekus</i> , <i>Capniidae</i> , <i>Agnatina</i>), Beetles (<i>Oulimnius</i> , <i>Optioservus</i> , <i>Ectopria</i>), Non-biting midges (<i>Crictopus</i> , <i>Polypedilum</i>), Mayflies (<i>Ephemerella</i> , <i>Serratella</i>), Flies (<i>Hexatoma</i>), 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, Myriophyllum sp Macroinvert Indicators: Mollusca (<i>Pisidium</i>)-Caddisflies (<i>Polycentropus</i>)-Mayflies (<i>Litobranca</i>)-Dragon/damselflies (<i>Cordulegaster</i>)		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: Potamogeton spp, Elodia, Nymphaea		Calc bedrock Slope 0-2%

Macroinverts: Flies (<i>Tipula</i> , <i>Atherix</i> , <i>Simulium</i>)-Non-biting midges (<i>Apsectrotypus</i> , <i>Rheocricotopus</i>)-Crustacea (<i>Hyallolella</i>)-Mollusca (<i>Pisidium</i>)-Mayflies (<i>Stenonema</i>) (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 (<i>Chloroperlidae</i>)-Caddisflies (<i>Dolophilodes</i> , <i>Rhychophila</i>)-Flies (<i>Hexatoma</i>)-Beetles (<i>Oulimnius</i>) Generally poor mussel diversity, with acid tolerant species. Other preferential Taxa: Caddisflies (<i>Brachycentrus</i> , <i>Lepidostoma</i> , <i>Apatania</i> , <i>Symphitopsyche?</i> , <i>Polycentropus</i>), Beetles (<i>Promoresia</i> , <i>Optioservus</i>), Non-biting midges (<i>Eukiefferella</i> , <i>Tvetenia</i> , <i>Parachaetocladius</i> , <i>Micropsectra</i> , <i>Microtendipes</i> , <i>Polypedilum</i>), Mayflies (<i>Epeorus</i> , <i>Rhithrogena</i>), Dragon/damselflies (<i>Gomphidae</i>), Stoneflies (<i>Capniidae</i> , <i>Peltoperla</i> , <i>Leuctridae</i> , <i>Agnetina</i> , <i>Isogenoides</i>). 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, algae and bryophytes. Macroinverts: (Vt type 4 lower valleys) Stoneflies (<i>Chloroperlidae</i>)-Caddisflies (<i>Dolophilodes</i> , <i>Rhychophila</i>)-Flies (<i>Hexatoma</i>)-Beetles (<i>Oulimnius</i>) Mayflies (<i>Isonychia</i>), Non-biting midges (<i>Polypedilum</i>), Beetles (<i>Dubiraphia</i> , <i>Promoresia</i>). Other possible taxa: Beetles (<i>Psephenidae</i>), Alder flies (<i>Corydalidae</i>), Dragon/damselflies (good diversity; <i>Calypterygidae</i>), Mollusca (<i>Elliptio</i> , <i>Pyganodon</i> , <i>Sphaerium</i> , questionably <i>Margaritifera</i>), Mayflies (<i>Ephemeridae</i>), Crustacea (<i>Cambaridae</i>) (green stoneflies (<i>Chloroperlidae</i>), <i>Dolophilodes</i> , <i>Hexatoma</i> , <i>Rhychophila</i> , <i>Oulimnius</i>). Poor NYHP understanding of assemblage. (<i>Promoresia</i> , <i>Neoperla</i> , <i>Chimarra</i> , <i>Stenelmis</i>) 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 (<i>Dubiraphia</i>)-Non-biting midges (<i>Polypedilum</i>)-Mayflies (<i>Leptophelbidae</i>)-Mollusca (<i>Pisidium</i>)-Odonota (<i>Aeshinidae</i>) Broad winged damselflies <i>Calopterygidae</i> , Narrow winged damselflies <i>Coenagrionidae</i> , Clubtails	Slope 0-2% (wetflats) and not a slope bottom flat

			<i>Gomphidae</i> -Caddisflies (<i>Hydaphylax, Dubiraphia, Polypedilum</i>)	
			Fish, warmwater species, coldwater absent: Bluntnose minnow, Creek chub, Blacknose dace, Tessellated darter, White sucker.	
		Midreach stream entering large lakes	Need more information, Mollusca (<i>Potamilus, Lampsilis, Leptodea, Pyganodon, Sphaerium, Pisidium</i>)-Mayflies (<i>Hexagenia</i>)-Beetles (<i>Dubiraphia</i>)-Caddisflies (<i>Phyloctropus</i>)-Crustacea (<i>Gammarus</i>)-Non-biting midges (<i>Polypedilum</i>)-Flies (<i>Spheromias, Culicoides</i>) 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 1 st 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:

<hr/>

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:

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

TNC RANKING - Site Description:

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:

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RESULTS FOR AQUATIC SYSTEMS*

Modifications to Standard Method

The Aquatic Community Working Group led a multi-year effort to develop a classification of aquatic community types throughout the Saint Lawrence-Champlain Valley Ecoregion and to design the first iteration of a portfolio of occurrences important in conserving the aquatic biodiversity of the ecoregion. This effort spanned from 1999 to 2002 and had two components.

In the first approach, David Hunt took the lead in addressing community-level features, attempting to integrate Heritage Program methodology for aquatic communities with recent TNC efforts in aquatic biodiversity conservation. We will call this the Heritage component. The community classification is described in *Saint Lawrence/Champlain Valley (STL) Aquatic Community Classification, "Heritage Approach."* The portfolio results are described in *Aquatic Community Classification and Portfolio: Summary, Viability Assessment, Portfolio Development.*

In the second component, Mark Anderson took the lead in addressing system-level features to integrate community and species occurrences with landscape features. We will call this the System component. The standard methods are described in *Planning Methods for Ecoregional Targets: Freshwater Aquatic Ecosystems and Networks.*

These two components were supplemented by, and integrated with, a data set that had been previously developed for Vermont through the Vermont Biodiversity Project. We will call this the Vermont Biodiversity Project Stream/Lake data.

Heritage component

The Aquatic Community Working Group started by developing a classification system for both river and lake macrohabitats, intending to be comprehensive for the New York and Vermont portion of the ecoregion, and also intending to include the suspected community types in the Canada portion of the ecoregion. The basic classification was modeled after the coarse-scale names of the New York Natural Heritage Program classification and the extensive aquatic species data from the Vermont Department of Environmental Conservation, but borrowed from the holistic classifications of heritage programs in other states, the holistic regional heritage classification, TNC classification efforts, and classifications of species assemblages and holistic units in the general aquatic literature. This resulted in a list of 36 aquatic community types to be included in the list of primary targets. The group set a conservation goal of up to 6 examples of each, distributed throughout the natural range of the community. Ecoregion subsections were used to assess this.

The final number of community occurrences included in the portfolio from this approach is 66, out of 246 Element Occurrences assessed.

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for aquatic systems. Based on Thompson, E. et al. 2002. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Systems component

The GIS aquatic ecosystem classification was performed according to the standard Northeast Division methods. The analysis resulted in the following number of aquatic ecosystem types being defined within Ecological Drainage Unit based on the physical characteristics of the watershed.

Lake Champlain EDU(63_1):	9 Size 2 Systems 6 Size 3 Systems
NW Adirondacks EDU (61_4):	6 Size 2 Systems 3 Size 3 Systems
Northeastern Lake Ontario EDU (48_14):	7 Size 2 Systems 3 Size 3 Systems

Over 25 variables related to landcover, roads, dams, drinking water supplies, and point sources were calculated for each size 1, size2, and size 3 watershed in GIS. The spatial data and tables included with this plan show the results of the GIS condition ranking and analysis.

Vermont biodiversity project stream/lake data

In 1998 the Vermont Biodiversity Project (VBP) published a classification of aquatic communities for Vermont. This classification was integrated into the ecoregion-wide classification described above in the Heritage Approach, but was also assessed independently for this plan. In addition to the classification itself, the VBP document identified lakes, ponds, and stream reaches that best represent each of the community types identified. These are known as VBP Priority Aquatic Features. All of these are included in the portfolio.

Portfolio Results for Aquatic Systems

A final portfolio of priority stream networks and lake/pond features was assembled by the Aquatic Working Group based on the information generated by all three components parts. The assembly process emphasized identifying high quality stream networks that encompassed all the best examples of aquatic features identified by the heritage and VBP assessments. Additionally a strong effort was made to link aquatic networks to matrix forest and palustrine community occurrences where possible and advisable.

All in all, 125 aquatic features, ranging in size from huge systems such as the St. Lawrence River and Lake Champlain, to small features such as ponds, are included in the portfolio (see Appendix F3).

The portfolio results are described in *Aquatic Community Classification and Portfolio: Summary, Viability Assessment, Portfolio Development*.

THREATS ASSESSMENT AND TEN-YEAR ACTION PLAN*

When the portfolio was assembled, the core team met (on May 28, 2002) to review the portfolio, identify key threats in the ecoregion, and select sites on which to focus conservation attention over the next ten years.

The key threats to the ecoregion, as described by the group, include

- **Direct loss of biodiversity** through the conversion of natural systems to human-use areas as the population increases and as our per-capita consumption of resources increases.
- **Regulation of water**, especially dams on the St. Lawrence and other rivers, as they impact fish movement and habitat, bird habitat, flood-dependent communities, water quality, and other ecological values.
- **Fragmentation** caused by continued new road building and its accompanying development. This impacts forested systems most severely, reducing connectivity.
- **Exotics**, both in terrestrial and aquatic systems. Troublesome examples include zebra mussel and water chestnut in aquatic systems, and honeysuckle, buckthorn, and purple loosestrife in terrestrial systems. This threat is much greater in this ecoregion than in the neighboring Northern Appalachians.
- **Intensive agriculture and forestry** as it influences connectivity, natural succession, and water quality.
- **Lack of a conservation ethic** in much of the population of the region, including a fear of predators.
- **Pollution** caused locally by poor agriculture and forestry practices, and also globally by industry and fossil fuel consumption.

Other less pervasive threats listed by the group were identified as follows, in two categories: 1) those affecting primarily aquatic systems and 2) those affecting primarily terrestrial systems:

1. Threats affecting primarily aquatic systems

- Bilge pumping (causing pollution, exotics introduction, and introduction of waste)
- Fisheries management (e.g. lampricide)
- PCBs
- Dredging
- Navigation
- Non-point source pollution
- Bank stabilization
- Shoreline development
- Confined livestock
- Unconfined livestock
- Ski area water withdrawal
- Fish stocking
- Ground water extraction

* Thompson, E., M.G. Anderson et al. 2003. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, MA

- Water level regulation
 - Recreational boating
 - Septic systems
 - Increased road runoff
 - Oil spills
 - Dams on tributaries
 - Transportation of toxic substances on bridges
 - Acidification
2. Threats affecting primarily terrestrial systems
- Sprawl
 - Natural succession (reducing, for example, grassland bird habitat)
 - High-intensity recreation (golf, skiing)
 - Property tax pressures
 - Subdivision/parcelization
 - Fire suppression
 - Highway development (e.g. “rooftop” highway across northern New York and Circumferential Highway in Vermont)
 - Drainage for forestry, agriculture
 - Agribusiness
 - Conversion of forest to agriculture
 - Land conversion in general
 - Loss of old growth
 - Pest control
 - Land conversion
 - Global climate change
 - Deer overbrowse and other wildlife management problems
 - Population
 - Casinos and related sprawl
 - Loss of agriculture and other traditional uses
 - Legacy of past land use – dumping, landfills
- We will work to abate these threats in a variety of ways, focusing on the list of terrestrial and aquatic sites in Appendix G.

OUTSTANDING ISSUES AND INFORMATION NEEDS*

This plan represents an intensive three-year period of data gathering and analysis on biological and physical features of the St. Lawrence – Champlain Valley Ecoregion. We have developed a plan for conservation action that will forward our vision and goals for the ecoregion in a significant way.

As in any planning effort, however, the information we had was incomplete in some areas. We have identified the following as areas where further work is needed

- Canada – For this plan, the Canadian portion of the ecoregion was considered in some areas but not in others. The botany working group fully incorporated Canadian data and identified Canadian sites for the portfolio. Canadian information was used to develop an understanding of the pre-settlement vegetation of the ecoregion. Animal distributions were analyzed using Canadian data. But much remains to be done. The Canadian portion of the plan is due to be completed in 2004, led by Louise Gratton of the Nature Conservancy of Canada (NCC). This work will require the participation of TNC staff and coordination with the efforts that have are represented in this plan.
- Personnel – This plan had four different episodes of leadership, and each of the team leaders has now left The Nature Conservancy. It will be important to find a new leader for the United States portion of the region who has an understanding of the process used to develop this plan, and who has access to all the supporting data.
- Boundaries – The ecoregion boundaries may need adjusting, especially where the boundary presently coincides with the Québec/Ontario border rather than natural changes in topography, climate, and vegetation. The boundary of the ecoregion at the Vermont- Québec border also needs to be adjusted to conform to environmental conditions rather than political boundaries.
- Aquatics – Our review of the aquatics data at the May 28, 2002 core team meeting was insufficient to make action decisions with confidence. The group needs to have a more thorough understanding of the aquatics data and also a better understanding of aquatic conservation in general before developing a plan of action for aquatic features.
- Restoration – We recognize that considerable restoration work will be needed to ensure the long-term viability of many of the natural communities and species of the ecoregion, but we have much to learn about the techniques and tools that we will use.
- Viability – There may be some sites in the portfolio of questionable viability. Each portfolio site should be scrutinized more closely for viability during the Site Conservation Planning process, if it is chosen as an action site.
- Inventory – The lack of information on many species and natural communities in the ecoregion points out the need for continued inventory and research. In particular, aquatic systems, forest communities, and invertebrates need more inventory on location and/or condition .
- Consistency in choosing action sites – The number of portfolio sites chosen for conservation action in the next 10 years varied considerably from chapter to chapter.

* Thompson, E., M.G. Anderson et al. 2003. St. Lawrence – Champlain Valley Ecoregion: Biodiversity Conservation Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, MA

We need to assess whether this discrepancy represents real differences across the ecoregion.

- Site conservation planning -- We need site planning for large landscape-scale areas (for example the west side of Lake Champlain) as well as all chosen matrix blocks and standard sites.
- Partners – The success of this plan will rely on developing or continuing good relationships with our conservation partners in the ecoregion. Our partners need to understand what biodiversity is and how its conservation fits with their own missions. We need to develop good communications tools to inform others about this plan and its implications for the ecoregion.
- Abating threats – We need to think more strategically than ever in this ecoregion about abating threats, since the threats are enormous in scope.

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.

APPENDIX A
St. Lawrence/Champlain Valley Ecoregion
Potential Plant Targets

Proposed 12/22/00

Primary Targets: G1 through G3G4 Species with Known EOs in the Ecoregion

Global Scientific Name	Synonyms	Global Common Name	ELCODE	Grank	Nrank (Canada)	Distribution	Range (from Gleason & Cronquist)	Habitat	Notes	# of EORs*
AMMOPHILA CHAMPLAINENSIS	AMMOPHILA BREVILIGULATA VAR. CHAMPLAINENSIS	CHAMPLAIN BEACH GRASS	PMPOA08030	G5T1T2	---	Restricted	In Champlain Valley	Dunes & Dry Sandy Shores		4
BIDENS EATONII	----	EATON'S BEGGAR-TICK	PDAST180M0	G2	N2	Limited	Que to NY	Estuaries		31
BOTRYCHIUM RUGULOSUM	----	GRAPEFERN	PPOPH010P0	G3	N2N3	Peripheral	NH, CT, & s Que to WI & MI	Oods, Moist Pastures, Swampy Places	Only known from Quebec	2
CICUTA MACULATA VAR VICTORINII	----	SPOTTED WATER-HEMLOCK	PDAP10M054	G5T2	N2	Restricted	Que	Tidal Shores, Near Daily High Tide Limit		27
CYPRIPEDIUM ARIETINUM	----	RAM'S HEAD LADY-SLIPPER	PMORC0Q020	G3	N3	Widespread	Que to Man, s to MA, NY, MI & MN	Moist Acid Soils In Coniferous Woods	Only known from Quebec	21
ERIGERON PHILADELPHICUS SUBSP. PROVANCHERI	----	PHILADELPHIA FLEABANE	PDAST3M362	G5T2?	N1N2	Limited	Que and Ont to VT, NY and Mich	Rocky Shores		4
ERIOCAULON PARKERI	----	PARKER'S PIPEWORT	PMERI01070	G3	N2	Peripheral	ME & Que to MA & c NY, s coast to NC	Tidal Flats & Muddy Shores, Often Submerged	Also in Vermont?	14
GENTIANOPSIS VICTORINII	----	VICTORIN'S GENTIAN	PDGEN080C0	G2Q	N2	Restricted	Que	Rocky Or Gravelly Tidal Shores, Above High Tide	Only known from Quebec	17
LYCOPUS LAURENTIANUS	----	BUGLEWEED	PDLAM0X0A0	G2Q	N2	Restricted	Que	Rocky Or Gravelly Tidal Shores, Above High Tide	Only known from Quebec	28
POLEMONIUM VAN BRUNTIAE	----	EASTERN JACOBS-LADDER	PDPLM0E0L0	G3	N1N2	Peripheral	Me, VT & n NY to WV	Swamps & Streambanks	Only known from Quebec	2
POTAMOGETON HILLII	----	HILL'S PONDWEED	PMPOT030F0	G3		Peripheral	MA & VT to PA and w to Ont, Ohio & MI	Clear, Cold, Calcareous Waters		6
ZIZANIA AQUATICA VAR. AQUATICA	ZIZANIA AQUATICA VAR. BREVIS	WILD RICE	PMPOA6J012	G5T3T4	N3N4	Limited	New Brunswick to Ont, also VT?	Intertidal Flats		0
Subtotal, Number of EORs										156

Provisional Primary Targets: Species with Taxonomic Questions

Global Scientific Name	Synonyms	Global Common Name	ELCODE	Grank	Nrank (Canada)	Distribution	Range (from Gleason & Cronquist)	Habitat	Notes	# of EORs*
EPILOBIUM COLIATUM SSP. CILIATUM	EPILOBIUM CILIATUM VAR. ECOMOSUM	HAIRY WILLOW-HERB	PDONA06041	G5T2Q	?	Limited	St. Lawrence and Miramichi estuaries	Estuaries	Only known from Quebec	19
GRATIOLA NEGLECTA VAR. GLABERRIMA	----	CLAMMY HEDGE-HYSSOP	PDSCR0R071	G5T2Q	N2	?	Que?	Tidal Shores	Only known from Quebec	10
PHYSOSTEGIA VIRGINIANA VAR. GRANULOSA	----	FALSE DRAGONHEAD	PDLAM1G0A4	G5T2T3	N1	?	Que?	Rocky Or Gravelly Tidal Shores, Above High Tide	Only known from Quebec	2
Subtotal, Number of EORs										31

Secondary Targets: State- or Province-Rare Species

Global Scientific Name	Synonyms	Global Common Name	ELCODE	Grank	Nrank (Canada)	Distribution	Range (from Gleason & Cronquist)	Habitat	Notes	# of EORs*
ANEMONE MULTIFIDA		EARLY THIMBLEWEED	PDRAN040E0	G5	---	Peripheral	Nf to Alas, s to ME, VT, n NY Mich etc	Shores & Rocky Banks In Calc Soils	S edge of range	3
ARMORACIA LACUSTRIS	NEOBECKIA AQUATICA	LAKE-CRESS	PDBRA07010	G4?	?	Peripheral	Que to MN, s to Fla & Tex	Alkaline Ponds, Quiet Water, Muddy Shores	In decline, NE edge of range	12
ASCLEPIAS AMPLEXICAULIS		BLUNT-LEAVED MILKWEED	PDASC02020	G5	---	Peripheral	NH to se Minn, s to Fla Neb Tex	Dry Fields, Prairies, Open Woods	In decline, N edge of range	12
BOUTELOUA CURTIPENDULA		SIDE-OATS GRAMMA	PMPOA10060	G5	---	Peripheral	ME to MT, s to AL, CA, S Amer	Dry Woods, Limey Openings	E edge of range	1
CAREX FORMOSA		HANDSOME SEDGE	PMCPY034Y0	G4	?	Peripheral	Mass, Conn, and s Que to Mich, Wis and ND	Moist Soil In Woods And Thickets	NE edge of range	16
CAREX LUPULIFORMIS		HOP-LIKE SEDGE	PMCPY037T0	G4	N2	Peripheral	VT and Que to MN, s to VA, KY & TX	Edge Of Open Water, In Shallow Water, Ff	NE edge of range	24
CAREX MOLESTA		TROUBLESOME SEDGE	PMCPY038T0	G4	?	Peripheral	Que to Va, w to the Pacific	Dry Soil	E edge of range	5

APPENDIX A
St. Lawrence/Champlain Valley Ecoregion
Potential Plant Targets

Proposed 12/22/00

Secondary Targets: State- or Province-Rare Species

Global Scientific Name	Synonyms	Global Common Name	ELCODE	Grank	Nrank (Canada)	Distribution	Range (from Gleason & Cronquist)	Habitat	Notes	# of EORs*
CAREX SARTWELLII		SEDGE	PMCPY03C00	G4	?	Peripheral	NY & Ont to BC, s to IN, MO & CO	Rich Fens, Open Swamps, Shallow Water	E edge of range	1
CAREX TENUIFLORA		THIN-FLOWERED SEDGE	PMCPY03DL0	G5	---	Peripheral	Circumboreal, s to ME, NY, MI & MN	Wet Woods And Bogs	S edge of range	5
CASTILLEJA COCCINEA		PAINTED CUP	PDSCR0D0J0	G5	---	Peripheral	MA to Ont & Man, s to SC, MS, & OK	Damp Sands & Gravels W/ Limestone & Diabase	NE edge of range	3
CEANOTHUS HERBACEUS		PRAIRIE REDROOT	PDRHA040K0	G5	?	Peripheral	VT NY Que, MI to MN & MT, s to IN, AS, TX	Sandy Or Rocky Soil, Prairies, Plains	E edge of range	3
CORYDALIS AUREA		GOLDEN CORYDALIS	PDFUM03020	G5	?	Peripheral	Que to Alas, s to Pa etc, widespread in w	Rocky Banks & Sandy Soil	E edge of range, under threat	15
CYNOGLOSSUM VIRGINIANUM VAR BOREALE		NORTHERN WILD COMFREY	PDBOR0B081	G5T4	?	Peripheral	Que & NB to n CT, NY, MI, WI, w to BC	Upland Woods, Openings	In decline fr succession; SE edge of range	9
DESCURANIA PINNATA		TANSY-MUSTARD	PDBRA0X030	G5	---	Peripheral	Throughout most of N Am	Dry, Open, Or Sparsely Wooded Places	NE edge of range?, introduced in Qc?	3
HIPPURIS VULGARIS		MARE'S-TAIL	PDHPR01030	G5	?	Peripheral	Circumboreal s to ME, n NY, n IN, IA NM	In Shallow, Quiet Water, Or Seldom On Mud	S edge of range	1
HUDSONIA TOMENTOSA		BEACH HEATHER	PDCIS03030	G5	?	Peripheral	Coastal Me to NC, inland Lab to W.Va	Sandy Habitats	Disjunct?	4
HYDRASTIS CANADENSIS		GOLDEN-SEAL	PDRAN0F010	G4	---	Peripheral	VT to MI & MN, s to NC, Tenn, Ark	Rich Woods	Exploitably vulnerable	2
LESPEDEZA HIRTA		HAIRY BUSH-CLOVER	PDFAB27070	G5	---	Peripheral	Me to Fla, w to Wis, Ill, Mo, Okla, Tex	Dry Soil	NE edge of range	2
LIPARIS LILIFOLIA		LILY-LEAVED TWAYBLADE	PMORC1M030	G5	---	?	Me to Minn, s to Ga & Ark	Rich Woods	?	2
LIPOCARPHA MICRANTHA	HEMICARPHA MICRANTHA	SEDGE	PMCPY0H040	G4	N1	Peripheral	Tropical Amer n to Me & Minn	Moist Sandy Soil	N edge of range	1
LITTORELLA UNIFLORA		LITTORELLA	PDPLN01010	G5	?	Peripheral	Nf & Que to Ont & n NY, also WI & MN	Sandy Shores Or Shallow Water	S edge of range?	3
LUDWIGIA POLYCARPA		MANY-FRUITED LOOSESTRIFE	PDONA0B0M0	G4	---	Peripheral	Mass & Conn, s Ont to Minn etc	Swamps, Marshes, Wet Prairies	NE edge of range	1
LUPINUS PERENNIS		WILD LUPINE	PDFAB2B340	G5	---	Peripheral	s Me to Fla, w to Minn & Ind	Dry Open Woods & Clearings	In decline, exploitably vulnerable	3
LYGODIUM PALMATUM		CLIMBING FERN	PPSCH02030	G4	---	Peripheral	s NH and e NY to O & sw MI, s to FL & Miss	Moist Thickets & Woods In Acid Soil	N edge of range	1
PETASITES FRIGIDUS VAR. PALMATUS		SWEET COLTSFOOT	PDAST71013	G5T5	---	Peripheral	Circumboreal, s to Mass, Mich, Minn, Calif	Meadows, Swampy Places, Moist Woods	S edge of range	2
POTAMOGETON STRICTIFOLIUS		STRAIGHT-LEAF PONDWEED	PMPOT03110	G5	---	Peripheral	Que to Mack, s to CT NY O, n IN, MN, UT	Alkaline Ponds & Streams	E edge of range	2
SPHENOPHOLIS OBTUSATA VAR OBTUSATA		BLUNT SPHENOPHOLIS	PMPOA5T030	G5	---	Peripheral	Nf to Alas, s to FL Mex	Moist Meadows, Streambanks, Pondshores	E edge of range	0
SPOROBOLUS ASPER		ROUGH DROPSEED	PMPOA5V030	G5	?	Peripheral	Me & Vt to NC Ky Tenn, w to ND, Wash	Dry Or Sandy Soil	N edge of range	3
VALERIANA ULIGINOSA		MARSH VALERIAN	PDVAL030J0	G4Q	?	Peripheral	ME & s Que to NY, n Ont, & w MI	Marshy Meadows, Swamps, Bogs	In decline, S edge of range	1
VIOLA PALMATA		EARLY BLUE VIOLET	PDVIO041F0	G5	---	Peripheral	Me to Minn, s to Fla & Tex	Well-Drained Soil In Woods & Clearings	N edge of range	1
Subtotal, Number of EORs										141
Grand Total, Number of EORs										328

of EORs*: Indicates number of element occurrences of this target species located within the STL ecoregion boundary, United States and Canada portions, or within a 1 km buffer area.

APPENDIX B1
St. Lawrence/Lake Champlain Valley (STL) Ecoregion
Final Animal Target Species List

PRIMARY TARGETS (22 Species)

Primary Vertebrate Targets (11 Species)

<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
AFCAA01020	ACIPENSER FULVESCENS		LAKE STURGEON	G3	
AFCQC01060	AMMOCRYPTA PELLUCIDA	ETHEOSTOMA PELLUCIDUM	EASTERN SAND DARTER	G3	
ARAAG01030	APALONE SPINIFERA	TRIONYX SPINIFERUS	SPINY SOFTSHELL	G5	
AFCJC01020	CARPIODES CYPRINUS		QUILLBACK	G5	
ARADE02040	CROTALUS HORRIDUS		TIMBER RATTLESNAKE	G4	
ARACH01050	EUMECEES FASCIATUS		FIVE-LINED SKINK	G5	
AFBAA01030	ICHTHYOMYZON FOSSOR		NORTHERN BROOK LAMPREY	G4	
AFCJC10090	MOXOSTOMA HUBBSI		COPPER REDHORSE	G1	
AMACC01130	MYOTIS LEIBII		EASTERN SMALL-FOOTED MYOTIS	G3	HIBERNACULA AND SUMMER MATERNITY COLONIES
AMACC01100	MYOTIS SODALIS		INDIANA BAT	G2	HIBERNACULA AND MATERNITY COLONIES
AFCJB28080	NOTROPIS ANOGENUS		PUGNOSE SHINER	G3	

Primary Invertebrate Targets (11 Species)

<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
IIEPH26220	BAETIS RUSTICANS		A MAYFLY	G2	
IICOL02100	CICINDELA HIRTICOLLIS		BEACH-DUNE TIGER BEETLE	G5	
IICOL02230	CICINDELA PATRUELA		PATTERNED GREEN TIGER BEETLE	G3	
IIODO08380	GOMPHUS QUADRICOLOR		RAPIDS CLUBTAIL	G3G4	
IMBIV21050	LAMPASILIS CARIOSIA		YELLOW LAMPUSSEL	G3G4	
IMBIV24010	LEPTODEA FRAGILIS		FRAGILE PAPERSHELL	G5	
IMBIV37010	POTAMILUS ALATUS		PINK HEELSPLITTER	G5	
IIEPH39050	RHITHROGENA ANOMALUS		A MAYFLY	G2	
IIEPH29010	SIPHONISCA AERODROMIA		TOMAH MAYFLY	G2	
IIODO80050	STYLURUS NOTATUS		ELUSIVE CLUBTAIL	G3	
IIODO34010	WILLIAMSONIA FLETCHERI		EBONY BOGHAUNTER	G3G4	

SECONDARY TARGETS (87 Species)

Secondary Vertebrate Targets (80 Species)

<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
ABNKC12040	ACCIPITER COOPERII		COOPER'S HAWK	G5	
ABNKC12060	ACCIPITER GENTILIS		NORTHERN GOSHAWK	G5	
ABNKC12020	ACCIPITER STRIATUS		SHARP-SHINNED HAWK	G5	
AAAAA01050	AMBYSTOMA JEFFERSONIANUM		JEFFERSON SALAMANDER	G5	
AAAAA01060	AMBYSTOMA LATERALE		BLUE-SPOTTED SALAMANDER	G5	

APPENDIX B1
St. Lawrence/Lake Champlain Valley (STL) Ecoregion
Final Animal Target Species List

Secondary Vertebrate Targets (80 Species)					
<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
ABPBXA0030	AMMODRAMUS HENSLOWII		HENSLOW'S SPARROW	G4	
ABPBXA0020	AMMODRAMUS SAVANNARUM		GRASSHOPPER SPARROW	G5	
ABNJB10040	ANAS RUBRIPES		AMERICAN BLACK DUCK	G5	
ABNGA04040	ARDEA ALBA		GREAT EGRET	G5	
ABNGA04010	ARDEA HERODIAS		GREAT BLUE HERON	G5	
ABNSB13040	ASIO FLAMMEUS		SHORT-EARED OWL	G5	BREEDING AND WINTERING
ABNSB13040	ASIO OTUS		LONG-EARED OWL	G5	
ABNNF06010	BARTRAMIA LONGICAUDA		UPLAND SANDPIPER	G5	
ABNGA01020	BOTAURUS LENTIGINOSUS		AMERICAN BITTERN	G4	
ABNKC19030	BUTEO LINEATUS		RED-SHOULDERED HAWK	G5	
ABNTA07070	CAPRIMULGUS VOCIFERUS		WHIP-POOR-WILL	G5	
ABNXD01020	CERYLE ALCYON		BELTED KINGFISHER	G5	
ABNUA03010	CHAETURA PELAGICA		CHIMNEY SWIFT	G5	
ABNNB03070	CHARADRIUS MELODUS		PIPING PLOVER	G3	
ABNNB03090	CHARADRIUS VOCIFERUS		KILLDEER	G5	
ABNNM10020	CHLIDONIAS NIGER		BLACK TERN	G4	
ABNTA02020	CHORDEILES MINOR		COMMON NIGHTHAWK	G5	
ABNKC11010	CIRCUS CYANEUS		NORTHERN HARRIER	G5	BREEDING AND WINTERING
ABPBG10010	CISTOTHORUS PLATENSIS		SEDGE WREN	G5	
ARAAD02010	CLEMMYS GUTTATA		SPOTTED TURTLE	G5	
ARAAD02020	CLEMMYS INSCULPTA		WOOD TURTLE	G4	
ABNRB02010	COCCYZUS ERYTHROPHALMUS		BLACK-BILLED CUCKOO	G5	
ABNYF10020	COLAPTES AURATUS		NORTHERN FLICKER	G5	
ARADB07010	COLUBER CONSTRUCTOR		EASTERN RACER	G5	
ABPAE32060	CONTOPUS VIRENS		EASTERN WOOD-PEWEE	G5	
ABPBX03050	DENDROICA CAERULESCENS		BLACK-THROATED BLUE WARBLER	G5	
ABPBX03240	DENDROICA CERULEA		CERULEAN WARBLER	G4	
ABPBXA9010	DOLICHONYX ORYZIVORUS		BOBOLINK	G5	
ARADB13030	ELAPHE OBSOLETA		EASTERN RAT SNAKE	G5	
ARAAD04010	EMYDOIDEA BLANDINGII		BLANDING'S TURTLE	G4	
ABPAT02010	EREMOPHILA ALPESTRIS		HORNED LARK	G5	
AFCHD01030	ESOX MASIQUINONGY		MUSKELLUNGE	G5	
AFCQC02240	ETHEOSTOMA EXILE		IOWA DARTER	G5	
ABNKD06070	FALCO PEREGRINUS		PEREGRINE FALCON	G4	
ABNME14020	FULICA AMERICANA		AMERICAN COOT	G5	
ABNME13010	GALLINULA CHLOROPUS		COMMON MOORHEN	G5	
ABNBA01030	GAVIA IMMER		COMMON LOON	G5	
ARAAD05040	GRAPTEMYS GEOGRAPHICA		COMMON MAP TURTLE	G5	
ABNKC10010	HALIAEETUS LEUCOCEPHALUS		BALD EAGLE	G4	
AAAAD08010	HEMIDACTYLUM SCUTATUM		FOUR-TOED SALAMANDER	G5	
AFCGA01020	HIODON TERGISUS		MOONEYE	G5	
ABPAU09030	HIRUNDO RUSTICA		BARN SWALLOW	G5	

APPENDIX B1
St. Lawrence/Lake Champlain Valley (STL) Ecoregion
Final Animal Target Species List

Secondary Vertebrate Targets (80 Species)					
<i>Elcode</i>	<i>Global Scientific Name</i>	<i>Synonym</i>	<i>Global Common Name</i>	<i>GRANK</i>	<i>Comments</i>
AFCJB16020	HYBOGNATHUS HANKINSONI		BRASSY MINNOW	G5	
ABPBJ19010	HYLOCICHLA MUSTELINA		WOOD THRUSH	G5	
ABPBXB9190	ICTERUS GALBULA		BALTIMORE ORIOLE	G5	
ABNGA02010	IXOBRYCHUS EXILIS		LEAST BITTERN	G5	
AFBAA02020	LAMPETRA APPENDIX		AMERICAN BROOK LAMPREY	G4	
ABPBR01030	LANIUS LUDOVICIANUS		LOGGERHEAD SHRIKE	G4	
ABNYF04040	MELANERPES ERYTHROCEPHALUS		RED-HEADED WOODPECKER	G5	
AFCJC10010	MOXOSTOMA ANISURUM		SILVER REDHORSE	G5	
AFCJC10170	MOXOSTOMA VALENCIENNESI		GREATER REDHORSE	G4	
AAAAE01040	NECTURUS MACULOSUS		MUDPUPPY	G5	
AFCJB28180	NOTROPIS BIFRENATUS		BRIDLE SHINER	G5	
AFCJB28520	NOTROPIS HETERODON		BLACKCHIN SHINER	G5	
AFCKA02070	NOTURUS FLAVUS		STONECAT	G5	
ABNKC01010	PANDION HALIAETUS		OSPREY	G5	
AFCQC04060	PERCINA COPELANDI		CHANNEL DARTER	G4	
ABPBX61030	PHEUCTICUS LUDOVICIANUS		ROSE-BREADED GROSBEEK	G5	
ABNCA02010	PODILYMBUS PODICEPS		PIED-BILLED GREBE	G5	
ABPBX95010	POOECETES GRAMINEUS		VESPER SPARROW	G5	
ABNME08020	PORZANA CAROLINA		SORA	G5	
AFCHA03030	PROSOPIUM CYLINDRACEUM		ROUND WHITEFISH	G5	
AAABC05070	PSEUDACRIS TRISERIATA		WESTERN CHORUS FROG	G5	
ABNME05030	RALLUS LIMICOLA		VIRGINIA RAIL	G5	
ABNMF19020	SCOLOPAX MINOR		AMERICAN WOODCOCK	G5	
ABPBX10030	SEIURUS MOTACILLA		LOUISIANA WATERTHRUSH	G5	
ABPBX94050	SPIZELLA PUSILLA		FIELD SPARROW	G5	
ABPAU07010	STELGIDOPTERYX SERRIPENNIS		NORTHERN ROUGH-WINGED SWALLOW	G5	
ABNNM08070	STERNA HIRUNDO		COMMON TERN	G5	
ARAAE02040	STERNOTHERUS ODORATUS	KINOSTERNON ODORATUM	COMMON MUSK TURTLE	G5	
ARADB36120	THAMNOPHIS SAURITUS		EASTERN RIBBON SNAKE	G5	
ABPBK06010	TOXOSTOMA RUFUM		BROWN THRASHER	G5	
ABPBX01030	VERMIVORA CHRYSOPTERA		GOLDEN-WINGED WARBLER	G4	
ABPBX01020	VERMIVORA PINUS		BLUE-WINGED WARBLER	G5	
ABPBX16030	WILSONIA CANADENSIS		CANADA WARBLER	G5	

Secondary Invertebrate Targets (7 Species)					
<i>Elcode</i>	<i>Global Scientific Name</i>	<i>Synonym</i>	<i>Global Common Name</i>	<i>GRANK</i>	<i>Comments</i>
IMBIV05010	ANODONTOIDES FERUSSACIANUS		CYLINDRICAL PAPERSHELL	G5	
IILEPA5040	EUCHLOE OLYMPIA		OLYMPIA MARBLE	G4G5	
IMBIV21130	LAMPSILIS OVATA		POCKETBOOK	G5	
IMBIV22030	LASMIGONA COSTATA		FLUTED-SHELL	G5	
IMBIV26020	LIGUMIA RECTA		BLACK SANDSHELL	G4G5	
IMBIV27030	MARGARITIFERA MARGARITIFERA		EASTERN PEARLSHELL	G4	

APPENDIX B1
St. Lawrence/Lake Champlain Valley (STL) Ecoregion
Final Animal Target Species List

Secondary Vertebrate Targets (80 Species)					
<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
IMBIV54030	PYGANODON GRANDIS		GIANT FLOATER	G5	

DROPPED TARGETS (15 Species)					
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Vertebrate (13 Species)					
<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
ABNJB10160	ANAS STREPERA		GADWALL	G5	
ABNJB11070	AYTHYA AFFINIS		LESSER SCAUP	G5	
ABNJB18010	BUCEPHALA CLANGULA		COMMON GOLDENEYE	G5	
ABNKC19130	BUTEO LAGOPUS		ROUGH-LEGGED HAWK	G5	
ABNME01010	COTURNICOPS NOVEBORACENSIS		YELLOW RAIL	G4	
AMACC02010	LASIONYCTERIS NOCTIVAGANS		SILVER-HAIRED BAT	G5	
AMACC05010	LASIURUS BOREALIS		EASTERN RED BAT	G5	
AMACC05030	LASIURUS CINEREUS		HOARY BAT	G5	
ABNGA11010	NYCTICORAX NYCTICORAX		BLACK-CROWNED NIGHT HERON	G5	
ABNNF20010	PHALAROPUS TRICOLOR		WILSON'S PHALAROPE	G5	
ABPAU08010	RIPARIA RIPARIA		BANK SWALLOW	G5	
ABPBX94030	SPIZELLA PALLIDA		CLAY-COLORED SPARROW	G5	
ABPBXB2020	STURNELLA MAGNA		EASTERN MEADOWLARK	G5	

Invertebrate (2 Species)					
<u>Elcode</u>	<u>Global Scientific Name</u>	<u>Synonym</u>	<u>Global Common Name</u>	<u>GRANK</u>	<u>Comments</u>
IMBIV02040	ALASMIDONTA MARGINATA		ELKTOE	G4	
IIDO80090	STYLURUS SCUDDERI		ZEBRA CLUBTAIL	G4	

APPENDIX B2: BIRD TARGET SUITES

Note: The suite of species is the target

PRIMARY TARGETS

Grassland Species Suite

HENSLOW'S SPARROW

Upland sandpiper

Bobolink

Sedge wren

Killdeer

Northern harrier (breeding and winter)

Short-eared owl (breeding and winter)

Loggerhead shrike

Vesper sparrow

Grasshopper sparrow

Horned lark

SECONDARY TARGETS

Shrub-early successional Species Suite

GOLDEN-WINGED WARBLER

Blue-winged warbler

American woodcock

Common nighthawk

Riparian-deciduous and mixed forest Species Suite

CERULEAN WARBLER

Canada warbler

Black-billed cuckoo

Wood thrush

Baltimore oriole

Eastern wood pewee

Black-throated blue warbler

Red-headed woodpecker

Whip-poor-will

Rose-breasted grosbeak

Sharp-shinned hawk

Northern goshawk

Long-eared owl

Red-shouldered hawk

Cooper's hawk

Freshwater wetland, lakeshore and river Species suite

Piping plover

American black duck

American bittern

Peregrine falcon

Short-eared owl (breeding and winter)

Least bittern

Northern rough-winged swallow

Northern harrier (breeding and winter)

Common loon

Black tern

Bald eagle

Pied-billed grebe

Osprey

Sora

Common tern

Shrub-early successional species suite

Brown thrasher

Field sparrow

Riparian-deciduous and mixed forest species suite

Wood thrush

Louisiana waterthrush

Freshwater wetland, lakeshore and river species suite

Belted kingfisher

Great blue heron

Common moorhen

American coot

Great egret

Black-crowned night heron

Virginia rail

Habitat Suite Uncertain

Chimney swift

Northern flicker

Barn swallow

APPENDIX C

NVC Associations Crosswalked to New York and Vermont Community Types in STL Ecoregion

<u>Gname</u>	<u>GnameTrans</u>	<u>Association ELcode</u>	<u>New York Community</u>	<u>Vermont Community</u>	<u>Community Scale</u>	<u>Regional Distribution Pattern</u>	<u>STL EORs?</u>	<u>Notes</u>
FORESTS								
Acer (rubrum, saccharinum) - Fraxinus spp. - Ulmus americana Forest	(Red Maple, Silver Maple) - Ash species - American Elm Forest	CEGL005038	Silver Maple-Ash Swamp	Red or Silver Maple-Green Ash Swamp; (Lakeside Floodplain Forest (in part)	Large Patch	Widespread	Y	
Acer rubrum - Fraxinus spp. / Nemopanthus mucronatus - Vaccinium corymbosum Forest	Red Maple - Ash species / Mountain-holly - Highbush Blueberry Forest	CEGL006220	Red Maple-Hardwood Swamp; Var. Red Maple-Black Ash Swamp	Red Maple-Black Ash Swamp	Large Patch	Limited	Y	
Acer rubrum - Nyssa sylvatica - Betula alleghaniensis / Sphagnum spp. Forest	Red Maple - Blackgum - Yellow Birch / Peatmoss species Forest	CEGL006014	Red Maple-Hardwood Swamp; Var. Red Maple-Black Gum Swamp	Red Maple-Black Gum Swamp	Small Patch	Peripheral	Y	
Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris Forest	Silver Maple - (Eastern Cottonwood) / Ostrich Fern Forest	CEGL006147	Floodplain Forest; Var. GL Silver Maple-Cottonwood Forest	Silver Maple-Ostrich Fern Riverine Floodplain Forest	Large Patch	Widespread	Y	Large Patch historically, probably Small Patch now
Acer saccharinum - Ulmus americana / Onoclea sensibilis Forest	Silver Maple - American Elm / Sensitive Fern Forest	CEGL006001	Floodplain Forest; Var. GL Silver Maple-Elm Forest	Silver Maple-Sensitive Fern Riverine Floodplain Forest (in part); Lakeside Floodplain Forest (in part)	Large Patch	Widespread	Y	Large Patch historically, probably Small Patch now
Acer saccharum - Betula alleghaniensis - (Tilia americana) Forest	Sugar Maple - Yellow Birch - (American Basswood) Forest	CEGL002457	Beech-Maple Mesic Forest; Var. GL Maple-Birch Forest		Matrix	Limited	N	consider synonymous with 6252 for STL
Acer saccharum - Betula alleghaniensis - Fagus grandifolia / Viburnum lantanoides Forest	Sugar Maple - Yellow Birch - American Beech / Hobblebush Forest	CEGL006252	Beech-Maple Mesic Forest; Var. Beech-Maple-Birch Forest	Northern Hardwood Forest	Matrix	Limited	Y	consider synonymous with 2457 for STL; Matrix historically, may be Large Patch now
Acer saccharum - Fraxinus americana - Juglans cinerea / Staphylea trifolia Forest	Sugar Maple - White Ash - Butternut / Bladderhut Forest	CEGL006020	Calcareous Talus Slope Woodland; Var. Maple-Basswood Talus Slope Woodland; Var. LNE Maple-Butternut Woodland	Transition Hardwood Talus Woodland (mostly); Mesic Maple-Ash-Hickory-Oak Forest (in part)	Small Patch	Peripheral	Y	
Acer saccharum - Fraxinus americana - Tilia americana Forest	Sugar Maple - White Ash - American Basswood Forest	CEGL006228	Maple-Basswood Rich Mesic Forest; Var. GL Maple-Basswood Forest Flats	Rich Northern Hardwood Forest (in part)	Matrix	Limited	Y	
Acer saccharum - Fraxinus spp. - Tilia americana / Matteuccia struthiopteris - Ageratina altissima Forest	Sugar Maple - Ash species - American Basswood / Ostrich Fern - White Snakeroot Forest	CEGL006114	Maple-Basswood Rich Mesic Forest; Var. Sugar Maple Floodplain Terrace	Sugar Maple-Ostrich Fern Riverine Floodplain Forest	Small Patch	Widespread	Y	
Acer saccharum - Fraxinus spp. - Tilia americana / Osmorhiza claytonii - Caulophyllum thalictroides Forest	Sugar Maple - Ash species - American Basswood / Blank Sweet-cicely - Blue Cohosh Forest	CEGL005008	Maple-Basswood Rich Mesic Forest; Var. NAP Basswood Cove Forest	Rich Northern Hardwood Forest	Small Patch	Limited	Y	
Acer saccharum - Pinus strobus / Acer pensylvanicum Forest	Sugar Maple - Eastern White Pine / Striped Maple Forest	CEGL005005	Pine-Northern Hardwood Forest; White Pine-Northern Hardwood Forest; Var. Mixed Forest	Northern Hardwood Forest; Var. White Pine-Northern Hardwood Forest	Small Patch	Limited	Y	
Acer saccharum - Quercus muehlenbergii / Clematis occidentalis Forest	Sugar Maple - Chinquapin Oak / Mountain Clematis Forest	CEGL006162	Limestone Woodland; Var. Sugar Maple-Chinquapin Oak Forest	Mesic Maple-Ash-Hickory-Oak Forest; Var. Transition Hardwoods Limestone Woodland	Small Patch	Peripheral	Y	
Betula papyrifera / Acer saccharum - Mixed Hardwoods Forest	Paper Birch / Sugar Maple - Mixed Hardwoods Forest	CEGL002464	Successional Northern Hardwood Forest; Var. Paper Birch Forest				N	successional communities not targeted for STL
Fraxinus nigra - Acer rubrum - (Larix laricina) / Rhamnus alnifolia Forest	Black Ash - Red Maple - (Tamarack) / Alderleaf Buckthorn Forest	CEGL006009	Red Maple-Tamarack Peat Swamp; Var. NAP/STL/GL Swamp	Calcareous Red Maple-Tamarack Swamp	Large Patch	Widespread	Y	
Picea mariana / Alnus incana / Sphagnum spp. Forest	Black Spruce / Speckled Alder / Peatmoss species Forest	CEGL002452	Black Spruce-Tamarack Bog; Var. GL Bog; Black Spruce-Tamarack Forest Assoc.	Black Spruce Swamp (mineral poor)	Large Patch	Limited	Y	

APPENDIX C
NVC Associations Crosswalked to New York and Vermont Community Types in STL Ecoregion

<u>Gname</u>	<u>GnameTrans</u>	<u>Association</u> <u>ELcode</u>	<u>New York Community</u>	<u>Vermont Community</u>	<u>Community</u> <u>Scale</u>	<u>Regional</u> <u>Distribution</u> <u>Pattern</u>	<u>STL</u> <u>EORs?</u>	<u>Notes</u>
Picea mariana / Ledum groenlandicum / Carex trisperma / Sphagnum spp. Forest	Black Spruce / Labrador-tea / Three-seed Sedge / Peatmoss species Forest	CEGL002485	Black Spruce-Tamarack Bog; Var. GL Bog; Black Spruce-Tamarack Woodland Assoc.	Black Spruce Woodland Bog	Small Patch	Widespread	Y	
Picea mariana - (Larix laricina) / Ledum groenlandicum / Sphagnum spp. Forest	Black Spruce - (Tamarack) / Labrador-tea / Peatmoss species Forest	CEGL005271	Black Spruce-Tamarack Bog; Var. NAP Bog; Black Spruce-Tamarack Forest Assoc.	Black Spruce Swamp (mineral poor)	Small Patch	Peripheral	Y	
Picea rubens - Abies balsamea - Betula papyrifera Forest	Red Spruce - Balsam Fir - Paper Birch Forest	CEGL006273	Balsam Flats and Spruce Flats	Lowland Spruce-Fir Forest	Large Patch	Peripheral	N	peripheral to NAP
Picea rubens - Abies balsamea / Gaultheria hispida / Sphagnum spp. Forest	Red Spruce - Balsam Fir / Creeping Teaberry / Peatmoss species Forest	CEGL006312	Spruce-Fir Swamp; Var. Spruce-Fir Swamp	Spruce-Fir-Tamarack Swamp	Small Patch	Peripheral	Y	
Picea rubens - Acer rubrum / Nemopanthus mucronatus Forest	Red Spruce - Red Maple / Mountain-holly Forest	CEGL006198	Spruce-Fir Swamp; Var. Red Maple-Fir Swamp	Spruce-Fir-Tamarack Swamp; Var. Red Spruce-Hardwood Swamp	Small Patch	Limited	N	expected in 212Ed
Picea rubens - Betula alleghaniensis / Dryopteris campyloptera Forest	Red Spruce - Yellow Birch / Mountain Woodfern Forest	CEGL006267	Spruce-Northern Hardwood Forest	Red Spruce-Northern Hardwood Forest	Large Patch	Peripheral	N	expected in 222Ob, 212Eb, and 212Ed
Pinus banksiana / Abies balsamea Forest	Jack Pine / Balsam Fir Forest	CEGL002437	Pine-Northern Hardwood Forest; Var. Jack Pine Forest		Small Patch	Limited	N	expected in 212Ea
Pinus rigida - Quercus (velutina, prinus) Lower New England / Northern Piedmont Forest	Pitch Pine - (Black Oak, Rock Chestnut Oak) Lower New England / Northern Piedmont Forest	CEGL006290	Pitch Pine-Oak Forest	Pine-Oak-Heath Sandplain Forest	Large Patch	Limited	Y	
Pinus strobus - (Acer rubrum) / Osmunda spp. Forest	Eastern White Pine - (Red Maple) / Royal Fern species Forest	CEGL002482	Red Maple-Tamarack Peat Swamp; Var. Red Maple-Pine Forest	Red Maple-White Pine-Huckleberry Swamp	Small Patch	Limited	Y	
Pinus strobus - Pinus resinosa - Pinus rigida Forest	Eastern White Pine - Red Pine - Pitch Pine Forest	CEGL006259	Pine-Northern Hardwood Forest; Var. Red Pine Forest; Var. GL Red Pine-Pitch Pine Forest; Conifer Zone		Large Patch	Limited	N	known to occur at The Gulf (NY and Que)
Pinus strobus - (Pinus resinosa) - Quercus rubra Forest	Eastern White Pine - (Red Pine) - Northern Red Oak Forest	CEGL002480	Pine-Northern Hardwood Forest; Var. Red Pine Forest; Var. GL Red Pine-Pitch Pine Forest; Mixed Zone		Large Patch	Limited	N	expected in 212Eb
Pinus strobus - Quercus (rubra, velutina) - Fagus grandifolia Forest	Eastern White Pine - (Northern Red Oak, Black Oak) - American Beech Forest	CEGL006293	Appalachian Oak-Pine Forest	White Pine-Red Oak-Black Oak Forest; Dry Oak Forest (in part)	Small Patch	Peripheral	Y	
Pinus strobus - Tsuga canadensis - Picea rubens Forest	Eastern White Pine - Eastern Hemlock - Red Spruce Forest	CEGL006324	Hemlock-Northern Hardwood Forest; Var. NAP Conifer Forest	Hemlock Forest; Var. Hemlock-Red Spruce Forest	Small Patch	Peripheral	N	possible in 222Ob, 212Eb, 212Ed, and 212Ee
Pinus strobus - Tsuga canadensis Great Lakes Forest	Eastern White Pine - Eastern Hemlock Great Lakes Forest	CEGL002590	Hemlock-Northern Hardwood Forest; Var. Great Lakes Conifer Forest		Small Patch	Limited	N	expected in 212Ea, 212Eb, and 212Ee
Pinus strobus - Tsuga canadensis Lower New England / Northern Piedmont Forest	Eastern White Pine - Eastern Hemlock Lower New England / Northern Piedmont Forest	CEGL006328	Hemlock-Northern Hardwood Forest; Var. LNE Conifer Forest	Hemlock Forest (LNE)	Small Patch	Peripheral	Y	
Pinus strobus / Acer spicatum - Corylus cornuta Forest	Eastern White Pine / Mountain Maple - Beaked Hazelnut Forest	CEGL002445	Pine-Northern Hardwood Forest; Var. White Pine-Northern Hardwood Forest; Var. Conifer Forest		Small Patch	Limited	N	possible in 212Ea, 212Eb, and 212Ec
Quercus alba - Carya (glabra, ovata) / Desmodium glutinosum Forest	White Oak - (Pignut Hickory, Shagbark Hickory) / Large Tick-trefoil Forest	CEGL006091	Appalachian Oak-Hickory Forest; Var. Great Lakes Forest	Mesic Maple-Ash-Hickory Oak Forest (in part, dry examples)	Large Patch	Limited	Y	Large Patch historically, probably Small Patch now
Quercus prinus - Quercus (rubra, velutina) / Gaylussacia baccata Forest	Rock Chestnut Oak - (Northern Red Oak, Black Oak) / Black Huckleberry Forest	CEGL006282	Chestnut Oak Forest	Dry Oak Forest	Small Patch	Peripheral	N	expected in 212Ec

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Quercus rubra - Acer saccharum - Fagus grandifolia / Viburnum acerifolium Forest	Northern Red Oak - Sugar Maple - American Beech / Mapleleaf Viburnum Forest	CEGL006173	Beech-Maple Mesic Forest; Var. LNE Appalachian Oak-Beech Forest	Mesic Red Oak-Northern Hardwood Forest	Large Patch	Peripheral		
Quercus rubra - Carya (glabra, ovata) / Ostrya virginiana / Carex pensylvanica Forest	Northern Red Oak - (Pignut Hickory, Shagbark Hickory) / Eastern Hop-hornbeam / Pennsylvania Sedge Forest	CEGL006301	Appalachian Oak-Hickory Forest; Var. LNE Forest	Dry Oak-Hickory-Hophornbeam Forest	Small Patch	Peripheral	Y	
Thuja occidentalis - Acer rubrum / Cornus sericea Forest	Northern White-cedar - Red Maple / Red-osier Dogwood Forest	CEGL006199	Northern White Cedar Swamp; Var. GL NWC-Red Maple Swamp	Red Maple-Northern White Cedar Swamp	Large Patch	Limited	Y	
Thuja occidentalis - Tsuga canadensis Saturated Forest	Northern White-cedar - Eastern Hemlock Saturated Forest	CEGL005171	Rich Hemlock-Hardwood Peat Swamp	Northern White Cedar Swamp; Var. Hemlock-NWC Swamp	Small Patch	Limited	N	possibly in 212Ec
Thuja occidentalis / Abies balsamea - Acer spicatum Forest	Northern White-cedar / Balsam Fir - Mountain Maple Forest	CEGL002449	Limestone Woodland; Var. Northern White Cedar Forest; Var. GL NW Cedar-Pine Forest		Small Patch	Limited	Y	
Thuja occidentalis / Carex eburnea Forest	Northern White-cedar / Bristleleaf Sedge Forest	CEGL006021	Limestone Woodland; Northern White Cedar Forest; Var. GL Northern White Cedar-Pine Forest	Limestone Bluff Cedar-Pine Forest	Large Patch	Limited	Y	
Thuja occidentalis / Hylocomium splendens Forest	Northern White-cedar / Stairstep Moss Forest	CEGL006007	Northern White Cedar Swamp; Var. NAP NWC-Black Spruce Swamp	Northern White Cedar Swamp	Small Patch	Limited	Y	
Tsuga canadensis - Betula alleghaniensis - Picea rubens / Cornus canadensis Forest	Eastern Hemlock - Yellow Birch - Red Spruce / Canadian Bunchberry Forest	CEGL006129	Hemlock-Northern Hardwood Forest; Var. NAP Mixed Forest	Hemlock Forest (in part); Hemlock-Northern Hardwood Forest (NAP)	Small Patch	Peripheral	Y	
Tsuga canadensis - Betula alleghaniensis / Ilex verticillata / Sphagnum spp. Forest	Eastern Hemlock - Yellow Birch / Winterberry / Peatmoss species Forest	CEGL006226	Hemlock-Hardwood Swamp	Hemlock Swamp; Var. Hemlock-Hardwood Swamp	Small Patch	Widespread	N	expected in 212Ea, 212Ec, and 212Ed
Tsuga canadensis - Betula alleghaniensis Lower New England / Northern Piedmont Forest	Eastern Hemlock - Yellow Birch Lower New England / Northern Piedmont Forest	CEGL006109	Hemlock-Northern Hardwood Forest; Var. LNE Mixed Forest	Hemlock-Northern Hardwood Forest (LNE)	Large Patch	Peripheral	N	expected in 212Ec; consider synonymous with 5042 for STL?
Tsuga canadensis - Fagus grandifolia - (Acer saccharum) Great Lakes Forest	Eastern Hemlock - American Beech - (Sugar Maple) Great Lakes Forest	CEGL005042	Hemlock-Northern Hardwood Forest; Var. Great Lakes Mixed Forest		Large Patch	Limited	Y	consider synonymous with 6109 for STL?
WOODLANDS								
Juniperus virginiana - Ostrya virginiana / Carex eburnea Woodland	Eastern Red-cedar - Eastern Hop-hornbeam / Bristleleaf Sedge Woodland	CEGL006180	Red Cedar Rocky Summit	Red Cedar Woodland	Small Patch	Limited	Y	
Picea mariana / Ledum groenlandicum - Empetrum nigrum / Cladina spp. Dwarf-shrubland	Black Spruce / Labrador-tea - Black Crowberry / Reindeer Lichen species Dwarf-shrubland	CEGL006268	Ice Cave Talus Community	Cold Air Talus Woodland	Small Patch	Peripheral	Y	
Picea rubens / Ribes glandulosum Woodland	Red Spruce / Skunk Currant Woodland	CEGL006250		Boreal Talus Woodland	Small Patch	Peripheral	Y	
Pinus banksiana - Pinus strobus - (Quercus rubra) / Cladina spp. Nonvascular Vegetation	Jack Pine - Eastern White Pine - (Northern Red Oak) / Reindeer Lichen species Nonvascular Vegetation	CEGL002491	Sandstone Pavement Barrens; Sparely Vegetated Pavement Zone		Small Patch	Limited	Y	
Pinus banksiana - Thuja occidentalis - Picea glauca / Juniperus communis Woodland	Jack Pine - Northern White-cedar - White Spruce / Common Juniper Woodland	CEGL005126	Limestone Woodland; Var. GL Alvar Woodland		Large Patch	Peripheral	Y	
Pinus banksiana / Photinia melanocarpa / Xanthoparmelia spp. Woodland	Jack Pine / Black Chokeberry / Xanthoparmelia Lichen species Woodland	CEGL005045	Sandstone Pavement Barrens; Var. Jack Pine Woodland; and Var. Pitch Pine Woodland; and White Pine-Gray Birch Woodland		Large Patch	Limited	Y	

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Pinus resinosa / Gaylussacia baccata - Vaccinium angustifolium Woodland	Red Pine / Black Huckleberry - Northern Lowbush Blueberry Woodland	CEGL006010	Pitch Pine-Oak-Heath Rock Summit; Var. Red Pine Rocky Summit	Red Pine Forest or Woodland	Small Patch	Peripheral	Y	
Pinus rigida / Photinia melanocarpa / Deschampsia flexuosa - Schizachyrium scoparium Woodland	Pitch Pine / Black Chokeberry / Wavy Hairgrass - Little Bluestem Woodland	CEGL006116	Pitch Pine-Oak-Heath Rock Summit (Typical)	Pitch Pine-Oak-Heath Rock Summit	Small Patch	Peripheral	Y	
Pinus rigida / Vaccinium myrtilloides / Sphagnum spp. Woodland	Pitch Pine / Velvetleaf Blueberry / Peatmoss species Woodland	CEGL006022	Pitch Pine-Blueberry Peat Swamp	Pitch Pine Woodland Bog	Small Patch	Limited	Y	
Pinus rigida / Vaccinium spp. - Gaylussacia baccata Woodland	Pitch Pine / Blueberry species - Black Huckleberry Woodland	CEGL005046	Pitch Pine-Heath Barrens		Large Patch	Limited	Y	
Populus deltoides - (Juniperus virginiana) Dune Woodland	Eastern Cottonwood - (Eastern Red-cedar) Dune Woodland	CEGL005119	Great Lakes Dune; Var. Lake Dune; Poplar Woodland Zone/Assoc.	Sand Dune (woodland)	Small Patch	Limited	Y	
Populus (tremuloides, grandidentata) - Betula (populifolia, papyrifera) Woodland	(Quaking Aspen, Bigtooth Aspen) - (Gray Birch, Paper Birch) Woodland	CEGL006303	Successional Northern Hardwood Forest; Var. Gray Birch Forest				N	successional communities not targeted for STL
Quercus rubra - (Quercus prinus) / Vaccinium spp. / Deschampsia flexuosa Woodland	Northern Red Oak - (Rock Chestnut Oak) / Blueberry species / Wavy Hairgrass Woodland	CEGL006134	Pitch Pine-Oak-Heath Rocky Summit; Var. Red Oak Rocky Summit	Dry Oak Woodland	Small Patch	Peripheral	Y	
Quercus rubra - Betula alleghaniensis / Polypodium virginianum Woodland	Northern Red Oak - Yellow Birch / Rock Polypody Woodland	CEGL006320	Acidic Talus Slope Woodland; Var. LNE Red Oak Talus Woodland	Transition Hardwood Talus Woodland (acidic)	Small Patch	Peripheral	N	expected in 212Ec
Thuja occidentalis / Oligoneuron album Woodland	Northern White-cedar / Prairie Goldenrod Woodland	CEGL006093	Northern White Cedar Rocky Summit; Var. GL Northern White Cedar Woodland	Temperate Calcareous Outcrop	Small Patch	Limited	Y	
Thuja occidentalis Carbonate Talus Woodland	Northern White-cedar Carbonate Talus Woodland	CEGL005172	Calcareous Talus Slope Woodland; Var. Maple-Basswood Talus Slope Woodland; Var. Northern White Cedar Talus Slope Woodland; Var. GL Northern White Cedar Woodland	Transition Hardwood Talus Woodland (cedar dominant)	Small Patch	Limited	Y	
Thuja occidentalis Limestone Bedrock Woodland	Northern White-cedar Limestone Bedrock Woodland	CEGL005050	Calcareous Pavement Barrens; NW Cedar Woodland Zone; and Limestone Woodland, Var. NW Cedar Woodland	Limestone Bluff Cedar-Pine Forest (in part ?)	Large Patch	Limited	Y	
Thuja occidentalis Saturated Woodland [Placeholder]	Northern White-cedar Saturated Woodland	CEGL003675	Rich Sloping Fen; Var. NW Cedar Woodland		Small Patch	Limited	Y	
Tilia americana - Fraxinus americana - (Acer saccharum) / Geranium robertianum Woodland	American Basswood - White Ash - (Sugar Maple) / Robert's Geranium Woodland	CEGL005058	Calcareous Talus Slope Woodland; Maple-Basswood Talus Slope Woodland; Var. GL/NAP Ash-Basswood Woodland	Northern Hardwood Talus Woodland (calcareous)	Small Patch	Limited	Y	
Tilia americana - Fraxinus americana / Acer spicatum / Cystopteris fragilis Woodland	American Basswood - White Ash / Mountain Maple / Fragile Fern Woodland	CEGL006204		Northern Hardwood Talus Woodland (acidic)	Small Patch	Limited	Y	
SHRUBLANDS								
Alnus incana Swamp Shrubland	Speckled Alder Swamp Shrubland	CEGL002381	Shrub Swamp; Var. NAP Alder Thicket	Alder Swamp	Large Patch	Widespread	Y	
Alnus (incana, viridis) Shrubland	(Speckled Alder, Green Alder) Shrubland	CEGL006062		Alluvial Shrub Swamp	Large Patch	Widespread	N	expected in all subsections
Betula pumila - Dasiphora fruticosa ssp. floribunda / Carex lasiocarpa - Trichophorum alpinum Shrubland	Bog Birch - Shrubby-cinquefoil / Wiregrass Sedge - Alpine Cottongrass Shrubland	CEGL002495	Rich Shrub Fen; Var. GL Fen	Rich Fen (STL, shrubby)	Large Patch	Limited	Y	

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Cephalanthus occidentalis Semipermanently Flooded Shrubland [Placeholder]	Buttonbush Semipermanently Flooded Shrubland	CEGL003908	Shrub Swamp; Var. Buttonbush-Water Willow Swamp	Buttonbush Swamp	Large Patch	Widespread	Y	
Chamaedaphne calyculata / Carex oligosperma / Sphagnum spp. Poor Fen Dwarf-shrubland	Leatherleaf / Few-seed Sedge / Peatmoss species Poor Fen Dwarf-shrubland	CEGL005277	Dwarf Shrub Bog; Var. GL Bog	Poor Fen (shrubby)	Small Patch	Widespread	Y	
Chamaedaphne calyculata - Ledum groenlandicum - Kalmia polifolia Bog Dwarf-shrubland	Leatherleaf - Labrador-tea - Bog Laurel Bog Dwarf-shrubland	CEGL005278	Dwarf Shrub Bog; Var. GL Bog	Dwarf Shrub Bog (STL)	Small Patch	Limited	Y	
Chamaedaphne calyculata - Myrica gale / Carex lasiocarpa Dwarf-shrubland	Leatherleaf - Sweet Gale / Wiregrass Sedge Dwarf-shrubland	CEGL005228	Medium Fen; Var. Northeastern Great Lakes Fen	Intermediate Fen (shrubby); Sweet Gale Shoreline Swamp	Small Patch	Widespread	Y	
Cornus sericea - Salix spp. - (Rosa palustris) Shrubland	Red-osier Dogwood - Willow species - (Swamp Rose) Shrubland	CEGL002186	Shrub Swamp; Var. Willow Shrub Swamp	Alder Swamp (in part)	Large Patch	Limited	Y	
Hudsonia tomentosa - Lupinus perennis Dwarf-shrubland	Woolly Beach-heather - Wild Lupine Dwarf-shrubland	CEGL006233	Great Lakes Dune; Var. Lake Dune; Hudsonia tomentosa shrubland Zone	Sand Dune (Hudsonia Dwarf Shrubland)	Small Patch	Limited	Y	
Juniperus communis - (Juniperus virginiana) - Rhus aromatica - Viburnum rafinesquianum / Oligoneuron album Shrubland	Common Juniper - (Eastern Red-cedar) - Fragrant Sumac - Downy Arrow-wood / Prairie Goldenrod Shrubland	CEGL005212	Calcareous Pavement Barrens; Var. Juniper Alvar Shrubland Zone		Large Patch	Limited	Y	
Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina spp. Dwarf-shrubland	Sheep Laurel - Leatherleaf - (Black Spruce) / Reindeer Lichen species Dwarf-shrubland	CEGL006225	Dwarf Shrub Bog; Var. NAP Bog	Dwarf Shrub Bog (NAP)	Small Patch	Peripheral	Y	
Vaccinium corymbosum - Gaylussacia baccata - Photinia melanocarpa / Calla palustris Shrubland	Highbush Blueberry - Black Huckleberry - Black Chokeberry / Water Arum Shrubland	CEGL005085	Highbush Blueberry Bog Thicket; Var. GL Calcareous Blueberry Bog	Alder Swamp (in part)	Small Patch	Limited	N	expected in 212Ee
HERBACEOUS and SPARSE								
Ammophila breviligulata - (Schizachyrium scoparium) Herbaceous Vegetation	American Beachgrass - (Little Bluestem) Herbaceous Vegetation	CEGL005098	Great Lakes Dune; Var. Lake Dune; Beachgrass Zone/Assoc.	Sand Dune (beachgrass)	Small Patch	Limited	Y	
Andropogon gerardii - Campanula rotundifolia - Solidago simplex Herbaceous Vegetation	Big Bluestem - Bellflower - Sticky Goldenrod Herbaceous Vegetation	CEGL006284	Shoreline Outcrop; Var. Great Lakes Outcrop	Riverside Outcrop	Small Patch	Widespread	Y	
Andropogon gerardii - Sorghastrum nutans Herbaceous Vegetation [Provisional]	Big Bluestem - Yellow Indiangrass Herbaceous Vegetation	CEGL006518	Riverside Ice Meadow; Riverside Grassland Zone	Rivershore Grassland	Small Patch	Peripheral	Y	
Cakile edentula Great Lakes Shore Sparse Vegetation	Sea-rocket Great Lakes Shore Sparse Vegetation	CEGL005162	Sand Beach, Var. Great Lakes Beach	Lake Sand Beach	Small Patch	Limited	Y	
Calamagrostis canadensis - Phalaris arundinacea Herbaceous Vegetation	Bluejoint - Reed Canary Grass Herbaceous Vegetation	CEGL005174	Shallow Emergent Marsh; Var. Bluejoint Marsh; Var. STL/GL Marsh	Shallow Emergent Marsh (Bluejoint/Reed canary grass type)	Small Patch	Widespread	Y	
Carex lasiocarpa - Rhynchospora alba - Scheuchzeria palustris Herbaceous Vegetation	Wiregrass Sedge - Northern White Beaksedge - Rannoch-rush Herbaceous Vegetation	CEGL002501	Inland Poor Fen; Var. Flat Low Elevation Fen; Var. Domed Bog	Poor Fen (graminoid)	Small Patch	Widespread	N	possibly in 222Ob, 212Ec, 212Ed, and 212Ee
Carex lasiocarpa - (Carex rostrata) - Equisetum fluviatile Herbaceous Vegetation	Wiregrass Sedge - (Swollen-beak Sedge) - Water Horsetail Herbaceous Vegetation	CEGL005229	Medium Fen; Var. Northeastern Great Lakes Fen	Intermediate Fen (graminoid)	Small Patch	Limited	Y	
Carex stricta Seasonally Flooded Herbaceous Vegetation [Placeholder]	Tussock Sedge Seasonally Flooded Herbaceous Vegetation	CEGL004121	Sedge Meadow; Var. Tussock Sedge Meadow	Sedge Meadow	Small Patch	Widespread	Y	
Cornus racemosa / Carex (sterilis, hystericina, flava) Shrub Herbaceous Vegetation	Gray Dogwood / (Sterile Sedge, Porcupine Sedge, Yellow Sedge) Shrub Herbaceous Vegetation	CEGL006123	Rich Graminoid Fen; Var. GL Lowland Fen	Rich Fen (STL, graminoid)	Small Patch	Limited	Y	

APPENDIX C
NVC Associations Crosswalked to New York and Vermont Community Types in STL Ecoregion

<u>Gname</u>	<u>GnameTrans</u>	<u>Association ELcode</u>	<u>New York Community</u>	<u>Vermont Community</u>	<u>Community Scale</u>	<u>Regional Distribution Pattern</u>	<u>STL EORs?</u>	<u>Notes</u>
Danthonia spicata - Poa compressa - (Schizachyrium scoparium) Herbaceous Vegetation	Poverty Oatgrass - Canada Bluegrass - (Little Bluestem) Herbaceous Vegetation	CEGL005100	Calcareous Pavement Barrens; Var. Poverty Grass Dry Alvar Grassland Zone		Small Patch	Limited	Y	
Dasiphora fruticosa ssp. floribunda / Clinopodium arkansanum - Argentina anserina - Primula mistassinica Sparse Vegetation	Shrubby-cinquefoil / Low Calamint - Silverweed - Bird's-eye Primrose Sparse Vegetation	CEGL002506	Calcareous Shoreline Outcrop, Var. Great Lakes Outcrop	Lake Shale or Cobble Beach (calcareous bedrock)	Small Patch	Limited	Y	
Deschampsia caespitosa - (Sporobolus heterolepis, Schizachyrium scoparium) - Carex crawei - Packera paupercula Herbaceous Vegetation	Tufted Hairgrass - (Prairie Dropseed, Little Bluestem) - Crawe's Sedge - Balsam Ragwort Herbaceous Vegetation	CEGL005110	Alvar Grassland; Var. Wet Alvar Grassland		Small Patch	Peripheral	Y	
Granite - Metamorphic Talus Northern Sparse Vegetation	Granite - Metamorphic Talus Northern Sparse Vegetation	CEGL002409	Acidic Talus Slope Woodland; Var. Open Acidic Talus Slope	Open Talus (acidic)	Small Patch	Widespread	Y	
Igneous - Metamorphic Cobble - Gravel River Shore Sparse Vegetation	Igneous - Metamorphic Cobble - Gravel River Shore Sparse Vegetation	CEGL002304	Riverside Sand and Gravel Bars; Var. GL Sandbars (gravel portion); also Cobble Shore; Var. GL River Shore	River Cobble Shore (in part); also River Sand or Gravel Shore (gravel portion)	Small Patch	Widespread	Y	
Inland Freshwater Strand Beach Sparse Vegetation	Inland Freshwater Strand Beach Sparse Vegetation	CEGL002310	Inland Calcareous Lake Shore; Var. GL Lakes; Sand Flats Association	Lake Sand Beach (wet portion); Lakeshore Grassland (in part)	Small Patch	Limited	Y	
Lake Mud Flats Sparse Vegetation	Lake Mud Flats Sparse Vegetation	CEGL002313	Inland Calcareous Lake Shore; Var. GL Lakes; Mud Flats Association	Lakeshore Grassland (minor part)	Small Patch	Limited	Y	
Limestone - Dolostone Great Lakes Shore Cliff Sparse Vegetation	Limestone - Dolostone Great Lakes Shore Cliff Sparse Vegetation	CEGL002504	Calcareous Cliff Community; Var. GL NW Cedar Cliff	Temperate Calcareous Cliff	Small Patch	Widespread	Y	
Limestone - Dolostone Talus Sparse Vegetation	Limestone - Dolostone Talus Sparse Vegetation	CEGL002308	Calcareous Talus Slope Woodland; Open Calcarous Talus Slope Association	Open Talus (limestone or dolostone)	Small Patch	Widespread	Y	
Limestone Cobble - Gravel Great Lakes Shore Sparse Vegetation	Limestone Cobble - Gravel Great Lakes Shore Sparse Vegetation	CEGL005169	Cobble Shore; Var. Great Lakes Shore; Var. Calcareous Cobble	Lake Shale or Cobble Beach (calcareous cobble)	Small Patch	Limited	Y	
Non-alkaline Cobble - Gravel Great Lakes Shore Sparse Vegetation	Non-alkaline Cobble - Gravel Great Lakes Shore Sparse Vegetation	CEGL002508	Cobble Shore; Var. Great Lakes Shore; Var. Acidic Cobble	Lake Shale or Cobble Beach (acidic cobble)	Small Patch	Limited	N	possibly in 212Ea and 212Ec
(Pinus strobus, Quercus rubra) / Danthonia spicata Acid Bedrock Wooded Herbaceous Vegetation	(Eastern White Pine, Northern Red Oak) / Poverty Oatgrass Acid Bedrock Wooded Herbaceous Vegetation	CEGL005101	Rocky Summit Grassland; Var. Little Bluestem Rocky Summit	Temperate Acidic Outcrop	Small Patch	Limited	Y	
Polypodium virginianum Cliff Sparse Vegetation [Provisional]	Rock Polypody Cliff Sparse Vegetation	CEGL006528	Cliff Community; Var. LNE Lowland Granite Cliff	Temperate Acidic Cliff (also Boreal Acidic Cliff)	Small Patch	Widespread	Y	
Pontederia cordata - Peltandra virginica Semipermanently Flooded Herbaceous Vegetation [Placeholder]	Pickereelweed - Green Arrow-arum Semipermanently Flooded Herbaceous Vegetation	CEGL004291	Deep Emergent Marsh; Var. Great Lakes Marsh; Pickereel Weed Marsh Association	Deep Broadleaf Marsh	Small Patch	Widespread	Y	
Quercus alba - Quercus macrocarpa / Andropogon gerardii Wooded Herbaceous Vegetation	White Oak - Bur Oak / Big Bluestem Wooded Herbaceous Vegetation	CEGL005121	Limestone Woodland; Var. Bur Oak Woodland		Small Patch	Limited	Y	
River Mud Flats Sparse Vegetation	River Mud Flats Sparse Vegetation	CEGL002314	Inland Calcareous Lake Shore; Var. GL Rivers	River Mud Shore	Small Patch	Limited	N	expected in 212Ec, and possibly in 212Ea, 212Ed, and 212Ee
Riverine Sand Flats-Bars Sparse Vegetation	Riverine Sand Flats-Bars Sparse Vegetation	CEGL002049	Riverside Sand and Gravel Bars; Var. GL Sandbars; also Inland Calcareous Lake Shore; Var. GL Lakes	River Sand or Gravel Shore	Small Patch	Widespread	Y	

APPENDIX C
NVC Associations Crosswalked to New York and Vermont Community Types in STL Ecoregion

<u>Gname</u>	<u>GnameTrans</u>	<u>Association</u> <u>ELcode</u>	<u>New York Community</u>	<u>Vermont Community</u>	<u>Community</u> <u>Scale</u>	<u>Regional</u> <u>Distribution</u> <u>Pattern</u>	<u>STL</u> <u>EORs?</u>	<u>Notes</u>
Schizachyrium scoparium - Danthonia spicata - Carex pensylvanica - (Viola pedata) Herbaceous Vegetation	Little Bluestem - Poverty Oatgrass - Pennsylvania Sedge - (Birdfoot Violet) Herbaceous Vegetation	CEGL002318	Successional Northern Sandplain Grassland; Var. Great Lakes Grassland		Large Patch	Limited	Y	discuss targetting a successional community
Schoenoplectus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	(Softstem Bulrush, Hardstem Bulrush) Eastern Herbaceous Vegetation	CEGL006275	Deep Emergent Marsh; Var. Bulrush Marsh	Deep Bulrush Marsh	Small Patch	Widespread	N	possibly in 212Ed
Schoenoplectus acutus - (Schoenoplectus fluviatilis) Freshwater Herbaceous Vegetation	Hardstem Bulrush - (River Bulrush) Freshwater Herbaceous Vegetation	CEGL002225	Deep Emergent Marsh; Var. Great Lakes Marsh; Bulrush Marsh Association	Deep Bulrush Marsh (Lake Champlain examples)	Small Patch	Limited	Y	
Scirpus cyperinus Seasonally Flooded Herbaceous Vegetation	Woolgrass Bulrush Seasonally Flooded Herbaceous Vegetation	CEGL006349	Shallow Emergent Marsh; Var. Woolgrass Marsh	Shallow Emergent Marsh (Woolgrass type)	Small Patch	Widespread	Y	
Shale Talus Sparse Vegetation	Shale Talus Sparse Vegetation	CEGL002575	Shale Talus Slope Woodland; Sparsely Vegetated Talus Zone	Open Talus; Var. Shale Talus	Small Patch	Widespread	N	expected in 212Ec
Small Eroding Bluffs Midwestern Sparse Vegetation	Small Eroding Bluffs Midwestern Sparse Vegetation	CEGL002315	Cliff Community; Var. Eroding/Unconsolidated Slope; Vars. Sand and Clay Slopes	Erosional River Bluff	Small Patch	Widespread	N	known to occur in 212Ec, possibly in 212Ea, 212Ed, and 212Ee
Spartina pectinata Great Lakes-North Atlantic Coast Herbaceous Vegetation	Prairie Cordgrass Great Lakes-North Atlantic Coast Herbaceous Vegetation	CEGL006095	Inland Calcareous Lake Shore; Var. GL Lakes; Interdunal Swale Association	Lakeshore Grassland (in part?)	Small Patch	Limited	Y	
Sporobolus neglectus - Sporobolus vaginiflorus - Isanthus brachiatus - Panicum philadelphicum - (Poa compressa) Herbaceous Vegetation	Barrens Dropseed - Poverty Dropseed - Fluxweed - Philadelphia Panicgrass - (Canada Bluegrass) Herbaceous Vegetation	CEGL005235	Alvar Grassland; Var. Annual Pavement Grassland		Small Patch	Peripheral	Y	
Tortella tortuosa - Cladonia pocillum - Placynthium spp. Sparse Vegetation	Twisted Moss - Cup Lichen - Crustose Lichen species Sparse Vegetation	CEGL005192	Calcareous Pavement Barrens; Var. Alvar Non-vascular Pavement Zone		Small Patch	Limited	Y	
Triantha glutinosa - Carex garberi Herbaceous Vegetation	Sticky Bog-asphodel - Elk Sedge Herbaceous Vegetation	CEGL006142	Riverside Ice Meadow; Var. Calcareous Riverside Seep	Calcareous Riverside Seep	Small Patch	Peripheral	Y	
Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Eastern Herbaceous Vegetation	(Narrowleaf Cattail, Broadleaf Cattail) - (Clubrush species) Eastern Herbaceous Vegetation	CEGL006153	Deep Emergent Marsh; Var. NAP Cattail Marsh	Cattail Marsh	Small Patch	Widespread	Y	
Typha spp. - Schoenoplectus tabernaemontani - Mixed Herbs Southern Great Lakes Shore Herbaceous Vegetation	Cattail species - Softstem Bulrush - Mixed Herbs Southern Great Lakes Shore Herbaceous Vegetation	CEGL005112	Deep Emergent Marsh; Var. Great Lakes Marsh; Cattail Marsh Association	Cattail Marsh (STL-GL type along Lake Champlain)	Large Patch	Limited	Y	
Zizania (aquatica, palustris) Herbaceous Vegetation	(Indian Wild Rice, Northern Wild Rice) Herbaceous Vegetation	CEGL002382	Deep Emergent Marsh; Var. Great Lakes Marsh; Wild Rice Marsh Association	Wild Rice Marsh	Small Patch	Limited	Y	
Dry Terrestrial Cave	Dry Terrestrial Cave	CAVE000400	Terrestrial Cave Community	Cave/Mine	Small Patch	Widespread	Y	target for STL?

Proposed or Potential New Associations for STL in New York and Vermont								
Spartina pectinata - Carex viridula - Potentilla anserina Lakeshore Herbaceous Vegetation		New Assoc #1	Cobble Shore Wet Meadow	Lakeshore Grassland	Small Patch	Restricted	Y	CEGL005109 and CEGL006095 are two closest associations.
Glyceria acutifolia - Scirpus cyperinus - Sinkhole Herbaceous Vegetation		New Assoc #2	Sinkhole Wetland		Small Patch	Restricted	Y	
Cystopteris bulbifera - Impatiens pallida - Eupatorium rugosum Sparse Vegetation		New Assoc #4	Calcareous Shoreline Outcrop; Var. HAP Shale Outcrop		Small Patch	Peripheral	Y	
Shale Cliff Sparse Vegetation		New Assoc #6	Shale Cliff and Talus	Temperate Calcareous Cliff (shale portion)	Small Patch	Peripheral	Y	
Vaccinium angustifolium - Spiraea alba - Aronia melanocarpa Dwarf-shrubland		New Assoc #10	Boreal Heath Barrens; Var. Nonvascular Zone		Small Patch	Limited	N	possibly in 212Eb

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<u>Gname</u>	<u>GnameTrans</u>	<u>Association ELcode</u>	<u>New York Community</u>	<u>Vermont Community</u>	<u>Community Scale</u>	<u>Regional Distribution Pattern</u>	<u>STL EORs?</u>	<u>Notes</u>
Quercus alba - Acer rubrum - Carya ovata / Viburnum acerifolium / Waldsteinia fragarioides Clayplain Forest		New Assoc #7	Limestone Woodland; Var. Lake Plain Bottomland Forest	Mesic Clayplain Forest	Matrix	Limited	Y	Matrix historically, now Large Patch
Quercus bicolor - Acer rubrum - Fraxinus pennsylvanica / Carpinus caroliniana / Carex spp. Temporarily Flooded Clayplain Forest		New Assoc #8		Wet Clayplain Forest	Small Patch	Limited	Y	EOs are currently included with Mesic Clayplain Forests (New Assoc #7)
Tsuga canadensis - Fraxinus americana - Acer saccharum / Cystopteris bulbifera Woodland		New Assoc #9	Shale Talus Slope Woodland; Var. Hemlock Woodland Zone		Large Patch	Peripheral	N	expected in 2220b
Kalmia angustifolia - Chamaedaphne calyculata - (Pinus banksiana) / Scirpus cyperinus Dwarf- shrubland		New Assoc #3	Perched Bog		Small Patch	Restricted	Y	
Fraxinus americana - Juniperus virginiana - Potentilla fruticosa / Aster ptarmicoides Schist Cliff Sparse Vegetation		New Assoc #5	Calcareous Cliff Community; Var. Eastern Red Cedar Temperate Cliff		Small Patch	Peripheral	Y	

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Acres	Ownership	Road Density	Dominant communities	Other biodiversity values	Notes on Aquatic Features	ELUs, geological features
101	The Gulf	NY or VT				none- large pine/ rich northern hardwood/ 1/4- 1/5 sandstone/ calcareous pavement?/ may be some old growth right along the Gulf	black spruce tamarack bog/ successional northern hardwood/ deer wintering area (starving- not much food)/ coyote	stream- poorly drained, high quality	flatrock sandstone, thin soils, wet
102	Lake Alice/ Altona	NY or VT				possible rich northern hardwood and northern hardwood matrix, limestone woodland, large jack pine forest (8,000-10,000 acres) on flatrock	large area of wetland- limestone woodland, large patch hemlock, pine and no. hardwoods, areas of grasslands west of the Vly- probably not natural, possible clay plain forest/ lots of beaver, no historic record of kirtlands warbler, habitat for ducks- early nesting ducks that need large trees,	basic wetland- northern white cedar, red maple swamp	deeper soils towards lake but probably not lake sediment,
103	Boquet Mt.	NY or VT				Rich northern hardwood- Appalachian type (App. Oak/Pine, Oak/ Hickory), clay forest, old growth, possible hemlock-northern hardwood and southern Appalachian	northern white cedar, limestone woodland, clayplain forest/ rattlesnakes northern limit, five-lined skinks northern limit, peregrine and osprey nesting, bald eagle, butterflies- Broad wing skipper	potential for clay plain forest, beaver corridor, swamp probably continuously forested	small patch talus slopes, rocky cliffs, rocky summits, shoreline communities
104	Westport Woods	NY or VT				northern hardwoods, no clay, no old growth	pine, hemlock/ bats, Barton Hill and Indiana, beaver activity, raven nesting underground	small, nice lakes and streams, less affected from acid rain	no clay
105	Ausable Delta	NY or VT				Northern Hardwood Forest/ Beech, Maple mesic/ Maple- Oak/ no clay	Limestone woodland/ Appalachian Oak-Pine/ Pitch-Oak, Champlain beachgrass	Ausable river estuaries, lake to higher elevation, very diverse area, intensively managed for fisheries, streambank restoration/ Champlain beachgrass mussels	Ausable Chasm, streambank restoration
201	Dead Creek	NY or VT				Champlain Clayplain forest	several remnants of clayplain forest- biggest 240A, marsh birds	Dead Creek is impounded, managed for waterfowl, narrow floodplain, muddy wetland	diversity of soil types, sand over clay with forest
202	Little Otter	NY or VT					bluff community, lakeshore	no water control, three creek mouths, significant aquatic features, deepwater marsh, VBP exceptional aquatics	sand and clay soils
203	Mud Hollow Brook	NY or VT					30-60% natural cover, small wooded patch at center of block		
204	Bridgeport/ Shoreham Road	NY or VT					upper clayplain at Otter Creek Gorge?	wet site, no significant aquatics	
205	Mt. Independence/ East Creek	NY or VT				rich transition hardwoods or limestone cobble	limestone bedrock forest to south		Vergennes soils
206	Bald Mt.	NY or VT				Hardwood, Rich hardwood			
207	Otter Creek Swamp	NY or VT							

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Disturbance history	Population density	Breeding area for area-sensitive species?	Connections to other sites?	Other notes
101	The Gulf	NY or VT	farmland abandonment, almost all pastured, poorly drained/ last burn in the 50's				extends into Canada- about 1/3 more "Covey Hill" which is partly protected, DEC purchased as a unique area
102	Lake Alice/ Altona	NY or VT	most in agriculture in late 1800's, mostly dairy farming (successful) - sheep, subsistence, a lot of untilled, maple sugar, minor logging, deeper soils on eastern side/ hard hit by ice storm		southernmost area for goldeneye?, osprey, was black tern	connective value- corridors along streams to Lake Champlain	ice storm damage, some salvage operations in hardwood forest, fear of fine- clear cutting in jack pine for fire breaks/ biggest maple-sugar production in area
103	Boquet Mt.	NY or VT	threatened-clearing, agriculture, tilled, crops/ management of private land in the area has been bad industrial agriculture, drained the wetland, all but swamp was cleared at one point		rattlesnakes viable pop.), skinks, peregrine, osprey nesting without platforms, bald eagle- nesting?	beaver corridor, possible to connect to high peaks, join with split rock with a corridor	Webb- Royce state owned swamp, wealthy area
104	Westport Woods	NY or VT	subsistence farming, slag piles- Mineville, first place mined for iron, slag pit site		Indiana bat site- hibernation in a mine	connects to the west to a large matrix block, continuous forest from here to matrix blocks, maybe one of the best places for wide-ranging animals to cross I-87	IP leases to hunting clubs, I87 underpass may be used by animals, road that cuts it is a seasonal dirt road, not much agriculture, Mineville is underpopulated since company moved out, very pretty site
105	Ausable Delta	NY or VT	some agriculture- crops, hay, corn, orchards/ a lot of tillable, sandy soil, abandoned				some vacation home pressure, easement on farmland (King Farm), was an active river association
201	Dead Creek	NY or VT	farming- corn and hay, some small untilled areas, abandoned farm at the mouth of Dead and Little Otter creek, recent logging			Just W. of Snake Mt.	development pressure for housing
202	Little Otter	NY or VT	farming- hay and corn, sprawl-type development, large boats on Otter Creek				TFM application for Lewis Creek
203	Mud Hollow Brook	NY or VT	abandoned farmland				2 small blocks?, not very intact, development pressure is high
204	Bridgeport/ Shoreham Road	NY or VT	agriculture, hay and corn, industrial agriculture				less development pressure, some second home development
205	Mt. Independence/ East Creek	NY or VT	dairy farming, corn				some agricultural easements, politically and socially not feasible
206	Bald Mt.	NY or VT					
207	Otter Creek Swamp	NY or VT					boundaries- expand eastward

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Tier
101	The Gulf	NY or VT	1
102	Lake Alice/ Altona	NY or VT	1
103	Boquet Mt.	NY or VT	1
104	Westport Woods	NY or VT	2
105	Ausable Delta	NY or VT	2
201	Dead Creek	NY or VT	1
202	Little Otter	NY or VT	1
203	Mud Hollow Brook	NY or VT	2
204	Bridgeport/ Shoreham Road	NY or VT	2
205	Mt. Independence/ East Creek	NY or VT	
206	Bald Mt.	NY or VT	1
207	Otter Creek Swamp	NY or VT	0

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Acres	Ownership	Road Density	Dominant communities	Other biodiversity values	Notes on Aquatic Features	ELUs, geological features
208	Hogback Mt.	NY or VT				Northern hardwood, lots of oak	no old growth, hemlock, oak, red pine	wetland around Bristol pond- aka Lake Winona	
209	Stewart's Hut	NY or VT				northern hardwood, rich northern hardwood		Brown's River branch at western edge	
210	Georgia Mt.	NY or VT				northern hardwood, rich northern hardwood	dry oak forest, no old growth, rocky woods, high pastures (likely areas that haven't been cleared)	nice river at edges, beaver complexes, Indian Brook, Colchester Pond, north to Lamoille River, upstream of Arrowhead Lake	A few EO's,
211	Missoaquoi Delta	NY or VT							
212	Snake Mt.	NY or VT				maple-ash-hickory-oak, clayplain forest, northern hardwoods, transition hardwood	cliff and talus, northern hardwoods, some old growth is present		
301	Beaver Pond/ Constable	NY or VT				maple-basswood rich mesic forest	50% forested	Beaver Pond Brook has contiguous forests surrounding it	
302	Brasher State Forest Complex	NY or VT				Northern hardwood- wet, no clay, no matrix, old growth?	large patch white cedar swamps, 60-70% forest cover, interesting botanically and for birds	swamps, marsh headwater streams and small main channel streams, intact hydrology?, St. Regis River and Salmon River- potential dam removal site	sandy soils, not much limestone, ELU diversity?, Rhodoro, rare willow- Salix pyrifolia, possibility of goshawk
303	St. Lawrence State Forest	NY or VT				successional northern hardwoods- large patch or matrix?	70% forested	parts of the Grass River	
304	Coles Creek	NY or VT					60% forested, large patch communities- pine northern hardwood and red maple hardwood swamp, small patch community- wetland around Coles Creek, some rare plants, possible cerulean warbler, colonial waterbirds	backwater sloughs, marshes around Coles Creek, blanding turtle	
305	Lisbon Swamp	NY or VT				matrix is a swamp- ash, elm, red maple with a lot of swamp and shrub, calcareous to poor fen, was a bog	many state rare plants, about 50% forest cover, diverse types of moderately globally rare communities- rich graminoid fen, rich shrub fen, red-maple tamarack peat swamp, northern white cedar swamp, limestone woodland, highbush blueberry bog thicket	Blanding turtle	
306	Upper and Lower Lakes Block	NY or VT				matrix may be agriculture converted from former clayplain forest		Large patch open mineral soil wetland types- shallow and deep emergent marshes, shrub swamp, potential sinkhole wetlands	

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Disturbance history	Population density	Breeding area for area-sensitive species?	Connections to other sites?	Other notes
208	Hogback Mt.	NY or VT	always forest, never farmed				management has logged and hates conservation
209	Stewart's Hut	NY or VT	not much farming, mostly forest with agriculture on edge				development- residential sprawl,
210	Georgia Mt.	NY or VT	mostly logged				development at fringes
211	Missoaquoi Delta	NY or VT					
212	Snake Mt.	NY or VT					use current block- include pink to east and gray to southeast----- (Most supported areas in the 200's are Dead Creek, Stewart Hill and Bald Mt.)
301	Beaver Pond/ Constable	NY or VT					
302	Brasher State Forest Complex	NY or VT	burned a lot on the past, planted jack pine, logged, not much farming, tilled?	population density is low- mostly along the river			aggregation of 4-5 blocks- large contiguous forest on the largest two blocks, continuous forest cover?
303	St. Lawrence State Forest	NY or VT					
304	Coles Creek	NY or VT	farmed	population density is low- mostly along the river			potential resistance to conservation activity, potential environmental enhancement
305	Lisbon Swamp	NY or VT	surrounded by farmland, was probably converted from a clayplain forest				
306	Upper and Lower Lakes Block	NY or VT					

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Tier
208	Hogback Mt.	NY or VT	1
209	Stewart's Hut	NY or VT	1
210	Georgia Mt.	NY or VT	2
211	Missoaquoi Delta	NY or VT	0
212	Snake Mt.	NY or VT	2
301	Beaver Pond/ Constable	NY or VT	1
302	Brasher State Forest Complex	NY or VT	1
303	St. Lawrence State Forest	NY or VT	2
304	Coles Creek	NY or VT	2
305	Lisbon Swamp	NY or VT	0
306	Upper and Lower Lakes Block	NY or VT	0

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Acres	Ownership	Road Density	Dominant communities	Other biodiversity values	Notes on Aquatic Features	ELUs, geological features
307	Black Lake/ Indian River Lake	NY or VT				maple-basswood rich mesic forest and successional southern hardwoods (former clayplain forest)	successional northern hardwood forest- moist green ash, clay, bur oak, butternuts hickory, some hackberry; oak forest area on Grindstone Island which may be protected; rare elm- rock elm along Maple Ridge Rd. and towards Osborne Lake, black rattle snake; this is a high priority area for forested landscape; frontenac axis goes through here, limestone is not a feature; wildlife source are for many species west end of Black Lake, sandstone pavement barrens, possible calcareous pavement barrens, possible large patch limestone woodland, large grasslands, potentially successional old fields along major roads, about 60-70% forested	Indian River Lake is comprised of deep and shallow water, great wetlands in the area, all the lakes in the area are very interesting botanically, all are natural, one is stocked, Red Lake is very attractive, Yellow Lake is remote and undeveloped, most of the lakes have a lot of development, abundant aquatic features including numerous lakes (winter-stratified monomictic lakes, eutrophic dimictic lakes, mesotrophic dimictic lakes, marsh headwater streams, main channel streams- Indian and Oswegatchie Rivers), possible sinkhole wetland complexes, possible rich fens, Large lakeshore wetland complexes- bordering Black Lake, Fish Creek, Hickory Lake, Mud Lake which contain communities including red-maple hardwood swamp, shrub swamp, and shallow emergent marsh	interesting geology up and down a large number of small lakes and in a small area
308	Fort Drum	NY or VT				suspected matrix of maple basswood rich mesic forest, but original survey said maple-basswood that was not necessarily rich	small to large patch features include successional northern sandplain grassland, northern white cedar swamp, rich fens and limestone woodland, about 60-70% forested		varied- sands on southwestern portion, sandplain, old pine plains, old lake bed, Adirondack limestone, lots of minerals, interesting rocks; lake sediments present but not as much as it appears, the southern part is more rocky
309	Pitcairn	NY or VT				maple-basswood rich mesic forest	large patch forest includes line northern hardwood forest, hemlock-northern hardwood forest, limestone woodland, about 80% forested	smaller patch features include red maple-tamarack peat swamp, several significant lake communities	farmland along old roads is now early successional grasslands
310	Stammer Creek	NY or VT				matrix may include beech-maple mesic forest	possible small patch sandstone pavement barrens, about 80% forested		
311	Boyd Pond	NY or VT				northern hardwoods, some maple-basswood forest	about 80% forest cover	nice water features, falls, north and south branches of the Grass River, small patch communities include floodplain forest and possible a red maple-tamarack peat swamp	

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Disturbance history	Population density	Breeding area for area-sensitive species?	Connections to other sites?	Other notes
307	Black Lake/ Indian River Lake	NY or VT	heavy icestorm damage, microburst, upland logged, grazed heavily for a brief period	there is a large area with very little human habitat, Indian River Lakes and Cerasse Lake- mixture of degrees of development, very chopped up, second home development, new access for boaters	upland sandpiper and other grassland nesting birds are NOT in this block, reservoirs of two birds- Cerulean warbler, golden- (this may be the best areas in NY for these species)	yes	there is a young land trust working in this area, there are three different Indian land claims going on in this area, Canadian Thousand Islands has a land trust
308	Fort Drum	NY or VT	agricultural land, management wants to retain it in early succession, some of eastern area was not farmed and near Lake Bonaparte, logging	some roads are no longer there		area around Lake Bonaparte could be expanded for matrix northern hardwood forest to Pitcairn block	active management on entire site, including logging, managing so they can maneuver through so they are keeping the understory clear, conservation could be compatible but military mission is number one priority, the fort has been there since the 1940's
309	Pitcairn	NY or VT					
310	Stammer Creek	NY or VT					little information available
311	Boyd Pond	NY or VT	farming along roads, back parts were always woods, affected by ice storm	low population density			

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Tier
307	Black Lake/ Indian River Lake	NY or VT	1
308	Fort Drum	NY or VT	1
309	Pitcairn	NY or VT	2
310	Stammer Creek	NY or VT	2
311	Boyd Pond	NY or VT	1

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Acres	Ownership	Road Density	Dominant communities	Other biodiversity values	Notes on Aquatic Features	ELUs, geological features
312	Trout Lake	NY or VT				early succession northern hardwoods	some maple-basswood in pockets, native red pine, trailing arbutus, small patch lakeshore communities include pine-northern hardwood forest, shoreline outcrops, 70-80% forest cover	large patch wetland complexes including white cedar swamps and sinkhole wetlands, several good quality lakes- eutrophic to oligotrophic simictic lakes, Oswegatchie River	some sandy soil
313	Boland Creek	NY or VT				successional southern hardwoods, possibly an old clayplain forest	roadside successional old fields, about 50% forested	large patch streamside wetland complex (shrub swamp, silver maple-ash swamp), sinkhole, wetland complexes	
314	North Croghan	NY or VT				maple-basswood rich mesic forest and successional hardwoods	small patch limestone woodlands, about 70-80% forested	wetland complexes, potentially calcareous peatlands (northern white cedar swamp, red maple-tamarack peat swamp and medium fen leads)	
315	Bush Corners	NY or VT				sandplains with boreal heath barrens, natural grassland, pine barrens	large patch pine-northern hardwood forest and successional northern hardwoods, about 80% forested	vernal pond in pine barrens	
316	Crystal Creek	NY or VT				sandplains with boreal heath barrens, natural grassland, pine barrens	large patch pine-northern hardwood forest and successional northern hardwoods, about 80%- 90% forested	vernal pond in pine barrens	
317	Chase Lake	NY or VT				sandplains with boreal heath barrens, natural grassland, pine barrens	large patch pine-northern hardwood forest and successional northern hardwoods, about 80%- 90% forested	vernal pond in pine barrens	
318	Lyonsdale	NY or VT				sandplains with boreal heath barrens, natural grassland, pine barrens, about 1,000 acres of putative old-growth	large patch pine-northern hardwood forest and successional northern hardwoods, about 80% forested	vernal pond in pine barrens, section of midreach stream	
319	Miller Brook	NY or VT					large patch communities include pine-northern hardwood forest and successional northern hardwoods, sandplain with boreal heath barrens, natural grassland, pine barrens, about 90% forested	vernal pond in pine barrens	
320	Tamarack Swamp	NY or VT				about 200 acre of putative old-growth forest	about 90% forested	wetland complex with black spruce-tamarack bog, section of midreach stream	

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Disturbance history	Population density	Breeding area for area-sensitive species?	Connections to other sites?	Other notes
312	Trout Lake	NY or VT	Trout Lake is pretty developed, some are undeveloped lakes, fire-not natural, areas farmed briefly and old farms are scattered about-mostly cleared and pastured, a lot of white pine				
313	Boland Creek	NY or VT					
314	North Croghan	NY or VT					more data in CWNY NAP files
315	Bush Corners	NY or VT					
316	Crystal Creek	NY or VT					
317	Chase Lake	NY or VT					
318	Lyonsdale	NY or VT					
319	Miller Brook	NY or VT					
320	Tamarack Swamp	NY or VT					more data in CWNY NAP files

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Tier
312	Trouf Lake	NY or VT	2
313	Boland Creek	NY or VT	2
314	North Croghan	NY or VT	1
315	Bush Corners	NY or VT	2
316	Crystal Creek	NY or VT	0
317	Chase Lake	NY or VT	1
318	Lyonsdale	NY or VT	1
319	Miller Brook	NY or VT	1
320	Tamarack Swamp	NY or VT	0

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Acres	Ownership	Road Density	Dominant communities	Other biodiversity values	Notes on Aquatic Features	ELUs, geological features
321	Jefferson County Alvar	NY	16,000	TNC: 3500; remainder private	moderate - several alvar blocks of 500-2000 acres within the mosaic	calcareous pavement barrens (=alvar shrubland), alvar grassland, limestone woodland in agricultural matrix	about 35 state rare plants; endemic land snails; state rare leps; grassland birds breeding and wintering in the ag matrix	strings of black ash swamp; beaver impoundment; impounded lake	expanse of fissured ordovician limestone at surface; very shallow soils

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Disturbance history	Population density	Breeding area for area-sensitive species?	Connections to other sites?	Other notes
321	Jefferson County Alvar	NY	grazed, logged; some limestone quarries; current ag is cattle grazing, hay, game farm; hay is cut once/year, late - opportunity for successful grassland bird breeding	low	upland sandpiper		this is an edaphic climax - barrens vegetation with prairie affinities developed on very shallow soils, severe flood-drought hydrologic regime

APPENDIX E
Matrix Blocks in St. Lawrence/Champlain Valley Ecoregion

Matrix #	Matrix Name	State(s)/ Province(s)	Tier
321	Jefferson County Alvar	NY	0

**APPENDIX F3
Aquatic Portfolio by Site Name**

aquatic Portfolio Report as of 5/24/2002: Northeast Lake Ontario (48_14), Lake Champlain/St. Lawrence (63_1), and NW Adirondacks (63_4) Ecological Drainage Units

PORTHUC SITE ID	Ecological Drainage Unit	8-Digit Watershed Name	Aquatic Site Name	SYS4	SYS3	SYS2	SYS1	Size 2 Watershed Land Cover/Road Rank within System Type (1=best)	Size 2 Watershed Dams and DWS Rank within System Type (1=best)	Size 2 Watershed Point Source Rank within System Type (1=best)	Aquatic Ecoregional Team Portfolio Code	Ecoregion	Subsections	Subsection/Type Hunt Portfolio Code	Biodiversity Rank	Urgency/Threat	Feasibility	Score
3	Lake Champlain 63_1	Ausable Watershed	Ausable Delta								PORT-L	STL	212Ec	Y				
4	Lake Champlain 63_1	Ausable Watershed	Ausable River, East Branch			2_5		1	1	4	PORT-S1	NAP	M212Dc,M212Df					
5	Lake Champlain 63_1	Ausable Watershed	Ausable River, West Branch			2_5		3	4	3	PORT-S1	NAP	M212Dc,M212Df					
101	Lake Champlain 63_1	Ausable Watershed	Bouquet River, Size 2			2_5		4	2	5	PORT-S1c	STL, NAP	212Ec,M212Dc,M212De,M212Df	Y				
20	Lake Champlain 63_1	Ausable Watershed	Bouquet River, Size 3		3_5						PORT-S1c	STL	212Ec	Y				
32	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Corbeau Creek				1				PORT-S1c	STL	212Ea,212Eb	Y				
102	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Great Chazy River, Size 2			2_8		1	1	1	PORT-S1c	STL, NAP	212Ea,212Eb,M212Dc	Y				
42	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Great Chazy River, Size 3		3_6						PORT-S1c	STL	212Ea	Y				
48	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Kings Bay								PORT-L	STL	212Ea	Y				
73	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Point Au Roche Swamp								PORT-L	STL	212Ec	Y				
79	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Riley Brook				1				PORT-S1	STL	212Ea,212Ec	Y?				
85	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Saranac River, North Branch			2_6		1	2	1	PORT-S1c	NAP	M212Dc					
84	Lake Champlain 63_1	Great Chazy-Saranac Watershed	Saranac River, Size 3		3_4						PORT-S1c	STL, NAP	212Ec,M212Dc	N				
8	Lake Champlain 63_1	Lake George Watershed	Beebe Pond								PORT-L?	LNE	221Bb					
23	Lake Champlain 63_1	Lake George Watershed	Burr Pond								PORT-L?	LNE	221Bb					
25	Lake Champlain 63_1	Lake George Watershed	Castleton River		2_3			6	6	5	PORT-S1c	LNE	221Bb,M212Cb					
116	Lake Champlain 63_1	Lake George Watershed	Castleton River Tributaries				1				PORT-S1c	LNE	M212Cb					
31	Lake Champlain 63_1	Lake George Watershed	Coot Hill Tributary				1				PORT-S1	STL	212Ec	Y				
36	Lake Champlain 63_1	Lake George Watershed	Glen Lake								PORT-L?	LNE	221Bb					
43	Lake Champlain 63_1	Lake George Watershed	Hinkum Pond								PORT-L?	LNE	221Bb					
44	Lake Champlain 63_1	Lake George Watershed	Hubbardton River			2_4		5	9	3	PORT-S1c	LNE	221Bb,221Bc					
117	Lake Champlain 63_1	Lake George Watershed	Hubbardton River Tributaries				1				PORT-S1c	LNE	221Bb					
47	Lake Champlain 63_1	Lake George Watershed	Indian River Tributary, Flower Brook				1				PORT-S1	LNE	M212Cb					
103	Lake Champlain 63_1	Lake George Watershed	Poultney River, Size 2			2_3		6	6	5	PORT-S1c	LNE	221Bb,221Bc,M212Cb	Y				
74	Lake Champlain 63_1	Lake George Watershed	Poultney River, Size 3		3_3						PORT-S1c	STL, NAP, LNE	212Ec,221Bc,M212De	Y				
89	Lake Champlain 63_1	Lake George Watershed	Poultney River, South Brook				1				PORT-S1c	LNE	M212Cb					
80	Lake Champlain 63_1	Lake George Watershed	Root Pond								PORT-L?	LNE	221Bc	Y?				
92	Lake Champlain 63_1	Lake George Watershed	Sunset Lake								PORT-L?	LNE	221Bb					
1	Lake Champlain 63_1	Lamoille Watershed	Allen Brook				1				PORT-S1	STL	212Ec					
50	Lake Champlain 63_1	Lamoille Watershed	Lake Champlain, Trout Brook				1				PORT-S1	STL	212Ec					
104	Lake Champlain 63_1	Lamoille Watershed	Lamoille River,Brown River			2_3		4	2	3	PORT-S1c	STL	212Ed	Y				

**APPENDIX F3
Aquatic Portfolio by Site Name**

aquatic Portfolio Report as of 5/24/2002: Northeast Lake Ontario (48_14), Lake Champlain/St. Lawrence (63_1), and NW Adirondacks (63_4) Ecological Drainage Units

PORTHUC SITE ID	Ecological Drainage Unit	8-Digit Watershed Name	Aquatic Site Name	SYS4	SYS3	SYS2	SYS1	Size 2 Watershed Land Cover/Road Rank within System Type (1=best)	Size 2 Watershed Dams and DWS Rank within System Type (1=best)	Size 2 Watershed Point Source Rank within System Type (1=best)	Aquatic Ecoregional Team Portfolio Code	Ecoregion	Subsections	Subsection/Type Hunt Portfolio Code	Biodiversity Rank	Urgency/Threat	Feasibility	Score
118	Lake Champlain 63_1	Lamoille Watershed	Lamoille River, Brown River Tributaries				1				PORT-S1c	STL, NAP	212Ed, M212Ca	Y				
57	Lake Champlain 63_1	Lamoille Watershed	Lamoille River, N. Branch			2_2		1	1	1	PORT-S1c	NAP	M212Ca					
119	Lake Champlain 63_1	Lamoille Watershed	Lamoille River, N. Branch Tributaries				1				PORT-S1c	NAP	M212Ca					
105	Lake Champlain 63_1	Lamoille Watershed	Lamoille River, Size 2			2_1		2	4	5	PORT-S1c	NAP	M212Ba, M212Ca					
56	Lake Champlain 63_1	Lamoille Watershed	Lamoille River, Size 3			3_1					PORT-S1c	STL, NAP	212Ec, 212Ed, M212Ca	Y				
61	Lake Champlain 63_1	Lamoille Watershed	Long Lake, VT								PORT-L	STL	212Ec	Y				
81	Lake Champlain 63_1	Lamoille Watershed	Round Pond								PORT-L	STL	212Ec	Y				
99	Lake Champlain 63_1	Lamoille Watershed	Wolcott Pond								PORT-L?	NAP	M212Ba					
64	Lake Champlain 63_1	Missisquoi Watershed	Missisquoi River			3_1	1				PORT-S2c	STL	212Ec, 212Ed	Y, N				
65	Lake Champlain 63_1	Missisquoi Watershed	Missisquoi River, Tyler Branch			2_3		1	4	4	PORT-S2c	STL	212Ed	Y				
97	Lake Champlain 63_1	Missisquoi Watershed	VT Unnamed Pond # 52/ Swanton Oxbow								PORT-L	STL	212Ec	Y				
7	Lake Champlain 63_1	Otter Watershed	Baker Brook				1				PORT-S1	NAP	M212Ca					
51	Lake Champlain 63_1	Otter Watershed	Lake Dunmore								PORT-L	STL	212Ec	Y				
59	Lake Champlain 63_1	Otter Watershed	Lewis Creek			2_4		2	1	5	PORT-S1c	STL	212Ec, 212Ed	Y, N				
121	Lake Champlain 63_1	Otter Watershed	Lewis Creek Tributaries				1				PORT-S1c	STL	212Ec, 212Ed	Y?, N				
30	Lake Champlain 63_1	Otter Watershed	Otter River, Cold River			2_9		1	1	2	PORT-S1c	LNE, NAP	M212Cb, M212Cd					
120	Lake Champlain 63_1	Otter Watershed	Otter River, Cold River Tributaries				1				PORT-S1c	NAP	M212Cd					
58	Lake Champlain 63_1	Otter Watershed	Otter River, Lemon Fair			2_4		3	2	1	PORT-S1c	STL	212Ec					
62	Lake Champlain 63_1	Otter Watershed	Otter River, Middlebury River			2_9		2	1	1	PORT-S1c	STL, NAP	212Ec, M212Ca					
136	Lake Champlain 63_1	Otter Watershed	Otter River, Size 2			2_9		4	3	4	PORT-S1c	LNE	M212Cb					
71	Lake Champlain 63_1	Otter Watershed	Otter River, Size 3			3_2					PORT-S1c	STL, LNE	212Ec, M212Cb					
98	Lake Champlain 63_1	Otter Watershed	Winona Lake								PORT-L	STL	212Ed	Y				
12	Lake Champlain 63_1	St. Francois Watershed	Black River - to Lake Memphremagog			2_1		3	1	1	PORT-S1c	NAP	M212Ba, M212Ca					
54	Lake Champlain 63_1	St. Francois Watershed	Lake Willoughby								PORT-L	NAP	M212Ae, M212Ae					
86	Lake Champlain 63_1	St. Francois Watershed	Seymour Lake								PORT-L	NAP	M212Af, M212Ba					
6	Lake Champlain 63_1	Winooski Watershed	Austin Brook				1				PORT-S1	NAP	M212Ca					
33	Lake Champlain 63_1	Winooski Watershed	Crossett Brook				1				PORT-S1			Y?				
35	Lake Champlain 63_1	Winooski Watershed	Dog River			2_1		5	2	6	PORT-S1	NAP	M212Ba, M212Ca					
122	Lake Champlain 63_1	Winooski Watershed	Dog River Tributaries				1				PORT-S1	NAP	M212Ca					
52	Lake Champlain 63_1	Winooski Watershed	Lake Iroquois								PORT-L	STL	212Ed	Y				
87	Lake Champlain 63_1	Winooski Watershed	Shelburne Pond								PORT-L	STL	212Ec	Y				
88	Lake Champlain 63_1	Winooski Watershed	Shephard Brook				1				PORT-S1	NAP	M212Ca					
11	Ontario 48_14	Black Watershed	Black River Mainstem	4	3_11						PORT-S1c	NLP, STL	212Ee, 222Ob, 222Pa	Y				

**APPENDIX F3
Aquatic Portfolio by Site Name**

aquatic Portfolio Report as of 5/24/2002: Northeast Lake Ontario (48_14), Lake Champlain/St. Lawrence (63_1), and NW Adirondacks (63_4) Ecological Drainage Units

PORTHUC SITE ID	Ecological Drainage Unit	8-Digit Watershed Name	Aquatic Site Name	SYS4	SYS3	SYS2	SYS1	Size 2 Watershed Land Cover/Road Rank within System Type (1=best)	Size 2 Watershed Dams and DWS Rank within System Type (1=best)	Size 2 Watershed Point Source Rank within System Type (1=best)	Aquatic Ecoregional Team Portfolio Code	Ecoregion	Subsections	Subsection/Type Hunt Portfolio Code	Biodiversity Rank	Urgency/Threat	Feasibility	Score
13	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Beaver River		3_11						PORT-Sxc?	STL, NAP	222Ob,M212Db	Y?				
14	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Beaver River Black Creek Tributary				1				PORT-Sxc?	STL	222Ob	Y?				
16	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Deer River			2_20		1	2	1	PORT-S1c	STL, NAP	222Ob,M212Fb	Y				
17	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Independence River			2_21		1	1	3	PORT-S1c	STL, NAP	222Ob,M212Db	N				
107	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Moose River Size 2			2_22		1	1	1	PORT-S1c?	NAP	M212Db,M212Dd	Y				
18	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Moose River Size 3		3_11						PORT-S1c	STL, NAP	222Ob,M212Db,M212Dd	Y				
19	Northeastern Lake Ontario 48_14	Black Watershed	Black River, Whetstone Creek				1				PORT-S1c	STL, NAP	222Ob,M212Fb	Y				
28	Northeastern Lake Ontario 48_14	Chaumont-Perch Watershed	Chaumont River			2_16		1	2	3	PORT-S1c	STL	212Ee	Y?				
123	Northeastern Lake Ontario 48_14	Chaumont-Perch Watershed	Chaumont River Tributary				1				PORT-S1c	STL	212Ee	Y?				
72	Northeastern Lake Ontario 48_14	Chaumont-Perch Watershed	Perch River			2_16		2	3	1	PORT-S2c	STL, NLP	212Ee,222Pa	N				
124	Northeastern Lake Ontario 48_14	Chaumont-Perch Watershed	Perch River Tributary				1				PORT-S2c	STL, NLP	212Ee,222Pa	N				
96	Northeastern Lake Ontario 48_14	Chaumont-Perch Watershed	Upper Perch Lake								PORT-L	STL	212Ee	Y				
27	Northwest Adirondack 63_4	English-Salmon Watershed	Chateaugay River			2_11		6	6	6	PORT-N?	STL	212Eb	Y				
82	Northwest Adirondack 63_4	English-Salmon Watershed	Salmon River		3_0						PORT-Sxc	STL	212Ea,212Eb	N				
83	Northwest Adirondack 63_4	English-Salmon Watershed	Salmon River, Little Salmon River			2_12		3	2	2	PORT-S1c	STL	212Ea	N				
26	Northwest Adirondack 63_4	Grass Watershed	Cedar Lake								PORT-L	STL	212Eb,212Ee	Y				
133	Northwest Adirondack 63_4	Grass Watershed	Grass River, Elm Creek				1				PORT-S1c	STL	212Eb,212Ee	N				
39	Northwest Adirondack 63_4	Grass Watershed	Grass River, Little River			2_12		4	3	5	PORT-S1c	STL	212Ea,212Eb	Y?				
38	Northwest Adirondack 63_4	Grass Watershed	Grass River, Mainstem Size 3		3_7						PORT-S1c	STL	212Ea,212Eb,212Ee	Y				
40	Northwest Adirondack 63_4	Grass Watershed	Grass River, North Branch			2_10		3	1	4	PORT-S1c	STL, NAP	212Eb,M212Da	Y				

**APPENDIX F3
Aquatic Portfolio by Site Name**

Aquatic Portfolio Report as of 5/24/2002: Northeast Lake Ontario (48_14), Lake Champlain/St. Lawrence (63_1), and NW Adirondacks (63_4) Ecological Drainage Units

PORTHUC SITE ID	Ecological Drainage Unit	8-Digit Watershed Name	Aquatic Site Name	SYS4	SYS3	SYS2	SYS1	Size 2 Watershed Land Cover/Road Rank within System Type (1=best)	Size 2 Watershed Dams and DWS Rank within System Type (1=best)	Size 2 Watershed Point Source Rank within System Type (1=best)	Aquatic Ecoregional Team Portfolio Code	Ecoregion	Subsections	Subsection/Type Hunt Portfolio Code	Biodiversity Rank	Urgency/Threat	Feasibility	Score
110	Northwest Adirondack 63_4	Grass Watershed	Grass River, South Branch Size 2			2_10		8	1	6	PORT-S1c	STL, NAP	212Eb,M212Da,M212Dc	Y				
93	Northwest Adirondack 63_4	Grass Watershed	Grass River, Tanner Creek			2_13		2	1	3	PORT-S1c	STL	212Ee	Y				
125	Northwest Adirondack 63_4	Grass Watershed	Grass River, Tanner Creek Tributary				1				PORT-S1c	STL	212Ee	Y				
60	Northwest Adirondack 63_4	Grass Watershed	Little River, Canton Pond								PORT-S1c	STL	212Ea	Y?				
9	Northwest Adirondack 63_4	Indian Watershed	Black Creek/Jewett Creek			2_14		2	2	3	PORT-S1c	STL	212Ea,212Ee	Y				
10	Northwest Adirondack 63_4	Indian Watershed	Black Lake/Black Creek Lake								PORT-S1c	STL	212Ea,212Ee	Y, N				
15	Northwest Adirondack 63_4	Indian Watershed	Black River, Black Creek				1				PORT-S1c	STL, NAP	222Ob,M212Db	Y?				
24	Northwest Adirondack 63_4	Indian Watershed	Butterfield Lake								PORT-L?	STL	212Ee					
112	Northwest Adirondack 63_4	Indian Watershed	Indian River Size 2			2_13		1	3	2	PORT-S1c	STL	212Ee,222Ob	Y				
46	Northwest Adirondack 63_4	Indian Watershed	Indian River Size 3		3_9						PORT-S1c	STL	212Ee	Y				
66	Northwest Adirondack 63_4	Indian Watershed	Mud Lake Diana								PORT-L	STL	212Ee	Y				
129	Northwest Adirondack 63_4	Indian Watershed	Otter Creek				1				PORT-S1c?	STL	212Ee	N				
68	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Cranberry Lake to Chaumont Pond			2_10		2	7	9	PORT-S1c	NAP	M212Db,M212Dc					
131	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Hawkins Creek				1				PORT-S1c?	STL	212Ee	N				
135	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Mainstem	4							PORT-S1c	STL	212Ea	Y, N				
69	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Middle Branch			2_10		6	3	3	PORT-S1c	STL, NAP	222Ob,M212Db					
130	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Sawyer Creek				1				PORT-S1c?	STL	212Ee	N				
67	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, Size 3		3_9						PORT-S2c	STL, NAP	212Ea,212Eb,212Ee,M212Db	Y, N				
70	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, West Branch			2_10		6	3	3	PORT-S1c	STL, NAP	212Ee,222Ob,M212Db	N				
137	Northwest Adirondack 63_4	Oswegatchie Watershed	Oswegatchie River, West Branch Size 3		3_9						PORT-S1c	STL	212Ee	N				

**APPENDIX F3
Aquatic Portfolio by Site Name**

Aquatic Portfolio Report as of 5/24/2002: Northeast Lake Ontario (48_14), Lake Champlain/St. Lawrence (63_1), and NW Adirondacks (63_4) Ecological Drainage Units

PORTHUC SITE ID	Ecological Drainage Unit	8-Digit Watershed Name	Aquatic Site Name	SYS4	SYS3	SYS2	SYS1	Size 2 Watershed Land Cover/Road Rank within System Type (1=best)	Size 2 Watershed Dams and DWS Rank within System Type (1=best)	Size 2 Watershed Point Source Rank within System Type (1=best)	Aquatic Ecoregional Team Portfolio Code	Ecoregion	Subsections	Subsection/Type Hunt Portfolio Code	Biodiversity Rank	Urgency/Threat	Feasibility	Score
95	Northwest Adirondack 63_4	Oswegatchie Watershed	Twin Ponds								PORT-L	STL	212Ee	Y				
100	Northwest Adirondack 63_4	Oswegatchie Watershed	Yellow Lake								PORT-L	STL	212Ee	Y				
75	Northwest Adirondack 63_4	Raquette Watershed	Raquette River	4	3	8	1				PORT-Sxc	STL, NAP	212Ea,212Eb,M212Da,M212Dc,M212Dd	N				
76	Northwest Adirondack 63_4	Raquette Watershed	Raquette River, Jordan River			2	11	1	1	1	PORT-S1c	NAP	M212Da					
77	Northwest Adirondack 63_4	Raquette Watershed	Raquette River, Lake Raquette to Long Lake			2	10	4	4	2	PORT-S1c	NAP	M212Dc,M212Dd					
78	Northwest Adirondack 63_4	Raquette Watershed	Raquette River, Round Lake Outlet to Tupper Lake			2	10	7	5	5	PORT-S1c	NAP	M212Dc					
34	Northwest Adirondack 63_4	St. Regis Watershed	Deer River			2	11	4	2	2	PORT-N?	STL	212Ea,212Eb	Y				
126	Northwest Adirondack 63_4	St. Regis Watershed	Deer River Tributary					1			PORT-N?	STL	212Ea,212Eb	Y				
134	Northwest Adirondack 63_4	St. Regis Watershed	St Regis River, East Branch			2	11	4	2	2	PORT-S1c	NAP	M212Da					
114	Northwest Adirondack 63_4	St. Regis Watershed	St. Regis River, Size 2			2	11	4	2	2	PORT-S1c	NAP	M212Da,M212Dc					
90	Northwest Adirondack 63_4	St. Regis Watershed	St. Regis River, Size 3	3	7						PORT-S1c	STL, NAP	212Ea,212Eb,M212Da	N				
91	Northwest Adirondack 63_4	St. Regis Watershed	St. Regis River, West Branch			2	11	2	3	3	PORT-S1c	STL, NAP	212Ea,212Eb,M212Da	N				
94	Northwest Adirondack 63_4	St. Regis Watershed	Trout Brook			2	12	1	1	4	PORT-S1c	STL	212Eb	Y?				
127	Northwest Adirondack 63_4	St. Regis Watershed	Trout Brook Tributary					1			PORT-S1c	STL	212Eb	Y?				
2		St. Lawrence Shore	America Narrows								PORT-L	STL		Y				
21		St. Lawrence Shore	Brockville								PORT-L	STL		Y				
29		St. Lawrence Shore	Chippewa Bay								PORT-L	STL, NLP		Y				
37		St. Lawrence Shore	Goose Bay								PORT-L	STL		Y				
45		St. Lawrence Shore	Indian Chief Shoals								PORT-L	STL		Y				
53		St. Lawrence Shore	Lake of the Isles								PORT-L	NLP	222Pa	Y				
49			Lake Champlain								PORT-S1c	STL, LNE	212Ea,212Ec,221Bc	Y				

APPENDIX G: U.S. Ten-Year Action Sites by State

This document is available from The Nature Conservancy's New York State Office, Vermont State Office, or Conservation Science Support in Boston.

Bibliography*

- Abell, R. A., D.M. Olson, E. Dinerstein, P.T. Hurley, J.R. Diggs, W. Eichbaum, S. Walters, W. Wettengel, T. Allnutt, C.J. Loucks, and P. Hedao. 2000. Freshwater Ecoregions of North America: a conservation assessment. World Wildlife Fund – US, Island Press, Washington, DC. 319pp.
- Allen, J.D. 1995. Stream Ecology: Structure and function of running waters. Kluwer Academic Publishers. Dordrecht, The Netherlands
- Anderson, M.G. 1999. Viability and Spatial Assessment of Ecological Communities in the Northern Appalachian Ecoregion. University of New Hampshire, Durham, NH. Ph.D. dissertation.
- Anderson, M.G., P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reid, R. Schneider, B. Vickery, and A. Weakley. 1999. Guidelines for representing ecological communities in ecoregional conservation plans. The Nature Conservancy. 74 pp.
- Anderson, M.G., M.D. Merrill, and F.D. Biasi. 1998. Connecticut River Watershed Analysis: Ecological communities and Neo-tropical migratory birds. Final Report Summary to USGS Biological Resources Division. The Nature Conservancy, Boston, MA.
- Anderson, M.G., M.D. Merrill, F.D. Biasi and K.A. Poiani. 1998. Developing biodiversity surrogates for ecoregional planning in the Central Appalachians The Nature Conservancy, Boston, MA. Unpublished report.
- Anderson, M.G. and A.P. Olivero. 2000. The Lower New England Ecological Land Units: Draft Dataset Documentation. The Nature Conservancy, Boston, MA.
- Anderson, M.G. and B. Vickery. Scaling the coarse filter: determining the adequate size of ecosystem-based reserves. Conservation Biology. In press.
- Angermeier, P.L. and I.J. Schlosser. 1995. Conserving aquatic biodiversity: Beyond species and populations. American Fisheries Society Symposium 17: 402-414.
- Angermeier, P.L. and M.R. Winston. 1998. Local vs. regional influences on local diversity in stream fish communities of Virginia. Ecology 79: 911-927.
- Argent, D.G., J.A. Bishop, J.R. Stauffer, Jr., R.F. Carline, W.L. Myers. 2002. Predicting freshwater fish distributions using landscape-level variables. Fisheries Research 1411:1-16.
- Armitage, P.D. 1978. Downstream changes in the composition, numbers, and biomass of bottom fauna in the Tees below Cow Green Reservoir and in an unregulated tributary Maize Beck, in the first five years after impoundment. Hydrobiologia, 58:145-56.
- Arya, S. 1999. Explaining biotic integrity and habitat across multiple scales: an empirical analysis of landscape, land use, and land cover variables in an Ohio ecoregion, www.ucgis.org/oregon/papers/arya.htm

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

- Bailey, R.G., P.E. Avers, T. King, and W.H. McNab (editors). 1994. Ecoregions and subregions of the United States. Map (scale 1:7,500,000). U.S. Department of Agriculture, Forest Service.
- Bailey, R.G. 1995. Description of the ecoregions of the United States. 2nd Edition, USDA Forest Service Miscellaneous Publication 1391, Washington, DC 108pp.
- Baker, W.L. 1992. The landscape ecology of large disturbances in the design and management of nature reserves. *Landscape Ecology* 7: 181-194.
- Barnes, B.V. 1984. Forest ecosystem classification and mapping in Baden-Wurttemberg, West Germany. In: *Forest land classification: experience, problems, perspectives. Proceedings of the symposium; 1984 March 18-20*, pp. 49-65. Madison, WI
- Barnes, B.V., K.S. Pregitzer; T.A. Spies, and V.H. Spooner. 1982. Ecological forest site classification. *Journal of Forestry* 80: 493-98.
- Berkman, H.E. and C.F. Rabeni. 1987. Effect of siltation on stream fish communities. *Environmental Biology of Fishes*, 18:285-94.
- Bolstad, P.V. and W.T. Swank. 1997. Cumulative impacts of landuse on water quality in a Southern Appalachian watershed. *Journal of the American water resources association*, 33(3).
- Brittingham, M.C, and S.A. Temple. 1983. Have cowbirds caused forest songbirds to decline? *BioScience* 33:31-35
- Brody, A.J. and M.P. Pelton. 1989. Effects of roads on black bear movements in western North Carolina. *Wildl. Soc. Bull.* 17:5-10.
- Bryer, MT., R. Smith. 2001. *The Nature Conservancy's Aquatic Ecoregional Planning*. The Nature Conservancy. Arlington, VA.
- Burke, D.M., and E. Nol. 1998. Influence of food abundance, nest-site habitat, and forest fragmentation on breeding ovenbirds. *Auk* 115(1):96-104.
- Burnett, M.R., P.V. August, J.H. Brown, Jr., and K.T. Killingbeck. 1998. The influence of geomorphological heterogeneity on biodiversity. I. A patch-scale perspective. *Conservation Biology* 12: 363-370.
- Canham, C.D., and O.L. Loucks. 1984. Catastrophic windthrow in the presettlement forests of Wisconsin. *Ecology* 65:803-809.
- Chandler, D.S. 1987. Species richness and abundance of Pselaphidae (Coleoptera) in old-growth and 40-year-old forests in New Hampshire. *Can. J. Zool.* 65:608-615.
- Chasko, G.G., and J.E.Gates. 1982. Avian habitat suitability along a transmission-line corridor in an oak-hickory forest region. *Wildlife Monographs* 82:1-41.
- Couch, C. et al. 1997 *Fish Dynamics in Urban Streams Near Atlanta, Georgia*. Technical Note 94. *Watershed Protection Techniques*. 2(4): 511-514.
- Cox, J., R. Kautz, M. MacLaughlin, and T. Gilbert. 1994. *Closing the gaps in Florida's wildlife habitat conservation system*. Tallahassee (FL): Office of Environmental Services, Florida Game and Fresh Water Fish Commission.

- Culbertson, D.M., L.E. Young, and J.C. Brice. 1967. Scour and fill in alluvial channels. U.S. Geological Survey, Open File Report, 58 pp.
- Curatolo, J.A., and S.M. Murphy, 1986. The effects of pipelines, roads, and traffic on the movements of Caribou (*Rangifer tarandus*) *Canadian Field Naturalist* 100: 218-224.
- Dreher, D.W. 1997. Watershed urbanization impacts on stream quality indicators in Northeastern Illinois: pp. 129-135 in D. Murray and R. Kirschner (ed.) *Assessing the Cumulative Impacts of Watershed Development on Aquatic Ecosystems and Water Quality*. Northeastern Illinois Planning Commission, Chicago, IL.
- Duffy, D.C. and A.J. Meier. 1992. Do Appalachian herbaceous understories ever recover from clearcutting? *Conservation Biology* 6:196-201.
- Falinski, J.B. 1986. *Vegetation dynamics in temperate lowland primeval forests: ecological studies in Bialowieza Forest*. W. Junk Publ., Dordrecht.
- Fausch, K.D., C.E. Torgensen, C.V. Baxter, H.W. Li. 2002. Landscapes to riverscapes: bridging the gap between research and conservation of stream fishes. *BioScience* 52(6):483-498.
- Feminella, J.W. 2000. Correspondence between stream macroinvertebrate assemblages and 4 ecoregions of the southeastern USA. *Journal of the North American Benthological Society* 19:442-461
- Ferree, C.F. 2003. *Ecological systems: Supplementary metadata for systems30 raster data*. Northeast & Caribbean Division, The Nature Conservancy, Boston, MA.
- Ferris, C.R. 1979. Effects of Interstate 95 on breeding birds in northern Maine. *Journal of Wildlife Management* 43:421-427.
- Fitzhugh, T. 2001. *Watershed characteristics and aquatic ecological integrity: A literature review*. The Nature Conservancy, Freshwater Initiative.
- Forman, R.T.T. 1995. *Land mosaics: the ecology of landscapes and regions*. Cambridge University Press. Cambridge, 632 p.
- Forman, R.T.T. and L.E. Alexander. 1998. Roads and their major ecological effects. *Annu. Rev. Ecol. Syst.* 29:207-231.
- Foster, D.R., and E.R. Boose. 1992. Patterns of forest damage resulting from catastrophic wind in central New England. *Journal of Ecology* 1980:79-98.
- Foster, D.R., D.H. Knight, and J.F. Franklin. 1998. Landscape patterns and legacies resulting from large infrequent forest disturbances. *Ecosystems* 1:497-510.
- Franklin, J.F. 1993. Preserving biodiversity: species, ecosystems, or landscapes? *Ecological Applications* 3: 202-205.
- Frisell, C. A., W.J. Liss, C.E. Warren, and M.D. Hurley. 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed context. *Environmental Management* 10(2): 199-214
- Gates, J.E. 1991. Powerline corridors, edge effects and wildlife in forested landscapes of the Central Appalachians, in J.E. Rodiek and E.G. Bolen (eds.) *Wildlife and Habitats in managed landscapes*. Island Press, Washington, D.C.

- Gerritsen, J., M.T. Barbour, and K. King. 2000. Apples, oranges, and ecoregions: on determining pattern in aquatic assemblages. *Journal of the North American Benthological Society* 19: 487-496.
- Getz, L.L., F.R. Cole, and D.L. Gates. 1978. Interstates roadsides as dispersal routes for *Microtus pennsylvanicus*. *Journal of Mammalogy* 59:208-212.
- Gleick, P. 1993. *Water in Crisis. A Guide to the World's Fresh Water Resources*, Oxford University Press.
- Gordon, S.I. and S. Majumder. 2000. Empirical stressor-response relationships for prospective risk analysis. *Environmental Toxicology and Chemistry*, vol. 19, no. 4(2): 1106-1112.
- Grossman, D.H., D. Faber-Langendone, A.S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation of The United States. Volume I. The National Vegetation Classification System: development, status and applications*. The Nature Conservancy, Arlington, VA
- Groves, C., L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval, B. Runnels. 2000. *Designing Geography of Hope: A Practitioner's Handbook for Ecoregional Conservation Planning*. Arlington, VA: The Nature Conservancy.
- Groves, C.R., D.B. Jensen, L.L. Valutis, K.H. Redford, M.L. Shaffer, J.M. Scott, J.V. Baumgartner, J.V. Higgins, M.W. Beck, and M.G. Anderson. 2002. Planning for biodiversity conservation: Putting conservation science into practice. *BioScience*. 52(6): 499-512.
- Haney, J.C., and C.P. Schaadt. 1996. Functional role of eastern old-growth in promoting forest bird diversity. In M.B. Davis (ed.) *Eastern old-growth forests: prospects for rediscovery and recovery*. Island Press. Washington DC.
- Hansen, A.J., T.A. Spies, F.J. Swanson, and J.L. Ohman. 1991. Conserving biodiversity in managed forests. *BioScience* 41(6):382-392.
- Harmon, M.E., J.F. Franklin, F.J. Sanson, et al. 1986. Ecology of coarse woody debris in temperate ecosystems. *Adv. Ecol. Res.* 15:133-302.
- Hartley, M.J. and M.L. Hunter, Jr. 1997. A meta-analysis of forest cover, edge effects, and artificial nest predation rates. *Conserv. Biol.* 12(2): 465-469.
- Hawkins, C.P. and Vinson, 2000. Weak correspondence between landscape classifications and stream invertebrate assemblages: implications for bioassessment. *Journal of the North American Benthological Society* 19 (501-517).
- Higgins, J.V., M. Lammert, M.T. Bryer, M. M. DePhilip and D.H. Grossman. 1998. *Freshwater Conservation in the Great Lakes basin: Development and Application of an Aquatic Community Classification Framework*. The Nature Conservancy, Great Lakes Program, Chicago, IL.
- Higgins, J., M. Lammert, M. Bryer, T. FitzHugh, M. DePhilip, P. Gagnon, R. Smith. 2002. *Draft Standards for the Freshwater Components of Ecoregional Planning*. The Nature Conservancy. Unpublished report. 16pp.

- Hill, M.O. 1979. TWINSpan—A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ithaca, NY: Ecology and Systematics, Cornell University.
- Hodson, N.L. 1966. A survey of road mortality in mammals (and including data for the Grass snake and Common frog). *Journal of Zoology (London)* 148:576-579.
- Hudson, P.L., R.W. Griffiths, and T.J. Wheaton. 1992. Review of habitat classification schemes appropriate to streams, rivers, and connecting channels in the Great Lakes drainage basin. Pages 73-108 in Busch, W.D.N. and P.G. Sly eds. *The development of an aquatic habitat classification system for lakes*. Boca Raton, FL: CRC Press.
- Huey, L.M. 1941. Mammalian invasion via the highway. *Journal of Mammalogy* 22:383-385.
- Hunter, M.L. Jr. 1996. *Fundamentals of Conservation Biology*. Blackwell Science, Cambridge, MA. 482 pp.
- Jackson, D.A. and H.H. Harvey. 1989. Biogeographic associations in fish assemblages: Local vs. regional processes. *Ecology* 70: 1472-1484
- Jensen, M.E., I. Goodman, N.L. Poff, P.Bourgeron, J.R. Maxwell, C.J. Edwards, and D. Cleland. In Press. Use of ecological classification and mapping units in the characterization of aquatic systems for ecosystem management. *Water Resources Bulletin*.
- Johnson, R.K. 2000. Spatial congruence between ecoregions and littoral macroinvertebrate assemblages. *Journal of North American Benthological Society* 19:475-486.
- Jones, R. and C. Clark. 1987. Impact of Watershed Urbanization on Stream Insect Communities. American Water Resources Association. *Water Resources Bulletin*. 15(4).
- Keys, Jr.,J., C.Carpenter, S. Hooks, F. Koenig, W.H. McNab, W. Russell, M.L. Smith. 1995. *Ecological Units of the Eastern United States: first approximation*. Atlanta, GA: U.S. Department of Agriculture, Forest Service. CD-ROM.
- Klein, D.R. 1971. Reactions of reindeer to obstructions and disturbances. *Science* 173:393-398.
- Lammert, M., and J.D. Allan. 1999. Assessing biotic integrity of streams: Effects of scale in measuring the influence of land use/cover and habitat structure on fish and macroinvertebrates. *Environmental Management* 23: (2) 257-270.
- Lande, R.1988. Genetics and demography in biological conservation. *Science* 241: 1455-1460.
- Langdon, R., J. Andrews, K. Cox et al. 1998. *A Classification of The Aquatic Communities of Vermont*. Prepared by The Aquatic Classification Workgroup for The Nature Conservancy and the Vermont Biodiversity Project.
- Langton, T.E.S. (ed.). 1989. *Amphibians and Roads*. AOC Polymer Products LTD. Shefford, Bedfordshire, England.

- Leopold, L.B. and Wolman, M.G. 1957. River channel patterns: braided, meandering, and strait. U.S. Geological Survey Prof. Paper 282-B.
- Lorimer, C.G. 1977. The presettlement forest and natural disturbance cycle of northeastern Maine. *Ecology* 58: 139-148.
- Mader, H.J. 1984. Animal habitat isolation by roads and agricultural fields. *Biol. Cons.* 29:81-96.
- Mader, H.J. 1988. The significance of paved agricultural roads as barriers to ground dwelling arthropods. In K-F. Schreiber (ed.), *Connectivity in Landscape Ecology*, Ferdinand Schoningh, Paderborn Germany.
- Marchant, R., F. Wells, and P. Newall. 2000. Assessment of an ecoregion approach for classifying macroinvertebrate assemblages from streams in Victoria, Australia. *Journal of the North American Benthological Society* 19:497-500.
- Maxwell, J.R., C.J. Edwards, M.E. Jensen, S.J. Paustian, H. Parrott, and D.M. Hill. 1995. *A Hierarchical Framework of Aquatic Ecological Units in North America (Neararctic Zone)*. General Technical Report NC-176. St. Paul, MN: U.S. Department of Agriculture, Forest Service. 72 pp.
- Maybury, Kathleen P. (ed.). 1999. *Seeing the Forest and the Trees: Ecological Classification for Conservation*. The Nature Conservancy, Arlington, VA
- Meffe, G.K., and C.R. Carroll. 1994. *Principles of Conservation Biology*. Sinauer Associates, Sunderland, MA.
- Meixler, M.S. and M.B. Bain, 1999. *Application of GAP Analysis to New York Waters Final Report*. New York Cooperative Fish and Wildlife Research Unit. Department of Natural Resources Cornell University, Ithaca, NY.
- Mello, R.A. 1987. *Last stand of the red spruce*. Island Press. Washington, DC.
- Minshall, G.W., R.C. Petersen, K.W. Cummins, et al. 1983. Interbiome comparisons of stream ecosystem dynamics. *Ecological Monographs*. 53:1-25
- Missouri Gap Valley Segment Classification. 2000. <http://www.cerc.cr.usgs.gov/morap/>
- Morris, W., D. Doak, M. Groom, P. Kareiva, J. Fieborg, L. Gerber, P. Murphy, and D. Thompson. 1999. *A practical handbook of population viability analysis*. The Nature Conservancy, Arlington, VA.
- Moyle, P.B., and P.J. Randall. 1998. Evaluating the biotic integrity of watersheds in the Sierra Nevada, California. *Conservation Biology* 12(6): 1318-1326.
- Nightengale, E., G. Podniesinski, T. Davis, et al. 2001. *Aquatic Ecosystem Classification and Identification of Reference Systems: A comparison of Methodologies*. EPA 2001-STAR-LI Grant Proposal. Pennsylvania Science Office of The Nature Conservancy.
- Noss, R.F. 1987. Protecting natural areas in fragmented landscapes. *Natural Areas Journal* 7: 2-13.
- Odum, E.P. 1985. Trends expected in stressed ecosystems. *BioScience* 35:419:422.

- Oliver, C.D. and E.P. Stevens. 1977. Reconstruction of a mixed-species forest in central New England. *Ecology* 58(3):562-572.
- Olivero, A.P. 2003. Development of a GIS based freshwater aquatic ecosystem classification and conservation prioritization in Lower New England. Masters thesis, University of Massachusetts Boston.
- Oswood, M.W., J.B. Reynolds, J.G. Irons, and A. M. Milner. 2000. Distributions of freshwater fishes in ecoregions and hydroregions of Alaska. *Journal of the North American Benthological Society* 19:405-418.
- Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small mammals. *J. Appl. Ecol.* 11:51-59.
- Page, L.M., and B.M. Burr. 2001. *A Field Guide to Freshwater Fishes of North America North of Mexico*. Houghton Mifflin Co., Boston.
- Pan, Y., J.R. Stevenson, B.H. Hill, and A.T. Herlihy. 2000. Ecoregions and benthic diatom assemblages in mid-Atlantic Highland streams, USA. *Journal of North American Benthological Society* 19(3):518-540.
- Panetta, F.D., and A.J.M. Hopkins. 1992. Weeds in corridors: invasion and management. In D.A. Saunders and R.J. Hobbs, eds *Nature Conservation 2: the role of corridors*. Chipping Norton, Australia.
- Partners in Flight — U.S. 2003. <http://www.partnersinflight.org/>
- Paton, P.W.C. 1994. The effect of edge on avian nest success: how strong is the evidence? *Conserv. Biol.* 8:17-26.
- Pelton, M.R. 1996. The importance of old-growth to carnivores in eastern deciduous forests. In M.B. Davis (ed.) *Eastern old-growth forests, prospects for rediscovery and recovery*. Island press. Washington D.C. 383p.
- Perry, D.A. 1994. *Forest Ecosystems*. The John Hopkins University Press, Baltimore, MD.
- Peters, R.S., D.M. Waller, B. Noon, S.T.A. Pickett, D. Murphy, J. Cracraft, R. Kiester, W. Kuhlmann, O. Houck, and W.J. Snape, III. 1997. Standard scientific procedures for implementing ecosystem management on public lands. Pages 320-336 in Pickett STA, Ostfeld RS, Shachak M, Likens GE, eds. *The ecological basis of conservation: heterogeneity, ecosystems, and biodiversity*. New York (NY): Chapman and Hall.
- Pflieger, W.L. 1989. *Aquatic community classification system for Missouri*. Jefferson City, MO: Missouri Department of Conservation, Aquatic Series No. 19.
- Pickett, S.T.A. and J.N. Thompson. 1978. Patch dynamics and the design of nature reserves. *Bio. Cons.* 13: 27-37.
- Poff, N.L. and J.D. Allan 1995. Functional organization of stream fish assemblages in relation to hydrological variability. *Ecology* 76:606-627.
- Poiani, K.A., B.D. Richter, M.G. Anderson and H.Richter. 2000. Biodiversity conservation at multiple scales: Functional sites, landscapes, and networks. *BioScience* 50:133-146.

- Ponds Wilderness Areas, Adirondack Park, New York. M.S. Thesis, University of Vermont.
- Pulliam, H.R., 1988. Sources, sinks, and population regulation. *Am. Nat.* 132: 652-661.
- Quinn, J.F., and A. Hastings. 1987. Extinction in subdivided habitats. *Conservation Biology* 1:198-208.
- Rabeni, C. F. and K. E. Doisy. 2000 The correspondence of stream benthic invertebrate communities to regional classification schemes in Missouri. *Journal of the North American Benthological Society.*19:419-428.
- Rapport, D.J. 1989. What constitutes ecosystem health? *Pers. Bio. Med.* 33:120-132.
- Rapport, D.J., H.A. Regier, and T.C. Hutchinson. 1985. Ecosystem behavior under stress. *Am. Nat.* 125:617:640.
- Regier, H.A. and Meisner, J.D. 1990. Anticipated effects of climate change on freshwater fishes and their habitat. *Fisheries.* 15:10-15
- Reijnen, M.J.S.M., J.Thissen, and G.J. Bekker. 1987. Effects of road traffic on woodland breeding bird populations. *Acta Oecologia Generalis* 8:312-312.
- Reschke, C. 1990. Ecological Communities of New York State. New York Natural Heritage Program. NYS Department of Environmental Conservation, Latham, NY.
- Richards, C, L.B. Johnson, , and G.E. Host. 1996, Landscape-scale influences on stream habitats. *Canadian Journal of Fisheries and Aquatic Species* 53 (Supplement 1): 295-311
- Ritters, K.H., B.E. Law, and R.C. Kucera. 1992. A selection of forest condition indicators for monitoring. *Environ. Monit. Assess.* 20:21-33.
- Robbins, C.S., D.K. Dawson, and B.A. Dowell. 1989. Habitat area requirements of breeding forest birds of the Middle Atlantic States. *Wildlife Monographs* 103:1-34.
- Robinson, G.R., Jr. 1997. Portraying chemical properties of bedrock for water quality and ecosystem analysis: An approach for New England: U.S. Geological Survey Open-file report 97-154, 11 p.
- Rosgen, D.L. 1994. A classification of natural rivers. *Catena* 22: 169-99.
- Rost, G.R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. *Journal of Wildlife Management* 43:634-641.
- Rowe J.S., and B.V. Barnes. 1994. Geo-ecosystems and bio-ecosystems. *Bulletin of the Ecological Society of America* 75(1): 40-41
- Sandin, L., and R.K. Johnson. 2000. Ecoregions and benthic macroinvertebrate assemblages of Swedish streams. *Journal of North American Benthological Society* 19:462-474.
- Schlosser, I.J. 1982. Fish community structure and function along two habitat gradients in a headwater stream. *Ecological Monographs* 52: 395-414.
- Schlosser, I.J. 1991. Stream fish ecology: a landscape perspective. *BioScience* 41(10)704-712.

- Schlosser, I.J. 1995. Critical landscape attributes that influence fish population dynamics in headwater streams. *Hydrobiologia* 303:71-81.
- Schlosser, I.J. and P.L. Angermeier. 1995. Spatial variation in demographic processes in lotic fishes: conceptual models, empirical evidence, and implications for conservation. *American Fisheries Society Symposium* 17:392-401
- Schreiber, R.K., and J.H. Graves. 1977. Powerline corridors as possible barriers to the movements of small mammals. *American Midland Naturalist* 97:504-508.
- Schueler, T. 1994. The importance of imperviousness. *Watershed Protection Techniques* 1 (3): 100-111.
- Schumm, S.A. 1963. A tentative classification of alluvial river channels. U.S. Geological Survey Circular 477. Washington, DC.
- Schumm, S.A. 1977. *The Fluvial System*. Wiley, New York, 388pp.
- Seelbach, P.W., M.J. Wiley, J.C. Kotanchik, and M.E. Baker. 1997. A landscape-based ecological classification for river valley segments in lower Michigan. State of Michigan, Department of Natural Resources, Fisheries Division, Research Report 2036.
- Selva S. 1996. Using lichens to assess ecological continuity in northeastern forests. In M.B. Davis (ed.) *Eastern old-growth forests, prospects for rediscovery and recovery*. Island press. Washington D.C. 383p.
- Sheldon, A.L. 1968. Species diversity and longitudinal succession in stream fishes. *Ecology* 49: 193-198.
- Shugart, H.H., and West, D.C. 1981. Long term dynamics of forest ecosystems. *American Scientist* 69: 647-652.
- Singer, F.J. 1978. Behavior of mountain goats in relation to US Highway 2, Glacier National Park, Montana. *Journal of Wildlife Management* 42:591-597.
- Singer, F.J. and J.L. Dougherty. 1985. Movements and habitat use in an un hunted population of mountain goats (*Oreamnos americanus*). *Canadian Field Naturalist* 99:205-217.
- Smith, T.L. 1991. *Natural ecological communities of Pennsylvania*. Middletown, PA: The Nature Conservancy Pennsylvania Natural Diversity Inventory - East.
- Sneddon, L. (ed.). 1993. *Field form instructions for the description of sites and terrestrial, palustrine, and vegetated estuarine communities*. Version 2. Eastern Heritage Task Force, The Nature Conservancy. Boston, Massachusetts.
- Soule, M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. In Soule, M.E. and Wilcox, D.A. (eds.). *Conservation biology: an ecological-evolutionary perspective*. Sinauer Association, Sunderland, Massachusetts.
- Spies, T.A., J. Tappeiner, J. Pojar and D. Coates. 1991. Trends in ecosystem management at the stand level. *Transactions of the North American Wildlife and Natural Resources Conference* 56: 628-639.

- Stanford, J.A. and J.V. Ward, 1979. Stream regulation in North America, in *The Ecology of Regulated Rivers* (eds. J.V. Ward and J.A. Stanford). Plenum Publishing Corporation, New York, p. 215-236.
- Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in Southern Ontario. *Canadian Journal of Fisheries and Aquatic Sciences*. 45:492-501.
- Steele, R.C., and R.C. Welch (eds.). 1973. *Monks Wood: a nature reserve record*. Natural Environment, Research Council Huntingdon.
- Stevens, M.S. 1996. Wind disturbance of trees and the forest floor in old-growth and logged forests, Five Ponds Wilderness Areas, Adirondack Park, New York. M.S. Thesis, University of Vermont.
- Stoms, D.M., W.J. Okin, and F.W. Davis. 1997. Preserve selection modeling in the Columbia Plateau. Final report to The Nature Conservancy of Washington by the Institute for Computational Earth System Science and Department of Geography, University of California, Santa Barbara, CA.
- Theobald, D.M. (ed.) and U.S. Census Bureau. 2001, U.S. Census Block Group Housing Unit Density: 1960-1990, estimates 2000-2040.
- Tonn, W.M. 1990. Climate change and fish communities: A conceptual framework. *Transactions of the American Fisheries Society* 119: 337-352.
- Tonn, W.M., J.J. Magnuson, M. Rask, and J. Toivonen, 1990. Intercontinental comparison of small-lake fish assemblages: The balance between local and regional processes. *American Naturalist* 136: 345-375.
- Turner, M.G. and Dale, V.H. 1998. Comparing large infrequent disturbances: what have we learned? *Ecosystems* 1:493-496.
- Tyrrell, L.E., and T.R. Crow. 1994. Structural characteristics of old-growth hemlock-hardwood forests in relation to age. *Ecology* 72:370-386.
- United States Forest Service. 2001. Forest Service Stream Classification: Adopting a First Approximation. http://www.stream.fs.fed.us/streamnt/apr01/apr-01_01.htm
- Van der Zande, A.N., W.J. Ter Keurs, and W.J. van der Weidjen. 1980. The impact of roads on the densities of four bird species in an open field habitat – evidence of a long distance effect. *Biological Conservation* 18:299-321.
- Van Gelder, J.J. 1973. A quantitative approach to the mortality resulting from traffic in a population of *Bufo bufo* L. *Oecologia* 13:93-95.
- Vannote, R.L., G.W. Minshall, K.W. Cummings, et al. 1980. The river continuum concept. *Canadian Journal of Fisheries and Aquatic Science* 37:130-7.
- Van Sickle, J., and R.M. Hughes 2000. Classification strengths of ecoregions, catchments, and geographic clusters for aquatic vertebrates in Oregon. *Journal of the North American Benthological Society* 19:370-384.

- Verkaar, H.J. 1988. The possible role of road verges and river dykes as corridors for the exchange of plant species between natural habitats In K-F Schreiber (ed.) *Connectivity in Landscape Ecology*, pp79-84. Ferdinand Schoningh, Paderborn, Germany.
- Waite, I.R., A.T. Herlihy, D.P. Larsen, D.J. Klemm. 2000. Comparing strengths of geographic and nongeographic classifications of stream benthic macroinvertebrates in the Mid-Atlantic Highlands, USA. *Journal of North American Benthological Society* 19(3):429-441.
- Wang, L., J. Lyons, and R. Gatti. 1997. Influences of watershed land use on habitat quality and biotic integrity in Wisconsin streams. *Fisheries* 22 (6) 6-12.
- Waring, R.H. 1985. Imbalanced forest ecosystems, assessments and consequences. *For. Ecol. Manage.* 12:93-112.
- Wilcox, B.A., and D.D. Murphy. 1989. Migration and control of purple loosestrife (*Lythrum salicaria* L.) along highway corridors. *Environmental Management* 13:365-370.
- Williams, J.D. 2002. *National Audubon Society Field Guide to Fishes: North America. Revised Edition.* Chanticleer Press, Inc., New York.
- Wilson, E.O. 1987. The little things that run the world (the importance and conservation of invertebrates). *Conservation Biology* 1(4):344-346.
- Yoder, C.O., R. Miltner, and D. White. 1999. Assessing the Status of Aquatic Life Designated Uses in Urban and Suburban Watersheds, pp. 16-28 in R. Kirschner (ed.) *National Conference on Retrofit Opportunities for Water Resources Protection in Urban Environments*, EPA/6325/R-99/002.