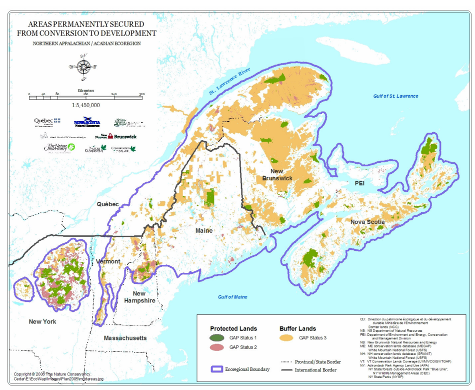
The Northern Appalachian / Acadian Ecoregion: Conservation Assessment
Status and Trends: 2006

Ecosystems

Species

Streams



Land

The Nature Conservancy: Eastern Regional Science
in collaboration with
The Nature Conservancy of Canada: Atlantic and Quebec regions
M. G. Anderson, B. Vickery, M. Gorman, L. Gratton,
M. Morrison, J. Maillet, A. Olivero, C. Ferree, D. Morse, G. Kehm, K. Rosalska

• KEY MESSAGES

Seven percent of the region is exclusively devoted to biodiversity protection. Another 28 percent is secured from conversion to development. Most secured lands are in the mountainous areas. Coastal regions and lowland valleys are the least protected.

The proportion of land secured from conversion to development is three times greater than that of land converted to agriculture or development. This is the only ecoregion in Eastern North America where land secured against conversion is proportionally higher than converted lands. Most likely this is due to the prominence of the forest products economy that has maintained forest cover across the region and slowed conversion to agriculture.

Large carnivores such as the wolf and mountain lion have been extirpated from the region. Another 148 endemic species (plants, vertebrates and invertebrates) are identified as specific conservation priorities because their populations are too small or few, or are declining too fast, to rely on broad-scale ecosystem protection alone as a conservation strategy. Of these 62% have fewer than ten protected populations.

Contiguous and ecologically complete forest ecosystems that once dominated the region are now largely young, simplified and increasingly fragmented by roads and development. Some 174 priority areas were identified that still maintain relatively intact interior forest systems over 25,000 acres in size. However only, twenty-eight percent of these have core protected areas on a scale that could maintain these ecosystems.

Forest cover has been increasing since the extensive deforestation of the 19th century. As a result, excluding developed land, agricultural land and roads, the remaining areas with over 80 percent natural cover amount to over 50% percent of the region. The Northern Appalachian / Acadian ecoregion is the most intact ecoregion in the eastern US and contains the broadest extent of nearly contiguous natural forest.

Non-forested upland ecosystems harbor extensive biodiversity. Over 400 sites containing 6000-plus examples, of beaches, barrens and alpine balds, grassy openings, stunted woodlands and stands of distinct forest types have been targeted for conservation. Of these, only very high elevation areas and serpentine bedrock features are over 50% protected for biodiversity. Protection of key places for coastal dunes and shores, acidic and calcareous barrens, and clay-plain forests are all below 30%

Critical wetland ecosystems have considerably less explicit protection than their upland counterparts, averaging 13%. Acidic wetlands, such as peatlands, enjoy the highest level of protection with about 37% protected for biodiversity. Floodplain and riverside systems as well as coastal and tidal wetlands all have less than 20% of their best examples on protected lands.

Conservation in this ecoregion is a collective effort. The protection of large contiguous areas of forest from conversion is mostly on state and provincial lands. Conservation of rare species and ecosystems is the result of actions by dozens of different public agencies and private organizations. Private ownerships account for 4% of the land protected for biodiversity in the ecoregion. Three quarters of that is attributable to The Nature Conservancy and the Nature Conservancy of Canada.

Threats to this region are on the rise. While in general the ecoregion is less threatened by housing development than other regions in the east, coastal and floodplain ecosystems are vulnerable to intense pressure in the next half-century. Further, there are emerging threats that cannot be prevented by land protection alone, such as impacts from atmospheric deposition, climate change, and invasive species, especially forest tree pathogens. These will require new conservation strategies.

KEY TERMS

Defining "Secured," "Protected" and "Managed"
The region encompasses many states and provinces with their own distinctive land use and ownership patterns, as well as institutional contexts. Our goal was to assess the conservation status of these lands and identify areas that were intended (by policy and practice) to contribute toward biodiversity conservation. We conducted a multi-jurisdictional review that used a standard framework to compare natural areas across administrative and political boundaries

As scientists and conservationists we agreed on conventions for talking about, mapping, and analyzing Land Status. The terms **Secured,** and **Protected** were very problematic. Our conventions are explained below:

Lands Permanently Secured against Conversion to Development (PSCD). This designation does not imply any specific biodiversity value other than ownership or restrictions that prevent land from being converted to development. Most secured lands are managed for extraction and/or recreation and some are managed very poorly. Secured lands are largely public lands subject to policy restrictions but they include some private management easements. Volunteer conservation lands or land under forest certification are not included under this heading as they have no permanent status and can be withdrawn at any time. Although we use the term permanence it is understood that the term is a hopeful one as it is theoretically possible to undue the protection of virtually any land in the region. For example, there may be provisions within state, crown or private conservation lands that allow it to be sold to new owners with lesser restrictions.

The PSCD lands are subdivided in to three levels of management status, with progressively less biodiversity focus. We classified the 3 groups into two basic levels: Protected and Secured

Protected (P): refers throughout this document to GAP 1 and GAP 2 lands. **GAP 1** lands are explicitly protected for biodiversity with a management plan to ensure this purpose and to allow for natural processes to occur freely (nature reserves, research natural areas). **GAP 2** lands are explicitly conserved for biodiversity but allow for alterations of natural processes, artificial manipulations and multiple uses (wildlife refuges, some US national parks).

Secured (S): refers throughout this document to lands that are secured only, and equal to a **GAP 3** status. Mostly they are public lands subject to extractive practices such as logging but governed to policy restrictions such as maintaining stream buffer areas (Crown lands, state forests). GAP 3 land will remain in primarily natural cover and is likely to play an important supporting role in maintaining biodiversity. Public managed lands are included here but commercially managed lands owned by private companies are not.

The shorthand used throughout this report is given below. We defined no standard meaning for "**Managed"**

Protected (P) = GAP 1, 2
Secured only (S) = GAP 3
<u>Total</u> Secured (P+S) = GAP 1,2,3

Our rules for assigning a value to a tract of land were consistent with the US GAP program in that:

- Management regime rather than institutional authority, mandate or ownership type would be the primary determinant in assigning status.
- Management intent (e.g., maintaining forest cover) would be used to define status, rather than the legal designation (e.g., protected area)
- Management effectiveness would not be measured, i.e., whether the management objectives or prescription had achieved the desired outcome.

Other terms The terms "occurrence", "example" and "element" may also require clarification.

Occurrence: Area of land and/or water where a species or natural community is, or was, present and has practical conservation value. For species these are often mapped locations of persistent breeding sites. For ecosystems and communities the word **Example** is sometime used as a synonym, as in "the best example of a floodplain forest". *see* <u>*Natural Heritage Methodology.*</u>

Element: Unit of natural biological diversity, representing species, ecological communities, ecological systems, or biological entities, such as migratory species aggregation areas.

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Acknowledgements

Ecoregional Core Team

Mark Anderson, Barbara Vickery, Martha Gorman, Louise Gratton, Greg Kehm, Charles Ferree, Arlene Olivero, Josette Maillet, Kasia Rozalska, Margo Morrison, Kara Brodribb, John Riley, Vince Zelazny, Rosemary Curley, Bill Glenn, Mary Lynn McCourt, David MacKinnon, Peter Neily, Robert Cameron, Sean Basquill, Shyama Khanna.

Science Teams

Mammals, Reptiles, Amphibians, Fish: Josette Maillet, Tom Herman, Mark Elderkin, Dwayne Sabine. Jacques Jutras, Claude Daigle, Nathalie Desrosiers, Walter Bertacchi, Norman Courtemanche, Alain Demers. Merry Gallagher, Fred Kircheis, Ken Sprankle, Phillip deMaynadier, Michale Glennon, Mark Ferguson, Rose Paul, John Roe

Birds: Barbara Vickery, Kate Bredin, Dan Busby, Richard Elliot, Tony Erskine, Mark Elderkin, Dwayne Sabine, Tom Hodgman, Peter Vickery, Nancy Sferra, Paul Novak, Pam Hunt , John Roe, Rose Paul, Mark Ferguson, Josée Tardif, Diane Amirault, Andrew Boyne, Yves Aubry, François Shaffer, Robert Houston, Lindsay Tutor, Brad Allen, Barbara Louks, Margaret Fowle, Michael Amaral, Dan Lambert.

Invertebrates: Barbara Vickery, Josette Maillet, Paul Brunelle, Mark Elderkin, Dwayne Sabine, Reg Webster, Phillip DeMaynadier, Paul Novak, John Roe, Rose Paul, Mark Ferguson.

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Forests, Terrestrial, Palustrine and Estuarine Ecosystems: Mark Anderson, Louise Gratton, Vince Zelazny, Judy Loo, Sean Basquill, Peter Neily, Kate MacQuarrie, Jon Hutchinson, Eric Sorenson, Liz Thompson, David Hunt, Greg Edinger, Doug Bechtel, Dan Sperduto, Stephanie Neid, Sue Gawler, Andy Cutko, Josh Royte.

Ecoregional Secured-Lands Team
Core team plus Craig Cheeseman (NY), Barnaby Friedman (NY), Sarah Wakefield (VT), Pete Ingraham (NH), Daniel Coker (ME)

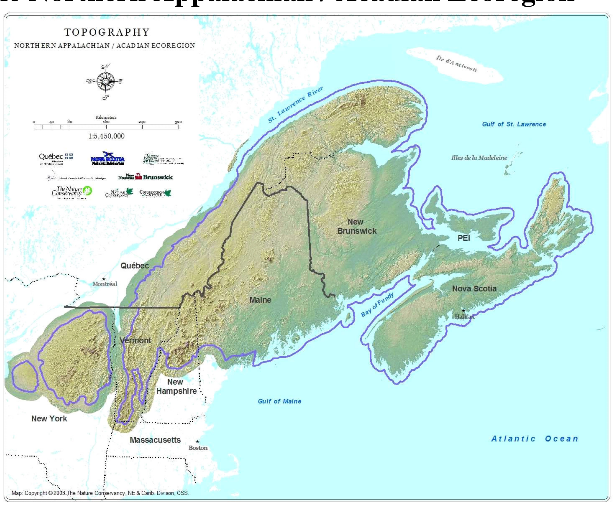
(final draft Anderson 06)

• Introduction

This report aims to measure and summarize the status of Nature Conservation in the Northern Appalachian / Acadian Ecoregion. Using sophisticated quantitative and spatial analysis techniques, it summarizes three decades of ecological inventory data, geological, hydrological, and landcover mapping, advanced predictive modeling techniques, and expert knowledge from the abundant store of academic, state, provincial and privately based conservation scientists in the region.

In particular, this analysis reports the results of The Nature Conservancy and the Nature Conservancy of Canada's **Ecoregional Assessment** completed over the last 3 years by a team of scientists representing many different institutions and areas of expertise. Additionally, it utilizes the Conservancy's recently compiled **Secured and Protected Lands data base** representing over 150,000 tracts of land in the eastern US and maritime Canada that have conservation value.

The Northern Appalachian / Acadian Ecoregion



The extent of the ecoregion is shown above. The 83 million acre area includes four Northeastern States, three Canadian Maritime Provinces and the portion of Quebec from the St. Lawrence river southward. It is a region of immense physical diversity from windswept alpine mountains to rugged rocky shoreline. Almost entirely forested, the region contains a wide range of bedrock types, landforms, elevation gradients, and an estimated 3,844 species of mammals, reptiles, amphibians, birds, plants, and macro-invertebrates. *Detailed information on the ecoregion assessment and each of the target ecosystems and species may be found in the full document contained on the accompanying CD*

Our goal in this assessment was a rigorous, repeatable identification of the most critical ecological features of the region, and a consistent, transparent rendering of trends. For brevity we report most numbers, the majority of which are averages, without their standard deviations, variances and error bars. Instead we emphasize trends and comparisons by reporting in percentages or broad categories. This flattens out the endless small variations in the precise numbers while having little or no effect on the distribution patterns.

We hope this document serves as an initial benchmark against which we may measure, focus and improve our conservation efforts in this remarkable region.

Ecoregional Statistics

- Total Acres = 82,865,628
- Forest 83%
- Wetlands 4%
- Water 11%
- Natural cover 97%
- Developed 3%
- Agriculture 22%
- GAP:1,2 land 7%
- GAP:3 land 28%
- Rare species = 523
- All plants, vertebrates and macro invertebrate species = 3,844

What We Hoped to Achieve:

In a populated, highly managed, but resilient region such as this one, our hope is to maintain all of the region's native species, ecosystems and dynamic processes using a small, but strategically chosen, portion of the landscape. Designing the plan required enough detail to ensure that every place, population and feature selected for the portfolio was critically judged by its potential biotic impact on the larger landscape. The results reveal patterns of diversity and threats that suggest inventive strategies for improved conservation. Our hope is that the portfolio, when conserved, will maintain all biodiversity across the ecoregion.

An International Team:

The assessment team consisted of seven key scientists and planners, three from the US- based Nature Conservancy (TNC) and four from the Nature Conservancy of Canada (NCC), each of who contributed a portion of their time. The team was convened in 2003 by TNC's Regional Director of Conservation Science, Dr. Mark Anderson and consisted of three geographic co-leaders, Barbara Vickery for the US, Martha Gorman for Maritime Canada and Louise Gratton for Quebec. Greg Kehm, Charles Ferree, and Arlene Olivero from TNC's Eastern Regional Office and Josette Maillet, Kasia Rozalska and Margo Morrison, from the Atlantic Canada Regional Office, provided technical support.

Additional core team members included Kara Brodribb and John Riley of NCC, Vince Zelazny of the New Brunswick DNR, Prince Edward Island: Rosemary Curley, Bill Glenn, Mary Lynn McCourt from Prince Edward Island DAF, David MacKinnon and Robert Cameron of Nova Scotia DEL, Sean Basquill of ACCDC and Peter Neily of Nova Scotia DNR. The core team provided the leadership for the technical teams whose memberships are listed in the individual chapters.

Challenges to Achieving Our Goals: Capacity and Data overflow

The Northern Appalachian / Acadian Ecoregion is an extensively studied ecoregion and there is much available data. Numerous private and public agencies monitor forest and wetland resources, breeding bird population, lynx trapping and other aspects of biodiversity. US state-based Natural Heritage Programs and Canadian Conservation Data Centres track over 18,000 individual occurrences of "elements of diversity." Quantitative information on threats and constraints such as roads, dams, toxic release points, housing density and population growth are readily available.

The challenge of acquiring, deciphering, compiling and quality controlling data across four states and four Canadian provinces was constant and time consuming. Facilitating collaboration across countries, maintaining relationships and renegotiating data sharing MOUs with provincial and state programs was likewise demanding.

A key tenet of this effort was to maximize the utility of our products to other organizations by providing a comprehensive and scrupulously objective analysis of the biodiversity targets in the ecoregion. We expect that many other organizations and partners will access the data, study the analysis and draw their own conclusions.

• BASIC PRINCIPLES

This report aims to answer the question – *Where are, and how protected are, the places that sustain the biodiversity of the region?* Some places harbor unique features or rare populations; others have the best examples of common or representative ecosystem types, and still others have large and influential remnants of once contiguous forest. All of these places are important in maintaining biodiversity and natural processes across the entire region.

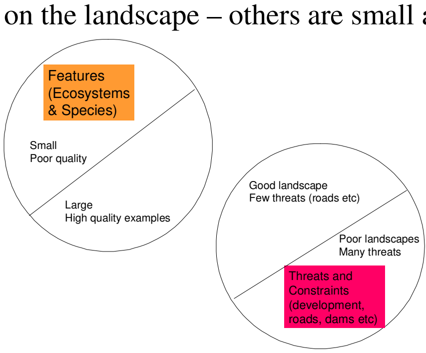
To assess the conservation status we examined the condition and spatial configuration of three factors:

- Conservation features
- Existing threats and constraints
- Land management status

The intersection of the first two factors produced what we refer to as the portfolio of critical occurrences (Figure 1 and 2). The portfolio is our best estimate of the most important places to protect to conserve all biodiversity. Adding the third factor (Figure 3 and 4) allowed us to determine the protection status of the lands that the critical features occur on to gauge where we stand with respect to the conservation of nature.

We developed comprehensive information concerning these three factors. Each data layer was obtained from the state or province, compiled for the region using comparable criteria, and maintained in a GIS framework. US Heritage programs and Canadian Conservation Data Centers provided ground inventory points with detailed information on rare species and community types.

Figure 1. The universe of conservation features within a region includes all examples of ecosystems, species, stream networks and special features. Some examples are robust, high quality examples with a large influence on the landscape – others are small and poor quality.



Likewise the landscape itself has regions that are functionally intact with few roads, little development, high amounts of natural cover and few threats. Other regions are highly fragmented and degraded by numerous factors.

Figure 2. The intersection of high quality examples with intact landscapes/low threats defines The Nature Conservancy's portfolio of critical examples

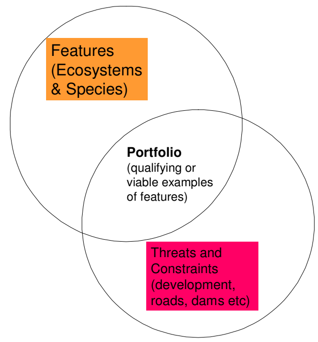


Figure 3. The third circle denotes the management status of land. Some lands are permanently dedicated to biodiversity conservation; others are only secured against conversion; most are unprotected.

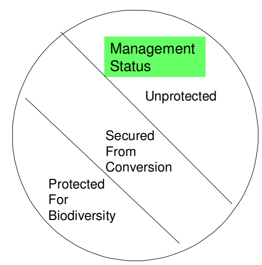
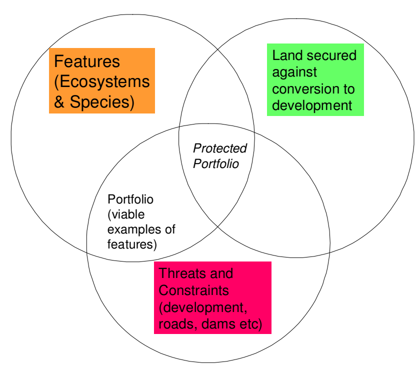


Figure 4. The intersection of these three dimensions, the **secured portfolio**, is the basis of this report on the conservation status of the region.



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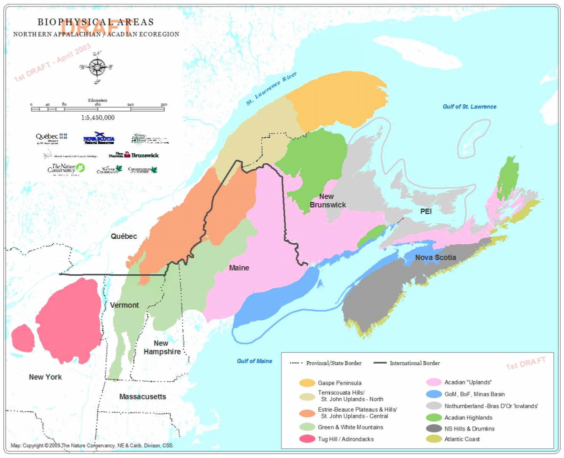
- **THE ECOREGION**



The map shows the subregions of the Ecoregion (full version in map appendix).

Location and Physiography:

The Northern Appalachian-Acadian (NAP) Ecoregion extends from the Tug Hill and Adirondack ranges of New York, across the Green Mountains of Vermont and the White Mountains of New Hampshire, into Maine and Maritime Canada. It includes all the provinces of New Brunswick, Nova Scotia, and Prince Edward Island, as well as Îles-de-la-Madeleine (Magdalene Islands) and the part of Quebec extending from the Gaspé Peninsula, southwesterly through the Appalachian complex of eastern Quebec to the United States border, south of Sherbrooke. (**See the <u>Atlas of the Ecoregion</u>** included on the CD for maps of elevation zones, climate zone, bedrock and surficial geology, topographic features, landcover and Ecological Land Units).

Subregions:

A set of relatively homogeneous subregions were delineated by a international team of scientists based on geology, elevations and landform patterns, using limits defined by previous research in the states and provinces. The resulting 11 subregions were used to ensure representation of conservation features across the full spectrum of ecological gradients characteristic of the region.

- **SUBREGIONS (by size)**

Acadian 'Uplands', 18,522,733 acres. Large lowland area with extensive wetland, rivers and floodplains.

Green & White Mountains, 10,461,891 acres. Mountainous regions in the US with several alpine peaks

Estrie-Beauce Plateaus & Hills/St. John Uplands - Central, 9,238,688 acres. Sedimentary region with low rolling hills on the US / Quebec boundary.

Northumberland - Bras D'Or 'lowlands', 8,003,893 acres. Very low wet region on the eastern Maritime coast. Includes all of Prince Edward Island.

Adirondacks & Tug Hill, 6,689,649 acres. Deciduous forest dominated region on ancient mountain core characterized by interesting bedrock (anorthosite) or shales in the Tug Hill.

Gaspè Peninsula, 6,169,321 acres. Sedimentary high mountains abruptly sloping to the Atlantic coast.

Acadian Highlands, 6,036,086 acres. Mid-elevation mountain region of northern New Brunswick.

Temiscouata Hills - St. John Uplands - North, 5,808,281 acres. Flat, northern sedimentary region of bogs and conifer forest.

Nova Scotia Hills & Drumlins, 5,747,103 acres. Glacially shaped region of Nova Scotia lowlands.

Gulf of Maine, Bay of Fundy, Minas Basin, 4,541,219 acres. Rocky shoreline and bay with very high tides and extensive tidal marshes.

Atlantic Coast, 1,371,542 acres. Southern rocky coastline of Nova Scotia, with bogs and tidal flats.

Total acres: 82,865,628

Ecoregion Boundaries and Subregions Team: Martha Gorman (NCC) Mark Anderson (TNC). Ting Li, Vince Gerardin, and Guy Jolicoeur (QC); Vince Zelazny (NBDNR), Connie Carpenter (USDA Forest Service NH); Peter Neily (NSDNR); Greg Kehm (TNC)

Biodiversity Significance:

The NAP Ecoregion extends over large ecological gradients from the boreal forest to the north and the deciduous forest to the south. The Gaspé Peninsula and higher elevations support taiga elements. At lower elevations and latitudes, there is a gradual shift toward higher proportions of northern hardwood and mixedwood species which marks the transition into the Acadian forest. It also supports local endemic species, as well as rare, disjunct, and peripheral populations of arctic, alpine, alleghenian and coastal plain species that are more common elsewhere.

The forest is a heterogeneous landscape containing varying proportions of upland hardwood and spruce-fir types. It is characterized by long-lived, shade-tolerant conifer and deciduous species, such as red spruce, balsam fir, yellow birch, sugar maple, red oak, red maple and American beech, while red and eastern white pine and eastern hemlock occur to a lesser but significant degree.

There has been a historical shift away from the uneven-aged and multi-generational "old growth" forest toward even-aged and early successional forest types due to human activities. This mirrors the historical trends toward mechanization and industrialization within the forest resource sector over the past century and a shift from harvesting large dimension lumber to smaller dimension pulpwood.

For vertebrate diversity, the NAP ecoregion is among the 20 richest ecoregions in the continental United States and Canada, and is the second-richest ecoregion within the temperate broadleaf and mixed forest types. The forests also contain 14 species of conifers, more than any other ecoregion within this major habitat type, with the exception of the Southern Appalachian-Blue Ridge Forests and the Southeastern Mixed Forests.

Characteristic mammals include moose, black bear, red fox, snowshoe hare, porcupine, fisher, beaver, bobcat, lynx, marten, muskrat, and raccoon, although some of these species are less common in the southern parts of the ecoregion. White-tailed deer have expanded northward in this ecoregion, displacing (or replacing) the woodland caribou from the northern realms where the latter were extirpated in the late 1800's by hunting. Coyotes have recently replaced wolves, which were eradicated from this ecoregion in historical times, along with the eastern cougar. The 148 endemic species are discussed in detail later in this document.

A diversity of aquatic, wetland, riparian, and coastal ecosystems are interspersed between forest and woodland habitats, including floodplains, marshes, estuaries, bogs, fens and peatlands, not to mention the vast stretches of cobble, sand and barrier beaches, dune systems that characterize the Northumberland Strait. Shoreline features include the coastal marshes and tidal mudflats of the Upper Bay of Fundy, the rocky headlands, ravines and coastal forests of the Lower Bay of Fundy and Atlantic Coast, and the many offshore islands that dot the coastline. Bald eagles reach their highest breeding density in eastern North America (Nova Scotia) and the Upper Bay of Fundy is a globally significant flyway for as many as 2.5 million semipalmated sandpipers that feed in the tidal mudflats. The ecoregion has many fast-flowing, cold water rocky rivers with highly fluctuating water levels that support rare species and assemblages.

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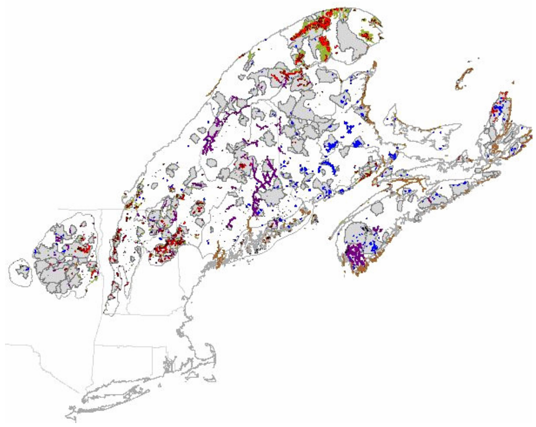
- **PORTFOLIO of CRITICAL OCCURRENCES**



The Portfolio Map (full version in appendix) shows the location of the best examples of:

- **Terrestrial Intact Forest Blocks**
  Large (10,000 – 100,000 acres) areas of contiguous forests with few roads and mostly intact interior forest ecosystem features.

- **Terrestrial Non-forest Ecosystems***
  Alpine ecosystems
  Summits and ridges
  Cliffs, steep slopes, bowls & ravines
  Barrens and flats
  Coastal dunes and beaches

- **Wetland Ecosystems**
  Forested swamps
  Bogs and fens
  Fresh water marshes
  Tidal salt and brackish marshes
  Seeps and swales
  Floodplains
  Shoreline meadows

- **Aquatic Stream Networks**
  Large rivers
  Medium sized streams
  Small headwater, feeder and coastal streams

- **Species**
  Rare mammals, birds, reptiles, amphibians, fish, invertebrates, plants and global endemics.
  Wide-ranging vertebrates
  Breeding, wintering and stopover concentrations of migratory waterfowl and other birds.

What is the Portfolio and Why is it Important?
The conservation portfolio was developed to identify those places that are the most critical to conserve. It reflects the understanding that some places play a more important role than others in maintaining biodiversity across the landscape. Particularly crucial are source habitats for interior forest species, complete and functional examples of common ecosystems, viable populations and breeding sites of rare species, and flowing stream systems connected from headwater to mouth.

These "occurrences" have been evaluated based on their size, condition and landscape context, and have had their importance confirmed by over 18,000 ground inventory points provided by US. State Natural Heritage Programs and Canadian Conservation Data centers. Additionally they reflect the knowledge and opinions of over 40 ecologists, biologists, forest managers and wildlife specialists from academic, state, provincial and federal institutions.

The portfolio of critical occurrences has taken almost four years of collaborative effort to develop and is revised and maintained annually based on new information and conservation progress.

How are these Data Used?
These are not the only places to do conservation, of course, but the portfolio provides a scientific gauge to assess whether our finite conservation dollars and efforts are being directed at the most influential and critical places.

Throughout this document conservation effort is summarized in two ways: 1) relative to all features in the region and 2) relative to the critical occurrences in the portfolio. The two perspectives allow for a refined understanding of how efforts are totaling up.

For further information on the portfolio contact your state Nature Conservancy office, provincial Nature Conservancy of Canada office or the Eastern Regional Conservation Science Team which is responsible for the development and maintenance of the information.

* Includes specialized patch-forming forest types

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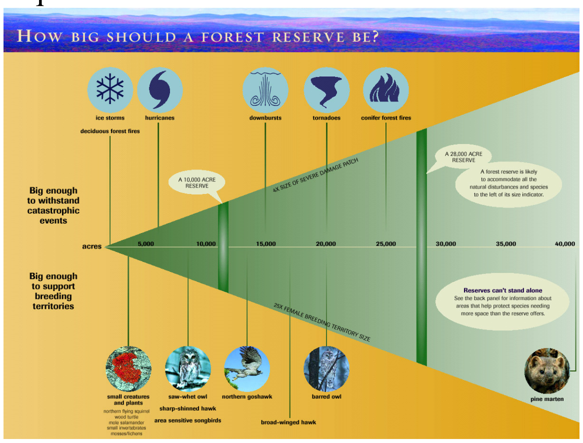
- **SCREENING CRITERIA**

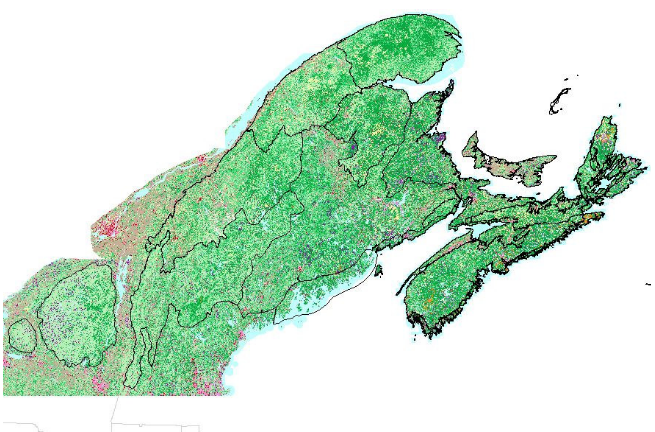
Size and Condition

Example: Chart of disturbances and species area requirements for Eastern Forests

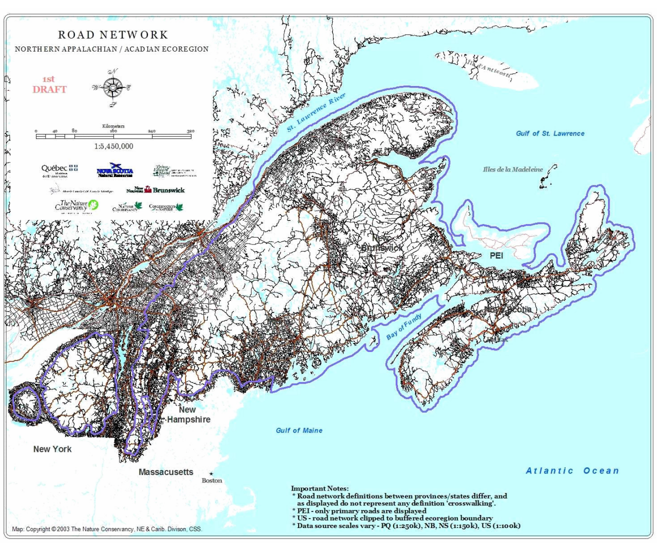


Threats Surface Map components

Example: Land-cover (full version in appendix)



Example: Roads



What are these Criteria and Why are they Important?

The influence of a particular ecosystem example or a species breeding location on maintaining regional biodiversity is due, in large part to its **size** and **condition**. Ideally, an ecosystem should be complete with respect to its component species, should serve as source habitat for characteristic species and play a pivotal role in exporting individuals to the larger landscape. High quality examples contain habitat in which the component species thrive because the habitat provides adequate resources, minimizes mortality and facilitates reproduction. Critical population sites or breeding areas consistently produce surplus individuals that emigrate to the larger landscape. High quality habitat may also serve as refugia or strongholds of rare or uncommon species that have already disappeared from the surrounding landscape.

The landscape context in which the occurrence is found is also crucial in determining whether the feature will persist into the next century and what sort of threat pressures are likely to constrain its influence or impair its function. Landscape context is commonly evaluated by creating a spatially explicit "**threat surface**" map, developed by compiling maps of features such as development, agriculture, quarries, mining leases, roads, dams, toxic release points, ownerships, housing density, etc. This allows any point on the landscape to be objectively ranked as to degree of threat and the pressure summarized by a numeric index.

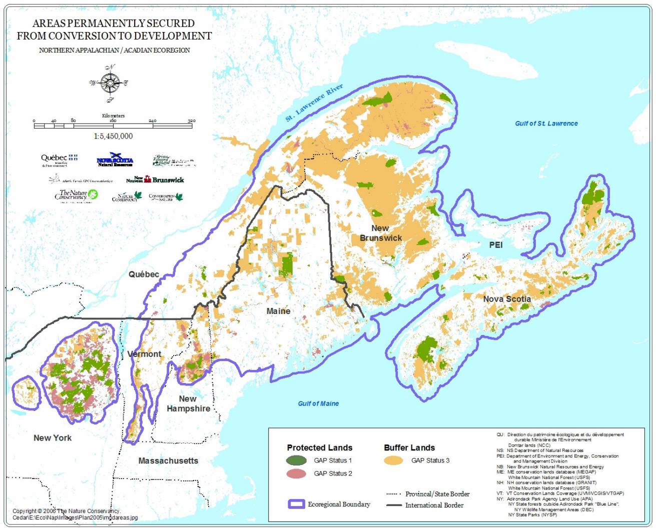
We established and applied **screening criteria** to every ecosystem and species example to determine if it was likely to be a **critical** occurrence and qualify for the portfolio. Those that met the criteria were referred to as **qualifying;** those that did not meet the criteria were classified as **supporting** occurrences – important but not crucial to the conservation of biodiversity in the ecoregion. The criteria used to separate the critical occurrences from the supporting ones were:

- **Size and Condition** of the occurrence.
- **Threat and Landscape context** surrounding the occurrence.

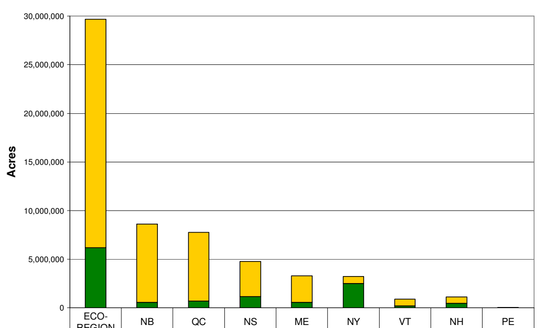
Application of the screening criteria eliminated thousands of potential occurrences from the portfolio narrowing the set of final places down to those that were judged to be absolutely critical in maintaining biodiversity in the region. These are used as a benchmark to determine the degree to which land protection is focused on crucial places.

PERMANENTLY SECURED LAND

Map of Areas Permanently Secured against Conversion to Development

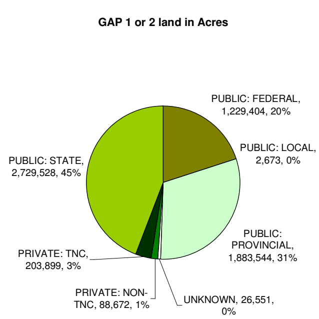


Protected (GAP:1,2) and Secured only (GAP: 3) Land by Ecoregion



	ECO-REGION	NB	QC	NS	ME	NY	VT	NH	PE
GAP3	23,511,282	8,027,615	7,053,500	3,594,334	2,732,390	722,089	715,734	631,699	4,369
GAP1,2	6,164,271	568,967	701,563	1,155,743	563,068	2,485,797	184,699	465,297	38,806

Distribution of Ownerships



Data Sources: TNC: Lands permanently secured from conversion to development (Dec 2005)

What is GAP Status and Why is it Important?
This indicator looks at land ownership and identifies those tracts of lands that have permanent legal protection against conversion to development. We classified the land into three status levels: GAP 1 lands are explicitly protected for biodiversity with a management plan to ensure this purpose and to allow for natural processes to occur freely (nature reserves, research natural areas). GAP 2 lands are explicitly conserved for biodiversity but allow for alterations of natural processes, artificial manipulations and multiple uses (wildlife refuges, some US national parks). Most of the lands shown are GAP 3, defined as subject to extractive practices such as logging but governed to policy restrictions such as maintaining stream buffer areas (Crown lands, state forests). GAP 3 land will remain in primarily natural cover and is likely to play a key supporting role in maintaining biodiversity.

What Do the Data Show? Thirty-six percent of the region, over 29 million acres, are secured against conversion but only 7% is explicitly protected for biodiversity. Amounts range from a high in New Brunswick of over 8.5 million acres to a low in PEI of 43,000 acres. New York has the highest amount of reserve land (GAP status 1 or 2) with almost 2.5 million acres, most of that in the Adirondack state park.

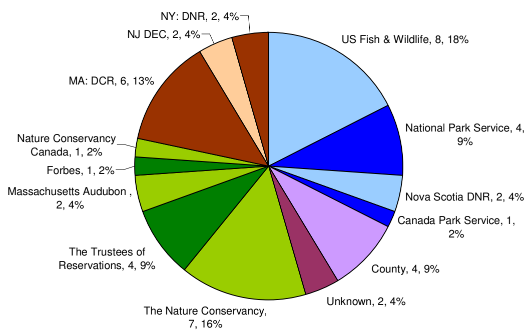
Public lands account for 96% of the GAP 1 & 2 lands and state or provincial lands make up the bulk of it. Private land accounts for 4% of the area explicitly protected for biodiversity. Nature Conservancy and Nature Conservancy of Canada lands account for three quarters of that – 204,000 acres.

How is this measure calculated?
The data base was created using existing state, provincial and federal data layers compiled and calibrated by The Nature Conservancy's Eastern Regional Science team into a single coverage. Base information was augmented with parcel data from The Nature Conservancy and other land trusts, collected, categorized and digitized using funding provided by Sweetwater Trust and other foundations.

- ## COLLECTIVE CONSERVATION
  ## Percent Ownership of Features

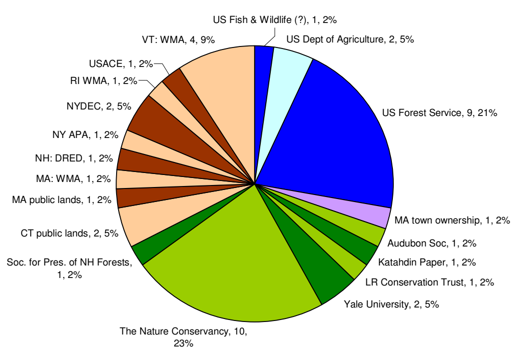
Species Example: Piping Plover

Piping Plover: Ownership of Viable Occurrences on Secured Lands



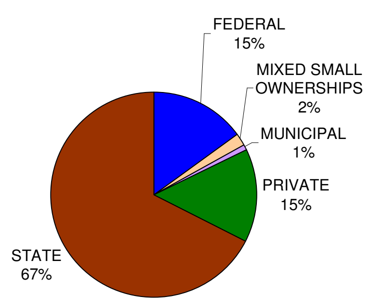
Ecosystem Example: Acidic Fens

Acid Fens: Ownership of Viable Occurrences on Secured Lands in 5 US ecoregions



Matrix Forest Example: Four US Ecoregions

Ownership of Forest Blocks across Four US Ecoregions



In the above charts Federal/Provincial land is in blue, State land in brown, Municipal land in purple and Private ownerships in green

Data source: TNC's ecoregional assessments

What is this Measure and Why is it Important? The conservation of critical ecosystems and species is a joint public–private effort. This measure examines, accounts for, and recognizes, the vast network of players involved in achieving a cumulative conservation effect. Sorting out acquisitions, fee ownership, management leads and easement holders can be complex. The charts and tables have been simplified to provide the clearest picture of how responsibilities are distributed across organizations and individuals.

What Do the Data Show? Patterns differ from target to target but general trends are reflected in these three examples given. The conservation of species such as the piping plover, and small ecological systems such as the acidic fens, is dispersed across ownerships (14 for the plover and 19 for the fens), ownership categories (shown by color groups) and ecoregions (3 for the plover, and 5 for the fens).

The conservation of large contiguous matrix-forest blocks in the US is dominated by state lands (70%) with federal and private contributing about 15 % each. In Canada the same pattern holds with provincial lands making up the bulk of forest protection. Within a single forest block conservation ownerships range from sole organizations to over 20 different organizations and individuals.

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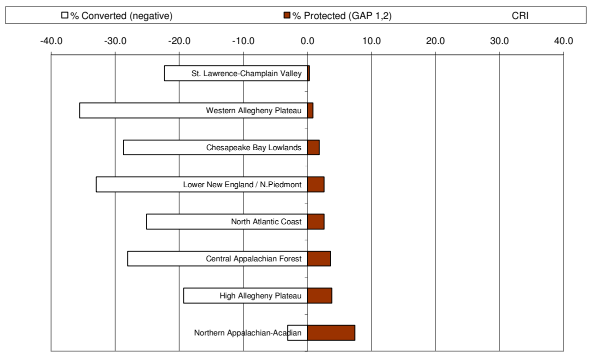
The analysis highlights the significant results achieved by collective and collaborative conservation efforts. Notable is the large role played by private conservation lands in the East.

How is the measure calculated? Information on tract boundaries, fee ownership, easement holders, organization types, acreages, and level of protection are maintained in a spatial data base of over 150,000 separate tracts of permanently secured lands. This information can be overlaid with other spatial data sets such as the locations of critical features to identify the correspondence between ownerships and targets.

(final draft Anderson 06)

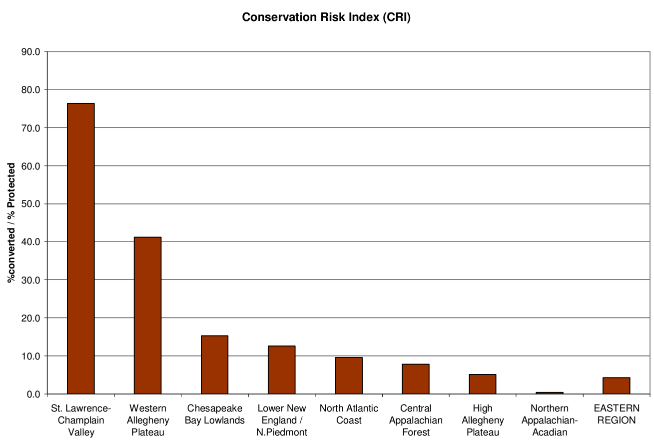
• CONSERVATION RISK INDEX

Ratio of Conversion to Protection by Ecoregion



	Northern Appalachian-Acadian	High Allegheny Plateau	Central Appalachian Forest	North Atlantic Coast	Lower New England / N.Piedmont	Chesapeake Bay Lowlands	Western Allegheny Plateau	St. Lawrence-Champlain Valley
CRI	0.4	5.1	7.8	9.6	12.6	15.3	41.2	76.4
% Protected (GAP 1,2)	7.4	3.8	3.6	2.6	2.6	1.9	0.9	0.3
% Converted (negative)	-3.1	-19.3	-28.1	-25.1	-33.0	-28.7	-35.6	-22.3

The Conservation Risk Index (CRI)



Data Sources: National Land Cover Dataset (NLCD- US Environmental Protection Agency), Permanently Secured Lands (The Nature Conservancy – Eastern US region)

Crisis and Opportunity Ecoregions have been identified at a coarse level for all the biomes and ecoregions on Earth. This categorization is an important part of the prioritization process used byT the Nature Conservancy to reach its 2015 goa.l

What is This Measure and Why is it Important? The Conservation Risk Index (CRI) measures the disparity between habitat loss and protection. It is calculated as:

CRI = % converted / % conserved

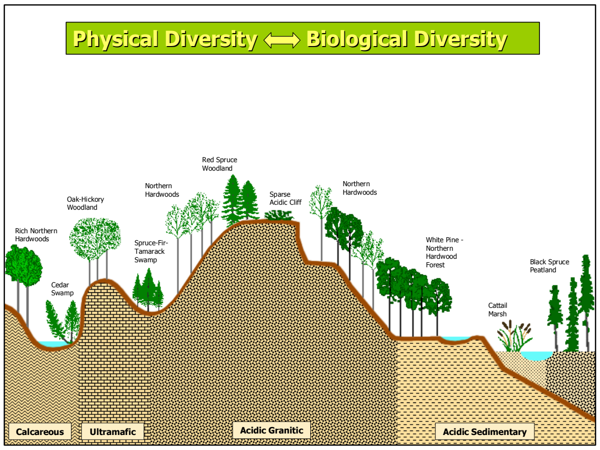
Assuming that the region was once entirely covered by natural systems, this indicator examines the proportion of the region that is now converted and compares it to the proportion that has been protected for biodiversity. A high CRI suggests that conversion is 5 to 10 to 50 times greater than conservation. Regions with 20% or above conversion and a CRI of over 2 (twice as much conversion as protection) are considered "Vulnerable" while those with conversion >40% and CRI > 10 are considered "Endangered" and those with conversion >50% and CRI > 24 are considered "Critically Endangered" (Hoekstra et al 2005). In these analyses, lands managed for forest extraction are treated as natural cover but are not considered protected.

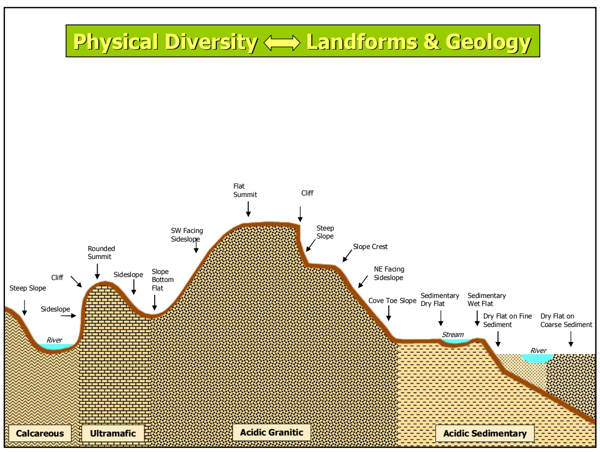
What Do the Data Show? The Northern Appalachian – Acadian ecoregion stands out among the eastern ecoregions as the only region where land protection is slightly ahead of land conversion, resulting in a CRI value less than 1. This is likely due to two factors, the first being the existence of large protected areas such as the Adirondack State Park in New York, Baxter State Park in Maine, the White and Green Mountain National Forests of Vermont and New Hampshire, and the extensive provincial reserve system in the Quebec highlands and Canadian Maritimes.

Second, historic logging activities have maintained forest cover across the region, preventing conversion to development or agriculture. Thus, although two centuries of logging has created young, simplified forests where structurally complex and biodiversity rich ecosystems once stood, it has been effective in preventing the wholesale conversion, at a landscape scale, that can be seen in other ecoregions.

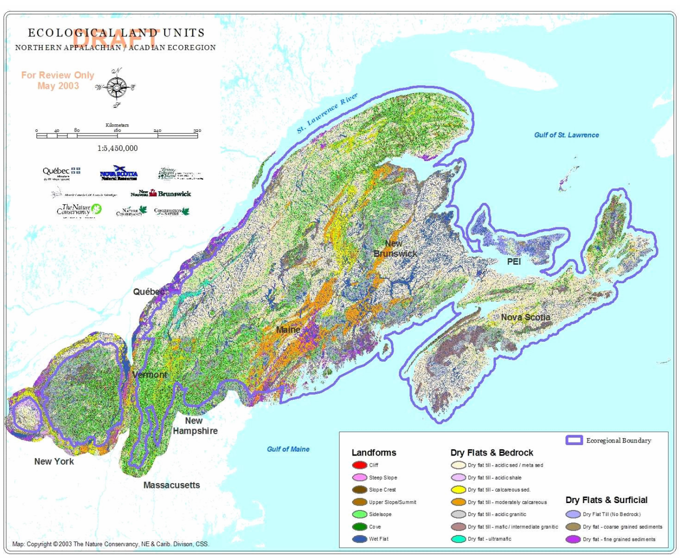
For comparison the US eastern region is 18% converted and has a 4 to 1 ratio of conversion to protection (CRI = 4.3), indicating that the amount of land that has been converted to non-natural cover is four times greater than the amount protected.

• ECOLOGICAL LAND UNITS





ELU MAP see MAP appendix for larger image



What are Ecological Land Units and Why are they Important?

This indicator examines the protection level of various physical and biophysical features to answer the questions - Are we consistently missing certain environments in our current protection network? Are we overemphasizing particular settings or features at the expense of others? To evaluate this we developed a data layer known as ecological land units (ELUs), composed of topographic landforms, bedrock and surficial geology and elevation zones. For example, a "high elevation granite cliff" is a single ELU. The units were carefully created to reflect physical environments that underlie and explain biodiversity patterns. The region's remarkable rich hardwood forests, for instance, tend to occur on steep slopes at mid elevations on solis derived from sedimentary or calcareous bedrock –a setting easily measured by an ELU analysis.

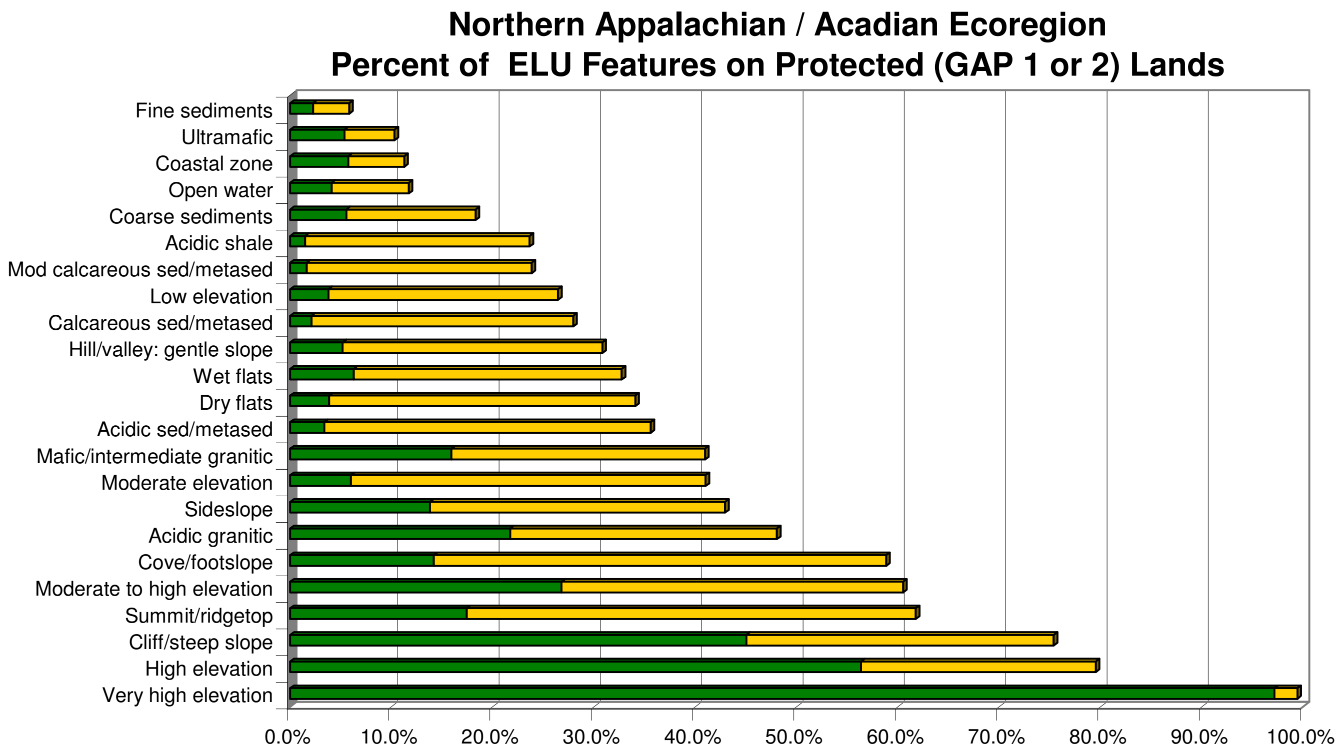
We consider two aspects of protection on the following two pages. **Percent protected** (page 16) summarizes the amount of each feature occurring on secured lands. **Representativeness** (page 17) examines the proportion of the feature that occurs on protected reserves (GAP1,2) relative to the proportion of that feature in the region.

What Do the Data Show? Both measures indicate that high elevations, cliffs, summits, ridge-tops and ravines are the most extensively protected features in the region and are many times more common in the protected lands than they are throughout the region. This indicates a strong bias in past conservation efforts towards scenic features that often occur on lands not suitable for other uses. Many of these settings, of course, have significant biodiversity components.

Fine sediment soils (floodplains, clayplains and valley bottoms), dry flatlands and gently sloping hills are poorly protected and much more common in the region than they are in the protected lands. Coastal areas and sandy soils are also incompletely protected and more common in the landscape than in the protected areas.

Data sources: TNC: Ecological land units, TNC Lands permanently secured from conversion.

- ## ELU: PERCENT OF FEATURE PROTECTED



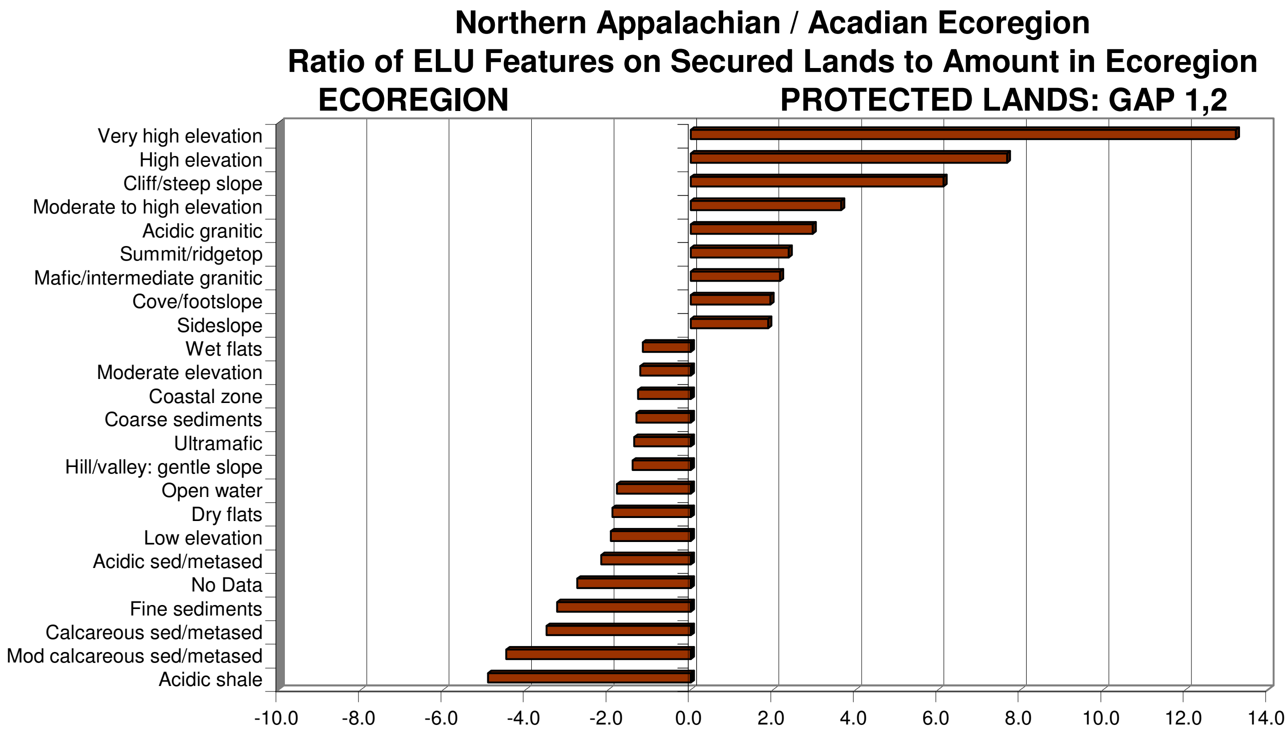
Ecological component features along the vertical axis are not mutually exclusive (e.g. cliffs occur across all elevations)

What is this Measure and Why is it Important? This indicator examines the amount of each of ecological feature on land permanently secured from conversion to development. To evaluate this we combined the ecological land unit (ELU) data layer with the secured lands data. The ecological land units (ELUs) reflect physical environments that underlie and explain biodiversity patterns (see previous page). They may be used to determine the cumulative effect of conservation efforts over the last two centuries.

What do the data show? High elevations over 1700‘ feet, and steep slopes and cliffs are well covered having over 40% on secured lands with a GAP 3 status. Very high alpine communities are almost 100% on secured lands with 98% of that being on land protected for biodiversity. Protected lands cover 20-40% of granite bedrock and mid-elevation features but drop to below 20% for all other features, including summits.

Urgently in need of protection are **fine sediment floodplains and marshes, coastal zone and coarse sediment features, low elevations and moderately calcareous to calcareous bedrocks**, and **unique bedrocks.** These are all settings below 10% on secured lands with very small percentages protected for biodiversity. The calcareous and unique bedrock regions coincide with high endemism. The coastal regions also harbor some of this regions most unique and threatened systems and species.

- ## ELU: REPRESENTATIVENESS



How do you read this chart? Ecological features that are found in protected lands at exactly the same proportion as they occur in the region would be shown on the chart at the vertical "zero line" indicating a 1 to 1 ratio. Those with proportionally higher representation in the protected lands are shown to the right of the line; those with proportionally larger abundances in the region are shown left of the line. The length of the bar indicates the magnitude of the discrepancy.

What Do the Data Show? In parallel to the previous chart, cliffs, high elevations, summits, ridge-tops, and ravines are two to fourteen times more common in the protected lands than they are in the region, indicating a strong bias in current land protection towards hard acidic bedrock features occurring on lands not suitable for other uses. Fine sediment soils (floodplains, clayplains and valley bottoms), calcareous soils, low elevation, dry flatlands and gently sloping hills are two to five times more common in the region than they are in the protected lands. We recommend that future protection efforts focus on the latter environments to achieve a balanced and representative conservation portfolio supporting all biodiversity.

Coastal zone and coarse sand features (almost all at very low elevations) are somewhat underrepresented in the protected areas, being two to three times more common in the landscape.

Wetlands are twice as common in the landscape as in the reserve lands. Many of the critical wetlands are large and occur at low elevations on coarse and fine sediments. These are mostly unprotected. See the pages on the wetland portfolio for more detailed information on the protection of the critical wetlands in the region.

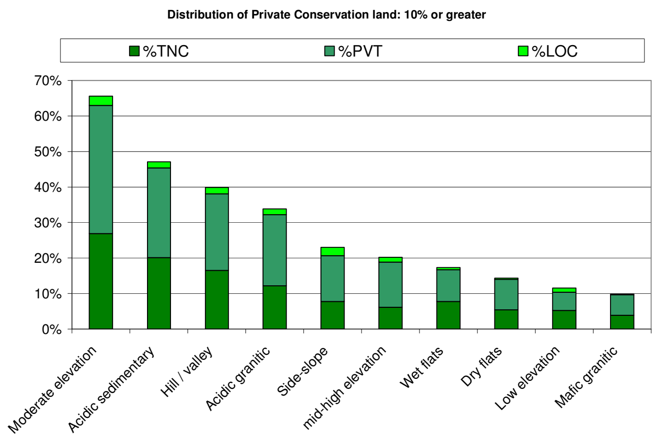
Data sources: TNC: Ecological land units, TNC Lands permanently secured from conversion.

• PERCENT OF FEATURES IN PRIVATE OWNERSHIP

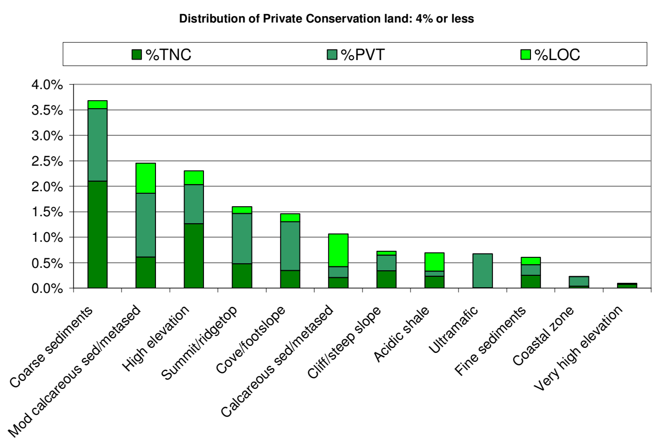
Conservation of Landscape Features on Private Land

TNC = The Nature Conservancy (US)
PVT = Other Private conservation lands, including the Nature Conservancy of Canada
LOC = Local, small public ownerships.

Features accounting for 10% or more



Features accounting for 4% or less



Note: In the figures above, features along the horizontal axis are not mutually exclusive, thus they do not sum to 100%.

What is this Measure and Why is it Important? The ecological land unit and secured lands analysis indicate that land conservation efforts should step up the protection of fine sediment, low elevation, calcareous bedrock and coastal/coarse sediment regions. To what extent is this already happening? This measure examines the secured lands data by ownership patterns to identify trends in who is protecting what.

What do the data show? In aggregate, private conservation efforts account for 6% of the total secured lands. Examination of private and local effort reveals that low to moderate elevations predominate as do acidic sedimentary and granite bedrocks. Flats and gently sloping hills collectively comprise 71% of the landforms.

Features accounting for less than 4% of private conservation lands can be divided into two categories. The first are features that currently enjoy high levels of protection in the existing conservation lands. These include:

- high and very high elevation
- steep slopes
- coves and toeslopes
- Ultra mafic bedrocks

The second are features and settings that could benefit from private efforts but that currently make up 1% or less of the private lands. These include

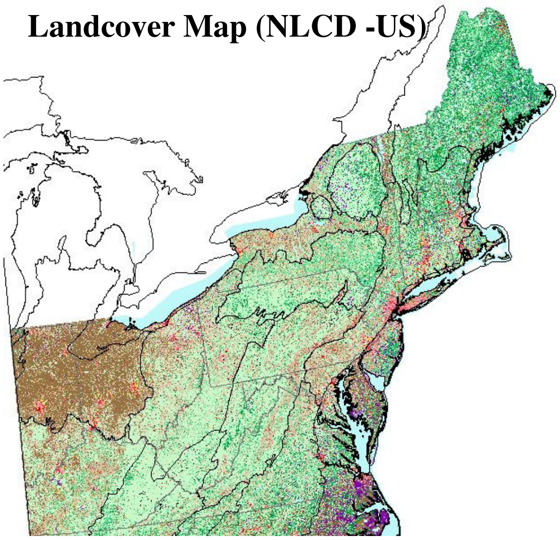
- Calcareous substrates
- Fine sediment settings
- Coastal zone features

This suggests areas of focus where private conservation dollars could strongly complement public land conservation.

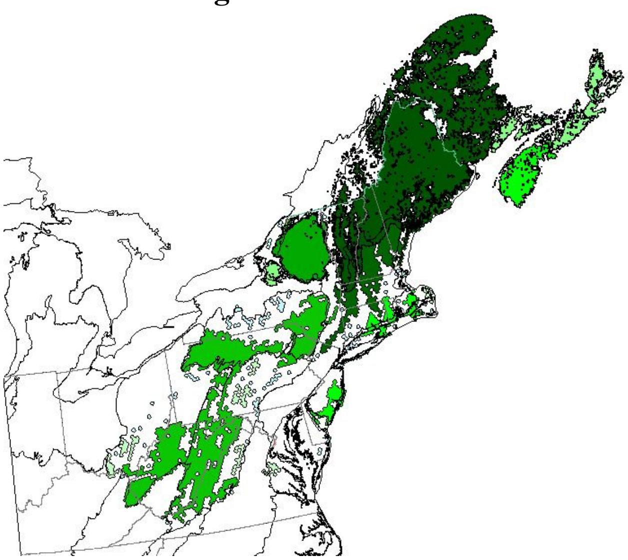
(final draft Anderson 06)

- LANDSCAPE INTACTNESS

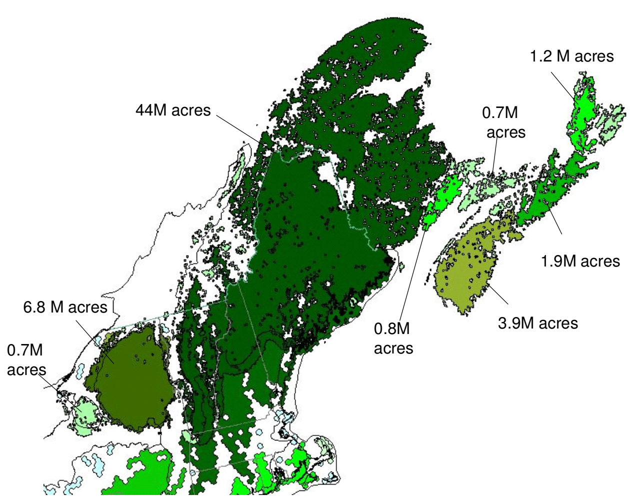
Landcover Map (NLCD -US)



Blocks of Contiguous Natural Cover over 80%



Close up of NAP /Acadia Ecoregion



What is this Measure and Why is it Important?
This measure is used to find areas of contiguous natural cover. Contiguous cover areas are likely to have intact landscape processes and high levels of connectivity. For features that occur in these areas, the likelihood of them persisting over time is greater than the same features occurring in highly fragmented areas.

How is this Measure Calculated?
To build this indicator the entire region was divided into a regular grid consisting of 25,000 acre interlocking cells (hexagons). The amount of natural land cover was calculated for each cell and those with natural land cover 80% or higher were selected.* Adjacent selected cells were aggregated into larger units.

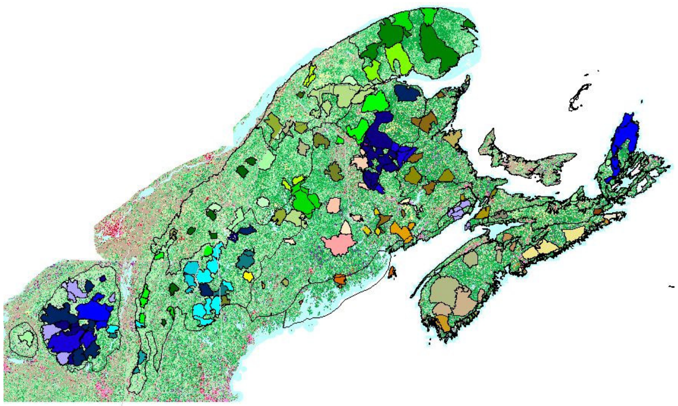
What Do the Data Show? The results identified 80+ blocks of contiguous cover in the eastern region with ten of them being over a half a million acres. The largest block, covering most of the Northern Appalachian / Acadian region, was over 44 million acres. These are potentially key areas where conservation could be taken to the landscape scale working with people and industry to prevent fragmentation and maintain critical connections. Smaller scale protection within these intact landscapes could focus on specific features.

The Northern Appalachians emerges as the most intact region in the Eastern US. Its huge central block extends from the Gaspè Peninsula, across most of southern portion of the ecoregion to the highlands of New Jersey. Other large blocks of natural cover include the Adirondack, southern and central Nova Scotia, Cape Breton and New Brunswick's Fundy region. The critical "bridge" region between Nova Scotia and New Brunswick as well as the Tug Hill plateau adjacent to the Adirondacks and the Gaspè to northern Maine region all emerge as key connections where natural landcover is still intact enough to facilitate the movement of many species.

* *for technical reasons, the cutoff used was actually 78%*

(final draft Anderson 06)

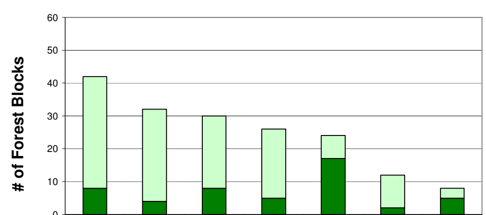
- **FOREST ECOSYSTEMS: PORTFOLIO**



Portfolio: Map shows 174 matrix forest "blocks" collectively representing all forest types of the region. The background shows land cover.

Reserves: The number of forest blocks that contain GAP 1,2 core reserves of 25,000 acres or more

Forest Core Analysis



	NB	ME	NS	QC	NY	VT	NH
% with core areas	19%	13%	27%	19%	71%	17%	63%
Total Tier 1 Blocks	42	32	30	26	24	12	8
Total Set of Potential Areas	86	92	49	30	40	29	14
Blocks without a 25,000 acre protected area	34	28	22	21	7	10	3
Blocks with 25,000 acre core protected area	8	4	8	5	17	2	5

Forest Blocks: Percent Secured. Total P:20%, S:39%

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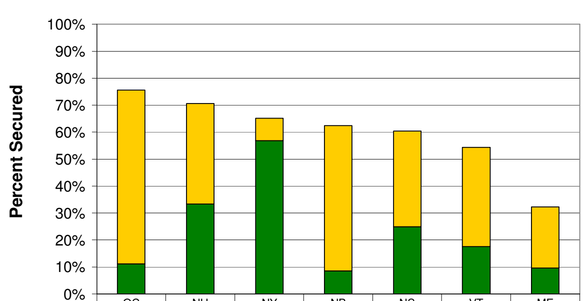
Northern Appalachians: Secured Lands in Forest Blocks



	QC	NH	NY	NB	NS	VT	ME
Total Tier 1 Blocks	26	8	24	42	30	12	32
Unsecured	992,063	292,733	1,116,666	2,109,460	1,537,926	335,324	2,593,400
Secured: GAP 3	2,617,534	370,744	263,596	3,030,812	1,378,101	270,855	869,920
Protected: GAP1,2	453,701	331,442	1,823,432	480,921	969,423	129,396	367,066

What are Matrix Forest Blocks and Why are they Important? Forests are the dominant ecosystem of Eastern North America, which is the center of distribution for many trees such as red spruce and striped maple as well as thousand of shrubs, ferns, herbs and forest dwelling species. The ecoregional assessments identified 174 critical forest blocks, representing the best remaining examples of forest interior regions, that collectively contain all forest types of the region.

This indicator examines two aspects of forest conservation: 1) the protection of large forest reserves where conservation is focused on the restoration of forest ecosystems and on providing source breeding areas for interior species, 2) the conservation of forest cover at huge scales through preventing conversion and promoting best management practices.

What Do the Data Show? The establishment of core reserves within the best remaining examples of every forest type is proceeding rapidly. Currently 28% of the 174 critical forest blocks have protected reserves (GAP 1,2) of 25,000 acres or greater. These protected forest cores are concentrated in the mountainous portions of the ecoregion. New York, via the Adirondack state park, has protected core forest in 71% of their blocks.

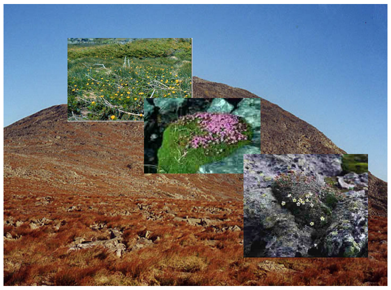
Securing the land from conversion can be an important first step in protecting and restoring interior forest ecosystems. The **percent secured** measure looks directly at the land status within each block regardless of whether there is a core protected area. The results show that in aggregate for the region, 20% of the forest block land is protected (GAP 1,2) and another 39% is secured only (GAP3). All states and provinces have over 30% of the land within their forest blocks in some form of securement (GAP1-3). Quebec leads the group in having secured 75% total (GAP1-3) of the land inside their forest blocks with 11% of that protected for biodiversity (GAP1,2). While New York leads in protected lands (GAP1) at 55%.

Many of the blocks that do not have full core areas do have partial or small core regions collectively accounting for 574,000 acres. To bring all of those blocks up to a 25,000 acre standard would require 2.5 million acres. Twice that amount is already secured within the blocks suggesting that core protection is largely a matter of raising the GAP status of the land from "3" to "1 or 2."
Data source: TNC's ecoregional assessments

(final draft Anderson 06)

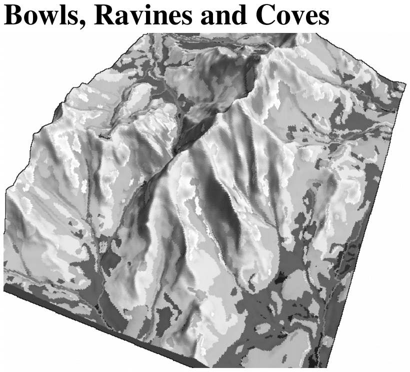
• UPLAND NON-FOREST* ECOSYSTEMS: BASIC TYPES

Summits, Peaks, Ridgetops, Knolls



Steep slopes and Cliffs

Bowls, Ravines and Coves



Flats, Barrens and Pavements

* Includes non-matrix patch-forming forest types.

Summits and Peaks: Ranging from alpine summits with a unique gem-like flora to the fog-shrouded granite domes of coastal islands, mountain and hill tops are some of the most characteristic features of the ecoregion. The stunted spruce-fir krummholz, alpine meadows and rare Bicknell's thrush bring them global attention.
Statistics: 104,745 individual summits, ave 26 acre
Total acreage: 2,758,928 acres, 3% of region
Portfolio: 9% of all summits, 0.03% of region
Portfolio Protection by area: P: 35% (GAP 1,2)

Steep slopes and Cliffs: Remote cliffs, rocky crags, landslide scars, river bluffs and talus slopes contribute unmistakable character to the rugged landscapes of the region. Unique biodiversity associated with these differs with bedrock types. Vertical cliff faces are choice settings for peregrine falcons and tenacious ferns like the slender cliff brake. Accumulated talus creates habitat for rattlesnakes, voles and shrews.
Statistics: 16,392 features, ave 27 acres
Total Acreage: 488,011, <1% of the region
Portfolio: 27% of steep slopes, 0.003% of region
Portfolio Protection by area: P:13% (GAP 1,2)

Bowls and Ravines: Gentle bowls, moist draws, wooded ravines, and enriched coves provide some of the most fertile settings in the region. As local repositories of soil minerals, this setting supports nutrient-loving plants such as ginseng, maidenhair and Goldie's fern, trillium, basswood, and white ash. Calcareous soils accentuate the fertility.
Statistics: 216272, ave 18 acres
Total Acreage: 3,889,364, 5% of ecoregion
Portfolio: 14% of all bowls/ravines, <1% of region
Portfolio Protection by area: P: 76% (GAP 1,2)

Flats, Barrens and Pavements. Dry flats are the most common setting in the region and are mostly dominated by matrix forest. The non-forest ecosystems of interest are extreme rocky pavements or glades with shallow soils, sparse trees and scattered heaths and grasses. Some are edaphically maintained but many are fire prone. These are not easy to locate using models. Our assessment relied heavily on ground inventory data.
Dry Flats
Total Acreage: 18, 844,515, 23% of ecoregion
Portfolio: 442 occurrences
Portfolio Protection by count: P:17% (GAP1,2), S:12% (GAP 3)

- ## WETLAND ECOSYSTEMS: BASIC TYPES

Open Bogs, Marshes, Fens, Meadows

Riparian wetlands

Coastal shores and wetlands:
Salt/brackish marsh, maritime bogs, beach/dunes, tidal flats.

(photo credit: Ron Garnett-AirScapes)

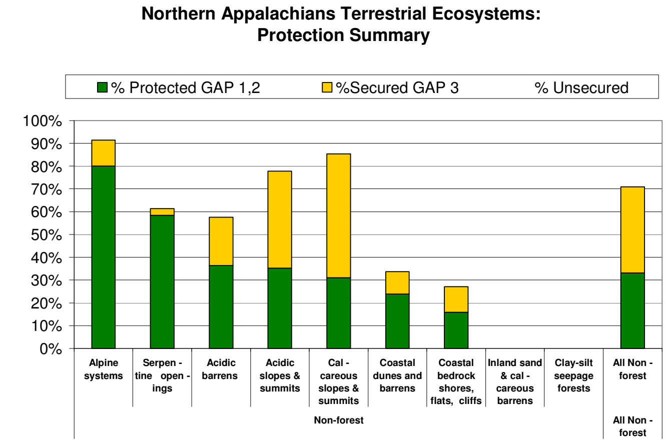
Data source: TNC's ecoregional assessments

Open Bogs and Marshes: Much of the Northern Appalachian / Acadian region is soggy. Holocene glaciers left behind a legacy of deranged drainage patterns forming over a million acres of marshes, mudflats, seeps, swamps and spongy bogs –especially in the Acadian lowlands. Breeding populations of rails, bitterns, night herons, marsh wrens, frogs, salamanders and insects - plus a myriad of sedges, rushes, bladderworts, orchids, water-lilies, and pondweeds depend on these ecosystems.
Statistics: 29,312 individual wetlands, ave 43 acres
Total acreage: 1,273,517 acres, 2% of region
Portfolio: 24% of all wetlands, 0.05% of region
Portfolio Protection by area: P: 26% (GAP 1,2), S: 30% (GAP3)

Riparian wetlands: Submerged riversides and floodplains provide critical feeding and spawning areas for many species. During dryer seasons, receding water reveals a myriad of fresh silt deposits, scoured riverbanks, sand bars, alluvial meadows and oxbow lakes amid lush floodplain forests. Rich in biodiversity, intact riparian systems provide habitat for flood tolerant trees like silver maple, green ash, American elm and box elder and ideal conditions for many native ferns, nettles, vines and herbs. Wood turtles, fowler's toad, and other herptiles breed on these wetlands.
Statistics: 21,834 features, ave 201 acres
Total Acreage: 4,282,458, 5% of the region
Portfolio: 18% of riparian features, 1% of region
Portfolio Protection by area: P:3% (GAP 1,2)

Coastal wetlands The 7,453 miles of coastal shoreline in this region hosts almost 24,000 examples of beaches, salt marshes, tidal flats and rocky shores although they account for less than 1% of the ecoregion surface. It is remarkable how much biodiversity is concentrated here. Tidal wetland are important to many of our rarest birds such as the salt marsh sparrow, roseate tern, arctic tern, willet and black-legged kittiwake. Rare or declining species include seaside dock, saltmarsh sedge, seashore saltgrass, creeping alkali grass, American sea-blite, and small spikerush.
Statistics: 23,950 features, ave size 39 acres
Total Acreage: 926,664, >1% of ecoregion
Portfolio: 44% of all coastal features, <0.05% of region
Portfolio Protection by area: P:18% (GAP 1,2)

• UPLAND NON-FOREST* PORTFOLIO OCCURRENCES



Portfolio: 6560 critical occurrences identified in nine ecosystem types described below. Protected **(P)** 33% on GAP 1 or 2 land, Secured **(S)** 38% on GAP 3 land.

Acidic slopes & summits: Sloping terrestrial ecosystems on acidic shales, conglomerates, sandstones, siltstones, or granites. Includes land with over 6% slope or narrow summits associated with sloping features. A large, diverse group that includes mountains, rocky summits, cliffs, talus slopes, steep hillsides, landslide scares, unstable shale slopes, bowls, ravines, dry river bluffs and craggy outcrops. P:35%, S:42%

Calcareous slopes & summits: Sloping terrestrial ecosystems on limestone, dolomites, or moderately calcareous sedimentary rocks. Includes land with over 6% slopes or narrow summits associated with sloping features. These calcareous summits, cliffs, talus slopes and river bluffs are uncommon due to their susceptibility to weathering. Many rare plants are associated with the high PH and nutrient content. P:31%, S:54%

Acidic barrens and pavements: Level terrestrial ecosystems on acidic shales, conglomerates, sandstones, siltstones, or granites and defined by flats with less than 6% slope. A common setting dominated by forest. The non-forest ecosystems are extreme rocky glades and pavements with shallow soils, sparse trees and scattered heaths and grasses. Many are fire prone. P:36%, S:21%

Calcareous barrens: Terrestrial ecosystems on limestone, dolomites, dolostone, or moderately calcareous shales and sandstones and defined by flats with less than 6% slope. Ecosystems in this group have exposed bedrock and shallow soils, exemplified by the limestone glades and woodlands. Most are sparsely wooded with scattered herbs and rarities. P:0%, S:0%

Sandy barrens and flats: Terrestrial ecosystems on coarse sands above 20ft elevation and not directly in the maritime zone. Ecosystems in this group have well drained, droughty acidic soils and are often fire-prone or slow to recover from disturbances. They share characteristics with acidic flats and coastal communities. The most common are pitch pine –scrub oak barrens associated with fires or agricultural abandonment. The group also includes dry oak forests, inland sand barrens and successional shrublands. P:0%, S:0%

Clay-silt seepage forest: Terrestrial ecosystems on fine grained silts and clays deposited on ancient lake beds at elevations above 20ft. Ecosystems in this group have poorly drained, silty soils sometimes rich in nutrients. A number of moist patch-forming forest types occur here often with "mesic", "seepage", or "clayplain" in their state names. Some distinctive grassland types including moist calcareous grasslands and related communities occasionally occur in this setting. P:0%, S:0%

Coastal dunes and barrens: Terrestrial ecosystems on coarse or fine sands directly on the coast at elevations below 20ft and influenced by maritime processes. Ecosystems in this group include maritime dunes and shrublands, coastal oak-holly woodlands, pitch pine woodlands, maritime spruce-fir forests, and coastal post oak forest. P:24%, S:10%

Coastal bedrock shores, flats and cliffs: Terrestrial ecosystems on rocky shores, coastal cliffs and open headlands. P:16%, S11%

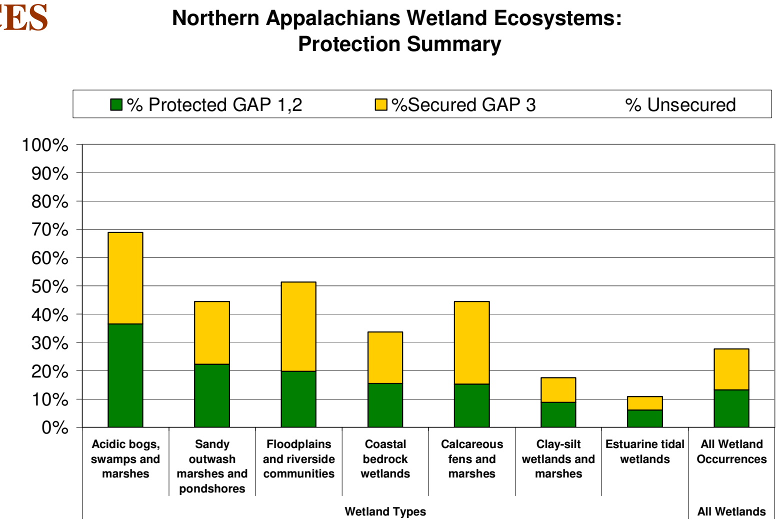
Serpentine Barrens and Openings: Terrestrial ecosystems on soils or bedrock very high in magnesium and ferric irons (mafic) toxic to many species but conducive to tolerant plant rarities. Mostly serpentine bedrock outcrops and openings. P:58%, S:3%

Alpine: Krummholz-meadow-rock mosaics over 4500'. P:80%, S11%

Caves: Subterranean systems, usually in limestone. P:8%, S:0%

* includes non-matrix, patch-forming forest types

- **WETLAND PORTFOLIO OCCURRENCES**



Portfolio: 4,682 critical occurrences identified in seven wetland types described below. Protected (**P**) 13% on GAP 1 or 2 land, Secured (**S**) 14% on GAP 3 land.

Acidic bogs, swamps and marshes: Palustrine ecosystems on acidic shales, conglomerates, sandstones or siltstones, or granites. A large diverse group that includes a variety of tree-dominated forested swamps, shrub-dominated bogs and shrub swamps, or sedge-dominated acidic fens and flushes. Most have pH values below 5 and accumulate sphagnum or sedge peat to form a spongy substrate. P:37%, S:32%

Calcareous fens and marshes: Palustrine ecosystems on limestone, dolomite or moderately calcareous sedimentary rocks. Rare plants are associated with the high PH waters, especially where oxygenated from mild flows along gentle slopes. Typical state named types include rich fens, sloping fens, shrub fens, red maple - larch treed fens, calcareous seeps and spring fens. These have had extensive inventory and study over the last decade. P:15%, S:29%

Sandy outwash pondshores and marshes: Palustrine ecosystems on coarse sands above 20ft elevation and not directly in the maritime zone. Wetland in this group tend to have fluctuating hydrologies resulting from being set in well-drained sands deposited over an impervious soil horizon. Emblematic of this group are the coastal plain pondshores with their unique floras. Equally common are vernal pools, buttonbush shrub swamps and coastal plain poor fens. P:22%, S:22%

Clay-silt wetlands and marshes: Palustrine ecosystems on fine grained silts and clays deposited on ancient lake beds at elevations above 20ft. A large proportion of emergent marshes and hardwood swamps occur in these sediments often in conjunction with the moist seepage forests of slightly drier areas. P:9%, S:9%

Estuarine tidal wetlands: Wetlands wholly or partially inundated by tidal saline waters. In sheltered bays tidal marshes may be extensive or they may occur as fringing wetlands along intricate shorelines. Typical communities include high and low salt marsh, brackish marsh, tidal flats and salt ponds. P:6%, S:5%

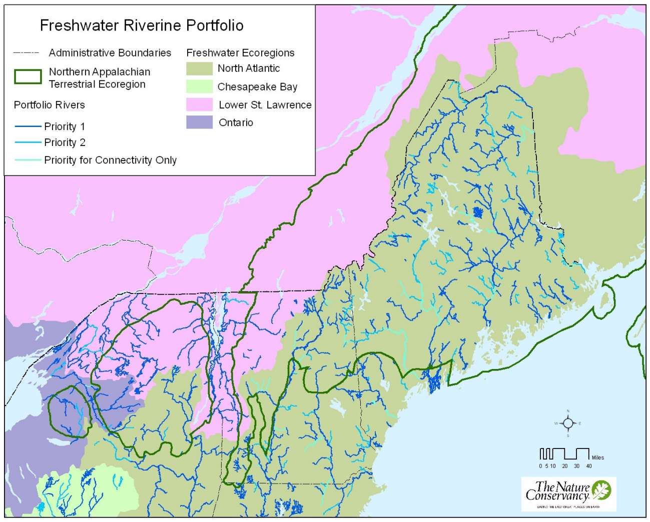
Coastal Bedrock wetlands: Wetlands in the maritime zone on relatively thin soils over bedrock. Types include maritime slope bog, coastal plateau bog and sea level fens. P:15%, S:18%.

Floodplains and riverside communities: Wetlands associated with moderate to large sized rivers and dependent on river flooding processes. Floodplain forests, riverside scour meadows, riverside seeps and outcrops, sand and gravel bar communities. (Note: upper floodplain terrace forests were classified as upland, and alluvial swamps and marshes were classified as palustrine wetlands in one of the previous groups). P:20%, S:32%.

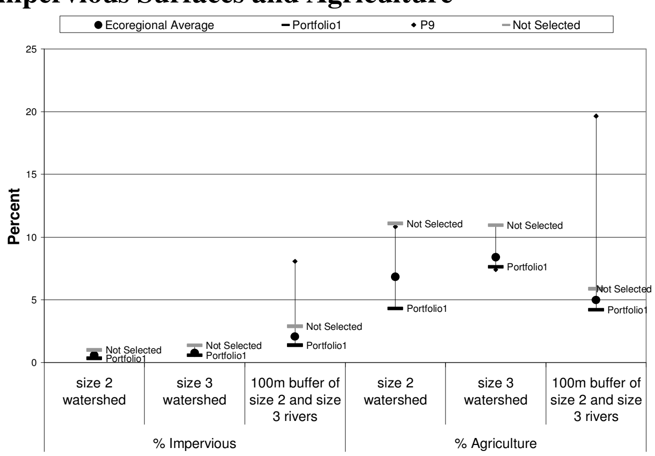
(final draft Anderson 06)

- **FRESHWATER ECOSYSTEMS**

Stream Portfolio for the U.S. Portion of the Northern Appalachians

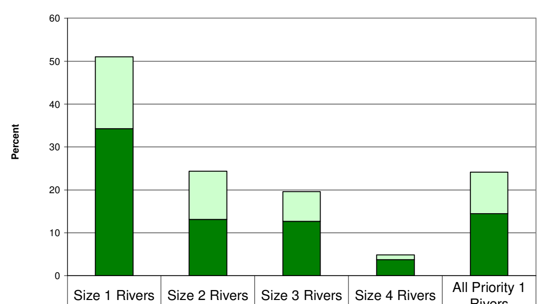


Impervious Surfaces and Agriculture



Riparian Zone Land Secured From Conversion

100m Buffer Riparian Zone % Land Secured from Conversion



	Size 1 Rivers	Size 2 Rivers	Size 3 Rivers	Size 4 Rivers	All Priority 1 Rivers
Total Secured: GAP1-3	51	24	20	5	24
% Secured: GAP 3	17	11	7	1	10
% Protected: GAP 1-2	34	13	13	4	14

River Size Class

What is the Stream Portfolio ?

The objective of the Nature Conservancy's freshwater aquatic system assessment was to identify the most intact and functional river networks and lake/pond ecosystems in such a way as to represent the full variety of freshwater diversity present within the ecoregions. Streams were evaluated within four general size classes: headwater and feeder streams (**Size 1**: 0-30 sq. mile watersheds), moderate-sized streams (**Size 2**: 30-200 sq. mile watersheds), large stream (**Size 3**: 200 – 1000 sq mile watersheds), and large deep rivers **Size 4**: 1000+ sq. mile watersheds). Portfolio "Priority 1" rivers were selected as the most viable and critical rivers. "Priority 2" rivers were identified as alternates to the portfolio. "Connectivity only" reaches were identified to complete critical connectivity networks in the region.

What Do the Data Show?

The portfolio selection process resulted in 3,407 miles of high quality, mostly connected, medium to large river systems. Additionally, 380 miles of stream reaches identified for connectivity purposes

Land use impacts, dam impacts, and level of conservation land protection were evaluated. Watersheds and stream buffers around the portfolio streams have very low levels of impervious surfaces and agricultural cover. Impervious surfaces are less than 2%. Given that impacts to aquatic biodiversity begin to be recognized at watershed level less than 5% (CWP 2003), the portfolio rivers are highly intact. Agricultural cover is less than 7%.

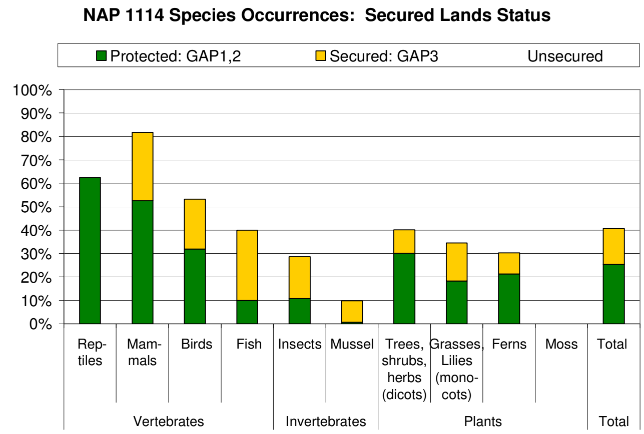
The portfolio rivers are fragmented by over 150 dams. Moderate to large river watersheds without dams are very rare, with 55% of size 2 and 86% of size 3 portfolio watersheds containing dams. Unfragmented river mainstems are also uncommon in the portfolio, with 28% of the size 2 and 66% of the size 3 rivers being fragmented by at least one dam on its mainstem..

Twenty four percent of the portfolio river buffers are secured against conversion. This ranges from over 50% in exemplary headwaters to 6% in large rivers. Overall 14% of portfolio river riparian land is protected for biodiversity (GAP1-2), while another 10% is secured from conversion (GAP3).

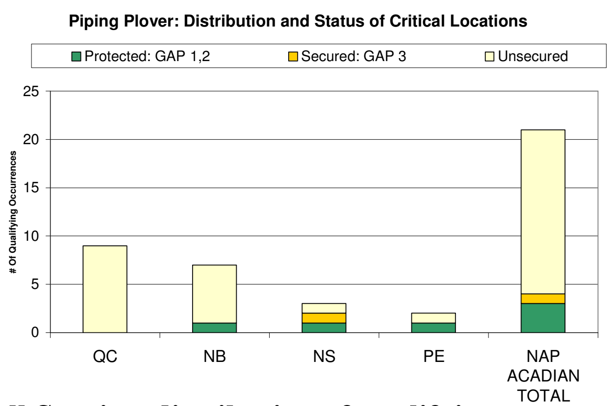
Data Sources: EPA NLCD Land Cover 2000. EPA National Inventory of Dams 1999. TNC: Lands permanently secured from conversion to development (Dec 2005)

• SPECIES PROTECTION LEVELS

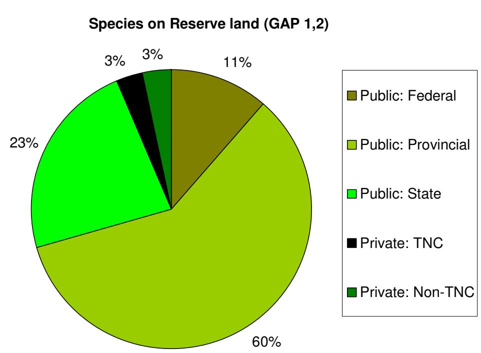
Estimated Flora and Macrofauna = 3,844
Primary Conservation Targets = 108
Qualifying Occurrences = 1,088 (1,114 incl. fish)
Overall Secured Status P:25%, S:15%



Individual Species Example: Piping Plover



All Species: distribution of qualifying occurrences on reserve lands



What is this Measure and Why is it Important?
For many rare species, direct protection of their habitat and breeding areas is a critical step towards ensuring their long term persistence. This indicator examines 108 rare, endemic or wide-ranging species* and asks the question – How many critical mapped locations (viable populations or persistent breeding sites) are currently found on reserve lands or secured lands? How many populations are unprotected? **(excluding fish)*

What Do the Data Show? In the East, considerable progress has been made in species conservation over the last several decades. Of the 1,112 qualifying occurrences identified for rare species 40% are secured on GAP 1-3 lands including 25% protected (GAP 1,2) on biodiversity focused reserves.

Conservation trends are relatively consistent across taxonomic groups. For **vertebrates** (mammals, birds, reptiles and amphibians) 61% of the 22 qualifying occurrences are on secured (GAP1-3) land, including 37% protected (GAP 1,2) on biodiversity reserves. Over 209 occurrences of rare **invertebrate** species have been located and 13% are now on secured (GAP1-3) land with 3% protected on biodiversity reserves. Rare **plants** are poorly protected with only 13% of the 565 qualifying locations now on secured (GAP1-3) lands, including 9% protected (GAP 1,2) on reserves.

Species-by-species information is summarized by region, ecoregion and state or province in the appendix. The Piping Plover example illustrates how to interpret the charts and tables. The Plover breeds at 21 critical locations (qualifying occurrences) in this ecoregion, 3 of these areas are protected on GAP 1,2 reserve lands, 1 is on GAP 3 secured lands and 17 are on unsecured lands. To meet an initial minimum goal for the protection of at least 10 breeding areas in the ecoregion, conservation should focus on the Quebec and New Brunswick occurrences which are mostly unprotected.

For all species in this region, private conservation accounts for 6% of the protected reserves (GAP 1,2).

Data Sources: TNC ecoregional plans, Natureserve: Natural Heritage occurrence data; used with permission

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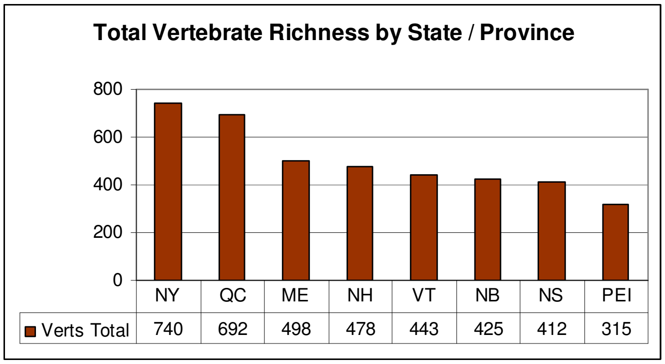
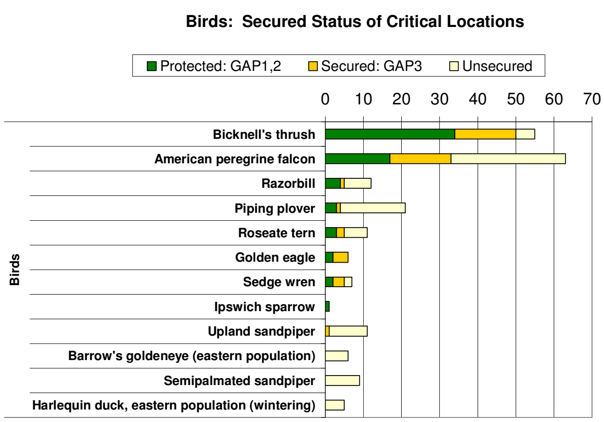
- ## VERTEBRATES

Estimated Fauna: 472 species
Primary Targets = 22 (28 incl. fish)
Qualifying Occurrences = 66, P:37%, S:24%

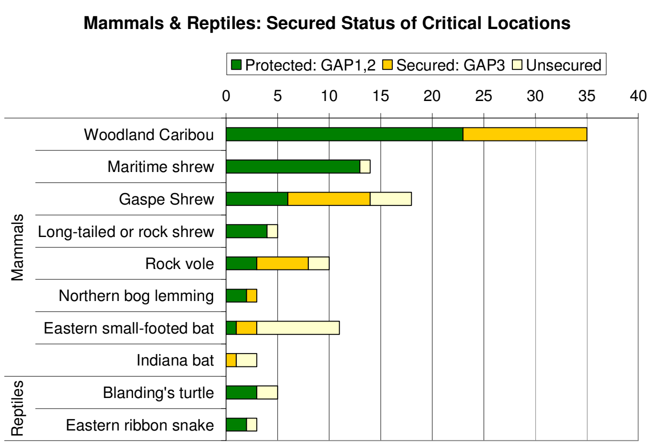
Total Vertebrate Richness



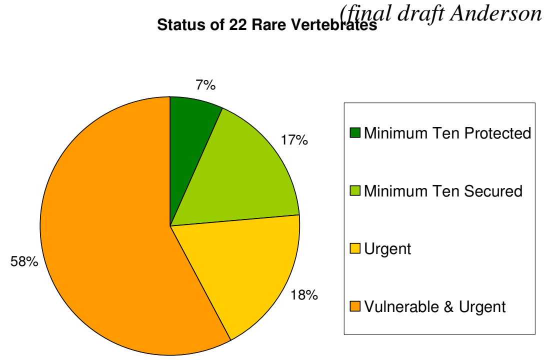
Primary Target Birds



Primary Target Mammals and Reptiles



Data Sources: TNC ecoregional plans, Natureserve: Natural Heritage occurrence data; used with permission. Scientific names given on pg 31



What is this Measure and Why is it Important? In the ecoregional planning process, 22 species of vertebrates were identified as needing direct conservation action. For each of these **primary targets**, known population sites were identified and evaluated, and a conservation plan was developed. This status measure looks specifically at high quality occurrences and groups them into protection categories

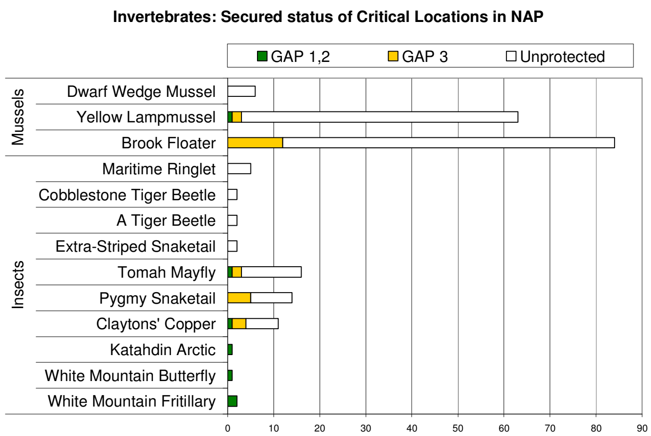
- **Vulnerable: not urgent (0%)** = less than 10 known qualifying occurrences, all are on GAP1-3 lands.
- **Vulnerable and Urgent (58%)** = less than 10 known qualifying occurrences and not all on GAP 1-3 lands.
- **Urgent (18%)** = more than 10 known qualifying occurrences but less than 10 on GAP 1-2 lands
- **Minimum Ten Secured (17%)** = over 10 qualifying occurrences on GAP 3 lands but less than 10 on GAP 1-2 reserves
- **Minimum Ten Protected (7%)** = over 10 qualifying occurrences on GAP 1-2 reserves

What Do the Data Show? Vertebrate protections is difficult to judge from qualifying occurrences, most of the location identified are critical breeding, wintering or feeding concentration areas that are used repeatedly from year to year. Bicknell's thrush, a high elevation breeder and peregrine falcon a cliff nester both have over thirty occurrences on secured lands. All the other bird targets have less than ten occurrences on secured lands although several may benefit from policy level protection relative to coastal and offshore features. The woodland caribou herd consisting of one small, mostly protected metapopulation in Quebec is experiencing disease problems related to the introduction of white-tailed deer. All other targets all have less than ten protected locations with the exception of the maritime shrew. Lynx, a wide ranging carnivore was treated in a separate report.

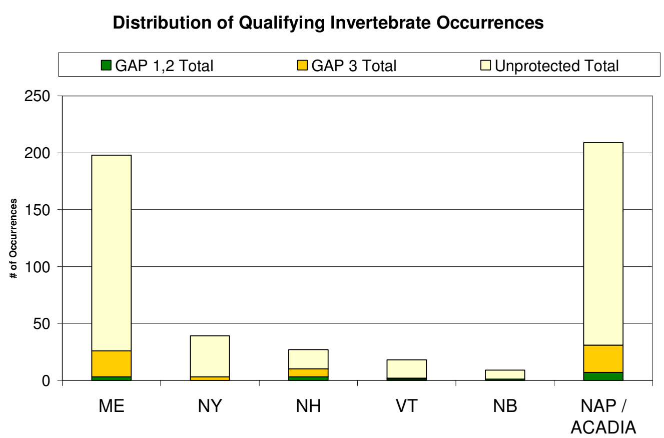
- **INVERTEBRATES**

Estimated Fauna: 668 species
Primary Targets = 13 species
Qualifying Occurrences = 209, P:3%, S:10%

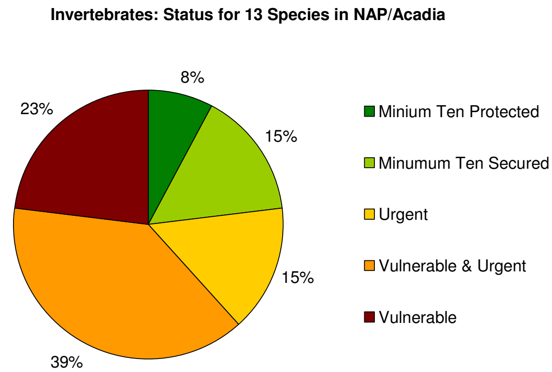
Invertebrate: Secured Status in NAP / Acadia



Distribution of Qualifying Occurrences by Province/State



Data Sources: TNC ecoregional plans, Natureserve: Natural Heritage and Canadian Conservation Data Center occurrence data; used with permission. Scientific names given on pg 31



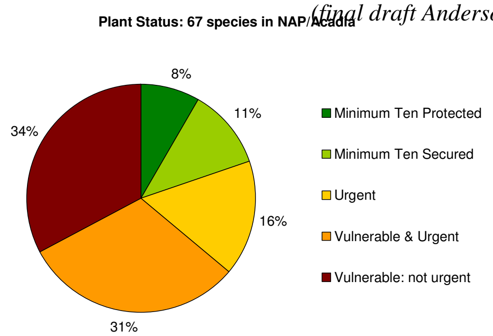
What is this Measure and Why is it Important?
In the ecoregional planning process, 13 species were identified as needing direct conservation action. For each of these **primary targets**, known population sites were identified and evaluated, and a conservation plan was developed. This status measure looks specifically at high quality occurrences and groups them into protection categories

- **Vulnerable: not urgent (23%)** = less than 10 known qualifying occurrences, all are on GAP1-3 lands.
- **Vulnerable and Urgent (39%)** = less than 10 known qualifying occurrences and some are not on GAP 1-3 lands.
- **Urgent (15%)** = more than 10 known qualifying occurrences but less than 10 on GAP 1-2 lands.
- **Ten Secured (15%)** = more than 10 qualifying occurrences on GAP 3 lands but less than 10 qualifying occurrences on GAP 1-2 reserves.
- **Ten Protected (8%)** = over 10 qualifying occurrences on GAP 1-2 reserves.

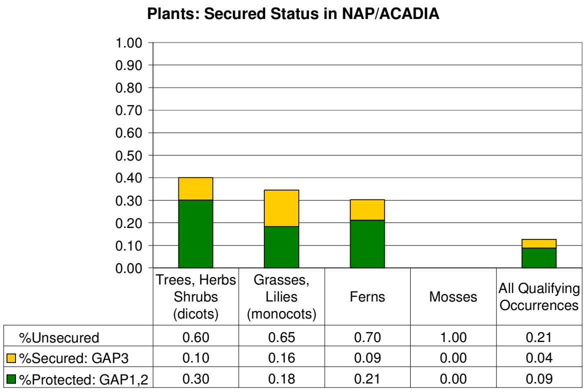
What Do the Data Show? Occurrences of rare invertebrates are not evenly tracked across states and provinces. Of those that are tracked 23% had more than ten occurrences on secured land. These were all butterflies and moths. Fifty-four percent of the species were still in urgent need of both protection and inventory efforts. Moreover, 62% are still vulnerable to extinction from due to low population and locations

- **PLANTS**

Estimated Flora: 2704 species
Primary targets = 67 species,
Qualifying Occurrences = 565, P:9%, S:4%

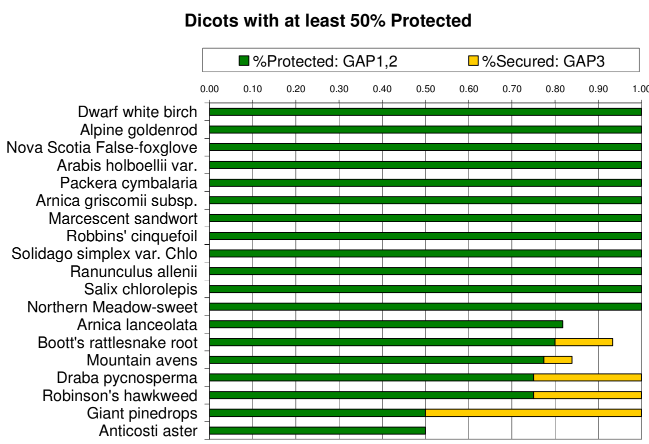


Primary Target Plants: Secured Status

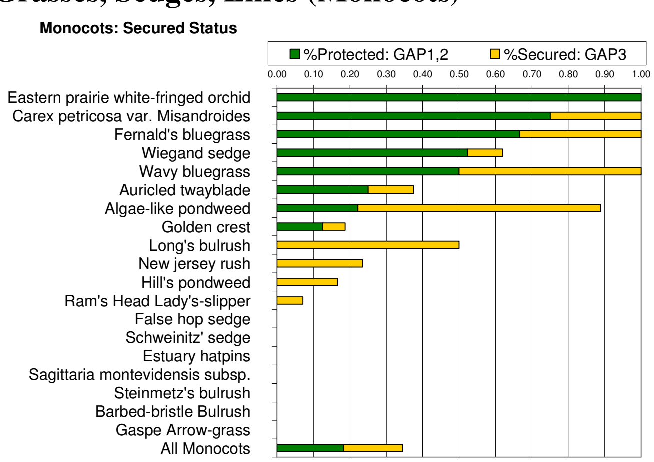


	Trees, Herbs Shrubs (dicots)	Grasses, Lilies (monocots)	Ferns	Mosses	All Qualifying Occurrences
%Unsecured	0.60	0.65	0.70	1.00	0.21
%Secured: GAP3	0.10	0.16	0.09	0.00	0.04
%Protected: GAP1,2	0.30	0.18	0.21	0.00	0.09

Trees, Shrubs, Herbs (Dicots)



Grasses, Sedges, Lilies (Monocots)



Data Sources: TNC ecoregional plans, Natureserve: Natural Heritage occurrence data; used with permission.

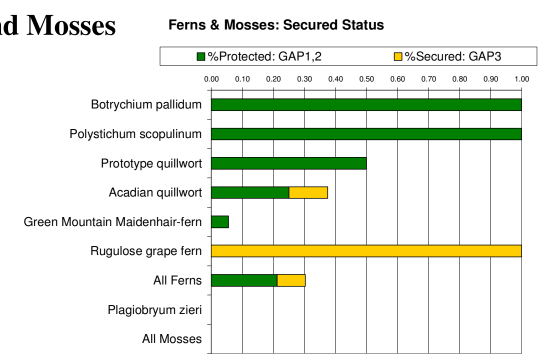
What is this Measure and Why is it Important?

In the ecoregional planning process 67 species were identified as needing direct conservation action. For each of these **primary targets**, known population sites were identified and evaluated, and a conservation plan was developed. This status measure looks specifically at high quality occurrences and groups them into protection categories

- **Vulnerable: not urgent (34%)** = less than 10 known qualifying occurrences, all are on GAP1-3 lands.
- **Vulnerable and Urgent (31%)** = less than 10 known qualifying occurrences and some are not on GAP 1-3 lands.
- **Urgent (16%)** = more than 10 known qualifying occurrences but less than 10 on GAP 1-2 reserves.
- **Minimum Ten Secured (11%)** = more than 10 qualifying occurrences on GAP 3 land but less than 10 on GAP 1-2 reserves.
- **Minimum Ten Protected (8%)** = over 10 qualifying occurrences on GAP 1-2 reserves.

What Do the Data Show? Nineteen percent of the species have at least a minimum of ten secured locations but 47% of the species were still in urgent need of both protection and inventory efforts. Moreover, 34% are still vulnerable to extinction due to low population sizes.

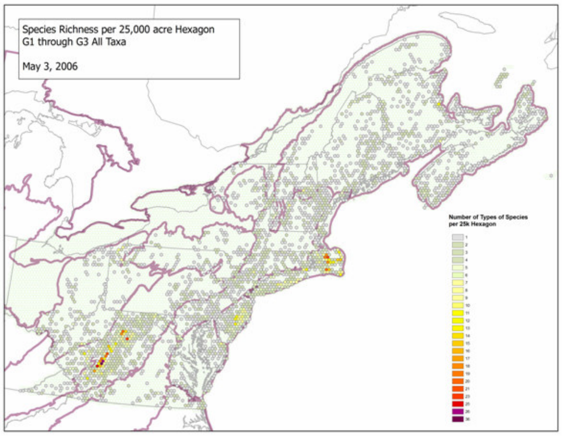
Ferns and Mosses



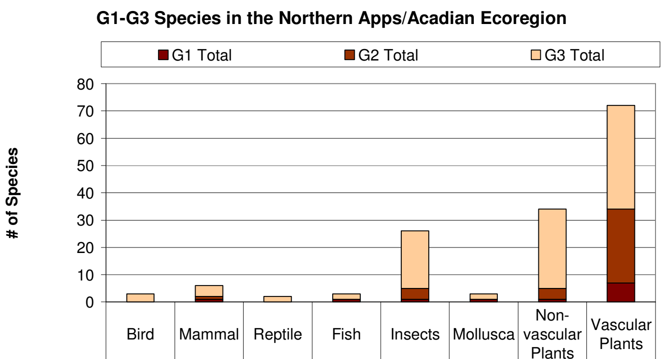
Scientific names given on pg 31

- **ENDEMISM**

All Endemic G1 – G3 Species

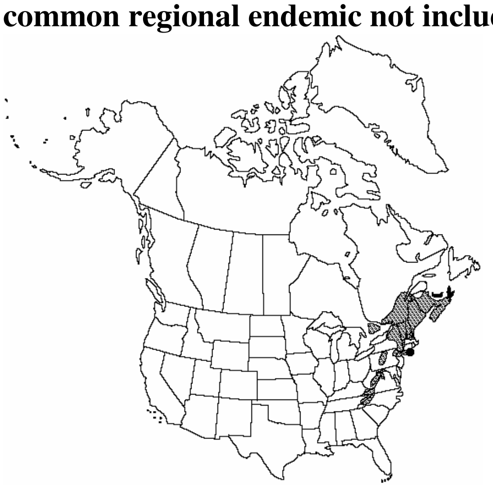


Distribution of 148 Rare G1-G3 Species



	Bird	Mammal	Reptile	Fish	Insects	Mollusca	Non-vascular Plants	Vascular Plants
G3 Total	3	4	2	2	21	2	29	38
G2 Total	0	1	0	0	4	0	4	27
G1 Total	0	1	0	1	1	1	1	7

Red Spruce distribution map, an example of a common regional endemic not include here.



Data Source: TNC ecoregional assessments, Natureserve, Natural Heritage community element occurrences. Flora of North America

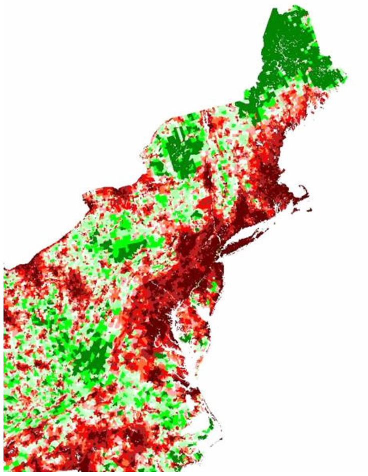
What is an Endemic and Why is it Important?
Endemic species are those for which the entire known population is restricted to, or centered around, a particular geographic region. It follows that the region is solely responsible for the conservation of that species. All of the globally rare G1 and G2 species in the east are endemic as are most of the slightly more common G3 species.

A few caveats are useful in interpreting endemic patterns. First, this analysis and most "Hot Spot" analyses are based largely on vertebrates, higher plants and well studied macro invertebrates. Estimates suggest that the former two (vertebrates and higher plants) account for about 10% of the species within an ecosystem. Adding the macro invertebrates is helpful although the data is less consistent. Fundamentally, however, most of the species that perform the functional aspects and account for the diversity of nature are the billions of micro-invertebrates, algae and fungi that are not well inventoried nor counted.

Second, most regional endemics such as red spruce or moosewood have the core of their distribution centered in this region but are not uncommon in the region. These "high regional responsibility" species were not included in this analysis. Many scientists have come to believe that the conservation of all species can probably only be accomplished through the protection of functioning ecosystems – hence the change in conservation biology from a species-by-species focus to an ecosystem focus.

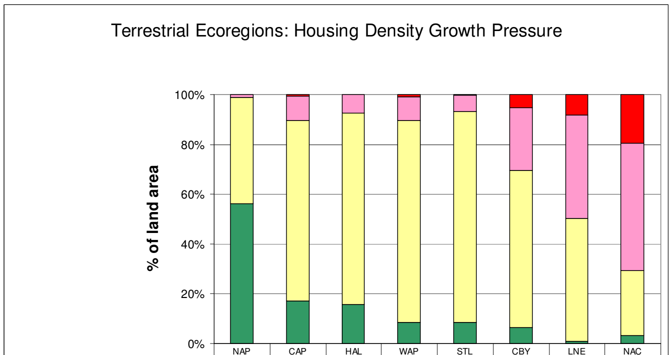
What Do the Data Show?
The Northern Appalachian / Acadian ecoregion is particularly rich in rare mosses and liverworts (34), vascular plants (72), and insects (26). Other taxa are represented by a few examples each.

• HOUSING DENSITY PRESSURE



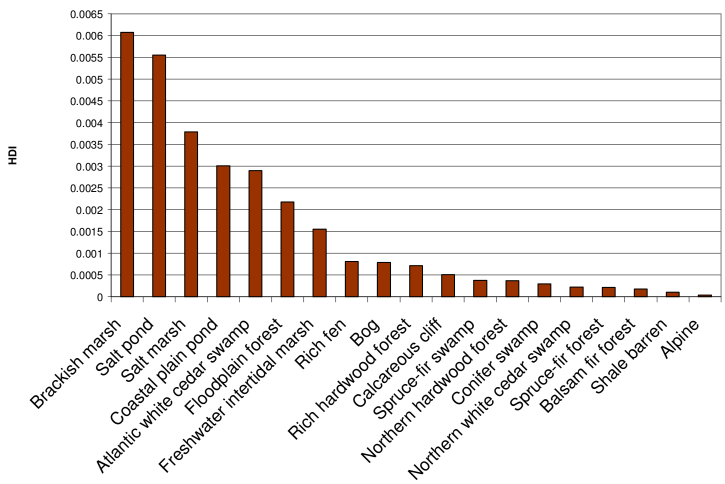
Highest rates
in dark red

Map of Housing Density Rates (explained in text) and rates summarized by ecoregion



	NAP	CAP	HAL	WAP	STL	CBY	LNE	NAC
4: Very Fast Growth: Tragectory Urban	0	1	0	1	0	5	8	19
3: Fast Growth: Trajectory Suburban	1	10	7	9	6	25	41	51
2: Moderate Growth: Tragectory Exurban	42	72	77	81	85	63	49	26
1: Low Growth: Tragectory Rural	56	17	16	9	8	6	1	3

Natural Communities and Ecosystems in relation to Housing Density Pressure:



What is this Measure and Why is it Important?
The Housing Density Pressure (HDP) index estimates rate and intensity of housing pressure based on trends in the census data from 1940 projected through 2050. On the map dark red indicates areas where the rate of change is fast with housing density predicted to reach urban levels in the next 45 years, dark green indicates areas where the rate of change are slow. The latter areas will remain at low density rural levels through 2050. The index is calculated by fitting a regression line to five decades of census data and four decades of forecasted trends.

What Do the Data Show?
Coastal systems are subject to the highest housing density pressure with in the next half century. Our best salt marshes, beaches, coastal plain ponds and tidal wetlands are all found in counties that are rapidly moving towards urban densities. **Floodplain systems**, already heavily impaired by agricultural fragmentation and water regulations, are also at high risk from housing density pressure. **Calcareous soil ecosystems** such as rich fens and rich hardwood forests are subject to moderate rates of housing density pressure.

At the other end of the spectrum, alpine systems, high elevation spruce fir forests and remote conifer swamps are under very little development pressure for the next half century. These systems are also the ones most prevalently on lands secure against conversion, underscoring the pattern that protection has historically focused on some of our regions least threatened ecosystems.

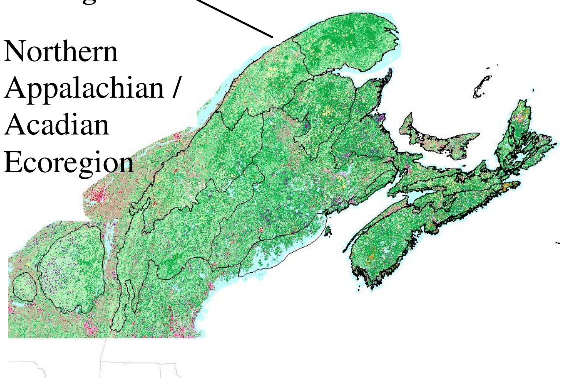
The Northern Appalachian / Acadian ecoregion stands out as the region in the eastern US that is least subject to housing density pressure with almost 60% of the area expected to remain in a rural state over the next 50 years.

Data Source: Theobold 2003, TNC Eastern Conservation Science TNC ecoregional assessments, Natureserve, Natural Heritage community element occurrences

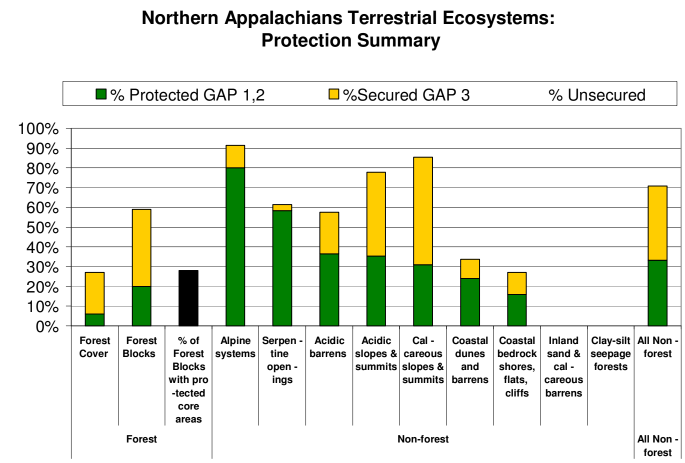
(final draft Anderson 06)

ECOREGION SUMMARY

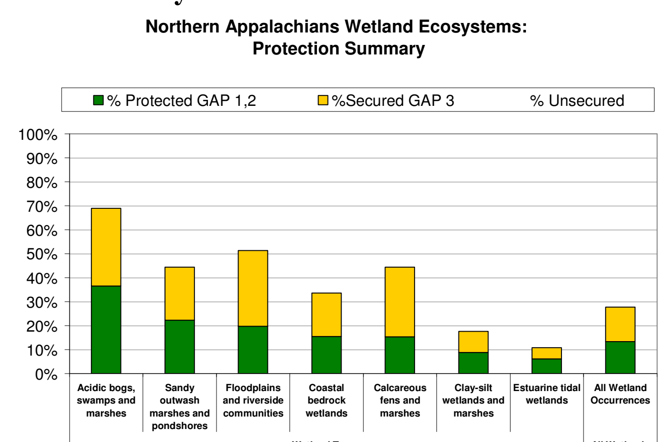
Ecoregion: Land Cover



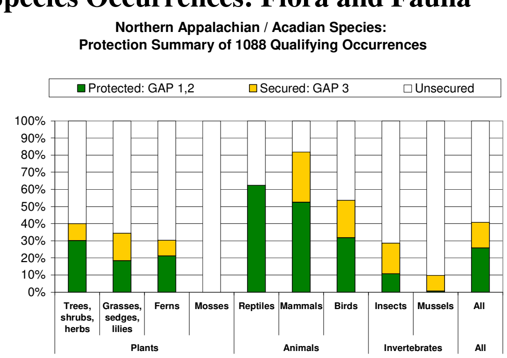
Upland Ecosystems: Forest & Non-Forest



Wetland Ecosystems



Species Occurrences: Flora and Fauna



NORTHERN APPALACHIAN / ACADIAN

Rugged region of mountains, lowlands and shoreline extending from the Adirondack Mountains to the Quebec Highlands and south to the coast. Heavily forested, variations of red spruce-balsam fir and maple-beech-birch northern hardwood forests dominate. High relief areas contain alpine communities, rocky summits, cliffs, and talus slope. Low-lying areas with extensive peatlands, floodplain forests, and riverside seeps. Coastal islands, rocky shores, intermittent beaches and tidal marshes flank the Atlantic.

- **Size: 82,865,628 acres**
- **GAP 1,2 = 7%, GAP 3 = 28%**
- **Unsecured = 65%**
- **Converted to Protected ratio: 3.1**
- **Natural Cover: 97%**
- **# Endemic species: 148**
- **Portfolio Target Occurrences: 11,206**
- **Portfolio Streams: 3,407 miles US only**

Portfolio Protection Status: Qualifying Occurrences

Terrestrial

- **Forest Blocks: 174 / 28% w Cores**
- **Non-Forest occurrences 6,560 / 33% GAP 1,2**
- **Wetland occurrences: 3,384/ 13% GAP 1,2**
- **Species occurrences: 1,088 / 26% GAP 1,2**

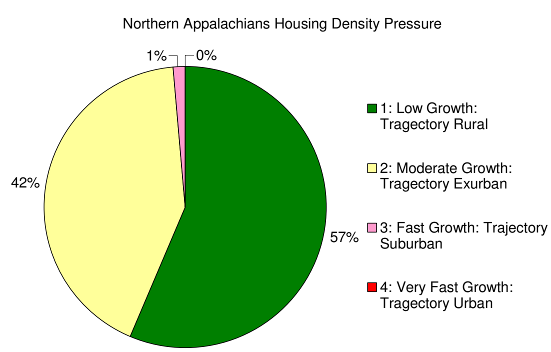
Average = 25% =/- 9%
Sum = 26%

Aquatic

- **Stream miles: 3,407 / 14% GAP 1,2 (US)**

Terrestrial Protection Average = 25% +/- 9%

Housing Density Pressure



Northern Appalachian / Acadian Ecoregion .

(final draft Anderson 06)

COMMON NAME	STANDARD NAME
A moth	Siphlonisca aerodromia
A tiger beetle	Cicindela ancocisconensis
Acadian quillwort	Isoetes acadiensis
Acipenser brevirostrum	Acipenser brevirostrum
Acipenser oxyrinchus	Acipenser oxyrinchus
Algae-like pondweed	Potamogeton confervoides
Alpine goldenrod	Solidago multiradiata var. Arctica
American burying beetle	Oeneis melissa semidea
American ginseng	Panax quinquefolius
American peregrine falcon	Falco peregrinus (anatum)
Anticosti aster	Symphyotrichum anticostense
Arabis boivinii	Arabis boivinii
Arabis holboellii var. Secunda	Arabis holboellii var. Secunda
Arnica griscomii subsp. Griscomii	Arnica griscomii subsp. Griscomii
Arnica lanceolata	Arnica lanceolata
Astragalus australis	Astragalus australis
Auricled twayblade	Listera auriculata
Barbed-bristle bulrush	Scirpus ancistrochaetus
Barrow's goldeneye	Bucephala islandica
Beach pinweed	Lechea maritima var. Subcylin
Bicknell's thrush	Catharus bicknelli
Blake's milk-vetch	Astragalus robbinsii var. Minor
Blanding's turtle	Emydoidea blandingii
Boott's rattlesnake root	Prenanthes boottii
Botrychium pallidum	Botrychium pallidum
Brook floater	Alasmidonta varicosa
Brook snaketail	Ophiogomphus howei
Carex petricosa var. Misandroides	Carex petricosa var. Misandroides
Cobblestone tiger beetle	Cicindela marginipennis
Connecticut beggar-ticks	Bidens heterodoxa
Coregonus huntsmani	Coregonus huntsmani
Cut-leaved coneflower	Rudbeckia laciniata var. Gaspèrea
Draba pycnosperma	Draba pycnosperma
Dwarf wedge mussel	Alasmidonta heterodon
Dwarf white birch	Betula minor
Eastern jacob's ladder	Polemonium vanbruntiae
Eastern prairie white-fringed orchid	Platanthera leucophaea
Eastern ribbon snake	Thamnophis sauritus
Eastern small-footed bat	Myotis leibii
Eaton's beggarticks	Bidens eatonii
Estuary hatpins	Eriocaulon parkeri
False hop sedge	Carex lupuliformis
Fernald's bluegrass	Poa laxa ssp. Fernaldiana
Furbish lousewort	Pedicularis furbishiae
Gaspè arrow-grass	Triglochin gaspensis
Gaspè shrew	Sorex gaspensis
Giant pinedrops	Pterospora andromedea
Golden crest	Lophiola aurea
Golden eagle	Aquila chrysaetos
Green Mountain maidenhair-fern	Adiantum viridimontanum
Harlequin duck	Histrionicus histrionic
Hill's pondweed	Potamogeton hillii
Indiana bat	Myotis sodalis
Ipswich sparrow	Passerculus sandwichensis princep
Karner blue butterfly	Lycaena dorcas claytoni
Katahdin arctic	Ophiogomphus anomalus
Large-leaved sandwort	Moehringia macrophylla
Long's bulrush	Scirpus longii
Long-tailed or rock shrew	Sorex dispar
Marcescent sandwort	Minuartia marcescens
Maritime ringlet	Coenonympha nipisiquit
Maritime shrew	Sorex maritimensis
Mountain avens	Geum peckii
New Jersey rush	Juncus caesariensis
Northern bog lemming	Synaptomys borealis
Northern meadow-sweet	Spiraea septentrionalis
Nova Scotia false-foxglove	Agalinis neoscotica

COMMON NAME	STANDARD NAME
Osmerus sp. 1	Osmerus sp. 1
Oxytropis viscida	Oxytropis viscida
Packera cymbalaria	Packera cymbalaria
Piping plover	Charadrius melodus
Plagiobryum zieri	Plagiobryum zieri
Plymouth gentian	Sabatia kennedyana
Polystichum scopulinum	Polystichum scopulinum
Prototype quillwort	Isoetes prototypus
Ram's head lady's-slipper	Cypripedium arietinum
Ranunculus allenii	Ranunculus allenii
Razorbill	Alca torda
Robbins' cinquefoil	Potentilla robbinsiana
Robinson's hawkweed	Hieracium robinsonii
Rock vole	Microtus chrotorrhinus
Rose coreopsis	Coreopsis rosea
Roseate tern	Sterna dougallii
Rugulose grape fern	Botrychium rugulosum
Sagittaria montevidensis	Sagittaria montevidensis.
Salix chlorolepis	Salix chlorolepis
Salmo salar	Salmo salar
Salvelinus alpinus oquassa	Salvelinus alpinus oquassa
Schweinitz' sedge	Carex schweinitzii
Sedge wren	Cistothorus platensis
Semipalmated sandpiper	Calidris pusilla
Solidago simplex	Solidago simplex var. Simplex
Solidago simplex	Solidago simplex var. Chlo
St. Lawrence aster	Symphyotrichum laurentianum
Steinmetz's bulrush	Schoenoplectus x steinmetzii
Upland sandpiper	Bartramia longicauda
Wavy bluegrass	Poa fernaldiana
White Mountain butterfly	Oeneis polixenes katahdin
White Mountain fritillary	Boloria titania montinus
Wiegand sedge	Carex wiegandii
Woodland caribou	Rangifer tarandus
Yellow lampmussel	Lampsilis cariosa

Introduction to the Northern Appalachian–Acadian Ecoregional Assessment

Draft by Martha Gorman and Mark Anderson. Edited by Barbara Vickery July 2005 and by Mark Anderson June 2006.

Introduction to the Ecoregional Assessment

Introduction to the NAP Ecoregion

Introduction to the Ecoregional Assessment

In 1999 The Nature Conservancy (TNC) prepared a first iteration ecoregional plan for the US portion of the Northern Appalachian-Acadian (NAP) Ecoregion. That first iteration identified several key deficiencies to be addressed in a next iteration: 1) It addressed only the US portion of an international ecoregion. 2). It did not address freshwater aquatic features. 3) It did not adequately address habitat needs for viable populations of wide-ranging species. 4) It had not been developed with much input from partner organizations. In 2001 TNC began preparation for a second iteration of an ecoregional assessment that would better address those four components as well as incorporate the significant amount of new inventory and new conservation efforts.

TNC has been working with Nature Conservancy of Canada (NCC), the Atlantic Canada Conservation Centre (AC CDC), provincial and federal governments, land trusts and other partners to prepare this revised plan that includes the Canadian portion of the Ecoregion. The Nature Conservancy of Canada is the only national charity in Canada dedicated to the creation of nature preserves and the conservation of ecologically significant lands.

The study area encompasses parts of New England, New York and southern Québec, and all of the Gaspé Peninsula and the Maritime Provinces. It represents a massive revision of the 1999 material that is far more comprehensive in its scope.

The NAP Ecoregional Planning Team has been led by Mark Anderson of TNC. Barbara Vickery, TNC, was co-lead for the US portion, Martha Gorman, NCC, for the Maritimes and Louise Gratton, NCC for Québec. Louise Gratton was also lead for Plant Targets for the ecoregion overall; Barbara Vickery was lead on birds and Josette Maillet, NCC, for all other animal targets except lynx and other wide-ranging mammals. Mark Anderson led the assessment of ecosystems and communities. Arlene Olivero, TNC, led the assessment of freshwater features in the US. Greg Kehm, TNC, was the lead in compiling and integrating the many layers of geographic information essential for the plan. The many others who contributed to the assessment are listed in the Appendix.

Introduction to the NAP Ecoregion

The namesake and unifying feature of the Northern Appalachian/Acadian Ecoregion is the northern part of the Appalachian Mountains, which, along with the maritime and coast influences, have defined the geologic, natural and cultural history of the northeast. The NAP Ecoregion extends from the Tug Hill and Adirondack ranges of New York, across the Green Mountains of Vermont and the White Mountains of New Hampshire, then into Maine and Maritime Canada. It includes all the provinces of New Brunswick, Nova Scotia, and Prince Edward Island, as well as Îles-de-la-Madeleine (Magdalene Islands) and the part of Québec extending from the Gaspé Peninsula southwesterly through the Appalachian complex of eastern Québec to the United States border, south of Sherbrooke.

At 83 million acres, this is more than twice the area addressed in the first NAP plan and encompasses parts of four provinces as well as four states. It includes the largest expanse of forest remaining in eastern America south of the Boreal zone.

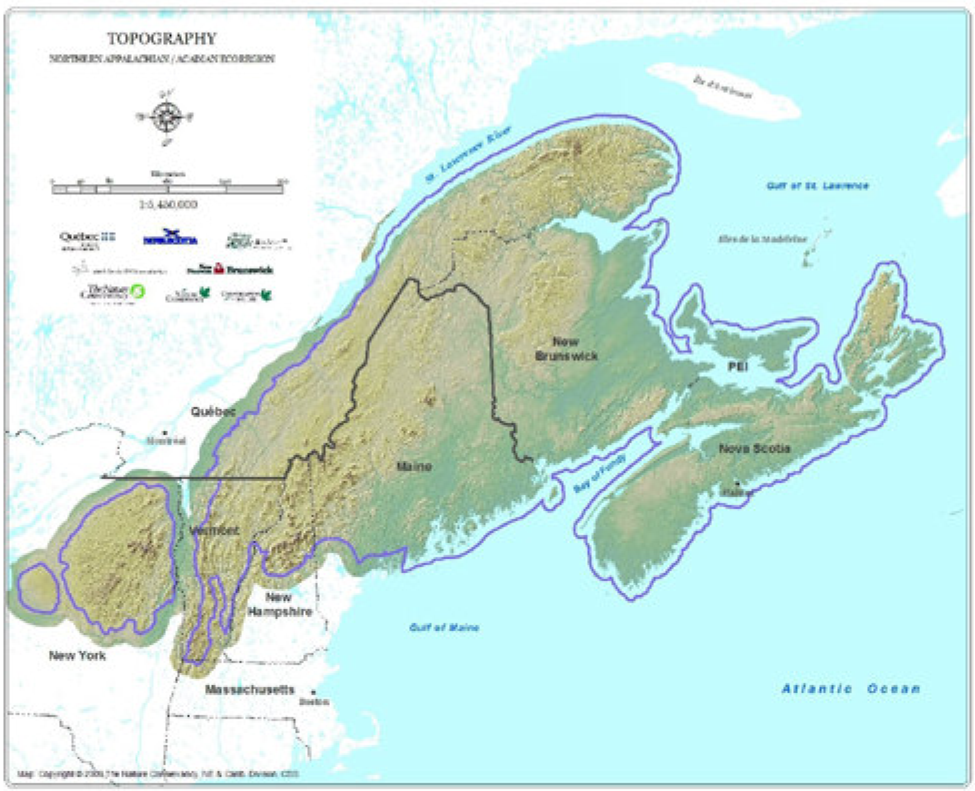


Figure 1. Topography of the Northern Appalachian- Acadian ecoregion.

Climate

The NAP Ecoregion is considered a transitional zone between the more temperate influences to the south and boreal conditions to the north. These changes in latitude are modified by the inland continental climate to the west and marine influences to the east. Especially in the eastern Acadian portion of the ecoregion the proximity to the Atlantic Ocean, the interplay of the Gulf Steam and the Labrador Current and the long and ragged coast have combined to produce a cool and humid maritime climate. In general, summers are warm and winters are long and snowy.

Geology and Landforms

The rugged landscape has endured extensive periods of volcanic activity, mountain building, erosion, sedimentation, and at least four major glaciations. The last of these, ten to twelve thousand years ago, is responsible for the present land forms of sculpted mountains, flat plateaus and carved valleys. Elevation ranges from sea-level on the Maine and Maritime coast to over 5000 feet on a few isolated peaks. The extensive but ancient mountain ranges are composed of granites and metamorphic rocks overlain by a thin veneer of glacial till. Most of the glacially broadened valleys are plugged with deep morainal or outwash deposits giving rise to thousands of swamps, bogs, lakes and ponds. Additionally, the region includes in the US alone over 68,000 miles of rivers and streams and at least 8000 lakes and ponds covering over a million acres.

Vegetation

The NAP Ecoregion is an ecological gradient or transition zone between the boreal forest to the north and the deciduous forest to the south. The Gaspé Peninsula and higher elevations support alpine, taiga and boreal elements. At lower elevations and latitudes, there is a gradual shift toward higher proportions of northern hardwood and mixed wood species (Anonymous, 2003), which marks the transition into the Acadian Forest defined by Loucks (1962), Rowe (1972) and others (Neily et al, 2003; Ecosystem Classification Working Group, 2003). It also supports local endemic species, as well as rare, disjunct and peripheral populations of arctic, alpine, alleghenian and coastal plain species that are more common elsewhere (Davis et al, 1996; Hinds, 2000; Gawler et al, 2004; MacDougall et al, 1998).

The Acadian Forest is a heterogeneous or patchy landscape composed of pure and mixed stands containing varying proportions of upland hardwood and spruce-fir types. It is characterized by long-lived, shade-tolerant conifer and deciduous species, such as red spruce, balsam fir, yellow birch, sugar maple, red oak and red maple, while American beech, red and eastern white pine and eastern hemlock occur to a lesser but significant degree (Loo et al, 2003).

Due to human activities, there has been a historical shift away from the uneven-aged and multi-generational "old growth" Acadian Forest toward even-aged and early successional forest types (Loo et al, 2003). This mirrors the historical trends toward mechanization and industrialization within the resource sector over the past century and a shift from harvesting large dimension lumber to smaller dimension pulpwood (Johnson, 1986).

A diversity of aquatic, wetland, riparian and coastal ecosystems are interspersed between forest and woodland habitats, including floodplains, marshes, estuaries, bogs, fens and peatlands. These inland systems are complemented by vast stretches of cobble, sand and barrier beach and dune systems that characterize the Northumberland Strait, as well as the salt marshes and tidal mudflats and the rocky headlands, ravines and coastal forests of the

Bay of Fundy/Gulf of Maine and Atlantic Coast and the many offshore islands that dot the coastline.

Wildlife

The NAP Ecoregion supports more than 225 bird species, including neotropical songbirds, shorebirds and seabirds, along with mammals, herptiles, fish, and thousands of plant and invertebrate species, making it the second-richest ecoregion within the temperate broadleaf and mixed forest types, and among the 20 richest ecoregions in the continental United States and Canada (Ricketts et al, 1999). The mixed forests contain 14 species of conifers, which is more than any other ecoregion within this major habitat type, with the exception of the Southern Appalachian-Blue Ridge Forests and the Southeastern Mixed Forests.

Bald eagles reach their highest breeding density in eastern North America (Nova Scotia), and the Upper Bay of Fundy is a globally significant flyway for as many as 2.5 million Semipalmated Sandpipers that feed on tiny shrimp found in the tidal mudflats. Some of most significant self-sustaining populations of Atlantic Salmon of North America are found in this region's rivers.

Characteristic mammals include moose (*Alces alces*), black bear (*Ursus americanus*), snowshoe hare (*Lepus americanus*), porcupine (*Erithyzon dorsatum*), fisher (*Martes pennanti*), beaver (*Castor canadensis*), bobcat (*Lynx rufus*), Lynx (*L. canadensis*), marten (*Martes americana*). White-tailed deer (*Odocoileus virginianus*) have expanded northward in this ecoregion; the woodland caribou (*Rangifer tarandus ssp. caribou*) has been reduced from its former range within the ecoregion to a small part of the Gaspé peninsula. Coyotes (*Canis latrans*) have recently replaced wolves, which were eradicated from this ecoregion in historical times along with the Eastern Cougar (*Felis concolor*).

Sub-regions

Internationally, the NAP Ecoregion is recognized as a Level II subdivision of the Ecological Regions of North America (Commission for Environmental Cooperation, 1997). It is also known as the Atlantic Northern Forest (Bird Conservation Planning Region 14) in the North American Bird Conservation Initiative (NABCI). The Canadian portion of the NAP Ecoregion is referred to as the Atlantic Maritime Ecozone in the National Ecological Framework for Canada (Ecological Stratification Working Group, 1996) and a "province naturelle" in the ecological framework for Québec (Li and Ducruc, 1999). In the US, it is recognized as a division in the USFS Ecological Regions of the United States (Bailey, 1994) and, reflecting the CEC framework, a Level II subdivision in the USEPA Ecoregions of the Conterminous United States (Omernik et al, 1987).

Since a unified classification of the NAP Ecoregion was not available at finer scales, we created an intermediate layer to stratify, relate and integrate sub-regional classification systems across jurisdictional boundaries. The 11 cross-border sub-regions that were delineated are provisionally defined as equivalent to Canadian ecoprovinces, Québec "régions naturelles" and USFS sections. See Figure 2. The ecological units that formed these subregions were generalized from USFS sections (Bailey et al, 1994) and subsections (Keys et al, 1995) in the US. Canadian sub-regions were aggregated from provincial ecoregions, ecodistricts and ecosections in Nova Scotia (Neily et al, 2003) and New Brunswick (Ecosystem Classification Working Group, 2003) and “region naturelles” in Québec (Li and Ducruc, 1999). The National Ecological Framework was used in Prince Edward Island and Îles-de-la-Madeleine.

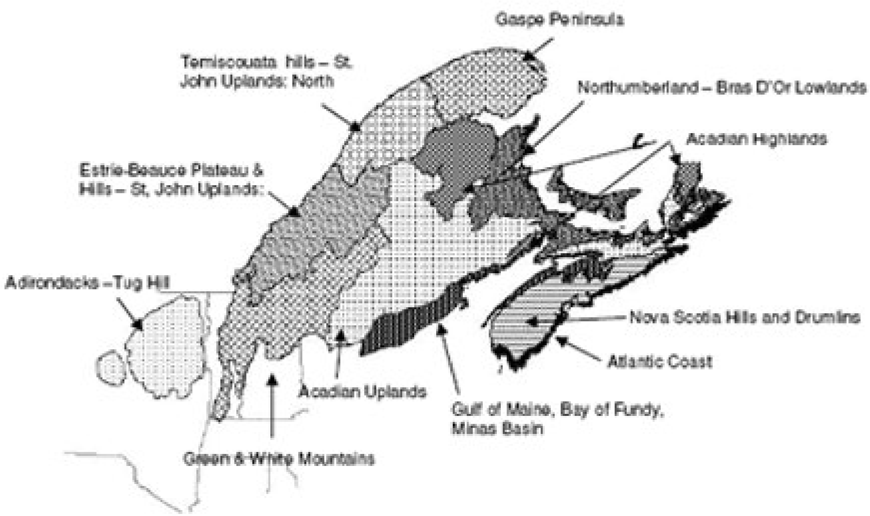


Figure 2. The eleven subregions of the Northern Appalachian- Acadian ecoregion.

Land Use/Land Ownership

Land ownership varies across the Ecoregion but is generally dominated by a mix of public and large corporate forest ownership with a smaller mixture of small farms and woodlots. This ownership pattern is not evenly distributed. Almost half of the parts of Québec, New Brunswick and New York that lie within the ecoregion are under state or provincial ownership. One third of Nova Scotia lies in Crown land. In Vermont and New Hampshire the Federal government owns over 1 million acres in the Green and White Mt National Forests. However, only 8% of Prince Edward Island and 6% of Maine are in public ownership. In Maine the ownership in the northern part of the state is primarily large industrial and non-industrial forest products companies. In the southern parts of the Ecoregion and Nova Scotia more small farms and woodlots occur. Prince Edward Island is not only Canada’s smallest province but is also its most densely populated. The majority (91%) of the land is in small private ownerships and about half is under cultivation.

Nearly 13 million acres of land are in commercial forestry, almost 40% of the Ecoregion. The forest industry is by far the largest employer. Recreation and tourism is the second most important source of employment. Because of the interstate highway system, about 70 million people live within an 8-hour drive of the Ecoregion. “This establishes the Northern Forest region as a premier natural recreation area for almost 30% of the population of the United States, as well as for the population of the major urban centers of southeastern Canada, with extensive opportunities for camping, hunting, fishing, hiking, canoeing, and skiing, and just plain ‘getting away’ to nature” (Trombulak, 1994). Agriculture plays a smaller role in the economy of the region, but still occupies approximately 12% of the Ecoregion. The patterns of intensive forestry, agriculture, development, lakes and vegetative cover are clearly shown in Land Cover Map (see Figure 3).

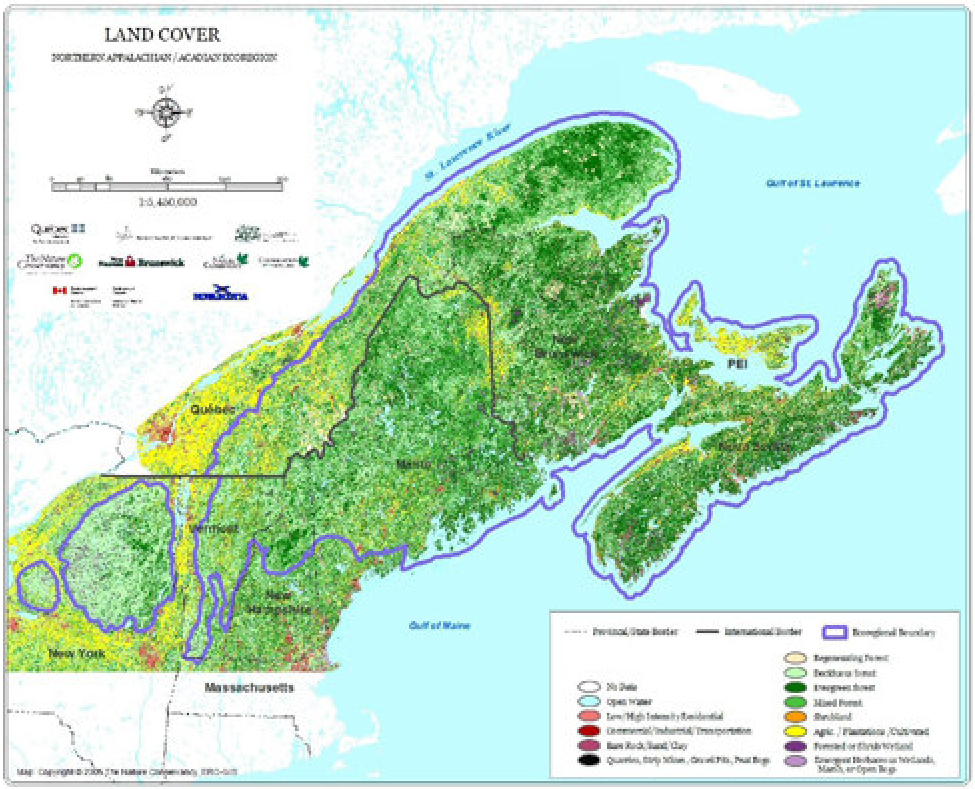


Figure 3. Land cover of the Northern Appalachian- Acadian ecoregion.

Ecosystem Targets
Northern Appalachian – Acadian Ecoregion

(final draft, Anderson 3/16/2006)

Coarse-filter and fine-filter targets

Conservation of biodiversity encompasses all aspects of nature from a single rare species to a complete ecosystem with all its associated species, structural components and ecosystem functions. This comprehensive protection approach is referred to as "coarse-filter / fine-filter" strategy where the coarse-filter targets are the ecosystems that characterize an region and define its landscapes. Coarse-filter targets not only implicitly conserve up to 99% of the species present in an ecoregion but also maintain the larger ecological context and processes. "Fine-filter" targets are the relatively few species that can not be adequately conserved by protecting ecosystems only but require individualized and direct conservation attention.

Ecosystem definitions

Ecosystem: an ecological community, together with its environment, functioning as a unit.

An ecosystem is defined by having a distinctive biota and physical setting but the term is scale-less and does not imply any particular size of feature. Floodplain forests, freshwater marshes, and peat-forming bogs are examples of moderately sized ecosystems. At smaller scales ecologists recognize cliff/talus slope ecosystems, rocky summit ecosystems and bowl/ravine ecosystems. These relatively discrete systems are associated with a discernable topographic setting, geologic situation or a dominant process and occur across the landscape in distinct patches. We named these *patch-forming ecosystems*. In contrast, a few ecosystem types dominate the natural land area in and around the patch systems forming a background matrix. We called these *matrix-forming ecosystems* and in eastern North America they are all forest types.

This way of scaling ecosystems recognizes an explicit 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, swamps and marshes (large patch systems) and even smaller settings of cliffs, outcrops and shores (small patch systems). Patch-forming ecosystems are often richer in species diversity than the matrix-forming ecosystems that surround them and are of great interest to conservationists as "special habitats" or "biotic hotspots." Regardless of scale, ecosystems are still coarse-filter targets as they are composed of many individual species populations and conservation activity is best directed at maintaining the entire system.

Not every landscape feature, geologic formation or natural process forms a distinct ecosystem. It was the task of the ecology team to name and describe those settings that do and, by default, those that do not. Toward this end a list of all potential ecosystems was compiled for the ecoregion based on the U.S. National Vegetation Classification (NVC[1]) and the Acadian Forest Taxonomy[2], which are hierarchical classifications organized by vegetation structure and hydrologic regime. Preliminary units for ecoregional targets were identified at the taxonomic scale of the *association* defined by the full floristic composition of the unit. Descriptions of the species

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[1] 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.

[2] Basquill 2003. Acadian Forest Association Taxonomy

composition, the physical setting, the typical size range of an occurrence and its distribution in the ecoregion were assembled.

Defining and Delineating the Ecosystem Targets

The classification work supplied a vision and understanding of the types of ecosystems that occurred in the ecoregion. However the taxonomies had been created primarily for the purpose of cataloging ground inventory data collected in the field. To comprehensively locate, identify and assess examples of each ecosystem type across the huge 84 million acre region we developed new ecosystem mapping and modeling techniques consistent with the classification systems.

Ecosystem Models

Ecosystem models were created based on a landform/topographic feature data layer available for the entire ecoregion (detail on the derivation of the landform coverage from a 90 meter digital elevation model are documented in Anderson 1999[3]). The landform coverage classified and mapped the ecoregion into 14 topographic settings that collectively covered 100% of the landscape:

- *Flat summit* *Slope crest*
- *Upper slope* *Cliffs and steep slopes*
- *NE facing side slope* *SW facing side slopes*
- *NE facing bowls & ravines* *SW facing bowls & ravines*
- *Gently sloping hills* *Dry flats and valley bottoms*
- *Wet flats and wetlands* *Slope bottom flats*
- *Lakes and ponds* *Rivers and streams*

Data on wet flats and wetlands were supplemented and enhanced by detailed digital maps of wetlands delineated from airphoto analysis and compiled from several sources:

National wetlands inventory (US, scale 1:24000)

Maritimes wetland inventory (Maritime Canada, scale 1:24000)

Quebec wetland mapping (Quebec, scale ?)

Relationships between the mapped landform units and the NVC/Natureserve community classification units were studied and made explicit through the overlay of over 8,000 ground inventory points for community types available in the U.S. and forest stand data points available in maritime Canada. Some relationships were directly synonymous (e.g. cliff and steep slope landform = Natureserve cliff and talus ecological system) others were more complex and we characterized them quantitatively (e.g. 80% of the rich northern hardwood forests occurred on bowl/ravine landforms, while 20% were on steep slopes). These relationships are discussed in detail in the individual ecosystem chapters.

After examining the relationships to the Heritage and CDC element occurrences we simplified the landform models to encompass six key settings that were highly correlated with, and logical surrogates for, patch-forming ecosystems. When tested against the US Heritage program element occurrences that included natural community types, **these six features collectively**

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[3] Anderson 1999. Viability and spatial assessment of ecological communities in the Northern Appalachians ecoregion.

contained almost 81% of the 8554 compiled element occurrences although the systems themselves covered only 15% of the ecoregion[4]. The final set included:

- Summits and hilltops
- Cliffs and steep slopes
- Bowls, hollows and ravine networks
- Freshwater wetlands
- Riparian and floodplains networks
- Coastal shores and wetlands

Other topographic settings, particularly side-slopes, gently sloping hills, dry flats and valley bottoms were associated with matrix-forming forest. Matrix was treated in a customized way described in the matrix-forming forest chapter.

To develop conservation targets for patch forming ecosystems the six landform models were stratified across a spectrum of biophysical settings encompassing the important ecological gradients identified for the ecoregion. To allow for this, consistent ecoregion-wide data layers were compiled for 5 physical factors (state, provincial and national data sets provided the data sources).

- Bedrock and surficial geology
- Elevation zones
- Ecological subregions
- Climatic zones
- Current landcover

Geologic and land cover units were simplified from more detailed local taxonomies to single regionally uniform units judged to have meaningful expressions for biodiversity. For instance all types of calcium-bearing rocks (limestone, dolomite, dolostone, marble etc) were mapped as "calcareous bedrock" and its presence coincides with fertile agricultural soils. State and provincial unit equivalences are given in the appendix. The compiled maps of each factor are presented in the map atlas section of this document.

Bedrock dependent models such as summits were stratified across bedrock types and elevation zones, whereas coastal wetlands were stratified geographically. The stratification scheme used for each model is described in the corresponding ecosystem section. In all cases the decisions on stratification were guided by the community classifications to insure that important biotic variation was captured by the ecosystem models.

Our goal was to closely approximate true taxonomically defined ecosystem targets. An ecosystem target was thus defined as an landform model in a specific biophysical and geographic setting (Table 1 and 2). For example the target defined as:

Cliffs and steep slopes on acidic sedimentary bedrock at low elevation

was considered roughly equivalent to the NVC association type (Table 2).

Sandstone dry cliff with sparse vegetation

[4] Note that adding lake and pond features would have boosted the EO capture to 84%

Table 1. Relationship between ecosystem models and their biophysical settings with Natureserve ecological system taxonomy and NVC associations. Further detail in Table 2

Final Ecosystem Models	# Set-tings.	Ecological Systems (Natureserve)	# NVC Assoc
Bowls and ravines	24	Sugar Maple – Hardwoods Forest (rich)	2
Cliffs and steep slopes	19	Acidic Cliff & Talus	12
		Alpine Mosaic	1
		Circumneutral Cliff & Talus	5
Coastal shores and wetlands	40	Atlantic Rocky Coast	6
		Coastal Raised Bog	5
		Estuary Marsh	3
		Saltmarsh	5
		Spruce-Larch Peatland	1
Freshwater wetlands	29	Acidic Open Fen	12
		Acidic Swamp	9
		Alkaline Open Fen	13
		Circumneutral Swamp	2
		Coastal Raised Bog	1
		Enriched Seepage Forest	3
		Forested Fen	5
		Inland Raised Bog	11
		Kettlehole Fen	9
		Patterned Acid Fen	6
		Patterned Alkaline Fen	3
		Shoreline Marsh	3
		Spruce-Larch Peatland	1
		Subalpine Fen	2
		Wet Meadow	4
Matrix forest	72	Lowland Spruce – Fir – Hardwood Forest	8
		Montane Spruce – Fir – Hardwood Forest	4
		Near-Boreal Spruce Flats	1
		Oak-Pine-Hemlock Forest	16
		Sugar Maple – Hardwoods Forest	4
Matrix forest (barrens & early successional)		Spruce Barrens	2
Riparian and floodplain	29	Ice-Scour Rivershore	4
		Inland Rocky Shore	2
		Near-Boreal Floodplain	5
		Temperate Floodplain	17
Summits and hilltops	22	Acidic Rocky Outcrop	16
		Alpine Mosaic	10
		Circumneutral Rocky Outcrop	5
		Oak-Pine-Hemlock Forest (woodland)	1
		Subalpine	7
Grand Total			250

Table 2 . The relationship between the ecosystem model stratification and the Natureserve and NVC classification. Targets were identified as a landform model (column 1) stratified across elevation and bedrock (column 2 and 3). Columns 4-7 provide information on the number of occurrences in the ecoregion, the conservation goal set and the total selected for the portfolio. Columns 5-6 show the equivalent ecological system type and corresponding association(s).

Cliff, Talus and Steepslope Ecosystems

LAND FORM	ELEV.	BEDROCK	Total in Region	% in Region	Goal	Total Selected	Nature serve System	NVC association: most likely type or types
Cliff and Steep slopes	0-800'	Sedimentary	424	10%	37	100	Acidic cliff/talus	Sandstone Dry Cliff Sparse Vegetation
		Granites	223	5%	19	41		Q. rubra – B. alleghaniensis / P. virginianum Woodland
		Mod Calc/ Mafic	168	4%	14	12		Igneous - Metamorphic Northern Dry Cliff Sparse Vegetation
		Calcareous	27	1%	2	14	Calcareous cliff/talus	Thuja occidentalis Cliff Woodland
	800-2500'	Sedimentary	1399	32%	121	268	Acidic cliff/talus	Sandstone Dry Cliff Sparse Vegetation
		Granites	717	16%	62	78		Granite - Metamorphic Talus Northern Sparse Vegetation
		Ultramafic	9	0%	2	4		Serpentine Cliff Sparse Vegetation?
		Mod Calc/ Mafic	428	10%	37	98		Igneous - Metamorphic Northern Dry Cliff Sparse Vegetation
		Calcareous	96	2%	8	32	Calcareous cliff/talus	Limestone - Dolostone Midwest Dry Cliff Sparse Vegetation
	2500-4000'	Sedimentary	255	6%	22	46	Acidic cliff/talus	Sandstone Dry (or Moist) Cliff Sparse Vegetation
		Granites	376	9%	32	67		B. papyrifera – P. glauca / A. spicatum/ P. virginianum Talus
		Ultramafic	24	1%	2	17		Serpentine Cliff Sparse Vegetation?
		Mod Calc/ Mafic	244	6%	21	39		Igneous - Metamorphic Northern Dry Cliff Sparse Vegetation
	4000+	Sedimentary	11	0%	1	8	Alpine cliff	Lichen Fellfield Sparse Vegetation
		Granites	1	0%	1	1		Lichen Fellfield Sparse Vegetation
		Mod Calc/ Mafic	5	0%	2	4		Lichen Fellfield Sparse Vegetation
			4407	100%	380	829		

$\underbrace{\hspace{20em}}_{\textbf{Stratification}}$ $\underbrace{\hspace{15em}}_{\textbf{Classification}}$

After mapping the ecosystems, individual examples of each ecosystem type were converted to discrete polygons or “modeled occurrences” (“MO”s, here after referred to as “occurrences”) using GIS region-group techniques allowing for assessment of each target across the ecoregion. Subsequently 20,000 to 120,000 examples of each described ecosystem were located and extensive information was assembled for each example relative to condition, landscape context and verification by other data sources (e.g. Natural Heritage or CDC element occurrences – Table 3). Each occurrence was individually screened as to its potential contribution towards conserving biodiversity using methods described below. The best examples were selected for the portfolio using representation goals to ensure that the selected examples were located across a spectrum of environmental settings.

Table 3: Example of a data compiled for one modeled occurrence of a low elevation bog

Wetland id#	**125078**	**Block size**	832 acres
Target type	Low elevation bog in coarse sediments	**Block size class**	4 (500-1000 acres)
Size in Acres	328.7	**# of Dams**	0
Size class	2	**Housing density pressure**	0.0012
State or Province	NB	**Land cover index**	19
Subregion	Acadian Uplands	**% in GAP 1 or 2**	28
Adjacency	Adj. to Size 4 river	**% in GAP 3**	45
Geology	Coarse sediments	**Distance to road: min**	0
% Deciduous	2.4	**Distance to road: mean**	343
% Conifer or Mixed	0.6	**Nearest road class**	4 – local road
% Swamp	61.4	**Site name**	
% Emergent	35.6	**EO communities**	1: Bog
Elevation Zone	Very low 20’-800’	**EO species**	0
Aquatic targets	Size 4 river	**EO rank**	A

During the screening process described below, quantitative methods were used to maximize the stacking of fine-scale targets within larger scale targets, but the co-occurrence of targets was not a requirement for inclusion in the portfolio. A key tenet of this effort was to maximize the utility of our data products to others by providing a comprehensive, transparent and objective analysis of the biodiversity targets in the ecoregion. We expect that other organizations will access the data, study the analysis and draw their own conclusions.

Identifying Critical Examples: Screening occurrences and determining their relative importance

Is it possible to permanently conserve all the biodiversity of an ecoregion using only a small proportion of the landscape? The answer to this question has not been scientifically established. While the Nature Conservancy, and many of its partners, recognizes the futility of trying to protect every acre of land or body of water, current research offers convincing evidence that certain places, and particular occurrences of key features, play a more important role in maintaining regional biodiversity than other places and features. Thus the question driving this analysis was - *which sites are the most critical to protect to insure the conservation of all biodiversity across the ecoregion.*

The influence of a particular ecosystem example on maintaining regional biodiversity may be due to its being particularly complete with respect to its component species or the occurrence may serve as source habitat for characteristic species and thus play a pivotal role in exporting individuals to the larger landscape. Ecologically complete occurrences contain all necessary parts of the ecosystem such as a full complement of associated species, key structural components and functioning processes that maintain dynamics. High quality examples contain habitat, in which the component species thrive because the habitat provides adequate resources, minimizes mortality and facilitates reproduction. Source areas consistently produce surplus individuals (juveniles or propagules) that emigrate to the larger landscape. The antithesis of source habitat, sink areas, are habitat patches where species subsist but are not reproducing or where mortality rates are very high. Populations in sink areas may persist over time but they are generally subsidized from the source habitats. High quality habitat may also serve as refugia or strongholds of rare or uncommon species that have already disappeared from much of the surrounding.

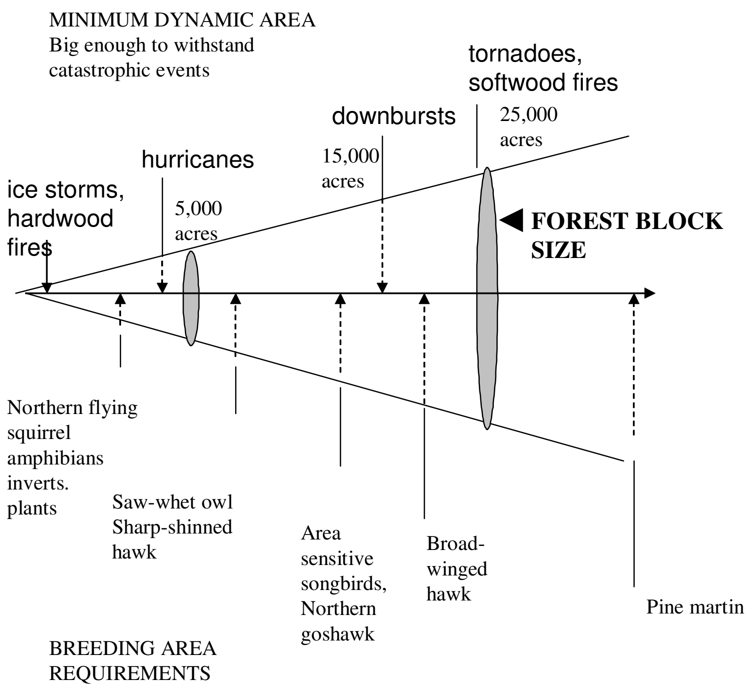
We established and applied **screening criteria** to every ecosystem example to determine if it was likely to be a **critical** occurrence and qualify for the portfolio. Those that did not meet the criteria were classified as **supporting** occurrences – important but not crucial to the conservation of biodiversity in the ecoregion. The criteria we used to separate the critical occurrences from the supporting ones were:

- Size of the occurrence.
- Landscape context surrounding the occurrence.
- Condition of the occurrence.

Criterion 1. Size of the occurrence: Acreage thresholds for ecosystems were based on the minimum dynamic area needed for an occurrence to absorb and recover from typical disturbances. Additionally we used the minimum area requirements of associated species and the average territory size of breeding females. The latter allowed us to estimate whether a given species would likely be present and whether there was physical space for at least 25 breeding territories to allow the population to persist (Figure 1 and 2.) Details on this approach may be found in Anderson (1999)[5]

[5] Anderson 1999. Viability and spatial assessment of ecological communities in the Northern Appalachian ecoregion.

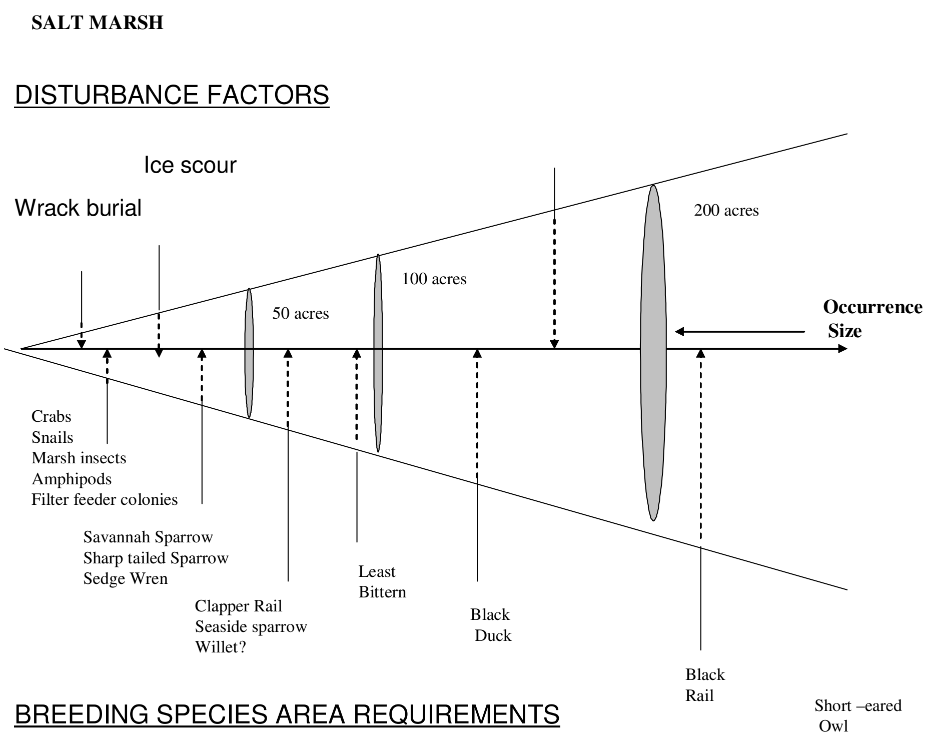
Figure 1. Scaling factors for matrix forming forest in the Northern Appalachian / Acadian ecoregion. A 25,000 area forest block, represented by the larger grey circle, should be accommodating of all the factors to its left.



Disturbance sizes are based the severe disturbance patch size as determined from published literature and air photo analysis

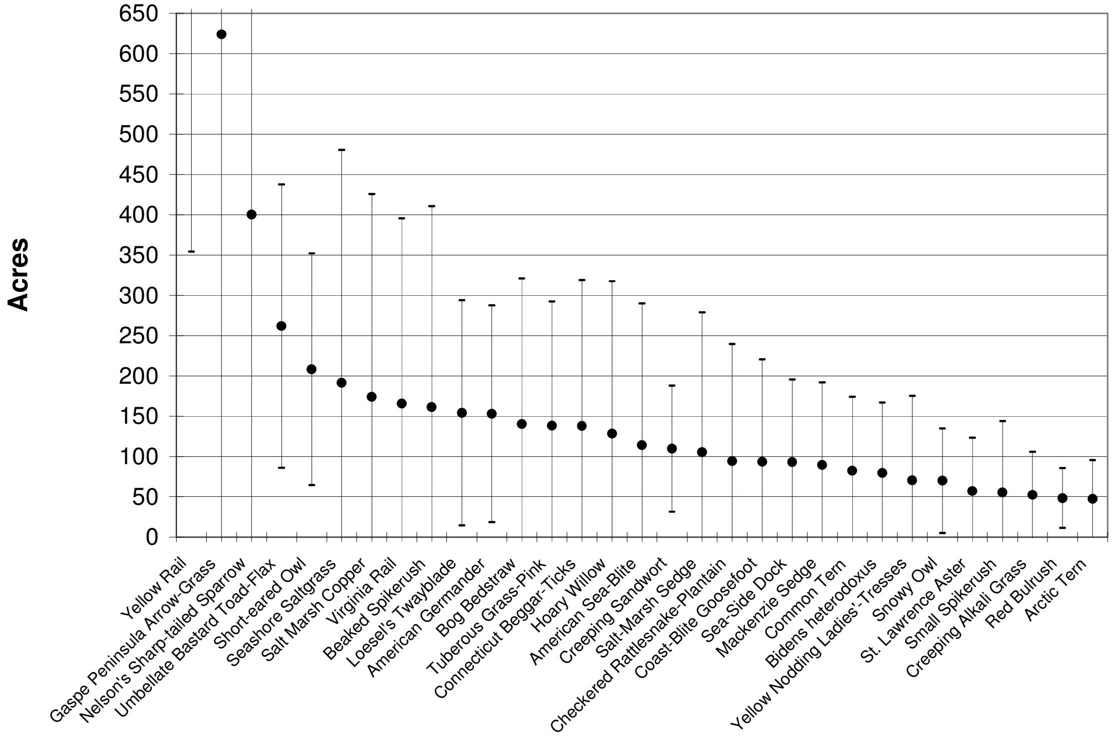
Female breeding area requirements are from Birds of North America (Poole and Gill eds.) and DeGraaf and Yamasaki 2000 New England Wildlife

Figure 2. Minimum dynamic area and breeding territory sizes for Northern Appalachian salt marshes.



Using ground survey information we assembled evidence on the relationship between occurrence size and species presence by calculating the average size of an ecosystem occurrence in which a particular species, or group of species had been found (Figure 3).

Figure 3. The average size and size range of coastal bogs and salt marshes where confirmed occurrences of characteristic species were found. Data from Canadian CDC programs and Maine Natural Heritage program, restricted to species with 3 or more occurrence and a location precision of 0 to 3. The grand average was 188 acres.



Criterion 2. Landscape context. This measure refers to the relative amount of development, agriculture, quarries, roads or other fragmenting features within an area directly surrounding a specific ecosystem occurrence. It provided an estimate of the isolation of the occurrence as well estimates of future encroachments on the occurrence. To assess landscape context we developed a landscape context index (LCI) based on these features within a 1 kilometer radius surrounding the occurrence (Figure 4). Base data layers included roads, high intensity developed lands, low intensity developed lands, agriculture, quarries and natural cover.

Figure 4. Schematic of Land Cover Index (LCI). An LCI below 20 indicated that the occurrence was surrounded primarily by natural cover. Higher LCIs indicated increasing amounts of roads, development and agriculture, Occurrences with LCIs above 50 were usually rejected as critical occurrences.

LCI < 20 Occurrence is surrounded by primarily natural land cover

LCI > 50 Occurrence is surrounded by roads, development and agriculture

Criterion 3. Condition.

This measure refers to the internal state of the occurrence. Had the example been ditched, dredged, mined, clear-cut, toxified, or otherwise degraded? Was it loaded with exotic pest species? We evaluated condition by requiring that every selected occurrence be corroborated by an independent source such as a US. Natural Heritage or Canadian Conservation Data Center ground inventory point. Other acceptable evidence was if the occurrence was coincidence with a described Audubon or Fish and Game important bird area or if it received expert confirmation by a recognized authority. For this verification we are greatly in debt to the US Natural Heritage programs and Canadian Conservation Data Centers who contributed over 29,000 ground inventory points and to the Provincial governments who contributed thousands of forest inventory points.

Our screening process filtered out many examples that may be capable of persisting through time, particularly if augmented by management, but our intent was to identify the most crucial examples of each target necessary to protect to maintain biodiversity across the ecoregion. Selected examples were judged to be extremely significant and vital to the resolution of the biodiversity crisis in this region. To avoid confusion we opted not to use the term *viable,* in reference to these examples instead referring to them as *qualifying* and to those selected for the portfolio as *critical occurrences*.

Setting Numeric Goals

Minimum numeric and distribution goals were set for each target based on the factors of representation and replication. Goals were used primarily to identify and measure gaps in portfolio sufficiency, however *the numeric goal also represents the smallest number of examples we think are needed to represent the target across all important gradients with a minimal degree of redundancy*. Minimum acreage goals were calculated by multiplying the numeric goals times the minimum size criteria. For instance, if ecosystem "A" had a goal of 100 examples and if each example had to be at least 50 acres than the minimum area needed is 5,000 acres.

Representation: The objective of the representation goal was to insure that we captured all the compositional variability inherent in the ecosystem. Some systems vary in their species composition across elevation zones, bedrock types, climatic regions and soil moisture levels. Our solution was to protect a set of examples selected from across the various gradients using the customized stratification schemes described in the ecosystem sections.

Replication and Redundancy: The objective of the replication goal was to minimize the risk of a given target disappearing by insuring that we had more than one example in the portfolio. Like back-up engines on an airplane, reliability theory suggests that many moderate quality/small examples might have the same probability of persisting over a century as fewer high quality/large examples. Thus we adjusted the numeric goal according to the scale of the target. For matrix forest blocks, which are huge in size, we required only 2 or 3 replicates whereas small features like cliffs needed 20 to 30 replicates.

Portfolio Status: Definitions and Codes:

Every occurrence of each ecosystem was assigned a final portfolio status and given a portfolio code based on the definitions given below. Only those examples termed "critical occurrences" were considered to be included in the portfolio and only those examples were used to calculate progress towards ecoregional goals.

1) Critical occurrence: an occurrence crucial to the conservation of biodiversity in the eocoregion. The occurrence met all screening criteria for size, landscape quality and verification. Critical occurrences are the only type counted towards meeting portfolio goals.

2) Candidate occurrence: an occurrence that met the size and landscape context criteria but was not corroborated or verified by an expert or ground inventory point. These occurrences were not considered part of the portfolio or used to meet goals. They are a priority for further inventory work to verify their condition and importance.

3) Supporting occurrence: an occurrence that is below the screening criteria for size or landscape context or has poor condition as verified by a third party. These occurrences are not considered part of the portfolio although they may contribute towards biodiversity in the ecoregion.

Ecosystem Criteria Summary

Summits and hilltops: 30 acres, LCI2<20
Cliffs and steep slopes: 25 acres, LCI2<20
Bowls, hollows and ravines (Coves): 25 acres, LCI2<20
Freshwater wetlands 50 acres, LCI2<20
Riparian and floodplains communities 100acres, LCI2<20
Coastal shores and wetlands:
  Beach: 20 acres, LCI2<30
  Rocky shore/Cliff: 10 aces, LCI2<30
  Salt marsh: 60 acres, LCI2<30

Tidal flat: 100 acres, LCI2<30
Coastal bog: 75 acres, LCI2<30

Technical Definitions

Candidate = Larger than the size criteria and below LCI 20 (30 for coastal)
Provisional Candidate= Larger than the size criteria and above 20 but below 50 LCI
Supporting = Smaller than the size criteria and any LCI or any size but greater than 50 LCI
Critical = Candidate and provisional candidate occurrences that had their significance corroborated and verified with appropriate ground inventory information (EO point) or expert knowledge.
Protected = Term applied if 50% or greater of the occurrence area was found on land with a GAP status 1 or 2.

Identifying the critical occurrences was a relatively straightforward process except for those occurrences in the "zone of indecision", the grey area where borderline occurrences were sorted through on a case-by-case basis with more subjectivity than at the two ends (Table 4). Adjustments to the final selection of occurrences were made via expert caveats based on knowledge of the site. Expert opinion generally overrode the assigned category and this came into play for approximately 5-10% of the selected critical occurrences.

Table 4: Screening Criteria Decision Rules for Freshwater Wetlands: Examples had to meet 3-way criteria of Size, Landscape Context and Confirmation by Element occurrences. The bottom row indicates the subset of the occurrences that needed case by case attention to determine the portfolio status.

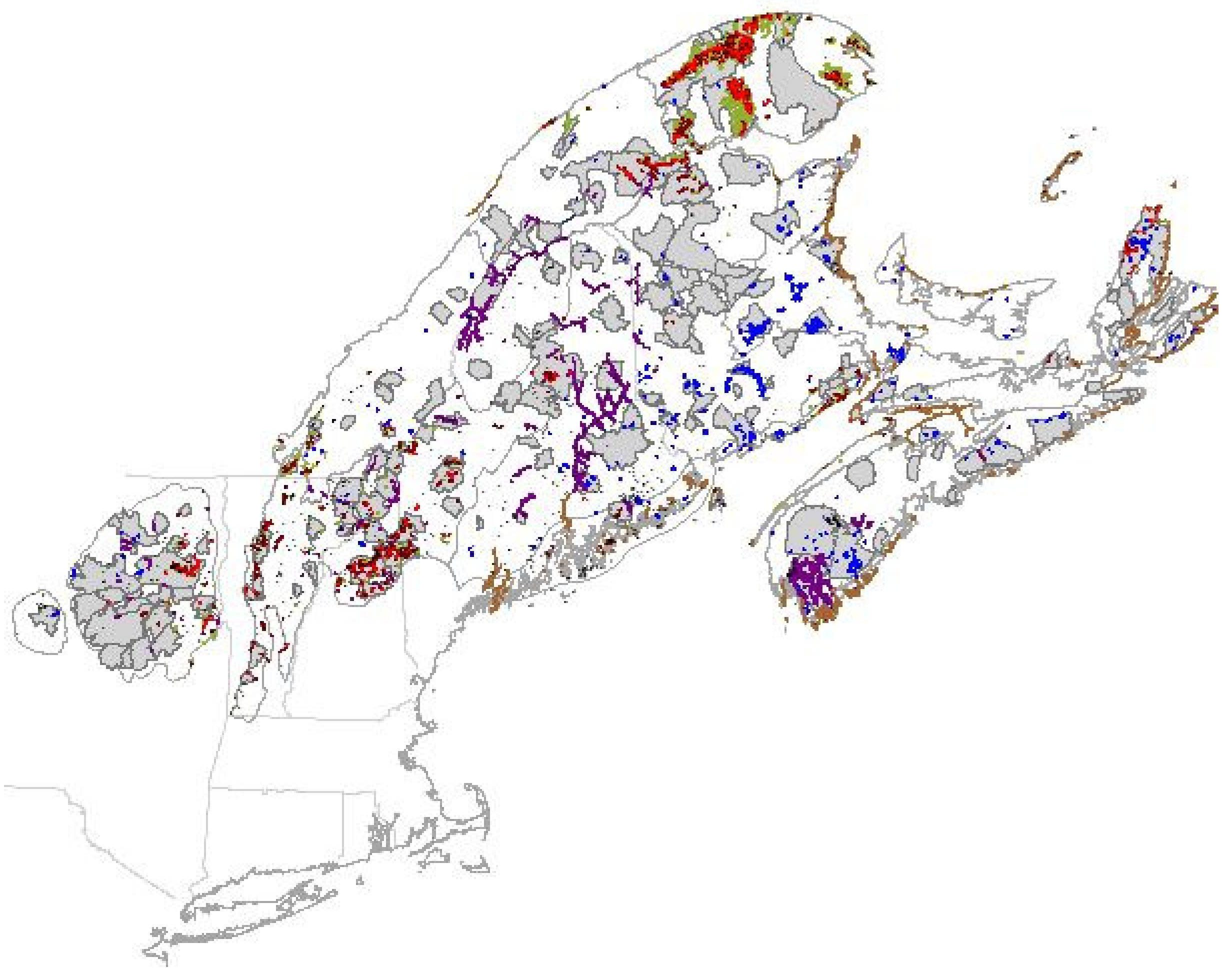
DECISION RULES	SIZE	LCI	Element Occurrences	Decision
Critical Occurrences	Greater than 1000 Acres	Less Than 20	EO verification or expert confirmation. Largest in ecoregion	**High confidence**
Critical Occurrences	Greater Than 50 Acres	Less Than 20	A-B quality communities or species OR many unranked occurrences	**High confidence**
Candidate Occurrences	Greater than 50 Acres	Less than 20	No verification	**Moderate confidence**
Provisional Candidate Occurrences	Greater than 50 acres	20 – 50	No verification	**Moderate confidence**
Supporting Occurrences	Less Than 20 acres	Greater than 50	No verification or D ranked or Historic Occurrences	**High confidence**
Various	20-50 Acres	20-50	C quality communities or species OR single unranked occurrence	**Case-by case decisions**

IV. Results: Our results suggest that about 29% of the ecoregion is critical for maintaining biodiversity of ecosystems in region (Table 5). Of that 27% was focused on matrix-forming forest and 2% on patch-forming ecosystems. When examined from the perspective of ecosystem types our results suggest that from 9% to 44 % (average 24%) of all possible examples were selected depending on the ecosystem type. Detailed results are included in each ecosystem chapter. Below are summaries and examples for all of the ecosystem types and a few illustrative species targets.

Table 5. Summary of Acreage Recommendations for the Northern Appalachians/Acadian region

ECOSYSTEM TYPE	GOAL % of all possible examples	GOAL % of the Ecoregion	% portfolio protected GAP 1/2	Total Acreage in the region	% System in the Region
Coastal (excl. tidal flat)	44%	0.01%	18%	926,644	1%
Steep slopes	27%	0.00%	13%	488,011	>1%
Freshwater wetlands	24%	0.05%	26%	1,273,517	2%
Riparian	18%	1.00%	3%	4,282,458	5%
Bowls/ravines	14%	0.50%	76%	3,889,864	5%
Summits	9%	0.03%	35%	2,758,928	3%
Total Non Forest		1.59%		13,619,422	15%
Matrix Forest Blocks	29%	27.00%	27%	67,724,133	82%
Subset for restoration cores		*5.00%*			
TOTAL PORTFOLIO		**28.59%**		**82,590,406**	**23,612,597**

Figure 5. The Northern Appalachian/Acadian Ecoregional Portfolio. This map does not show the background forest in order to emphasize the sites.



Ecosystem Summaries and Chapters

A) One-Page Summaries

Upland Ecosystems

Matrix-forming forest
Summits
Cliffs and steep slopes
Bowls, hollows and ravine networks

Wetland Ecosystems

Freshwater basin wetlands
Riparian and floodplain networks
Coastal shores and marshes

B) Ecosystem Chapters

Upland Ecosystems

Matrix-forming forest
Summits
Cliffs and steep slopes
Bowls, hollows and ravine networks

Wetland Ecosystems

Freshwater basin wetlands
Riparian and floodplain networks
Coastal shores and marshes

UPLAND ECOSYSTEMS

Matrix-forming Forest:

Red Spruce- Balsam fir, Beech-Birch-Maple Northern hardwoods, Red spruce-hardwoods, Others.

Forest comprises 84 percent of the ecoregion, most of it recovering from almost two centuries of logging. Now in its 3 or 4th rotation, forestry is less profitable and the land base is being sold for other uses. Forest ecosystems have lost their legacies of large coarse woody debris and they are presently crisscrossed by a vast network of roads and highways serving as both barriers between interior patches and conduits into once inaccessible places.

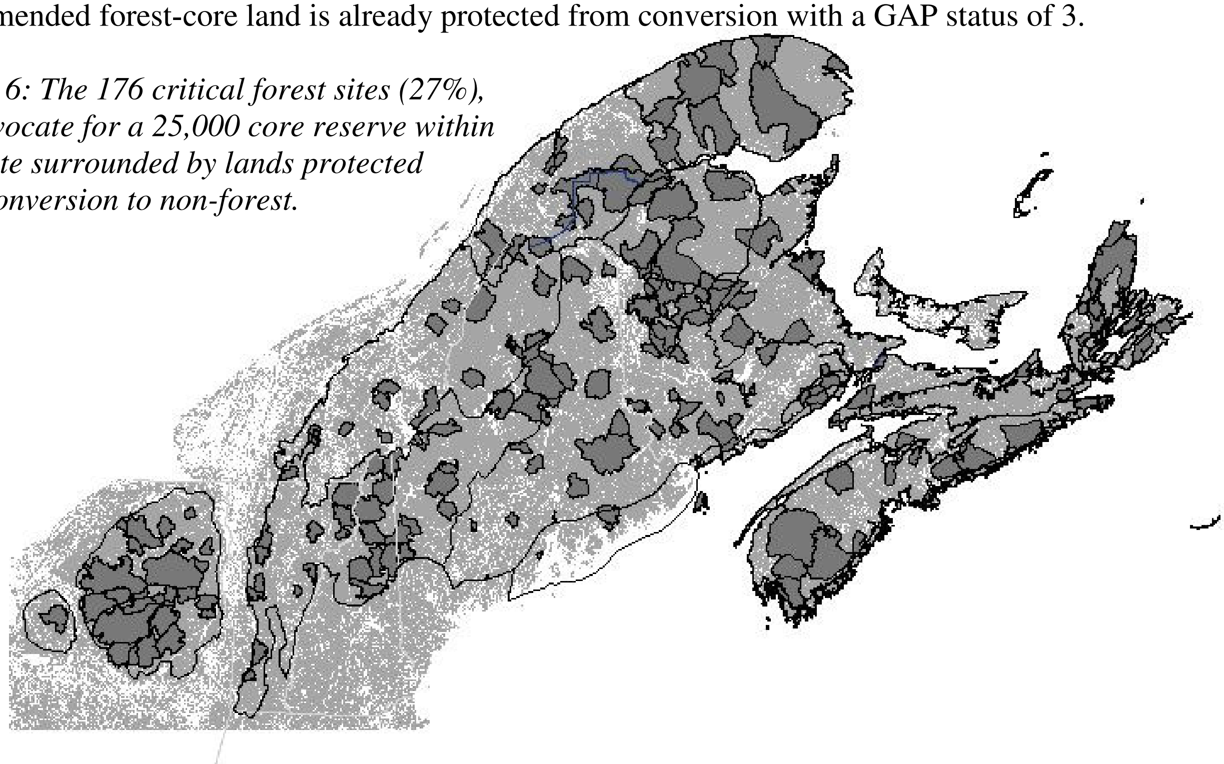
Acreage: 67,724,133 (82% of the ecoregion)
Portfolio goal: 1 site minimum per 72 ecological groups
Portfolio sites identified: 176 sites, each over 25,000 acres
Portfolio %: 27% with 5% subset for restoration of complete ecosystems with "old growth" characteristics
Protection: 27% have 25K cores in GAP 1or 2.
33% have1-24K cores in GAP 1 or 2
29% have less than 1K cores in GAP 1or 2

Key conclusions for forest

Based on our results we recommend that a minimum of 27% of the forest be conserved and restored in a series of 176 forest reserves, each comprised of 25,000 acres or more contiguous forest. Further we advocate that a subset of 5% (25,000 acres per block) be devoted to the restoration of complete forest ecosystems with biological legacies and "old-growth" characteristics. Outside of the core restoration areas, forest-cover and biodiversity should be maintained through methods that prevent conversion to non-forest cover and insure "well managed forest".

We are already more than one-third of the way towards meeting this goal. As of November 2005, almost one-third the 176 matrix forest areas have established 25,000 acre core areas and another third have established cores within a 5000 to 24,000 size range. Additionally 11% of the recommended forest-core land is already protected from conversion with a GAP status of 3.

Figure 6: The 176 critical forest sites (27%), We advocate for a 25,000 core reserve within each site surrounded by lands protected from conversion to non-forest.



Summits:

Mountain peaks, hilltops, ridgelines, knolls

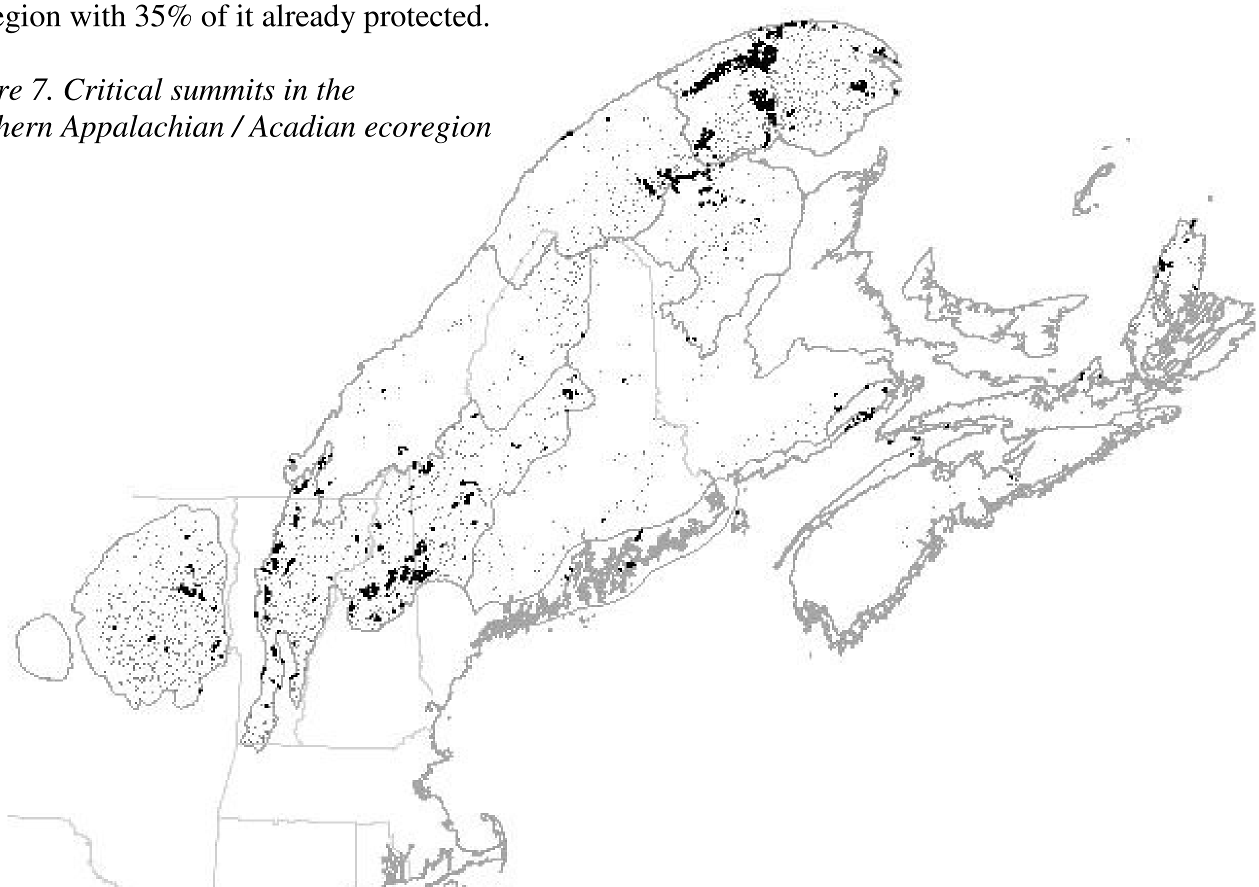
Ranging from alpine summits with a unique gem-like flora to the fog-shrouded granite domes of coastal islands - mountain top and hill crest features are some of the most characteristic and beloved features of the ecoregion. Their biodiversity contributions are well documented. The immense open barrens on serpentine rock or the smaller mid-elevation outcrops on calcareous rocks abound with plant rarities. Rocky pine/oak woodlands predominate at low elevation punctuated by open sparse grasslands and heath communities. Among the high spruce and fir, the stunted krummholz, open meadows and the rare Bicknell's thrush have brought them to global attention. .

Acreage: 2,758,928 (3% of the ecoregion)
Count: 104,745 (over 2 acres)
Average Size of Feature: 26 acres
Screening Criteria
Size: 30 acre minimum, LCI <20, Corroboration
Portfolio goal: 453 (20 examples * 22 "types")
Portfolio sites identified: 393 (1,938 occurrences)
Portfolio acreage: 9% of summits, 0.03% of Ecoregion
Portfolio Protection by area: 35% on GAP 1 or 2

Key conclusions for summits and mountains:

Summits comprise about 3 percent of the whole region. We recommend a minimum of 9% of all summits them be protected in a set of 393 key sites that concentrate almost 2000 of our most critical summit ecosystems. This is a very achievable goal amounting to less than 1 % of the whole ecoregion with 35% of it already protected.

Figure 7. Critical summits in the Northern Appalachian / Acadian ecoregion



Steep slopes:
Cliffs, talus slopes, crags, bluffs, outcrops

Remote cliffs, rocky crags, landslide scars, river bluffs and talus slopes contribute unmistakable character to the rugged landscapes of the Northern Appalachian - Acadian region. Unique biodiversity and ecosystems are associated with these features throughout the region, differing substantially with bedrock types. Vertical cliff faces are choice settings for peregrine falcons and golden eagles. Wiry, tenacious herbs like birds-eye primrose, slender cliff brake and fragrant cliff fern root in minute crevices. Accumulating talus at cliff basses creates a structure preferred by timber rattlesnake, rock vole and Gaspe shrew.

Acreage: 488,011 (<1% of the ecoregion)
Count: 16,392 (over 2 acres)
Average Size: 27 acres
Screening Criteria
Size: 25 acre minimum, LCI <20, Corroboration
Portfolio goal: 380 (20 * 19 "types")
Portfolio sites: 346 sites (829 occurrences)
Portfolio acreage: 27% of steep slopes, 0.003% of region
Portfolio Protection by area: 13% on GAP 1 or 2 (3% by

Key recommendations for steep slopes

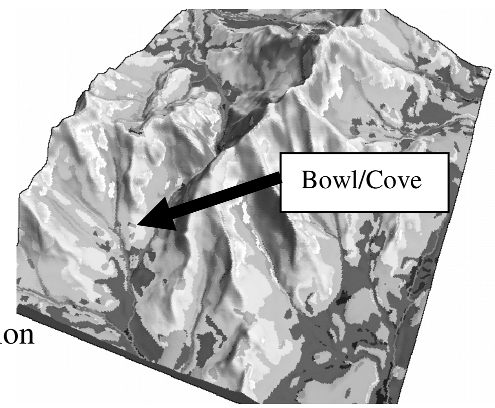
Over 15,000 examples of these features occur in the region totaling almost a half a million acres. Based on our analysis we recommend that 27% of the half million acres be protected in 346 critical sites. This amounts to less than a 1 percent of the ecoregion but includes over 800 of the most critical occurrences. As of this year, 13% of this set is already in a GAP 1 or 2 reserve status

Figure 8. Critical steep slopes in the Northern Appalachian / Acadian ecoregion

Bowls, Hollows and Ravine Networks:
Rich forests, moist draws, ravines, toe slopes, hillside benches

Moist draws, wooded ravines, enriched forests in bowls and hollows provide some of the most fertile settings in the region. Over 200,000 of these features occur, covering 5% of the ecoregion, although like streams, these systems form interconnected networks and it can be hard to determine where one occurrence ends and another begins.

The lush patches of forest that develop in these settings are known colloquially as “rich northern hardwood forests”, “rich mesic forest”, “maple-ash-basswood forest” or “cove hardwoods” and they are often sought out by botanists for their unique flora. The fertile damp soils that develop in these shallow bowls are local repositories of nutrients and support a variety of nutrient-loving plants such as ginseng or Goldie's fern, and trees like basswood, white ash and sugar maple. Calcareous soils accentuate the fertility of rich hardwood forests and remarkable understories of maidenhair fern, trilliums and impatience may result. Seventy-eight percent of the inventoried rich hardwood forests occurred in this setting.

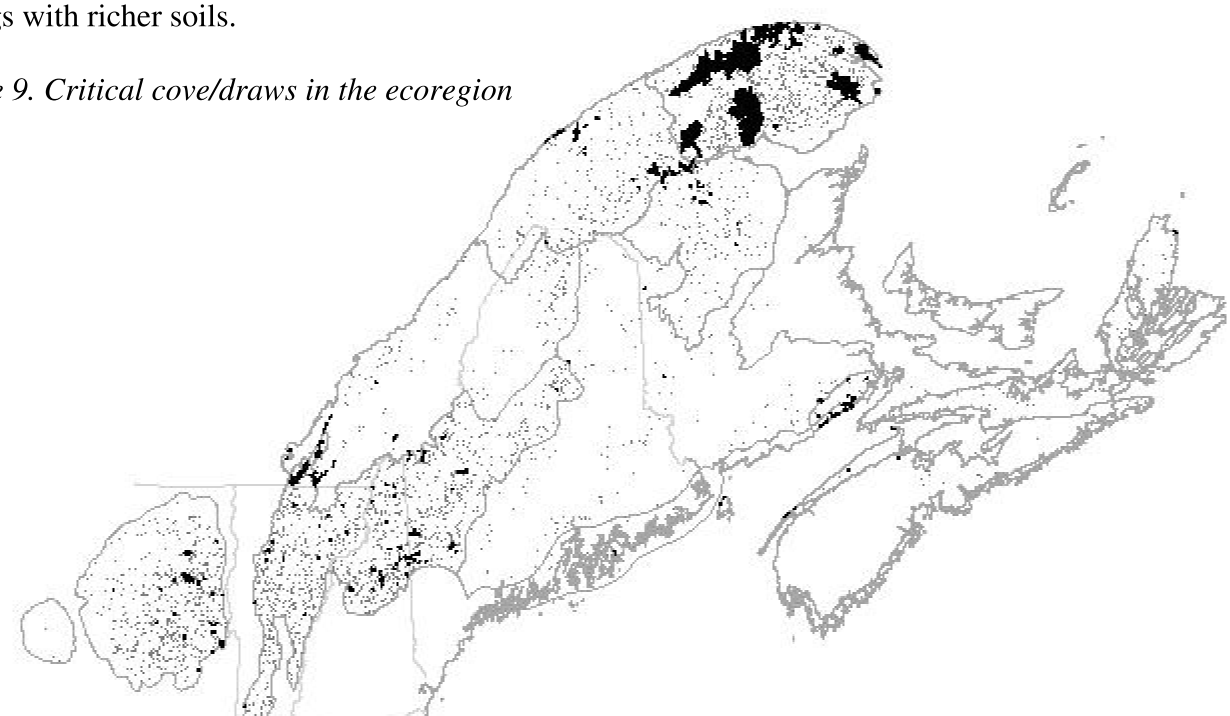


Acreage: 3,889,364 (5% of ecoregion)
Count: 216,272 (over 2 acres)
Average Size: 18 acres
Screening Criteria
Size: 25 acre minimum, LCI <20, Corroboration
Portfolio goal: 20 * 44 “types” = 480 (499)
Portfolio sites: 340-380 sites (roughly 1269 occurrences)
Portfolio acreage: 14% of all coves/draws, <1% of Ecoregion
Portfolio Protection by area: 76% on GAP 1 or 2
11% on GAP3

Key recommendations for cove forest and wooded ravines

We recommend that protection be established for 14 percent of these features in a set of 360 sites that contain a remarkable 1200 of our most critical occurrences. This goal is highly achievable as currently 76% of the critical examples identified in this portfolio are already protected in GAP 1 or 2 reserves. The final 24% may be a challenge however as they tend to occur in low elevation settings with richer soils.

Figure 9. Critical cove/draws in the ecoregion



WETLAND ECOSYSTEMS

Freshwater Basin Wetlands

Bogs, marshes, fens, wet meadows

Much of the Northern Appalachian / Acadian region is soggy. Massive Holocene glaciers left behind a legacy of deranged drainage patterns forming over a million acres of marshes, mudflats, seeps, swamps and spongy bogs. These features are unevenly distributed across all subregions with the easternmost Acadian uplands and the Bras D'Or lowlands having more than the rest of the subregions combined.

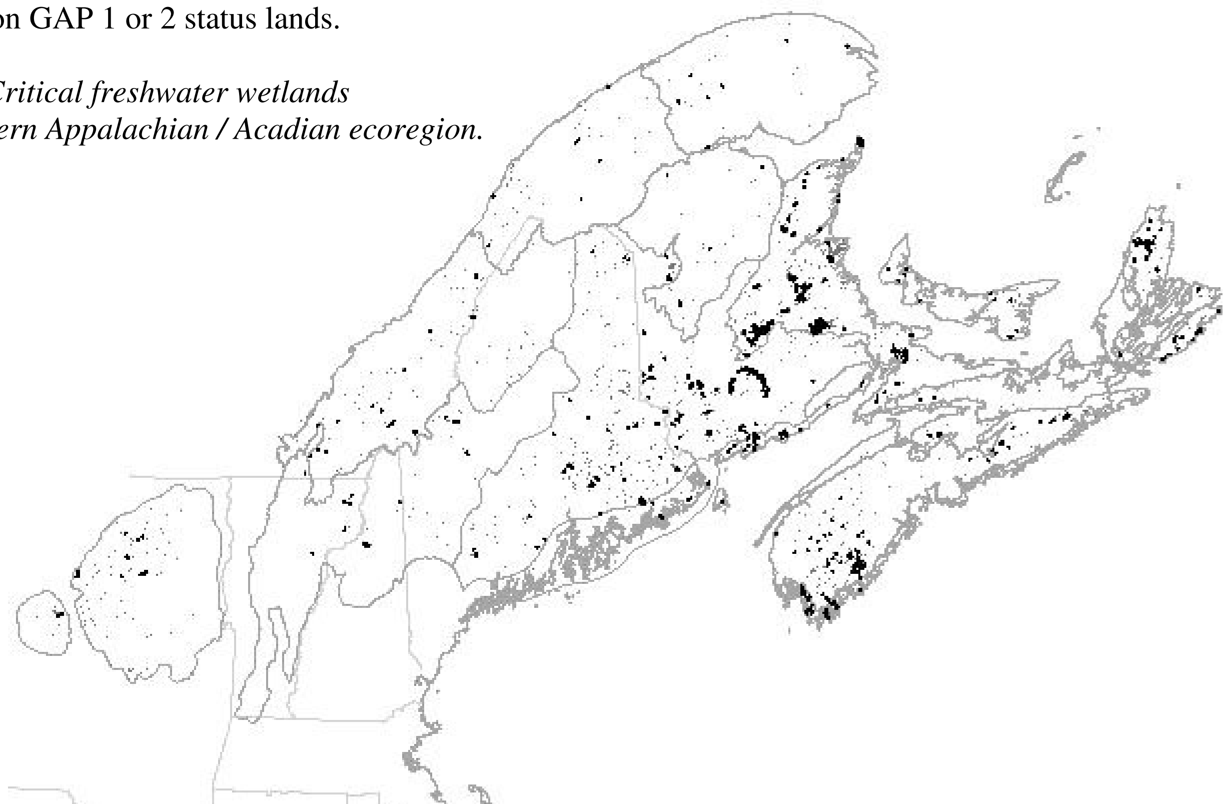
Breeding populations of birds such as Virginia rail, yellow rail, American bittern, marsh wrens, black-crowned night heron and ring-necked duck, herptiles such as pickerel frog, northern dusky salamander and Blanding's turtle, a myriad of sedges, rushes, bladderworts, orchids, water-lilies, pondweeds and insects from darners to dusky-wings depend on these wetlands.

Acreage: 1,273,517 (2% of the ecoregion)
Count: 29,312 (over 2 acres)
Average Size: 43 acres
Screening Criteria
Size: 50 acre minimum, LCI <20, Corroboration
Portfolio goal: 20 * 29 "types" = 580 occurrences
Portfolio sites: 568 critical occurrences
Portfolio acreage: 24% area of wetland, 0.05% of region
Portfolio Protection by area: 26% on GAP 1 or 2,
30% on GAP 3

Key Results for Freshwater Wetlands

Based on the results of this analysis we recommend that 24% of the 1.3 million acres of wetlands be protected for biodiversity in a set of 568 critical wetland complexes. About ¼ of these are already on GAP 1 or 2 status lands.

Figure 10. Critical freshwater wetlands in the Northern Appalachian / Acadian ecoregion.



Riparian wetlands

Floodplains, alluvial marshes, riverside seeps

Riversides and floodplains are some of the most dynamic areas of the landscape. During spring runoff, submerged floodplains provide critical feeding and spawning areas for fish and other aquatic species. In drier seasons, the water recedes to reveal a myriad of geomorphic features, each with its own characteristic flora and fauna. Fresh silt deposits, scoured riverbanks, sand bars, alluvial meadows, depression marshes, oxbow lakes, braided stream channels and lush floodplain forests interact to form a complex system rich in biodiversity.

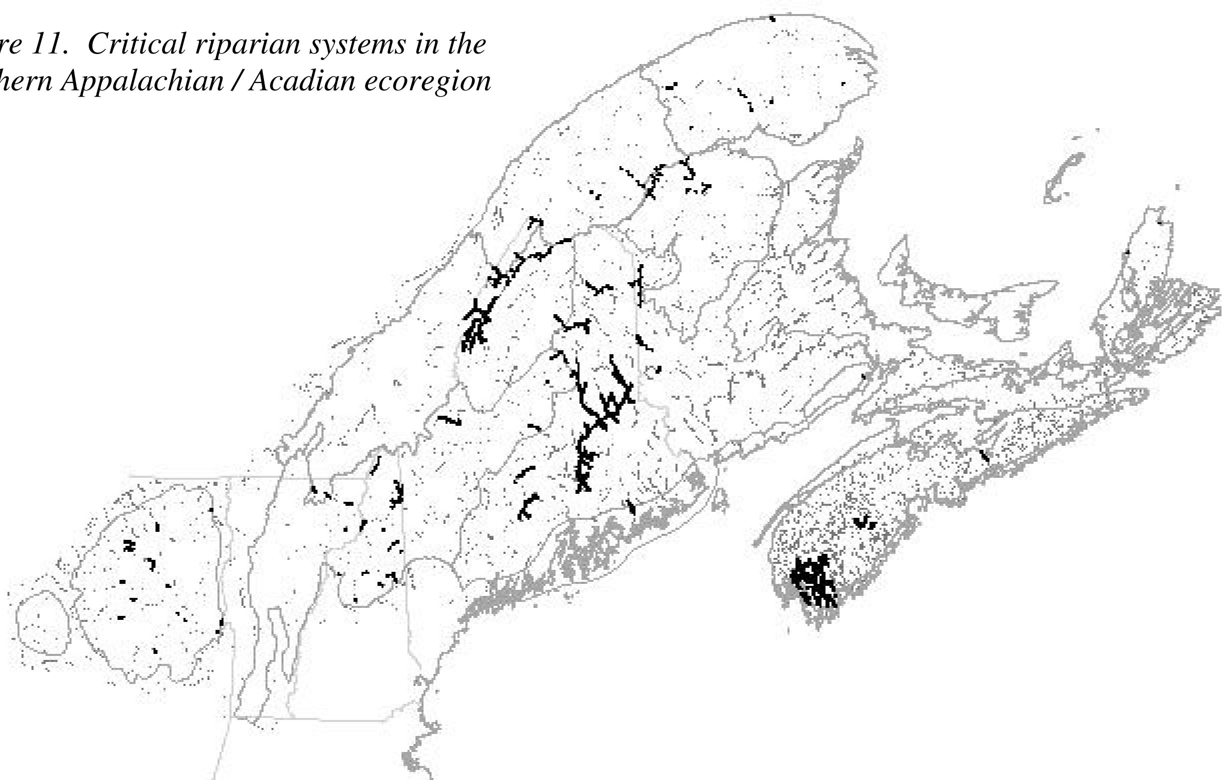
Intact riparian corridors and floodplains are linear features, averaging about 200 acres in the Northern Apps. They provide critical habitat for flood tolerant trees like silver maple, green ash, American elm and box elder as well as ideal conditions for many native ferns and herbs, such as ostrich fern, sensitive fern, wood nettle, tall meadow rue, jack-in-the-pulpit, riverbank grape and poison ivy. Wood turtles, fowler's toad, and many other frogs, turtles and salamanders depend on riparian systems as do brook trout, salmon and other native fish.

Acreage: 4,282,458 (5% of ecoregion)
Count: 21,834 (over 2 acres)
Average Size: 201 acres
Screening Criteria
Size: 100 acre minimum,
LCI <20, Corroboration.
Portfolio goal: 295 (10 * 29 "types")
Portfolio sites = 240 occurrences
Portfolio acreage: 18% of riparian features,
1% of ecoregion
Portfolio Protection by area: 3% on GAP 1 or 2

Key recommendations for Riparian systems

We recommend a minimum of 18% of all the intact riparian systems be protected for biodiversity in a network of 240 critical riparian systems.

Figure 11. Critical riparian systems in the Northern Appalachian / Acadian ecoregion



Coastal Shores and Wetlands

Salt marshes, beach/dunes, tidal flats, rocky shore, sea cliff, coastal bogs

The Northern Appalachian / Acadian ecoregion is rich with coastal features hosting almost 24,000 examples of beaches, salt marshes, tidal flats and rocky shores in a narrow zone tracking the continental shoreline. Although most features are relatively small (ave. 39 acres) and collectively they cover only 1% of the ecoregion it is remarkable how much biodiversity is concentrated at the coastal edge.

Tidal flats and marshes of this region are important to many of our rarest birds such as the salt marsh sparrow, roseate tern, arctic tern, willet and black-legged kittiwake. Specialized organisms, as exemplified by the dominant spartina grasses, have evolved mechanisms to resist desiccation and maintain salt balance in this dynamic setting. Rare or declining species include seaside dock, saltmarsh sedge, seashore saltgrass, creeping alkali grass, American sea-blite, and small spikerush are abundant in this setting

Acreage: 926,644, <1% of the ecoregion
Count: 23,950
Average Size: 39 acres
Screening Criteria
Size: Salt marsh 60, Beach 20,
Rocky shore 10, Bog 75,
Tidal flat 100 acres
LCI <30, Corroboration
Portfolio goal: 1440 occurrences (40 * 8 subregions)
Portfolio sites: 2311 features in 90 key sites
Portfolio acres: 44% of coastal features (- tidal flat)
1% of the Ecoregion
Protection: 18% protected with GAP 1-2 lands.

Key recommendations for coastal wetlands
We recommend that 44 % of all the tidal marsh, beaches, coastal bogs and salt ponds be conserved for biodiversity. This amounts to 423,052 acres in 90 critical marsh complexes.

Figure 12. Critical coastal wetlands and dunes in the Northern Appalachian / Acadian ecoregion

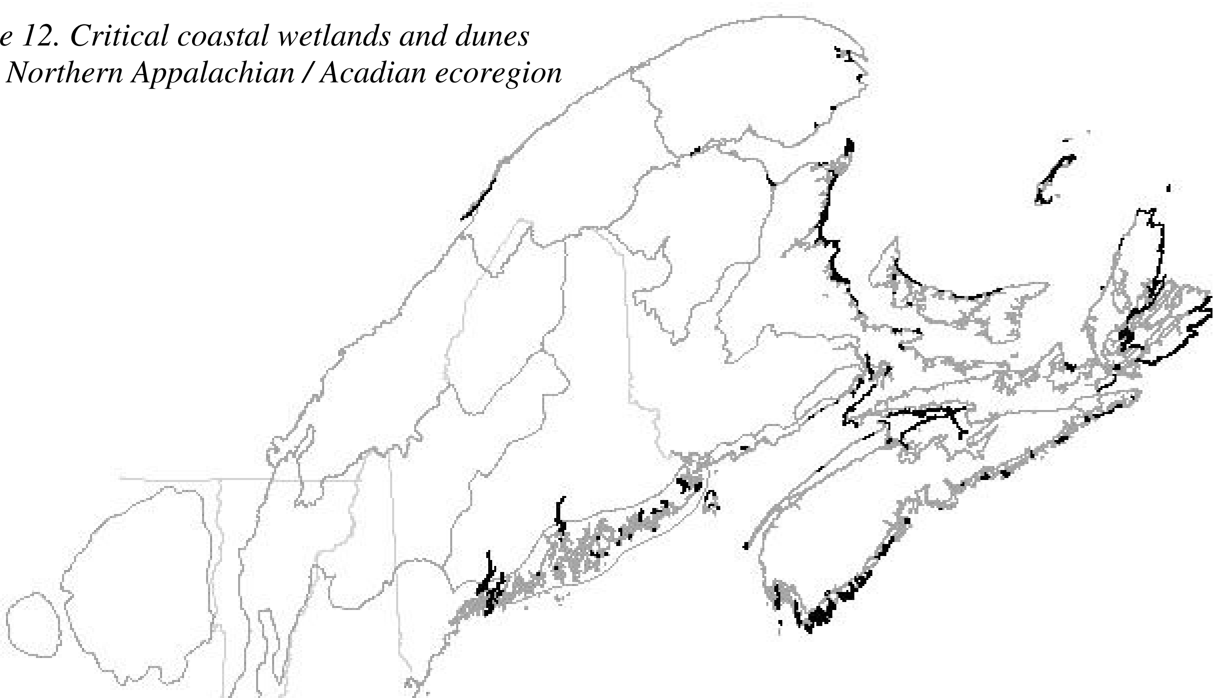
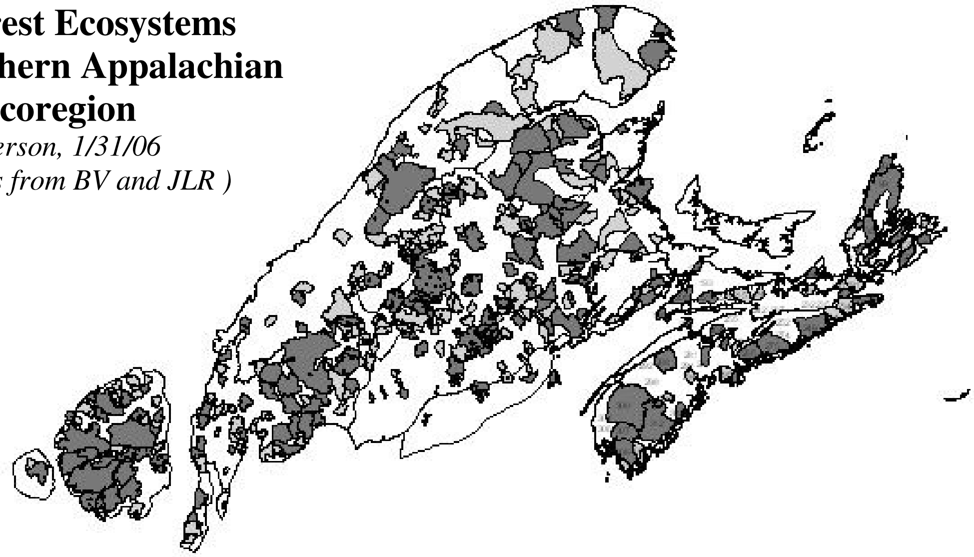


Table 2 Zoom in of cliff and steep slope

Ecological System (Natureserve)	Dominant ELU Feature	NVC Association
Acidic Cliff & Talus	Granite	Acer spicatum - Thuja occidentalis - Betula papyrifera / Taxus canadensis Shrubland Betula papyrifera - Picea glauca / Acer spicatum - Alnus viridis / Polypodium virginianum Talus Shrubland[Provisional] Granite - Metamorphic Talus Northern Sparse Vegetation Lichen spp. Nonvascular Vegetation Picea mariana / Ledum groenlandicum - Empetrum nigrum / Cladina spp. Dwarf-shrubland Picea rubens / Ribes glandulosum Woodland
	Low Elevation	Quercus rubra - Betula alleghaniensis / Polypodium virginianum Woodland
	Mafic	Basalt - Diabase Northern Open Talus Sparse Vegetation Igneous - Metamorphic Northern Dry Cliff Sparse Vegetation
	Sedimentary	Epilobium glandulosum - Viola spp. Cliff Sparse Vegetation[Provisional] Sandstone Dry Cliff Sparse Vegetation Sandstone Midwest Moist Cliff Sparse Vegetation
Alpine Mosaic	Alpine	Lichen Fellfield Sparse Vegetation [Provisional]
Circumneutral Cliff & Talus	Calcareous	Limestone - Dolostone Midwest Dry Cliff Sparse Vegetation Limestone - Dolostone Midwest Moist Cliff Sparse Vegetation Thuja occidentalis Carbonate Talus Woodland Thuja occidentalis Cliff Woodland Tilia americana - Fraxinus americana - (Acer saccharum) / Geranium robertianum Woodland

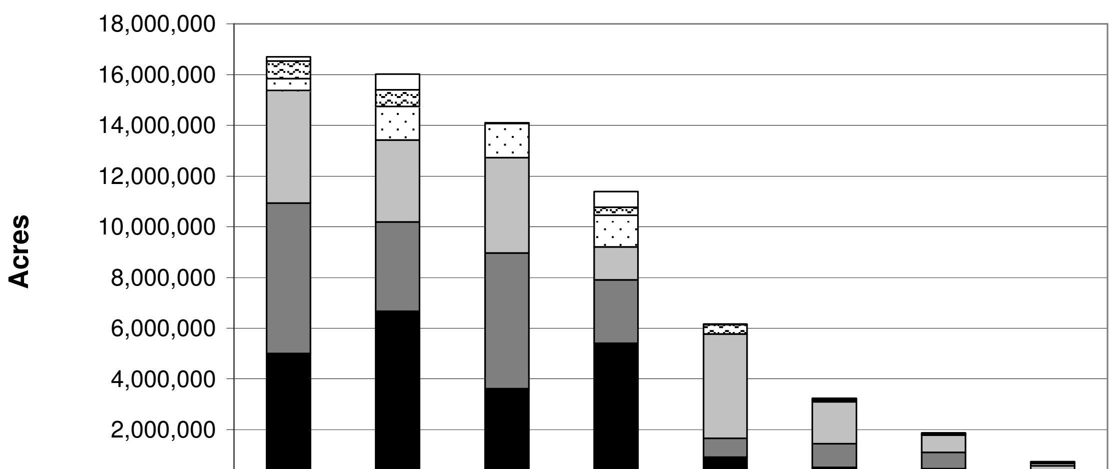
Matrix Forest Ecosystems in the Northern Appalachian /Acadian Ecoregion

(3rd draft Anderson, 1/31/06 including edits from BV and JLR)



The Northern Appalachian /Acadian ecoregion is a predominantly forested, rugged landscape clad in spruce, maple, beech, birch, pine, fir, hemlock, and oak. Eighty-two percent of the region's 82 million acres are covered by roughly equal amounts of conifer (28 percent), deciduous (24 percent) and mixed (24 percent) forest types. Presently, about 6 percent (4 million acres) of the forest is in an early successional state, most of that being "working forest" harvested in the last five years. The western and more southerly parts of the ecoregion in New York and Vermont are considerably more deciduous in nature than the large northeastern provinces New Brunswick, Nova Scotia and eastern Quebec which are chiefly coniferous (Figure 1).

Figure 1. Forest cover-types by state and province.



	Maine	New Brunswick	Quebec	Nova Scotia	New York	Vermont	New Hampshire	Prince Edward Island
Emerg. Wetland	161,391	620,640	1,331	616,134	26,065	46,161	24,875	20,941
Forested Wetland	690,113	663,461	18,912	315,703	365,101	64,133	42,073	53,551
Regen. or Barren	470,041	1,313,206	1,352,080	1,255,114	9,034	28,671	19,466	84,733
Deciduous Forest	4,440,433	3,237,340	3,758,050	1,296,036	4,108,182	1,652,717	677,180	178,507
Mixed Forest	5,932,374	3,525,839	5,357,761	2,500,443	747,896	939,105	646,355	282,989
Conifer Forest	5,006,211	6,665,508	3,614,662	5,403,863	910,665	506,134	461,097	112,942

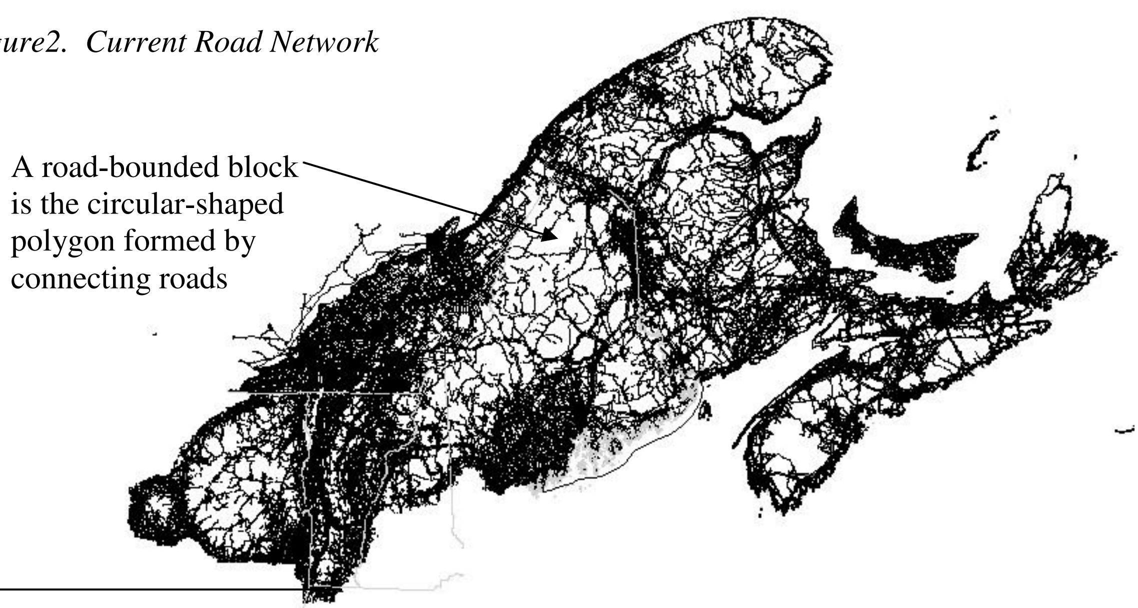
Dominant and contiguous ecosystems, referred to here as “matrix-forming” are singularly important for conservation as they define the fundamental ecological characteristics of a region such as total solar reflectance, evapotranspiration rates and regional responses to large-scale disturbances. Additionally, matrix-forming forests are important as “coarse filters”[1] for the conservation of most common species, from soil invertebrates and little known fungi to forest interior birds, large herbivores and wide-ranging predators.

Such large, contiguous systems pose an ironic challenge to conservation because it is unlikely that forest integrity and connective landscape can be protected throughout the entire ecoregion. Alternatively, we developed a five-step strategy to assess and protect the matrix forest system:

- Subdivide the entire forest into smaller semi-discrete “forest blocks.”.
- Classify all forest blocks into representative forest landscape types.
- Screen each forest block, using indicators of biodiversity value and resilience, size, condition and landcover in the surrounding landscape context criteria
- Identify for conservation action, a network of functional forest blocks representative of the diversity of forest types and landscape elements of the ecoregion
- Advocate for management practices to retain forest cover and functional connectivity between the blocks

We used roads and other fragmenting features to subdivide the larger forested landscape into semi-discrete units (road-bounded blocks). Roads are an appropriate choice for this task as they disrupt the movement of some organisms and ecological processes and increase the level of threats associated with access into interior forest regions. Additionally the location of roads, powerlines, logging trails, housing developments, agricultural lands and mining operations are highly correlated with human extractive activities such as logging. These features have increased dramatically as the present forest redeveloped after being cleared for agriculture in the 1800s (Figure 2).

Figure2. Current Road Network



[1] The concept of coarse filter is discussed in the chapter on Terrestrial Ecosystems and Communities.

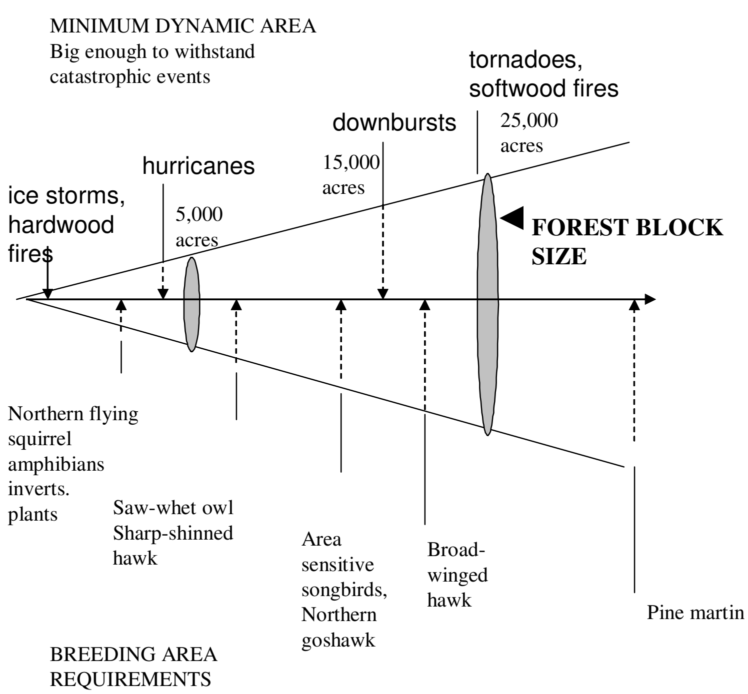
Using road-bounded blocks to tessellate the region creates thousands of potential forest blocks, most of them very small (Figure 2). Although large roadless regions are known to contain the most pristine and viable examples of forest ecosystems, many smaller examples in relatively good condition may be found scattered throughout the region. We developed screening criteria to define the characteristic of a functional forest block and then applied the criteria to the potential blocks to identify the best places for forest conservation.

The screening criteria had three dimensions:

- **Size**: Minimum of 25,000 acres (10,000 ha) based on the key factors of minimum dynamic area and species area requirements discussed below.
- **Condition:** Little internal fragmentation and at least 50 acres of old growth of mature forest with structural legacies. Confirmed evidence of high quality headwaters, high condition forest, or many examples of smaller scale ecosystems and species.
- **Landscape context:** Block surrounded on 75% of its boundary by natural or semi-natural land cover in a 10 mile radius

We determined the 25,000 acre critical size minimum for a forest block by examining the historic size ranges of documented catastrophic disturbance events along with the area requirements of forest-interior breeding species (Figure 3 –details in Anderson 1999)

Figure 3. Scaling factors for matrix forming forest in the Northern Appalachian / Acadian ecoregion. A 25,000 area forest block, represented by the larger grey circle, should be accommodating of all the factors to its left.



Disturbance sizes are based the severe disturbance patch size as determined from published literature and air photo analysis

Female breeding area requirements are from Birds of North America (Poole and Gill eds.) and DeGraaf and Yamasaki 2000 New England Wildlife

Representing forest blocks across all landscape types

Our goal was to identify for conservation forest ecosystems across all of the ecoregion's characteristic landscape types. Ecoregion-wide representation is a crucial part of our forest conservation strategy as it distributes risk in the face of severe region-wide threats such as climate change or acid deposition.

Stratifying forest block selection across all forest-landscape types maximizes the inclusion of different communities and species within the blocks. For example, some forest blocks encompass spruce forests on high-elevation granitic mountains. These blocks are likely to include acidic cliffs, alpine meadows, rocky summits and Bicknell's thrush populations. In contrast, other blocks encompassing deciduous forests in lowland valley settings underlain by rich calcareous and sedimentary soils may include rich fens, floodplain forests, rivershore grasslands and rare freshwater mussels. Even in blocks that share the same dominant forest type, one set may be situated so as to include extensive steeply cut rivers, while another set might occur within a landscape of moist flats with low rolling hills.

To assess the ecological characteristics of each potential forest area and determine which blocks could be considered interchangeable replicates of the same forested landscape, we developed a comprehensive region-wide data layer of physical features. We termed these *ecological land units* (ELUs). Technical details on the development of the ELUs are in the appendix. In brief, every 30 square meters of the ecoregion was classified[2] by its topographic position, its geology and its elevation zone (Table 1.), allowing us to identify discrete units such as "cliff on granite in the alpine zone" or "north facing sideslope on sedimentary rock at low elevations."

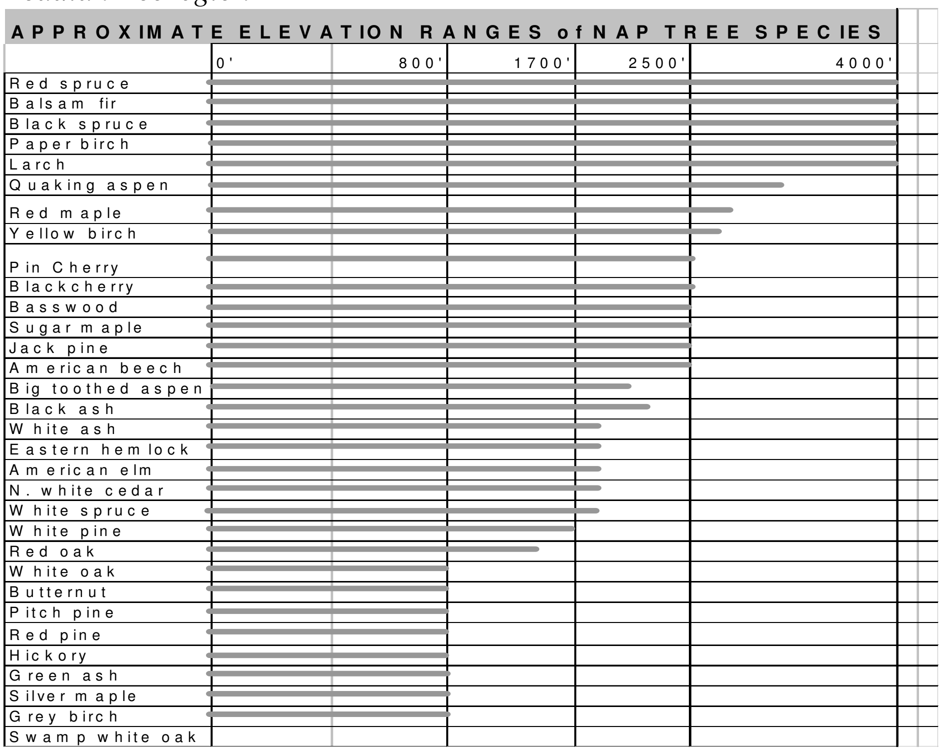
Table 1. Ecological Land Unit variables

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

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

The choice of elevation zones, bedrock types and topographic features used to develop the ELUs was determined by ecological considerations backed up by data. For example, elevation thresholds were based on tree distribution patterns (Figure 4)

Figure 4. Approximate elevation ranges for tree species in the Northern Appalachian / Acadian Ecoregion



By overlaying the boundaries of the potential forest blocks on the ecological land unit data layer, and tabulating the area of each ELU within the block, 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 to aggregate the forest matrix blocks into groups that shared a similar combination of physical features. The resulting groups consist for the most part of readily recognizable *forest-landscape combinations*, which we termed “ELU-groups.”

We corroborated the differences between ELU-groups using expert review by state and provincial scientists and by examining the distribution patterns of over 10,000 ground inventory points provided by Canadian Conservation Data Centers and US Natural Heritage programs. Both sources indicated that smaller scale ecosystems, communities and 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 both the current and potential biodiversity contained within each matrix block.

Selection Process

Identification of the Tier 1 blocks was done by local experts based on biodiversity values, forest condition, feasibility of protection, landscape context and complementarities to the other blocks. Materials provided included quantitative summaries of ELUs, current landcover, hydrologic features, element occurrences and protected lands as well as air photos and satellite imagery to assess forest condition

The section that follows describes the development and characteristic of specific Ecological Land Unit (ELU) groups. After the blocks within each ELU group were identified as potential conservation targets we reviewed them in detail with state, provincial and local experts. At each review session the participants were charged with examining a set of blocks within an ELU-group, and identifying the best and fewest blocks needed to fully represent the group. At a minimum this meant identifying a single block if the set was extremely homogeneous, but it ranged up to 9 if the set was heterogeneous or, especially, if there were blocks that clearly met the selection criteria and were already protected. It was felt that having several clusters of adjacent matrix blocks adding up to much larger areas of protected contiguous forest was not "redundant," but would make the resulting portfolio much more robust.

On average the experts identified 2 or 3 "Tier 1" blocks per ELU-group. Note that in some ELU groups there were few alternatives and perhaps no "Tier 2" alternates, whereas in some subregions and ELU groups there are alternatives that were designated Tier 2 to indicate they met the criteria, but, based on current condition or feasibility or overall portfolio efficiency, did not seem as good candidates. In practice it is recognized that both current condition and practical considerations of feasibility will change and the conservation importance of any given block will also change as the status of protected land changes.

Results: Ecological Land Unit Groups for the Northern Apps/Acadian Ecoregion

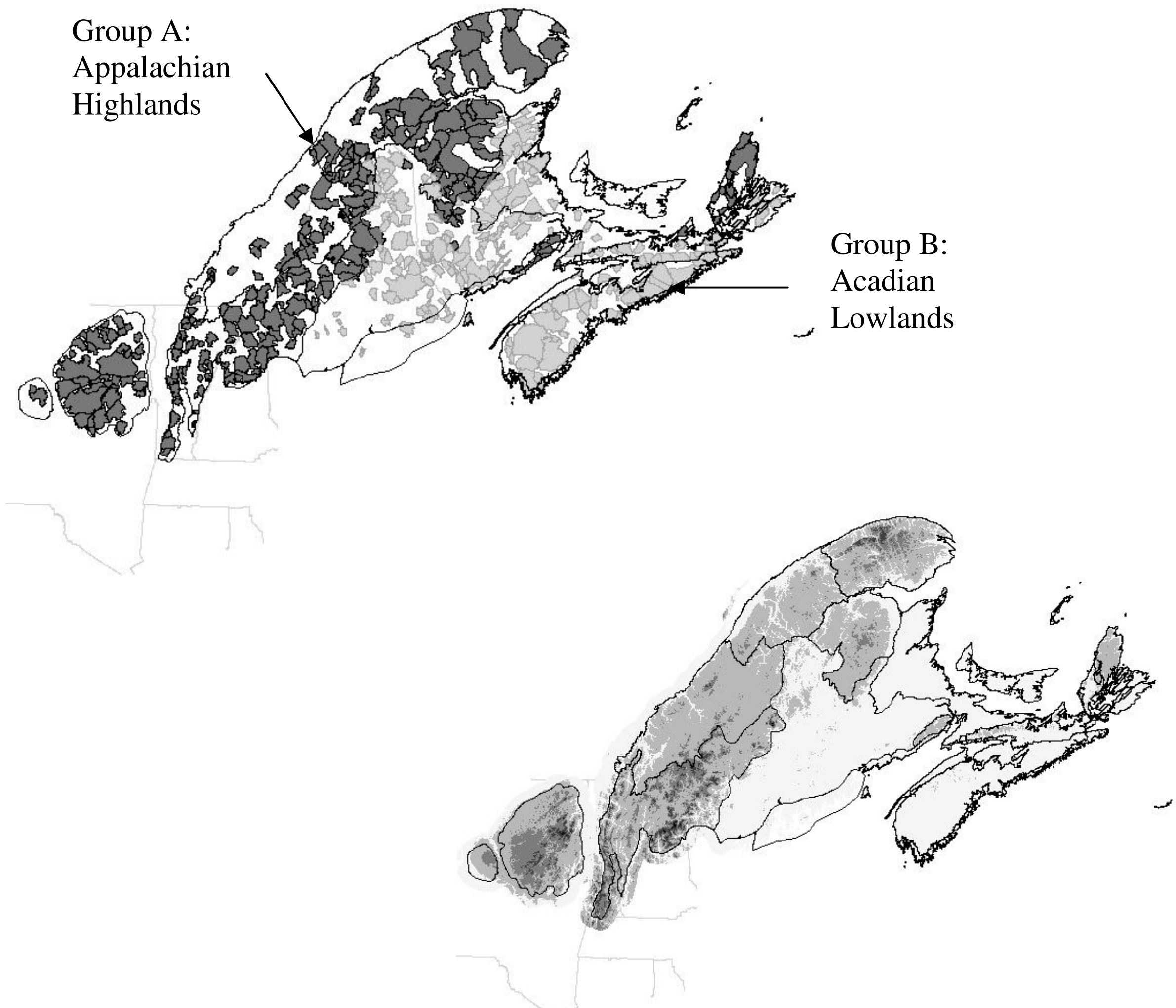
Through a combination of quantitative analysis and expert review we identified 71 distinct ELU-Groups, the basic template for representing all forest-landscape types occurring in the ecoregion. Preliminary groups were identified using Two-way Indicator Species Analysis or TWINSPAN (Hill 1979). A TWINSPAN analysis partitions a complete set of samples into increasingly smaller and more similar subsets based on dominant ecological gradients found in the data. Beginning with one undifferentiated set the partitioning proceeded as follows:

- 2 groups that corresponded with elevation
- 4 groups that corresponded with bedrock and elevation
- 17 groups that corresponded with bedrock, elevation, geography and climate
- 71 groups that corresponded with all of the above plus local landform differences

It is worth noting that ecologists across the ecoregion were agreed that the separations into the 17 groups (3 divisions) seemed to correspond to observable differences in natural species composition. They were not unanimous about the additional split into the finer set of ELU groups yielding a total of 72 groups. These seem meaningfully different in some cases, less clearly so in others. Tier 1 blocks for conservation priority were identified within each interchangeable set.

Examining each successive division and identifying the corresponding gradients will elucidate the logic behind the final set of ELU-groups. The initial division, for instance, corresponded with elevation (Figure 5).

Figure 5. The first TWINSPAN division (top left) corresponded directly to elevation zones (bottom right). The "A" group in dark grey was associated with elevations from 800-4000' while the "B" group was composed of blocks under 800' in elevation.



The result of the first division was a split of the blocks into those from the Appalachian highland region (A) and those from the Acadian lowland region (B). These two regions are dominated by different forest types and exhibit many other consistent ecological differences. To quantify the differences we examined the species, communities and ecosystems contained within the matrix blocks corresponding to the two groups.

The high elevation Appalachian region block contained 723 communities/species that were only recorded from this region. Very characteristic were mountain red spruce-balsam fir forests, balsam fir forests, transitional spruce-hardwood forests and a number of alpine communities such as krumholtz and alpine meadow. These blocks also contained much of the rich hardwood forests associated with coves, the bulk of the summit ecosystems, and all the cold-air talus slope communities. Preferential rare fauna included the rock vole, long-tailed shrew, northern bog lemming, Bicknell's thrush and three-toed woodpecker. Restricted plants in this region included dwarf white birch, bearberry willow, lance-leafed arnica, diapensia, Bigelow's sedge, alpine sweetbroom, boreal bentgrass, arctic rush and more than 400 additional species, most of them alpine.

The low elevation Acadian lowlands blocks contained a set of 334 communities/species found only in this half of the ecoregion. The lowland region coincides with the distribution of red oak- white pine forests, oak woodlands, pitch pine summits, large silver maple floodplain forests, hemlock-pine conifer forests and red maple swamps, although small examples of these communities may sometimes be found in low elevation pockets in the highland region. Birds partial to open woodlands or grasslands such as Baltimore oriole, great-crested flycatcher, indigo bunting, eastern phoebe, whip-poor-will, black-billed cuckoo, purple martin, upland sandpiper and eastern meadowlark are known only from this portion of the ecoregion. Marsh birds such as Virginia rail, yellow rail, black tern and marsh wren are much more common in this wetter lowland region as are greater scaups, brants and other lake associated waterfowl. Herptiles such as the grey treefrog, Blanding's turtle and the eastern ribbon snake are also restricted, within the ecoregion, to these warmer lowland settings.

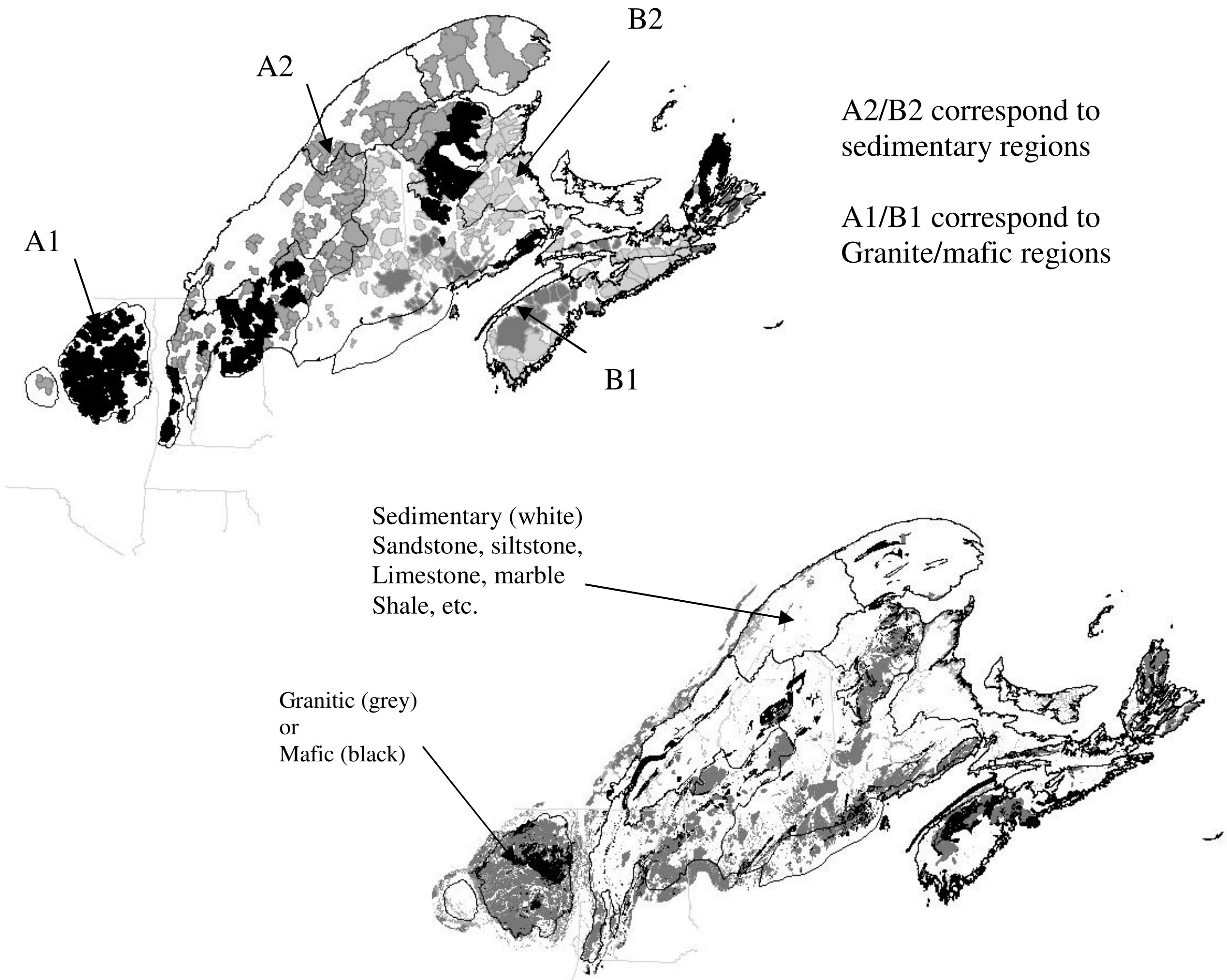
Over 200 plant species show up only in these lower elevation blocks including a few tracked tree species such as butternut and bur oak. Other species included four types of goldenrod, brookside alder, zigzag bladderwort, buttonbush, netted chainfern and coastal plain endemics like Virginia meadow-beauty, Plymouth gentian and twigrush.

The second TWINSPAN division further subdivided the two elevation groups into four sets based primarily on bedrock geology. Blocks falling chiefly on granite and mafic bedrock were separated form those occurring on sandstone, siltstone, limestone, dolomite, shale or other sedimentary bedrocks (Figure 6).

The bedrock groups have corresponding species and community differences with about 545 types showing a preference for blocks in granitic or mafic settings. These included breeding sites for peregrine falcon, northern goshawk, and black guillemot, most alpine species and much of the jack pine, pitch pine or maritime spruce forests. Granite favoring plants included White Mountain saxifrage, twining baronial, and Pickering's reed bent-grass.

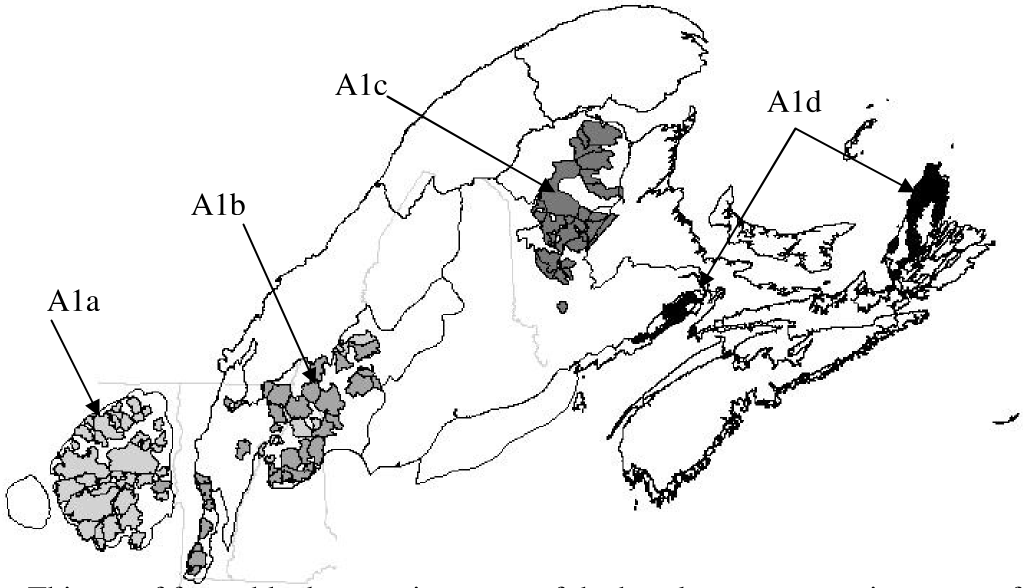
A set of 306 species and communities favored blocks in sedimentary settings. Examples included hardwood floodplains, riverside seeps, circumneutral and calcareous fens, shoreline outcrops and Atlantic white cedar bogs. Corresponding rare plants included the calcareous-favoring dioecious sedge and prairie sedge and others like Orono sedge, northern bog sedge, soft-leaved muhly, Gaspe shadbush and eastern blue-eyed grass. A majority of fish, mussel and bat hibernacula occur in matrix forest blocks in sedimentary regions.

Figure 6 The second TWINSPAN divisions (below left) were driven by bedrock differences. Both elevation groups split into a granitic/mafic set (A1, B1) and a sedimentary set (A2, B2). The overlay of the patterns is easy to see on the simplified geology map (below right).



In summary, the result of the first two divisions was a partitioning of the forest blocks into four basic block groups: A1 - Appalachian highland on granite or mafic bedrock, A2 -Appalachian highland on sedimentary bedrock, B1 - Acadian lowland on granite or mafic bedrock, B2- Acadian lowland on sedimentary bedrock. The next few pages examine each of the four groups more closely and present the results of the block selection process in detail. The expert review process and selection criteria were described on page 6

Appalachian Highland Blocks on Granitic or Mafic Bedrock (Block Group A1): Adirondacks, Southern Green Mountains, White Mountains, Mt Megantic, Mt Carlton Highlands, Fundy Highlands and Cape Breton Highlands



This set of forest blocks contains many of the best known mountain ranges of the ecoregion. Forests in these mountains stand on hard acidic granite or anorthosite, representing the plutonic cores of ancient mountains. In some areas the granites are intermixed with extremely resistant quartzite.

The Adirondack blocks (A1a) were the most unique group, being developed on magnesium and iron (mafic) rich anorthosites with origins and weathering properties quite different from the textbook granites of the other mountains. The forests in these mountains are also strongly deciduous in character and contain the best developed and most functional examples of old-growth northern hardwoods in the northeastern US.

The Fundy and Cape Breton Highland blocks (A1d) separated from the other based on their relatively lower elevations, warmer climate zone and maritime influences. Never-the-less they exhibit alpine like features similar to parts of the White Mts. and High Peaks of the Adirondacks. They further differentiate from each other based on the high proportion mafic soils of the Fundy region.

The White/Green mountains (A1b) separated from the New Brunswick highlands (A1c) based mostly on elevation with the former having strong gradients ranging from northern hardwoods at the lower elevations up to extensive spruce-fir forests well over 2500 ft and significant numbers of alpine peaks over 4000 ft in elevation. Although Mt Carleton, the highest point in the Maritimes, reaches 2690 ft., the New Brunswick highlands are mostly in the 800 – 1700 ft range, in a warmer climate zone, less dramatically sloped and more strongly coniferous than the White/Green mountain region.

The White/Green mountain blocks further separate into a southern Green mountain set on metamorphosed gneiss that is warmer and more deciduous than the White Mountain set. The New Brunswick uplands further separate on landform qualities with the flatter wetland regions separating from the steep mountainous blocks.

Each group was separated once more into a finer set of ELU-groups within which the blocks were judged to be most certainly interchangeable.

The final results of the selection process for group A1 are given in tables 2 and 3. The tables list the blocks by name, state or province, and provide the current protection status. Protection status is by GAP code as explained in the managed and protected lands section. Generally GAP 1 or 2 indicates a conservation reserve with no extraction and a management plan aimed at conserving biodiversity. GAP 3 refers to an area with extractive management (generally logging) but with easements or other legal restrictions to prevent conversion of the land from forest into agriculture, developed lands or other non-forested uses.

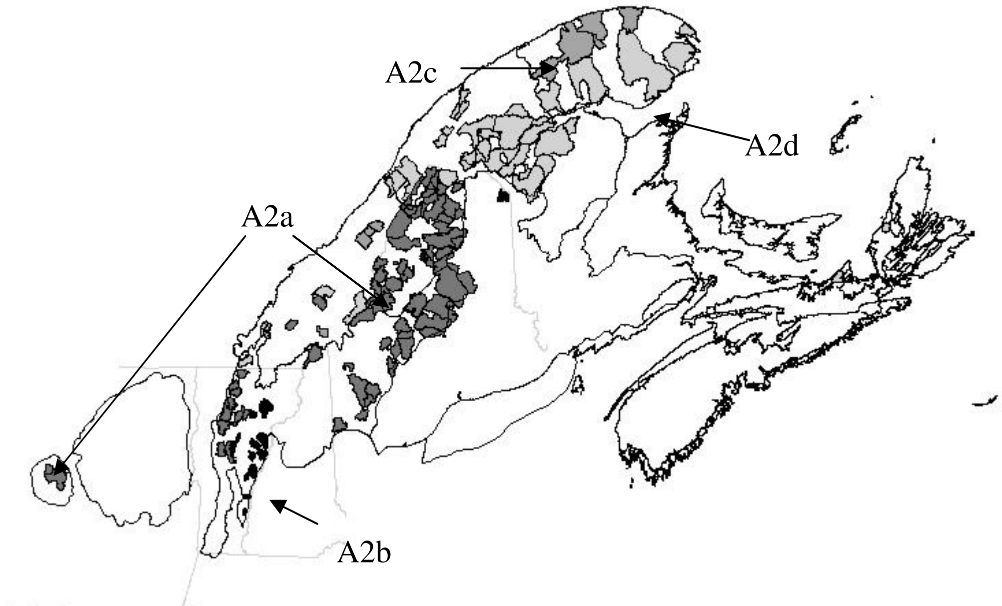
Table 2: Northern Appalachian Granite Highlands: Adirondacks Region (A1a)

HIER4	ELU_GROUP	Block Name	S/P	%GP1	%GP2	%GP3
A1a1	Adirondack Central Mt	Ferris Lake	NY	0	85.1	
		Hudson River Gorge	NY	0	61.9	0.8
		Pigeon Lake	NY	54.1	21.9	0.5
		Sargent Ponds	NY	0	67.1	2.4
		Siamese Ponds	NY	69.7	4	2.3
		Silver Lake	NY	67.2	17.8	0
		Wakely Mountain	NY	55.4	36.4	0.8
		West Canada Lakes	NY	33.4	38.2	2.7
		Wilcox Lake	NY	0	69.6	
A1a2	Granite Highlands	Coburn Gore	ME			26.7
		Lyon Mountain	NY		0.6	4
		Sable Mountains	NY		55.5	1.8
A1a3	Adirondack SW foothill	Five Ponds	NY	34	20.2	13.2
		Independence River	NY	14.1	35.6	4
		Jerseyfield Lake	NY		56.7	
A1a4	Adirondack Highlands	Giant Mountain	NY	71.4	2.7	0.1
		High Peaks	NY	49	9.2	4
		Hoffman Notch	NY	50.5	31.7	
		Jay Range	NY	18.9	4.1	0.2
		White Face	NY	66.5	11.9	6.6
A1a5	Adirondack NW flow	Jordan River	NY	1.1	22.3	40
		St Regis	NY	11.4	3.5	41.6
		Whitehill	NY		31.3	17.8
A1a8	Adirondack SE foothill	Jabe Pond	NY	0	68.7	3.3
		Pharoah Lake	NY	63.2	2.3	2.4
A1a9	Mafic Whites	Kilkenny	NH	0.1	29	39
		Number 5 Bog	ME		1.1	21.9

Table 3: Northern Appalachian Highlands: White and Green Mountain region (A1b)

HIER4	ELU_GROUP	Block Name	S/P	%GP1	%GP2	%GP3
A1b	Whie/Green Mts					
A1b1	Eastern whites	Bigelow	ME		1.9	67.1
		Mahoosucs	ME	0	4.1	15.4
		Mt. Abram	ME	1.7	4	9.3
A1b2	S .greens	The Burning	VT	49.8	3	33.8
		White Rocks	VT	15.9	30.9	30.1
A1b3	NE .kingdom	Nulhegan	VT	0		65.3
		Victory Basin	VT		0.4	31.6
		West Mountain	VT	0.9	19.7	31.8
A1b4	White Mountains	Baldpate	ME		3.8	18.3
		Bunnell/Nash Stream	NH	6	0.1	28.7
		Dead Diamond River	NH		0.7	21.1
		Monastery Mt	VT		10	59.9
		Pemigewasset	NH	31.7	41.1	22.7
		Presidentials/Dry River	NH	38.4	32.8	20.6
		Sandwich	NH	22	28.6	37.4
		Upper Magalloway	ME	13.9	1.5	29.6
		Wild River	NH	0.5	39.2	46.2
A1c	NB Mountains					
A1c1	Nb calcmafic	Jacquet River PA 1	NB	22.3		61.1
A1c2	Nb mount	Brighton Moutain	NB			49.1
		Gilman Peak	NB	0		14.3
		Mount Carleton region	NB	11.6		36.8
		NBCA118	NB			12.7
A1c3	Nb mod calc	Dungarven Lake	NB			94
		Kennedy Lakes PA	NB	46.2		49.8
		Mularchy Peak	NB			13.6
A1d	Cape Breton/Fundy					
A1d1	NS capebreton	Bornish Hills	NS	7.6		28.2
		Cape Breton High	NS	76.1		5.1
		Pollets Cove-Asp	NS	52.2	0.2	34.7
		Trout Brook	NS	5.5		54.8
A1d2	Nb coastmafic	Caledonia Gorge PA	NB	11.8		60
		Cape Chignecto	NS	32.7	0.1	13.2
		Donnegal	NB			42.1
		Fundy National Park PA	NB	64.2		28.7
		Ross Corner	NB			41.5

Appalachian Highland Blocks on Sedimentary Bedrock (Block group A2) Gaspe highlands, Northwest Maine, Northern Green Mountains, Vermont Piedmont and the Tughill plateau.



This group of forest blocks shares the similarity of being formed in sedimentary rocks of several types. As a general consequence, soils in this group are better drained and richer in nutrients than the granite-formed soils of group A1 and many of the rich hardwoods forests communities are found in this set. This group also tends towards more developed and deeply cut stream networks.

Mostly the forests are on resistant quartzite, conglomerate, metamorphosed sandstone, siltstone, hornfell and schist, with almost all bedrocks exhibiting some form of alteration due to heat and pressure. The Vermont piedmont region is dominated by calcareous marbles and altered limestone while the Tug Hill region has the only extensive shales of the ecoregion.

The blocks differentiate cleanly along some natural gradients. Blocks of the northernmost Mont Chic-Chocs region of the Gaspe highlands are the most different having strong elevation gradients with much of the area being over 2500 ft and containing extensive sections of alpine over 4000 ft.

The next most different set in this group is on the Vermont piedmont where there is richer calcareous bedrock, mixed forests, and broader valleys. A number of interesting small- patch communities like calcareous cliffs and outcrops occur here. One apparent outlier of this set, the Caswell block, shows up in far northeastern Maine were it remains as a large intact forested wetland complex sitting alone in a primarily agricultural setting.

The Tughill block is also somewhat of an outlier, being a high flat sedimentary plateau with deciduous forests and extensive wetlands. Its proximity to the Great Lakes gives it one of the highest snowfall accumulation areas in the US and the boundary area of this block exhibits shale cliffs and talus slopes which are unique for this ecoregion.

The remaining sedimentary expanse in this group differentiates based on landform properties. The northern section reaching to the tip of the Gaspe is strongly dissected with deeply cut stream channels and include extensive coves, confined floodplains and steep slopes. The southern set of sedimentary blocks is flatter with extensive wetlands and numerous hill complexes.

The results of the expert selection process for Tier 1 blocks are given in tables 4 and 5. Details on the selection process were given on page 10.

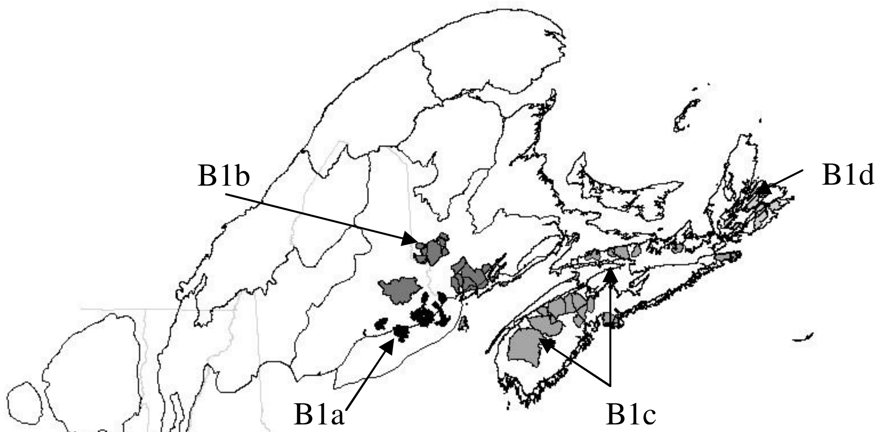
Table 4. Appalachian Sedimentary Highlands: Northern US and Southern Quebec sedimentary highlands (A2a&b)

HIER4	ELU_GROUP	NAME	S/P	%GP1	%GP2	%GP3
A2a	White/Green Mts					
A2a1	Qumaficflat	QCCA259	QC			
		QCCA222	QC	45.8		
A2a2	N. Greenmts	QCCA289	QC	7.4		
		Bone Mt	VT	1.4	0.4	41.1
		Breadloaf	VT	42.9	4	37.4
		Camels Hump	VT	3.7	0.3	38.9
		Indian Stream	NH	0.1	6.8	74.3
A2a3	Northernsedflat	QCCA213	QC			25.7
		Depot Lake-29 west	ME	14.6	1.3	33.5
		Tug Hill	NY	11.7		35.1
A2a4	(blank)	East Lake	ME			26
		Upper St. John Ponds	ME	4.3		58.5
A2a5	(blank)	Caribou/Speckled	ME	18.7	8.2	40.6
		Mt. Blue	ME		10.7	5.5
A2a6	(blank)	Deboulle	ME			21.9
		Little Black River	ME			63.9
A2a7	(blank)	Big Spencer	ME	2.7	1	9.5
A2a8	(blank)	Nahmakanta	ME	15.9	3.8	38.2
A2a9	(blank)	Big Reed	ME	8.2		57.2
		Chamberlain	ME		19.3	60
A2a10	(blank)	Baxter	ME	32.1	0.7	21
A2b	VT Piedmont					
A2b1	(blank)	Steam Mill Brook	VT			16
		Taylor Valley	VT			3.9
A2b2	(blank)	Pine Mountain	VT			5.6
A2b3	(blank)	Caswell	ME		0.4	5.2

Table 5. Appalachian Sedimentary Highlands: Quebec Highlands (A2c&d)

HIER4	ELU_GROUP	NAME	S/P	%GP1	%GP2	%GP3
A2c	Gaspe-N. coast					
A2c1	Qbsmount	QCCA136	QC			27.2
		QCCA146	QC		1.7	29.2
		QCCA267	QC	43.6	0.1	1.7
A2c2	Qusedmount	QCCA15	QC	17.6	44.4	38
		QCCA9	QC	17.6	2.1	58.5
A2c3	Qusednravines	QCCA1	QC	0.7	4.1	81.9
		QCCA6	QC	30.9	0.7	61.4
A2d	Gaspe – S. coast					
A2d1	Nbcalc	Forbes Gulch	NB			3.4
		Popelogan Depot	NB			97.2
A2d10	NSCBsedslope	Eigg Mountain	NS			27.7
		Mason's Mountain	NS			36.3
A2d12	Qbsedwet	QCCA199	QC	15.2		
A2d14	Qusedravines	QCCA52	QC		4.4	95.6
A2d2	Qbsedhills	QCCA64	QC		22	42.8
A2d3	Qbsedlflats	NBCA89c	NB	0.1		22.5
		QCCA89a	QC		0.2	73.7
		QCCA89b	QC			46.9
A2d4	Qbsslopes	Halfway Depot	NB			38.3
	Qusedtightslopes	Green River	QC	0	2.6	82.6
		Kedgwick	NB		1.5	97.3
		Restigouche	NB		3.1	65
A2d5	Qunlowslopes	QCCA37	QC		30.2	41.3
		QCCA50	QC		20.2	27
		QCCA51	QC		6.2	78.3
A2d6	Qusedncoast	QCCA10	QC	86.5	0	
		QCCA12	QC		5.2	76.4
A2d7	Qusedslopes	QCCA24	QC	0.2	1.8	79.7
		QCCA35	QC		1.4	74.9
A2d8	Quserpflat	QCCA262	QC			
		QCCA270	QC	0		

Acadian Lowland Blocks on Granite or Mafic Bedrock (Block Group B1): N. coastal Maine, Mouth of the St Croix, Minas Basin, Kejimkujik region, Bras'd'Or lake region.



This set of blocks all occur at elevations under 800 ft on granite or mafic bedrocks. Most are near the Bay of Fundy and have maritime influences.

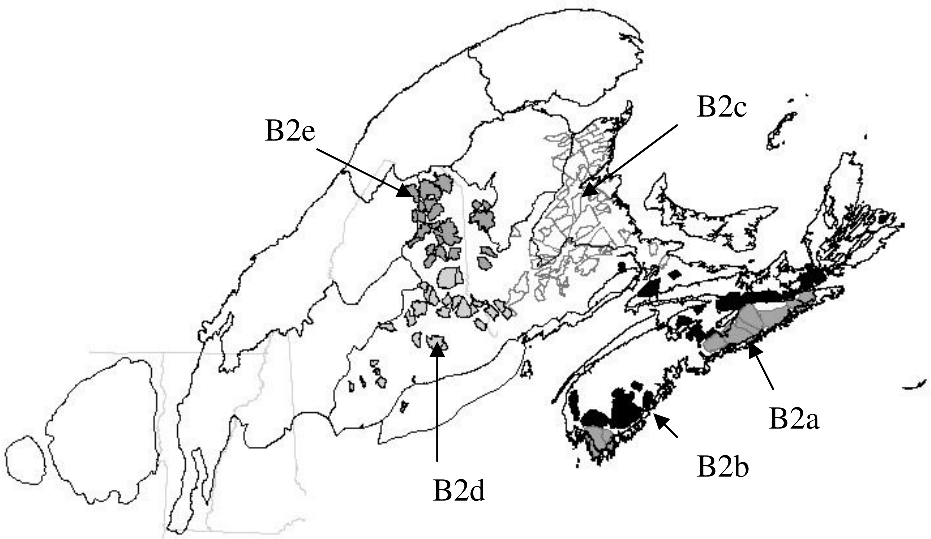
The first group (B1a) begins just north of Acadia National Park in the US and represents a set of rocky coniferous or mixed forests and islands, some with extensive coastal bogs and maritime spruce-fir woods. The second group (B1b) clusters around the mouth of the St Croix River, and are mainly granitic basins with large deposits of fine surficial sediment and extensive lakes and wetlands. The third group (B1c) consists of granite and mafic flats in the southern inland region of Nova Scotia, which contains the Kejimkujik National Park, and the ridge of hills just north of the Minas Basin. The final group (B1d) are a set of granite lowland blocks around Bras d'Or lake on Cape Breton.

The Tier 1 blocks identified by expert review are given in Table 6.

Table 6 Acadian lowland blocks: Granite and mafic coastal region (B1a-d)

B1	ELU_GROUP	Block Name	S/P	%GP1	%GP2	%GP3
B1a1	NB:Island	Grand Manan	NB			
	ME: acidicflatshills	Spring River Lake	ME		0.1	17.9
B1b1	NBcoastfs&g	Loch Alva PA 1	NB	22.9		62.2
		Oak Ridge	NB	0		2.8
B1b2	Nbfs&gf	Spednic Lake PA	NB	89.8		8.5
B1b3	ME: mixedflatslakes	Downeast Lakes	ME			9
B1c1	Nsgranmaficflat	Cloud Lake	NS	15.6		47.6
		Kejimkujik with redesign	NS	48.6		7.9
		Panuke Lake	NS	0.4		30.4
B1c2	Nsmaficcoast	Bonnet Lake Barrens	NS	42.8		11
		Canso Coastal Barrens	NS	72.9		5.1
		Terrance Bay	NS	48.8		13.3
B1c3	Nsmaficridge	Economy	NS	15.7		12.5
B1c4	Outlier	Cape Split	NS	8		0.5
B1d1	NSCBflats	Boisdale Hills	NS		0.4	30.4
		Marble Mountain	NS			32.8
B1d2	NSCBgranflats	Framboise-Middle River	NS	16.2		54.8
		Louisbourgh/Mira	NS			50.9

Acadian Lowland Blocks on Sedimentary Bedrock (Group B2): Northern Acadian uplands region (B2e), Central Acadian uplands, Northumberland lowlands, Nova Scotia Atlantic lowlands,



This group shares the similarity of sedimentary derived soils varying from metamorphosed or carboniferous sandstone and siltstone, and moderately calcareous mixtures of the same, to calcareous deposits of marble or limestone, A few areas are mélanges of sedimentary rock with inclusions of mafic granite. Almost all the blocks have large surficial deposits of coarse sandy outwash or fine-grained lake sediment. As a whole this is the wettest of the forest block group with extensive marshes, bogs and soggy forested basins are common in many of the groups.

Working from east to west, the first group (B2a) flanks the Atlantic-facing coastline of Nova Scotia and included two separate regions: a broad sedimentary lowland running from Halifax eastward to Chedabucto bay, and the eastern tip of the province around Cape Sable. Bedrock in both of these areas includes a significant component of mafic bedrock scrambled in with the primarily sedimentary environment. Group B2b captures a set of interesting inland forest regions in the central and southeast coast region including the Flintstone barrens.

Group B2c corresponds with the extensive Northumberland lowlands and the eastern edge of the Acadian upland section. This area is the wetland nucleus of the ecoregion having almost three times the amount of swamps, lakes, marshes and bogs than any other portion of the region. Group B2d consists of the southwestern portion of the Acadian uplands this region has moderately calcareous soils and extensive deposits of fine-grained lake sediments and coarse-grained glacial or river outwash. It is known for some large wetland complexes. Notably some of the blocks on the far western end are rather small and isolated occurring in one of the more developed sections of the region. The final Group, B2e, is a somewhat drier and more acidic flatland. The area is shared by Maine and New Brunswick and has a rich calcareous farmland in its center where there were no qualifying forest blocks.

The Tier 1 blocks identified by the expert review process (see page 10) are given in Table 7 below.

Table 7 Acadian lowlands on Sedimentary bedrock (B2 a-e)

HIER4	ELU_GROUP	NAME	S/P	%GP1	%GP2	%GP3
B2a	NS south coast					
B2a1	Nsscoastmafic	Quinan Lake	NS		0.8	71.6
B2a2	NSmidcoastsed	Liscomb River	NS	9.2		73.1
		Tangier	NS	22.6		38.7
		Waverly	NS	20.8		27.7
B2b	NS sed. lowland					
B2b1	Nsssedflat	Clare	NS			5.9
		Flintstone Barrens	NS	2.3		69.7
		Lake Rossignol	NS	17.7		29.5
B2b2	Nscentralsed	Long Lake	NS			21.7
	Nssedcoast	Cogmagun River	NS			62
B2b3	Nssedhills	Ogden	NS	36.1	0.5	9.5
B2b4	Nbsed	Nixon	NB			54.3
		River Hebert	NS		0	71.9
B2c	Northumberland					
B2c1	NBls&cf&wet	Bartholomew	NB			72
		Carr Barren	NB			44.5
		Dufferin	NB	0.1		88.1
		Hartts Island	NB			63.9
		Lavina Settlement	NB			
		North Bartibog River	NB			94.3
B2c2	NBlsf&wet	Amherst Bog	NS		2.5	16.2
		Caanan Bog PA	NB	39		60.5
		Jehu Lake	NB			95.8
B2c3	Nbfinesed	Gagetown	NB	0.9		0
		Portobello Creek	NB	4.8	25.9	0
B2c4	NBls&cf&wet	Miscou Island	NB			
	Nboutcoast	Point Escuminac	NB	26.5		46.4
B2d	S. Acadian Upland					
B2d1	NBmc&fs	Canoose Flowage PA	NB	19.6		69.2
		Magundy	NB			82.9
		Tyron Settlement	NB			80.6
B2d2	(blank)	Baskahegan	ME			0.5
		Bowerbank	ME			
B2d3	(blank)	Mattawamkeag Lake	ME			3.3
B2d4	(blank)	Amherst Matrix Block	ME		9.9	13.1
		Atkinson Block	ME	4.1	12.3	13.7
		Unity All	ME		0.2	
B2d5	(blank)	Camden / Lincolnville S.	ME	0.6	57.5	
B2d6	(blank)	Kennebec Highlands	ME		0.3	40.6
B2e	N. Acadian Upland					
B2e1	Nbsed*	Dow Settlement	NB			28.7
		Lampedo	NB			47.4
		Plaster Rock	NB	1.3		
B2e2	(blank)	Eagle Lake	ME	0.1		18.2
		Squa Pan	ME		0.3	6.9

Goals and Current status

The portfolio identifies 175 Tier 1 matrix blocks recommended by scientists through the review process described above. The minimum goal for the ecoregion was to identify one block for each of the 71 ELU-groups. If each group had been extremely homogeneous, the number of blocks identified would have been 71 in actuality experts identified from 1 to 9 blocks per ELU group, averaging 2.5 per group. Surpluses occurred especially were blocks were already protected

In the US, a Nature Conservancy based team agreed on a variation of the full ecoregional goal – that of representing blocks from each of the 17 ELU groupings (the next level up from the 71 ELU types) in each of the subregions in which it occurs at least twice, where there are the opportunities that meet landscape viability standards. This goal is slightly lower than the ecoregion goals, totaling to a minimum of 48 blocks based on how the 17 ELU groups distribute themselves across subregions. The goal may need to be confirmed or revised for the ecoregion as a whole by a wider team discussion.. (Aspects of the goals are still under discussion by the team)

Goal issues to resolve:

- Appropriate level of stratification by ELU group(i.e. third level split which breaks into 17 ELU groups vs. 4th level split which breaks into 72 groups.)
- Appropriate levels of replication and where (i.e. a more consistent application of large clusters of multiple blocks principle)
- Numeric Goals for buffer or permanently assured forested landscape context (e.g. Gap 3) as well as “core reserves” for forest blocks
- The need for a sliding scale for goal and “protection” such that blocks surrounded by very large areas of forest that will not be converted may be considered “adequately protected” with less than 25,000 acres in Gap 1 or 2; whereas, blocks in fragmented landscapes with lower surrounding forest cover may need much more than 25,000 core acres in Gap 1 or 2 to be adequately protected.
- How to account for additional forest protection in areas that were not selected as Tier 1 blocks in assessing progress towards overall forest goals.(the equivalent of “De facto” occurrences of matrix forest blocks)

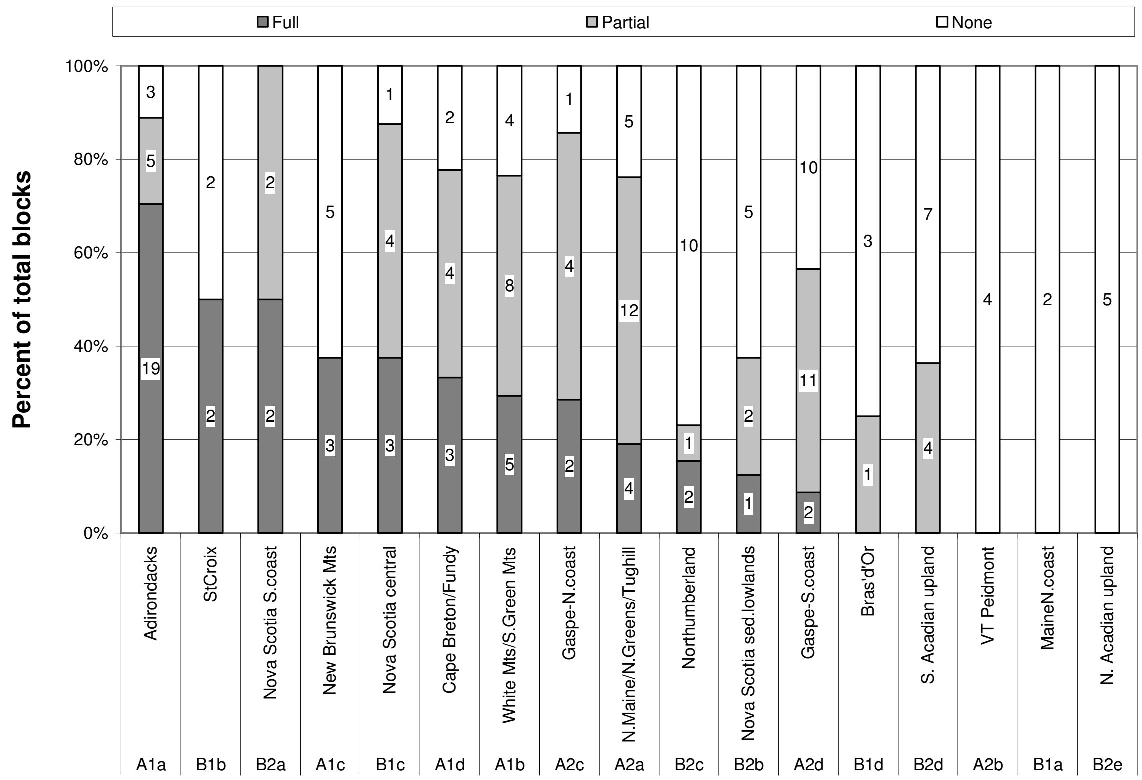
Evaluating Current Protection Levels

To assess initial protection levels we determined which of the blocks already contained at least a 25,000 acre core protected area in GAP status 1 or 2. This standard is a major component of our protection goals for each forest blocks. All blocks were categorized as ;

F = fully meets the minimum of 25,000 acres in GAP 1 or 2 protection
P = partially meets the minimum of 25,000 acres in GAP 1 or 2 protection.
N = no permanently assured Gap 1 or 2 protection

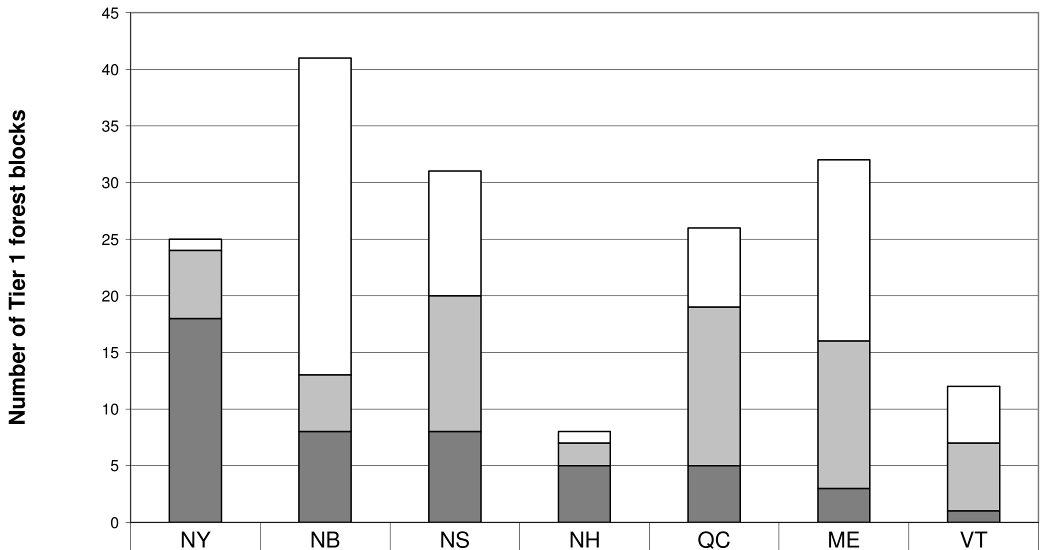
Results were summed across ELU groups (Figures x) and across states /provinces (Figure y). With respect to ELU groups higher elevation A groups were considerably more protected than lower elevation B groups and granite (1) groups were significantly higher than sedimentary (2) groups. There were notable exceptions to this generalization .

Figure x. Protection summary of Tier 1 blocks by ELU groups at third split. Percentages refer to the percent of the total blocks identified by the expert selection process. The percentages do not related to the "goal" at this stage. The chart simply reposts information across the 17 ELU group catagories.



Summed across states, New York had the most blocks that fully met the 25,000 acre core criteria (13) reflecting the advanced state of forest protection in the Adirondacks. New Brunswick and Nova Scotia both had (8) blocks fully meeting the criteria. At the other end of the scale was Vermont with 1 block and Maine with 3 blocks.

Figure y. Protection summary by province and state. The legend indicates the number of blocks that 1) fully meet the criteria, that is have >25,000 acres in Gap 1 or 2 protection; 2) partially meet the criteria, 1000-24,000 acres in Gap 1 or 2; or 3) do not meet the criteria for core regions in Gap 1 or 2 level protection.



	NY	NB	NS	NH	QC	ME	VT
None	1	28	11	1	7	16	5
Partial	6	5	12	2	14	13	6
Full	18	8	8	5	5	3	1

Note, we should also include a table or additional bar to above that indicates blocks with substantial acreage in Gap 3.

Table 8. Number of blocks with core protected areas of 25,000 acres or more: Group A

H1	H2	H3	ELUGROUP	Goal	Y	P	N	%Y
A	A1	A1a 70%	A1a1	9	8	1		89%
			A1a2	3	1		2	33%
			A1a3	3	3			100%
			A1a4	5	4	1		80%
			A1a5	3	1	2		33%
			A1a8	2	1	1		50%
			A1a9	2	1		1	50%
		A1b 29%	A1b1	3		2	1	0%
			A1b2	2	1	1		50%
			A1b3	3		1	2	0%
			A1b4	9	4	4	1	44%
		A1c 38%	A1c1	1	1			100%
			A1c2	4	1		3	25%
			A1c3	3	1		2	33%
		A1d 33%	A1d1	4	2	2		50%
			A1d2	5	1	2	2	20%
	A1 Total			61	30	17	14	49%
	A2	A2a 19%	A2a1	2	1		1	50%
			A2a10	1	1			100%
			A2a2	5		5		0%
			A2a3	3	1	1	1	33%
			A2a4	2		1	1	0%
			A2a5	2		2		0%
			A2a6	2			2	0%
			A2a7	1		1		0%
			A2a8	1	1			100%
			A2a9	2		2		0%
		A2b 0%	A2b1	2			2	0%
			A2b2	1			1	0%
			A2b3	1			1	0%
		A2c 29%	A2c1	3		2	1	0%
			A2c2	2	1	1		50%
			A2c3	2	1	1		50%
		A2d 9%	A2d1	2			2	0%
			A2d10	2			2	0%
			A2d12	1		1		0%
			A2d14	1		1		0%
			A2d2	1		1		0%
			A2d3	3			3	0%
			A2d4	4		3	1	0%
			A2d5	3		3		0%
			A2d6	2	2			100%
			A2d7	2		2		0%
			A2d8	2			2	0%
	A2 Total			55	8	27	20	15%
A Total				116	38	44	34	33%

Table 9. Number of blocks with core protected regions of 25,000 acres or more: Group B

H1	H2	H3	ELUGROUP	GOAL	Y	P	N	%Y
B	B1	B1a	B1a1	2			2	0%
		B1a Total		2			2	0%
		B1b	B1b1	2	1		1	50%
			B1b2	1	1			100%
			B1b3	1			1	0%
		B1b Total		4	2		2	50%
		B1c	B1c1	3	2		1	67%
			B1c2	3	1	2		33%
			B1c3	1		1		0%
			B1c4	1		1		0%
		B1c Total		8	3	4	1	38%
		B1d	B1d1	2			2	0%
			B1d2	2		1	1	0%
		B1d Total		4		1	3	0%
	B1 Total			18	5	5	8	28%
	B2	B2a	B2a1	1		1		0%
			B2a2	3	2	1		67%
		B2a Total		4	2	2		50%
		B2b	B2b1	3	1	1	1	33%
			B2b2	2			2	0%
			B2b3	1		1		0%
			B2b4	2			2	0%
		B2b Total		8	1	2	5	13%
		B2c	B2c1	6			6	0%
			B2c2	3	1		2	33%
			B2c3	2		1	1	0%
			B2c4	2	1		1	50%
		B2c Total		13	2	1	10	15%
		B2d	B2d1	3		1	2	0%
			B2d2	2			2	0%
			B2d3	1			1	0%
			B2d4	3		2	1	0%
			B2d5	1		1		0%
			B2d6	1			1	0%
		B2d Total		11		4	7	0%
		B2e	B2e1	3			3	0%
			B2e2	2			2	0%
		B2e Total		5			5	0%
	B2 Total			41	5	9	27	12%
B Total				59	10	14	35	17%
Grand Total				175	48	58	69	27%

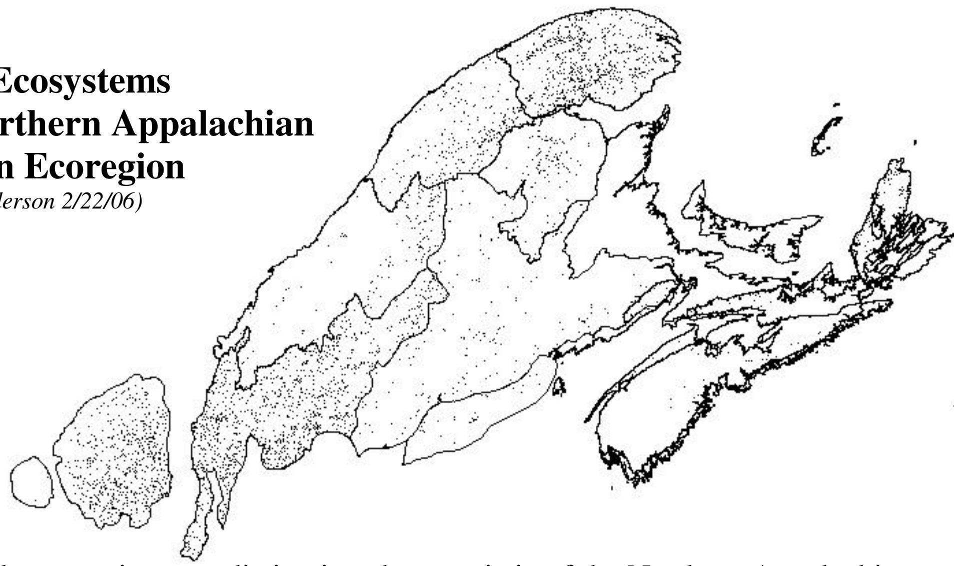
H = Hierarchy level. Goal = the number of blocks identified in the ELU group.
Y = the number of blocks with 25, 000 acres protected in GAP 1 or 2
P = the number of blocks with 1,000 - 24, 999 acres protected in GAP 1 or 2
N = the number of blocks with less than 1000 acres protected in GAP 1 or 2
%Y = the percent of blocks with 25000 protected cores.

Table 10. Full hierarchy and 72 ELU groups

Appalachian Highlands			ELU Group	Example Block	Acadian Lowlands			ELU Group	Example Block
A	A1	A1a	A1a1	Ferris Lake	B	B1	B1a	B1a1	Grand Manan
			A1a2	Coburn Gore			B1b	B1b1	Loch Alva PA 1
			A1a3	Five Ponds				B1b2	Spednic Lake PA
			A1a4	Giant Mountain				B1b3	Downeast Lakes
			A1a5	Jordan River			B1c	B1c1	Cloud Lake
			A1a8	Jabe Pond				B1c2	Bonnet Lake Barrens
			A1a9	Kilkenny				B1c3	Economy
		A1b	A1b1	Bigelow				B1c4	Cape Split
			A1b2	The Burning			B1d	B1d1	Boisdale Hills
			A1b3	Nulhegan				B1d2	Framboise-Middle River
			A1b4	Baldpate		B2	B2a	B2a1	Quinan Lake
		A1c	A1c1	Jacquet River PA 1				B2a2	Liscomb River
			A1c2	Brighton Moutain			B2b	B2b1	Clare
			A1c3	Dungarven Lake				B2b2	Long Lake
		A1d	A1d1	Bornish Hills				B2b3	Ogden
			A1d2	Caledonia Gorge PA				B2b4	Nixon
	A2	A2a	A2a1	QCCA259			B2c	B2c1	Bartholomew
			A2a10	Baxter				B2c2	Amherst Bog
			A2a2	QCCA289				B2c3	Gagetown
			A2a3	QCCA213				B2c4	Miscou Island
			A2a4	East Lake			B2d	B2d1	Canoose Flowage PA
			A2a5	Caribou/Speckled				B2d2	Baskahegan
			A2a6	Deboullie				B2d3	Mattawamkeag Lake
			A2a7	Big Spencer				B2d4	Amherst Matrix Block
			A2a8	Nahmakanta				B2d5	Camden / Lincolnville S
			A2a9	Big Reed				B2d6	Kennebec Highlands
		A2b	A2b1	Steam Mill Brook			B2e	B2e1	Dow Settlement
			A2b2	Pine Mountain				B2e2	Eagle Lake
			A2b3	Caswell					
		A2c	A2c1	QCCA136					
			A2c2	QCCA15					
			A2c3	QCCA1					
		A2d	A2d1	Forbes Gulch					
			A2d10	Eigg Mountain					
			A2d12	QCCA199					
			A2d14	QCCA52					
			A2d2	QCCA64					
			A2d3	NBCA89c					
			A2d4	Halfway Depot					
			A2d5	QCCA37					
			A2d6	QCCA10					
			A2d7	QCCA24					
			A2d8	QCCA262					

Summit Ecosystems in the Northern Appalachian / Acadian Ecoregion

(final draft Anderson 2/22/06)



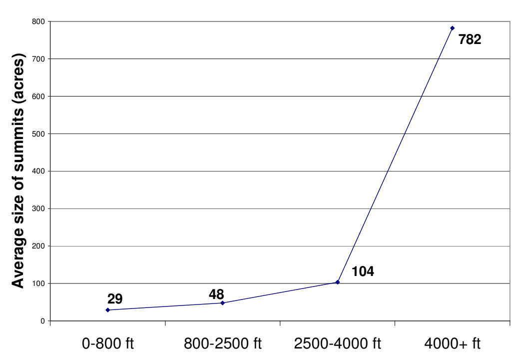
Rocky summits are a distinctive characteristic of the Northern Appalachian region which boasts over 100,000[1] examples of mountain peaks, bony ridges and stony hilltops. Some are dramatic features like the crest of Mt Katadin in Maine –the point of first light in the eastern US - others are simply hilltops in an otherwise flat plain. Concentrated along the backbone of ancient mountains, these well loved places are favorite haunts of ravens, buteos and naturalists availing themselves of the unique vantage point to contemplate the landscape.

Summits form where hard bedrock resists weathering. Thus, biodiversity differences among summits correlate strongly with bedrock types additionally influenced by elevation and climate. High elevation summits, composed of granitic rock or resistant quartsites, sport thin acidic soils, bouldery outcrops, sparse, stunted trees, and a distinct flora. Low elevation summits typically exhibit open-canopy woodlands and tend to be dry, thin soiled and fire-prone. Pines (jack, pitch, red or white) show a preference for these low rocky hilltops.

Overall, summits cover 3% of the ecoregion (2,758,928 acres), but 75% of them are smaller than 30 acres in size and the average summit is 26 acres (+- 55 acres). At high elevations summits aggregate and fuse into large contiguous features defining our important mountain ranges (Figure 1). The Gaspe, Adirondacks and Green/White Mountain subregions contain the largest summits of the region (28 of them over 1000 acres) including the 78 summits higher than 4000 feet that exhibit true alpine conditions.

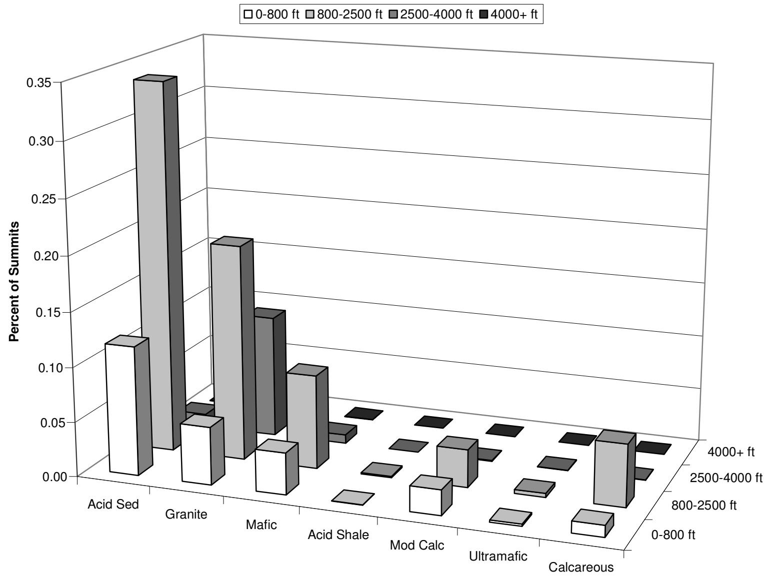
Figure 1. The relationship of summit size to acreage, percent, average size and elevation

Size class	Total Acres	Number	%	Ave Size
2-30 acres	666,208	79,695	76	8
30-70 acres	685,861	15,432	15	43
70-160 acres	722,828	7,200	7	98
160 + acres	684,030	2,418	2	251
	2,758,928	104,745	100%	



[1] Contiguous summits over 2 acres

Figure 2. The distribution of NAP/Acadian summits by bedrock and elevation.



Summit Biodiversity

Summits occur across all bedrock and elevation settings (Figure 2). Ecologists describe distinct summit communities on calcareous rock, shale, and ultra-mafic serpentine, although most occur on acidic bedrocks such as granite, anorthosite, or metamorphosed sandstones. Among the acidic types, floristic analysis distinguishes communities based on elevation zones and exposure. Short descriptions of common summit ecosystems are provided below (adapted from Basquill 2004, Anderson 1999).

Alpine summits: Mountain-top ecosystems at or above 4000 ft with a unique flora and a mosaic of snowbank, ridgetop, and meadow communities. Stunted spruce, known as "krumholz" and wind-blasted balsam fir forests are typical. Characteristic species include lance-leaved arnica, Boott's rattlesnake-root, dwarf white birch, mountain avens, wavy bluegrass, Robbins' cinquefoil and moths and butterflies such the Katahdin arctic or the White Mountain fritillary. Bicknell's thrush and American pipit nest in this setting.

Serpentine summits: Open barren communities on serpentine rock with soil toxic to many plants species. Plant rarities abound: minuartie de la serpentine, saxifrage del la Gaspe, gnaphale de Norvege, athyrie alpestre and green mountain maidenhair fern. The serpentine region of Quebec's Gaspe Peninsula hosts a small woodland caribou herd.

Montane spruce-fir summits: High elevation summits below the alpine zone but over 2500 feet occurring mostly on granitic or meta sedimentary bedrock. Subalpine fir forests, stunted spruce-fir woodlands and heath communities are common along with landslide and cliff features. Rarities include fir clubmoss, mountain sandwort, small-flowered rush and long-tailed shrew

Calcareous summits: Mid elevation summits on calcareous bedrock with diagnostic outcrop and talus communities. Plant rarities include ram's-head lady's-slipper, daisy fleabane and smooth cliff fern. Hibernacula and populations of Indiana and Small-footed bats are associated with summit and slope regions on calcareous substrates.

Low - mid elevation summits: On acidic substrates jack pine, pitch pine, red pine or oak woodlands predominate over open sparse grasslands and heath communities. Smooth sandwort, silverling, and slender cliffbrake are associated plant rarities. Peregrine falcons often nest on these features.

Coastal zone summits: Very low elevation resistant outcrops on acidic substrates. White and red spruces predominate with fir and white cedar. Summits in the wave zone may have sea-spray tolerant plants.

Summit Portfolio Summary

The screening criteria used to locate and identify the summits most critical to maintaining biodiversity required that each qualifying example:

- Was large and contiguous: minimum 30 acres, preferably over 70 acres.
- Was in good landscape settings (Land Cover Index < 20)
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contained other confirmed biodiversity features (verification by element occurrences)

The size criterion was intended to insure that examples selected for the portfolio contained all their inherent species diversity and ecosystem functions. We determined the size minimum by examining almost 1000 ground inventory points representing 204 species found on or directly adjacent to a summit. Of the species examined, many were only recorded from summits over 70 acres but none were restricted to summits under 30 acres (Table 1) suggesting that larger summits were more likely to contain a full complement of associated species. Notable species in this group were most alpine plants and rare species such as silverling *(Paronychia argyrocoma)*, Bicknell's thrush, and long-tailed shrew. On average 94% of the occurrences for any given species were likely to be on a summit over 30 acres..

In agreement with the earlier discussion of biodiversity, the presence of certain species on certain summits correlated strongly with differences in elevation (Table 2) and bedrock (Table 3). To make sure that we represented all summit biodiversity we set goals for locating and selecting a minimum of 20 qualifying examples for each of 22 bedrock/elevation combination. This amounted to a minimum goal of identifying 440 total occurrences distributed across the ecoregion. After examining the distribution of larger (>30 acre) summit occurrences we redistributed the 20-per-type numeric goal across the geology/elevation gradients in proportion with the number of possible occurrences (Table 4).

Table 1. Species associated with summits over 30 acres, final column gives the # of occurrences.

STANDARD NAME	COMMON NAME	<30 acres	<70 acres	<160 acres	160+ acres	#
Asplenium trichomanes-ramosum	Green Spleenwort				100%	3
Calamagrostis stricta	Bentgrass				100%	3
Carex atratiformis	Black Sedge				100%	5
Castilleja septentrionalis	Pale Painted-cup				100%	5
Crotalus horridus	**Timber Rattlesnake**				100%	5
Diphasiastrum sitchense	Alaskan Clubmoss				100%	3
Huperzia selago	Fir Clubmoss				100%	4
Minuartia groenlandica	Mountain Sandwort				100%	13
Solidago cutleri	Cutler's Goldenrod				100%	12
Sorex dispar	**Long-tailed or Rock Shrew**				100%	3
Vaccinium caespitosum	Dwarf Blueberry				100%	3
Vaccinium uliginosum	Alpine Bilberry				100%	6
Huperzia appalachiana	Appalachian Fir-clubmoss			7%	93%	14
Catharus bicknelli	**Bicknell's Thrush**			9%	91%	11
Luzula parviflora	Small-flowered Rush			11%	89%	9
Empetrum nigrum	Black Crowberry			14%	86%	22
Diapensia lapponica	Diapensia			9%	86%	47
Empetrum atropurpureum	Purple Crowberry			16%	84%	19
Geocaulon lividum	Northern Comandra			24%	76%	17
Paronychia argyrocoma	Silverling			25%	75%	4
Rhododendron lapponicum	Lapland Rosebay			25%	75%	8
Solidago multiradiata	Alpine Goldenrod			25%	75%	12
Osmorhiza chilensis	Mountain Sweet-cicely			33%	67%	3
Pinus banksiana	Jack Pine			33%	67%	3
Prenanthes nana	Dwarf Rattlesnake-root			38%	63%	8
Empetrum eamesii	Purple Crowberry			40%	60%	5
Dicentra canadensis	Squirrel-corn			67%	33%	3
Epilobium ciliatum	Ciliated Willow-herb			67%	33%	3
Calamagrostis stricta	Northern Reedgrass			100%		3
Trichophorum cespitosum	Deer's Hair Sedge		6%	18%	76%	17
Agrostis mertensii	Boreal Bentgrass		6%	13%	81%	16
Juncus trifidus	Arctic Rush		10%	10%	80%	10
Phyllodoce caerulea	Mountain Heath		13%		88%	8
Cassiope hypnoides	Moss Bell-heather		14%		86%	7
Prenanthes boottii	Boott's Rattlesnake Root		14%	7%	79%	14
Calamagrostis pickeringii	Pickering's Reed Bent-grass		14%	29%	57%	7
Paronychia argyrocoma	Silverling		14%	29%	57%	7
Polygonum douglasii	Douglas' Knotweed		14%	43%	43%	7
Geum peckii	Mountain Avens		16%		84%	19
Minuartia glabra	Smooth Sandwort		18%	36%	45%	11
Deschampsia atropurpurea	Mountain Hairgrass		25%		75%	4
Woodsia glabella	Smooth Cliff Fern		29%	29%	43%	7
Rhododendron lapponicum	Lapland Rosebay		38%		63%	8
Cryptogramma stelleri	Slender Cliffbrake		50%	25%	25%	4
Impatiens pallida	Pale Jewel-weed		50%	33%	17%	6

Table 2. Species -Summit relationships with respect to elevation (species with 5+ occurrences)

GNAME	GCOMNAME	0-800 ft.	800-1700 ft.	1700-2500 ft.	2500-4000 ft.	4000+ ft.	Total
Anarta melanopa	**A Noctuid Moth**					100%	8
Betula glandulosa	Dwarf Birch					100%	12
Cassiope hypnoides	Moss Bell-heather					100%	7
Castilleja septentrionalis	Pale Painted-cup					100%	5
Phyllodoce caerulea	Mountain Heath					100%	8
Rhododendron lapponicum	Lapland Rosebay					100%	16
Salix herbacea	Dwarf Willow					100%	5
Silene acaulis var. exscapa	Moss Campion					100%	7
Loiseleuria procumbens	Alpine Azalea				8%	92%	13
Geum peckii	Mountain Avens				11%	89%	19
Trichophorum cespitosum	Deer's Hair Sedge				12%	88%	17
Betula minor	Dwarf White Birch				14%	86%	22
Poa fernaldiana	Wavy Bluegrass				14%	86%	22
Salix uva-ursi	Bearberry Willow				14%	86%	29
Arctostaphylos alpina	Alpine Bearberry				14%	86%	7
Hierochloe alpina	Alpine Sweet Grass				18%	82%	28
Prenanthes boottii	Boott's Rattlesnake Root				21%	79%	14
Luzula spicata	Spiked Woodrush				23%	77%	13
Prenanthes nana	Dwarf Rattlesnake-root				25%	75%	8
Solidago cutleri	Cutler's Goldenrod				25%	75%	12
Empetrum nigrum	Black Crowberry				27%	73%	22
Diapensia lapponica	Diapensia				30%	70%	47
Carex bigelowii	Bigelow's Sedge				31%	69%	42
Agrostis mertensii	Boreal Bentgrass				31%	69%	16
Agrostis borealis	Boreal Bentgrass				33%	67%	18
Solidago multiradiata	Alpine Goldenrod				36%	64%	14
Juncus trifidus	Arctic Rush				40%	60%	10
Catharus bicknelli	**Bicknell's Thrush**				82%	18%	11
Luzula parviflora	Small-flowered Rush				89%	11%	9
Vaccinium uliginosum	Alpine Bilberry				100%		6
Empetrum atropurpureum	Purple Crowberry			8%	38%	54%	24
Carex scirpoidea	Canadian Single-spike Sedge			10%	40%	50%	10
Geocaulon lividum	Northern Comandra			12%	47%	41%	17
Calamagrostis pickeringii	Pickering's Reed Bent-grass			14%	29%	57%	7
Vaccinium boreale	Alpine Blueberry		8%	3%	29%	61%	38
Huperzia appalachiana	Appalachian Fir-clubmoss		14%		21%	64%	14
Minuartia groenlandica	Mountain Sandwort		15%		62%	23%	13
Paronychia argyrocoma	Silverling		18%	18%	55%	9%	11
Woodsia glabella	Smooth Cliff Fern		29%	29%	43%		7
Myotis leibii	**Eastern Small-footed Myotis**		63%	25%	13%		8
Minuartia glabra	Smooth Sandwort		64%	27%	9%		11
Polygonum douglasii	Douglas' Knotweed		86%		14%		7
Falco peregrinus	**Peregrine Falcon**	11%	33%	33%	22%		9
Calamagrostis stricta	Northern Reedgrass	14%	29%		43%	14%	7
Grand Total of all EOs		1%	11%	7%	25%	56%	939

Table 3. Species to summit relationships with respect to Bedrock. Sd = sedimentary or metasedimentary, Gr = Granitic, Ma = mafic or intermediate granitic, Mc = moderately calcareous. Ca = calcareous, Um = ultra mafic (e.g. serpentine) # = total # of occurrences. Percentages indicate the % of the total occurring on this bedrock type.

STANDARD NAME	COMMON NAME	Sd	Gr	Ma	Mc	Ca	Um	#
Adiantum aleuticum	Aleutian Maidenhair-fern						100%	2
Adiantum viridimontanum	Green Mt Maidenhair-fern						100%	2
Moehringia macrophylla	Large-leaved Sandwort						100%	2
Erigeron hyssopifolius	Daisy Fleabane		50%			50%		2
Astragalus robbinsii minor	Blake's Milk-vetch	50%				50%		2
Myotis sodalist	**Indiana Bat**			50%		50%		2
Cypripedium arietinum	Ram's Head Lady's-slipper			20%	20%	60%		5
Solidago multiradiata	Alpine Goldenrod		7%	86%	7%			14
Huperzia appalachiana	Appalachian Firmoss		43%	50%	7%			14
Oryzopsis pungens	Slender Mountain-rice	50%			50%			2
Juncus trifidus	Arctic Rush	30%		70%				10
Prenanthes nana	Dwarf Rattlesnake-root			100%				8
Trichophorum cespitosum	Deer's Hair Sedge		18%	82%				17
Empetrum nigrum	Black Crowberry	18%	5%	77%				22
Agrostis mertensii	Northern Bentgrass	13%	19%	63%	6%			16
Polygonum douglasii	Douglas' Knotweed		100%					7
Minuartia glabra	Smooth Sandwort	9%	91%					11
Minuartia groenlandica	Mountain Sandwort	38%	54%		8%			13
Loiseleuria procumbens	Alpine Azalea	77%	15%	8%				13
Luzula spicata	Spiked Woodrush	77%	15%	8%				13
Woodsia glabella	Smooth Woodsia	57%	29%			14%		7
Phyllodoce caerulea	Mountain-heath	75%	25%					8
Agrostis borealis	Boreal Bentgrass	78%	22%					18
Geum peckii	Mountain Avens	79%	21%					19
Arctostaphylos alpine	Alpine Bearberry	86%	14%					7
Luzula parviflora	Small-flowered Rush	89%	11%					9
Total of all Occurrences		48%	26%	21%	2%	1%	1%	939

Results

Our goal was to locate a minimum of **20 exemplary occurrences per 22 bedrock/elevation combinations.** Our results identified 1,938 critical occurrences, four times more than we needed to meet our total goal (Table 4). With small exceptions for shale and mid elevation calcareous summits we met our adequacy goals for identifying sites within each combination as well, thus, the portfolio is fully sufficient with respect to summits.

Defacto Candidate and Supporting Occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed summits that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.

- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them for context in some of our analyses. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Table 4: Portfolio Goal Summary based on Summit occurrences over 30 acres. The only inadequacy is for moderately calcareous or mafic slopes below 800'. Legend below.

ELEV.	BEDROCK	% Goal	CU	CP	PC	PS	OU	T	%	D
0-800'	Sedimentary	26	149	22	45	8	1250	1474	6%	145
	Calcareous	2	36	9	2		57	104	0%	43
	Granitic	14	28	25	56	4	662	775	3%	39
	Mafic	6	22	6	18	1	278	325	1%	22
	Mod calc.	3	36		6		146	188	1%	33
	Ultramafic	2	1	1				2	0%	0
800-2500'	Sedimentary	176	714	89	413	26	8765	10007	40%	627
	Shale	2	1				6	7	0%	-1
	Calcareous	27	72	29	34	2	1404	1542	6%	74
	Granitic	94	105	80	1729	109	3315	5338	21%	91
	Mafic	38	104	49	541	23	1464	2181	9%	115
	Mod calc.	16	18		31	2	837	888	4%	2
	Ultramafic	2	18	6	2		70	96	0%	22
2500-4000'	Sedimentary	12	61	46	115	4	432	658	3%	95
	Calcareous	2		1	2		27	30	0%	-1
	Granitic	16	30	37	460	13	354	896	4%	51
	Mafic	8	41	67	245	5	74	432	2%	100
	Mod calc.	2	2		1		39	42	0%	0
	Ultramafic	2	4	9	1		9	23	0%	11
>4000'	Sedimentary	2		5	9			14	0%	3
	Granitic	2		8	3			11	0%	6
	Mafic	2		7	10			17	0%	5
Grand Total		453	1442	496	3723	197	19189	25050	440	1485

%Goal = the portfolio goal
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 25 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
TC = total critical occurrences
D = the difference between the amount identified for the portfolio and the specified goal.

Sites and Occurrences

In this analysis, the term “site” refers to either a survey site associated with an exemplary individual summit feature or an important natural complex comprised of many co-occurring summit features. In some of the latter cases, not every individual summit met our selection criteria but most did and as an aggregate the area did as well. This allowed a few smaller summits to qualify as “critical”.

Counting occurrence numbers can be deceptive. Many of the summit features occur in close proximity to each other and might be more usefully thought of as one mega-occurrence then many adjacent occurrences. If the portfolio is counted by survey sites, it totals to a set of 393 sites, with each site containing from 1 to 413 critical occurrences (the latter being the Chic-Choc highlands of Quebec) and amounting to over 270,000 acres of summit features. The survey sites also contain another 3500 acres of the *defacto* candidate and supporting occurrences.

Current Protection Levels of Critical Features.

Critical summit occurrences amount to 2% by count and 9% by area of all the summit features in the ecoregion – thus amounting to roughly 0.03% of the entire region by acreage (Table 5). Currently 35% of the critical sites (95,041 acres) are on lands protected for biodiversity leaving 65% acres remaining for active protection efforts.

Table 5. Overall Summit Portfolio protection levels by acreage and count. Legend as for Table 4.

	CU	CP	PC	PS	OU	T
Total Acres	175,494	95,041	373,380	88,612	2,026,400	2,758,928
% Acres	6%	3%	13%	3%	73%	100%
Total Count	1459	895	3724	7387	91,280	104,745
% Count	1%	0.08%	3%	7%	87%	100%

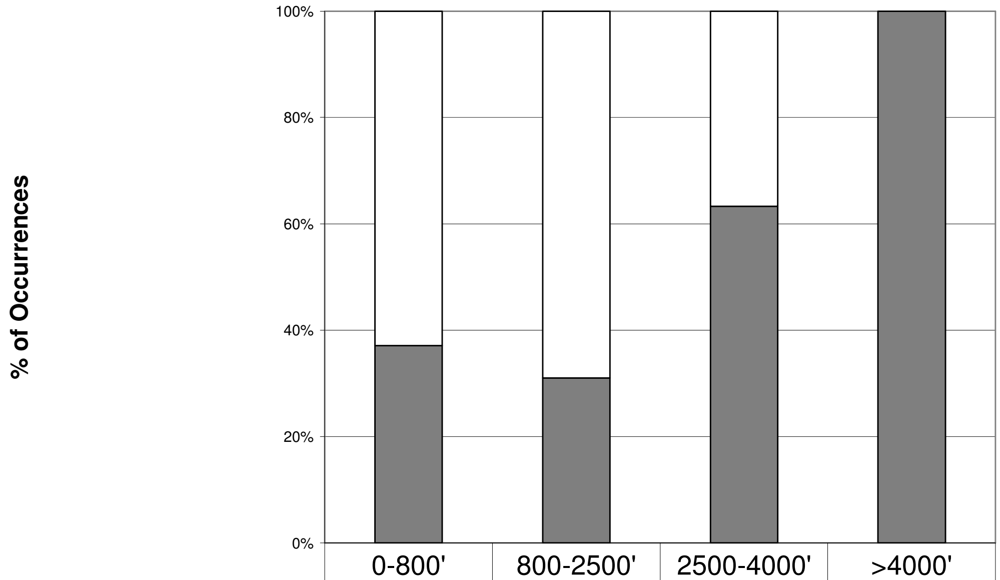
Protection levels vary with elevation and bedrock type. Above 4000 ft critical summits are virtually all protected. Below 2500 ft summits are less than 40% protected (Figure 3). Granites, ultramafic, intermediate granite and mafic bedrocks are all close to 60% protected while calcareous, sedimentary and shale summits are all less than 40% protected (Figure 4). Across the ecoregion high elevation granitic summits occur largely on lands protected for biodiversity. In contrast low elevation, sedimentary hilltops largely occur on lands that are managed for extraction or wholly unprotected.

Across provinces and states Quebec had the most acreage of critical summits (over 600,000 acres) with about 50,000 acres of that currently on protected lands. New York was next with over 400,000 acres of critical summits and over half of that already on lands protected for biodiversity. Nova Scotia had that least acreage at roughly 125,000 acres with 4,000 acres on protected land (Figure 5). If counted by individual occurrences as opposed to total acreage, New York had the most and the best protected summits (Figure 6)

Summary:

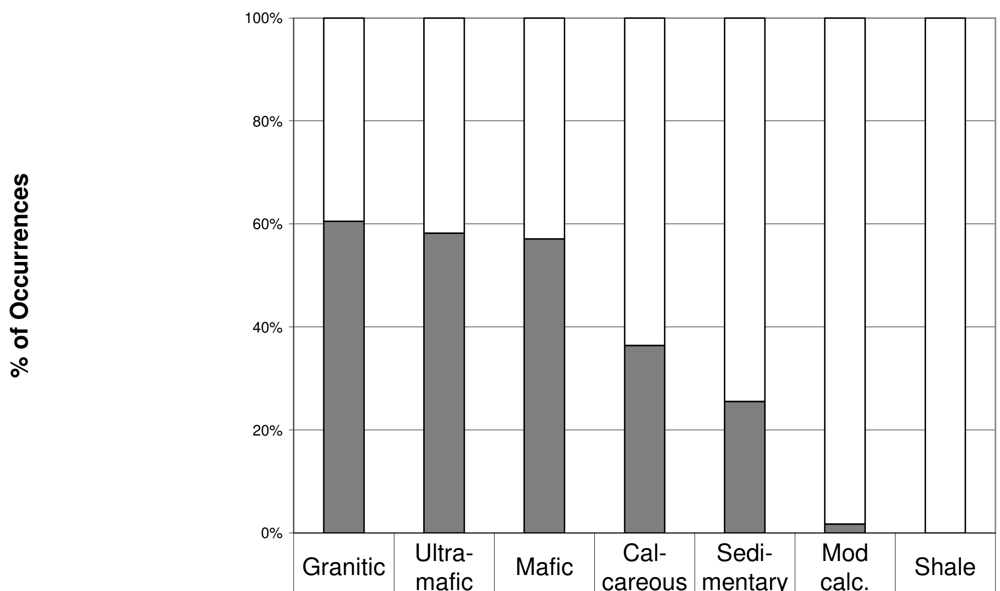
Of the 104 thousand summits in the ecoregion, our portfolio highlights 3 percent that are the most critical to biodiversity conservation of summit communities and species. This important subset, found in 393 key sites, is well distributed across bedrock and elevation gradients and is 35% unprotected. About 65% (175K acres) of the summit portfolio remains to be protected. Particularly urgent are low elevation and sedimentary summits

Figure 3. Protection level of critical occurrences by elevation. High elevations and granitic bedrocks have the highest protection. Low elevations and sedimentary settings have the lowest.



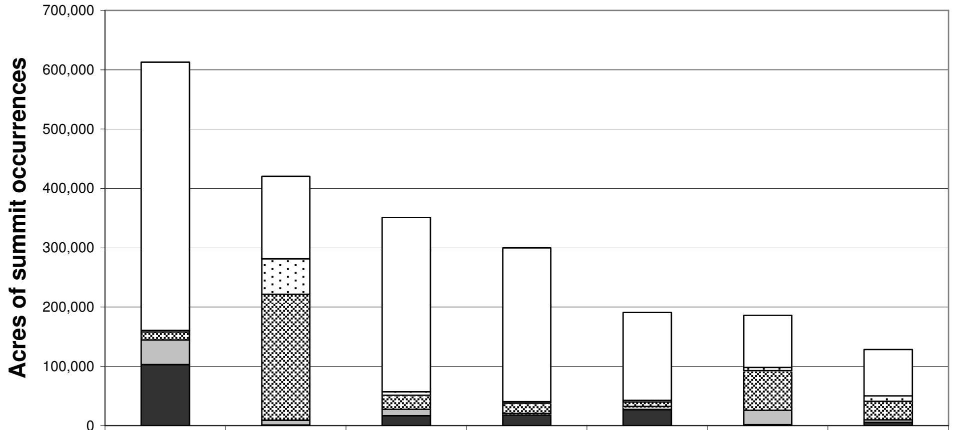
	0-800'	800-2500'	2500-4000'	>4000'
☐ Critical: Unprotected	278	1042	139	0
■ Critical: Protected	164	469	240	22

Figure 4. Protection level of critical occurrences by bedrock type (right). Granitic bedrocks have the highest protection while sedimentary settings have the lowest.



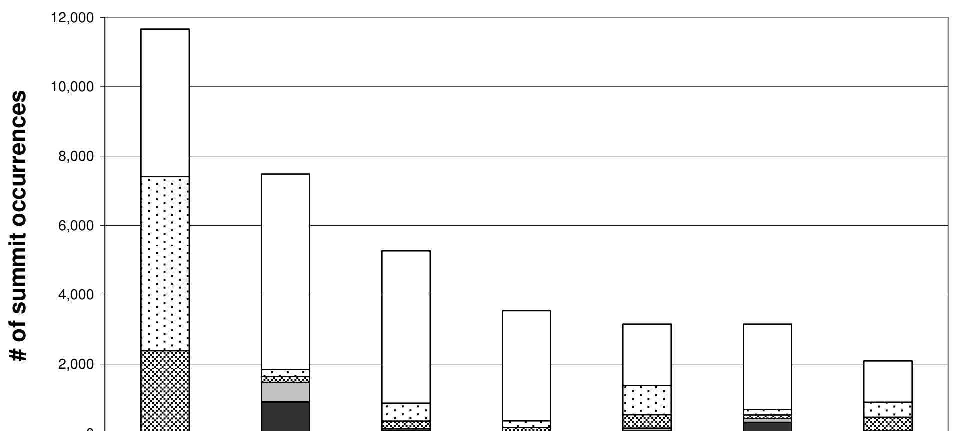
	Granitic	Ultra-mafic	Mafic	Cal-careous	Sedi-mentary	Mod calc.	Shale
☐ Critical: Unprotected	165	23	169	110	935	56	1
■ Critical: Protected	253	32	225	63	321	1	

Figure 5.Protection levels of critical and defacto summit occurrences. Chart shows ***Total Acreage*** *by state or province. Legend as for Table 4 (with slight difference PC = DP, PS = DS) Summits are all over 30 acres except in protected supporting category.*



	QC	NY	ME	VT	NB	NH	NS
OU	451,934	138,668	293,433	258,981	148,625	87,466	77,831
DS	3,014	59,870	5,828	2,662	2,270	5,762	9,206
DC	13,616	212,436	24,210	17,362	7,711	66,619	31,427
CP	40,975	7,902	10,528	2,436	5,193	23,930	4,079
CU	103,371	1,579	16,971	18,246	27,382	2,152	5,724

Figure 6.Protection levels of critical and defacto summit occurrences. Chart shows ***Total Number*** *by state or province. Legend as for Table 4 (with slight difference PC = DP, PS = DS). Only summits over 30 acres are shown except in protected supporting category.*



	NY	QC	ME	VT	NS	NB	NH
OU	4,263	5,644	4,389	3,178	1,773	2,463	1,196
DS	5,022	206	517	198	845	163	436
DC	2,338	163	230	117	383	94	399
CP	36	564	38	7	89	115	46
CU	14	908	90	46	64	318	18

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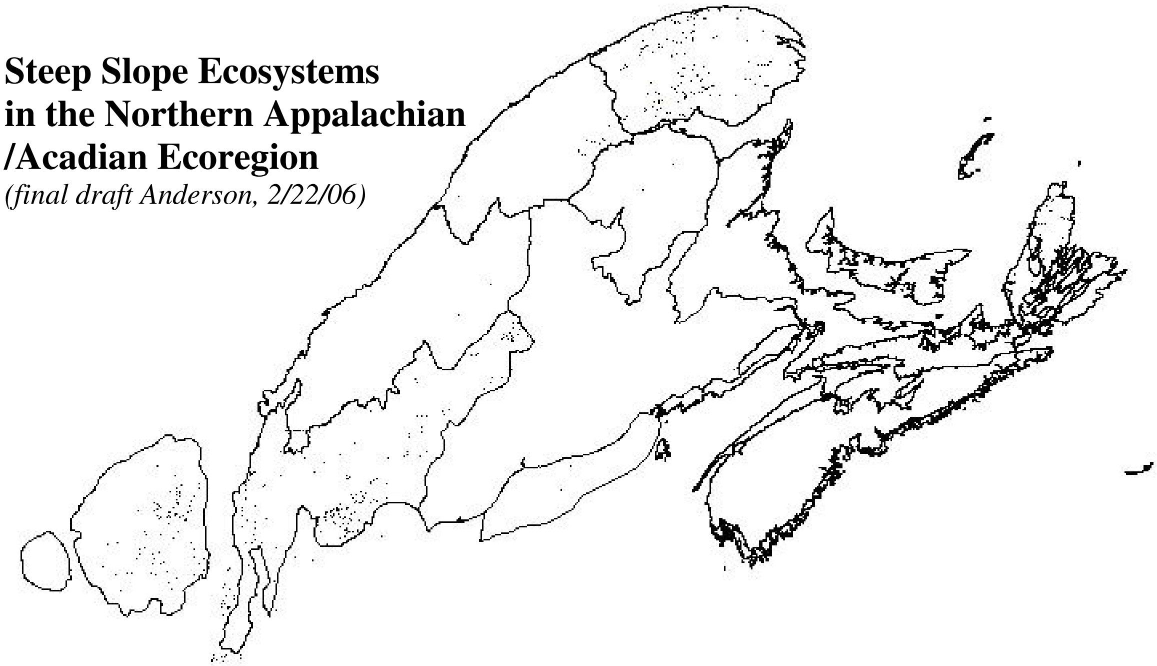
Steep Slope Ecosystems in the Northern Appalachian /Acadian Ecoregion

(final draft Anderson, 2/22/06)



Rocky crags, vertical cliffs, landslide scars, steep river bluffs and precipitous talus slopes contribute unmistakable character to the rugged landscapes of the region. Over 15,000 of these steep vertical features occur here, being concentrated in mountainous subregions but found across all elevation zones and bedrock types (Figure 1). Most steep slope features are small, averaging 27 acres, with 75% being less than 25 acres and accounting for 1% of the ecoregion in aggregate (Figure 2). At lower elevations steep slopes are associated with downcutting by rivers whereas at very high elevations, they intertwine with summits and hillcrests to form large complicated mountain features.

Figure 1. The distribution of steep slopes and cliffs across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion.

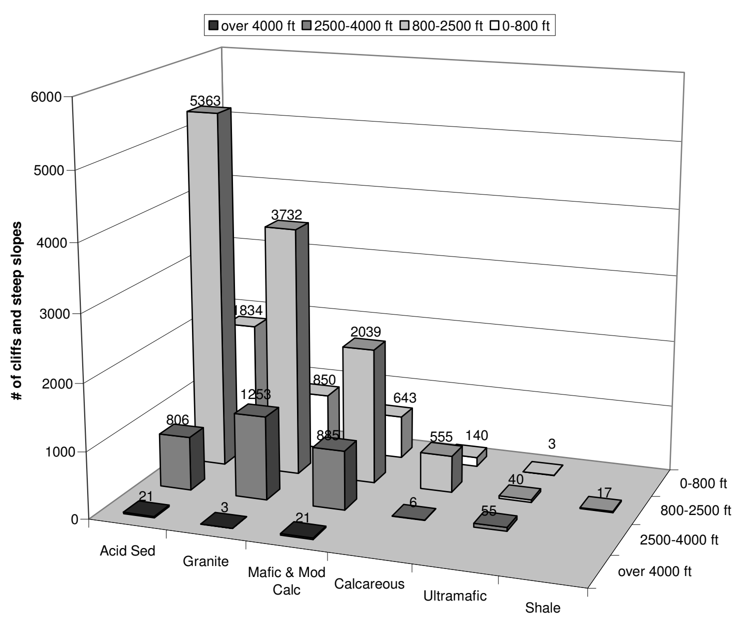
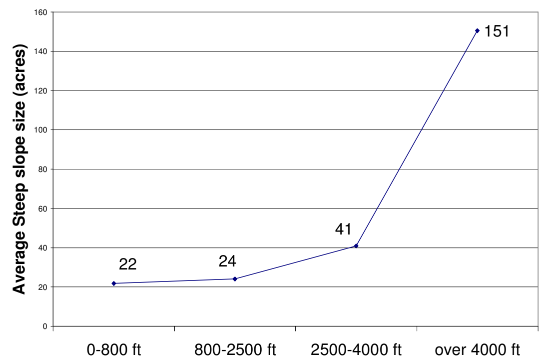


Figure 2. The distribution of steep slopes by size class and the average area of steep slope/cliff features by elevation zone.

Size Class	Total Acres	Total Number	% Num
S1: 2-25	110,756	12,386	0.76
S2: 25-75	132,513	2,884	0.18
S3: 75-240	124,839	925	0.06
S4: 240-2622	119,904	197	0.01
Total	488,011	16,392	1



Cliff, Talus and Steep slope Biodiversity

The various steep slope geomorphic features, although differing in genesis, share many ecological similarities. Their precipitous exposed faces slough off rock fragments and shed water, while accumulating soil and nutrients at their bases. This process creates contrasting habitats, the dry bedrock faces with little soil or nutrients, and moist nutrient-rich talus on the foot slopes.

Vertical cliff faces are choice settings for peregrine falcons and golden eagles which nest among the ledges and overhangs (57 nests of the former and 3 of the latter are known from steep slopes in the region). Snakes may be found sunning on south facing shelves. Wiry, tenacious herbs like birds eye primrose, slender cliff brake and fragrant cliff fern thread their roots into minute crevices while leathery liverworts find purchase directly on unbroken rock, extracting moisture from the air.

Talus of rock and rubble, accumulating at the slope bases, creates a structure preferred for denning by timber rattlesnake, rock vole, and Gaspe shrew. Tangles of vines, exploit this unstable substrate, crisscrossing the surface and rooting in pockets of soil. Other nutrient-loving plants like cranesbill, rock cress and knot weed are often found in the gravelly debris.

Communities associated with cliffs and steep slopes

Ecologists recognize several distinct, sparsely vegetated, communities on cliffs and talus slopes. The types are discriminated by floristic differences that correlate with bedrock and elevation. Enriched forests developing on the gentler undulating foot-slopes are discussed in the bowl/ravine section. Short descriptions of common steep slope ecosystems are provided below (from Basquill 2004, Anderson 1999).

Cliff and talus slopes on acidic substrates: Steep slopes on resistant granite, intermediate mafic rock or firmly cemented quartzite.

Alpine cliffs and talus: Landslide scars and scraped cirques at elevations over 4000 ft with open bedrock faces and unique alpine flora.

Mid -high elevation acidic cliffs and talus: Cliffs and vertical outcrops at elevations over 1700 ft with a flora of tough ferns and herbs such as Appalachian polypody, Rand's goldenrod, and three-toothed cinquefoil. Sporadic rarities include fragrant fern, scirpus-like sedge and deer-hair sedge. Talus slope woodlands of red spruce and heart-leaved birch at high elevations shift to yellow birch and white ash at elevations below 2500 ft. Rock voles and long-tailed shrews nest in these areas.

Low elevation acidic cliffs and talus: Open cliffs below 1700 ft. with a flora consisting of infrequent small herbs, ferns and lichens such as harebell, heart-leaved aster and rock tripe. Low elevation talus slopes include a diversity of warmer climate woody plants such as yellow birch, hemlock, red oak, mountain maple and red-berried elder. Typical herbs include poison ivy, Virginia creeper, marginal wood fern, and rusty woodsia. Most of the 13 known timber rattlesnake populations in the Northern Appalachians occur on these low talus features.

Cliff and talus communities of Calcareous and Mafic substrates: Steep slopes on marble, limestone or hard mafic bedrock.

Mid -high elevation calcareous cliffs and talus: Cliffs over 1700 ft. with a flora consisting of slender thin herbs and ferns such as harebell, scirpus-like sedge, red columbine and Steller's cliff brake. Plant rarities like birds-eye primrose, Blake's milkvetch, lyre-leaved rock cress and purple-mountain saxifrage may occur in the richer, limestone derived examples. Rich talus slope woodlands of sugar maple, red spruce, paper birch and northern white cedar with shrubs such as mountain maple, green alder, purple-flowering raspberry and, occasionally, shrubby cinquefoil form in this setting.

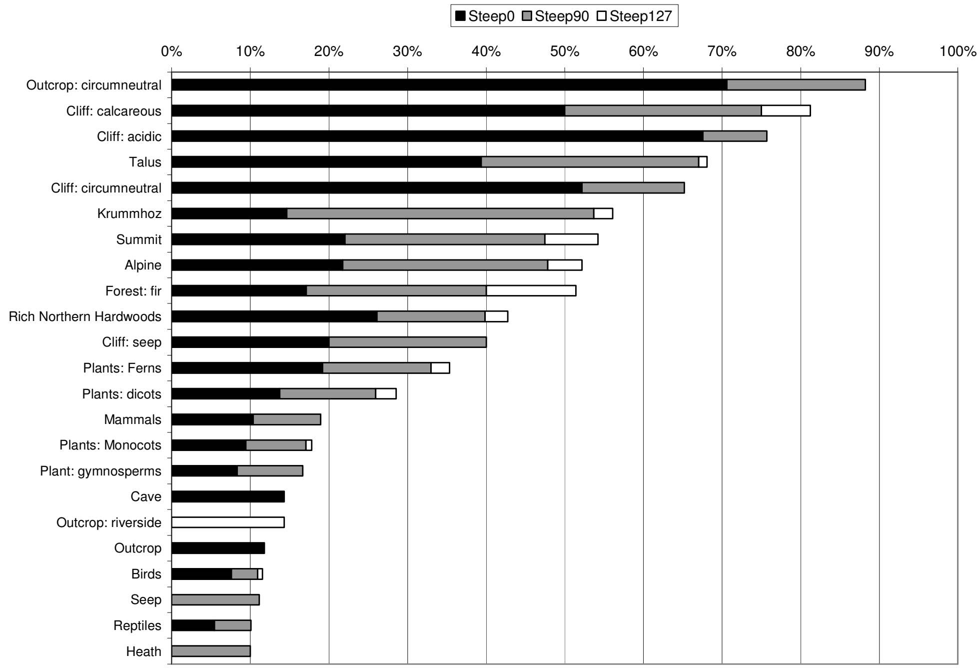
Low elevation calcareous cliff and talus: Cliffs below 1700 ft cliff with a flora of characteristic ferns and herbs such as ebony sedge, bulbet fern, wild columbine, purple-stemmed cliff brake, and wall rue. The low elevation talus slopes include a diversity of nutrient requiring woody species such as basswood, white ash, shagbark hickory, bitternut hickory and butternut. Vines and creeping shrubs such as mountain maple, Virginia creeper, and bladdernut are typical as are herbs like wild ginger, Herb Robert, clearweed and white snakeroot.

Riverside outcrop & erosional river bluffs: Waterfalls and gorges along major rivers develop steep slope communities analogous to those described above. These are mostly found at lower elevations and are often associated with richer calcareous soils. Herbs and vines that root on the vertical outcrops include harebell, red columbine, fringed loosestrife, Canada anemone, virgins bower and spreading dogbane.

Relationships between communities, rare species and the steep slope occurrences.

Compositional variation among the different community types correlate with recognizable bedrock-elevation combinations. Although the locally-defined community types do not conform precisely to physical factors, there was strong correspondence in the data between known community locations, steep slope features and the various bedrock types and elevation zones (Figure 3). To ensure that we located the best examples of steep slope ecosystems across the full spectrum of types we set a goal of locating 20 occurrences for each of 19 bedrock-elevation combination.

Figure 3: Biodiversity found on steep slopes. Bars show the primary mode of community and species occurrence as a percentage of all occurrences that were located on a steep slope feature. Black indicates the occurrence was located directly on the feature, grey indicates it was within 90 meters and white bars indicate it was within 127 meters. These (data provided by the Northeast US Natural Heritage programs and the Canadian CDCs).



Steep Slope Portfolio of Critical Sites

The screening criteria used to locate and identify the steep slope features most critical to maintaining biodiversity required that each qualifying occurrence:

- Was large and contiguous: over 25 acres.
- Was in good landscape settings (Land Cover Index < 20).
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source).
- Contained other confirmed biodiversity features (verification by element occurrences).

The size criterion was intended to insure that examples selected for the portfolio contained all their inherent species diversity and ecosystem functions. We determined the size minimum by examining over 1000 ground inventory points representing 298 species found on or directly adjacent to a steep slope feature. Of the species found on steep slopes, 69% were found only on examples greater than 25 acres, suggesting that larger features were more likely to contain a full complement of associated species. Restricting the analysis to a more narrowly defined set - species with three or more occurrences found consistently on steep slopes - 46 species were found only on examples over 25 acres, and no species were restricted to small examples. Included in the former group were much of the alpine flora, long-tailed rock shrew, rock vole, bald eagle, smooth cliff fern, mistassinica primrose, scirpus-like sedge, White Mt. saxifrage and many others (Tables 2 and 3). On average 88 % of the occurrences for any given species were likely to be on a slope over 25 acres.

Table 1 Species of larger slopes. Columns 4-7 give the % of known occurrence by size class.

Group	Com. Name	Standard Name	2-25 acres.	25-75 acres	75-240 acres	>240 acres	Tot#
Dicot	Mountain-heath	Phyllodoce caerulea				100%	9
Dicot	Moss Bell-heather	Cassiope hypnoides				100%	8
Dicot	Pale Painted-cup	Castilleja septentrionalis				100%	8
Dicot	Moss Campion	Silene acaulis var. exscapa				100%	6
Dicot	Mountain Sorrel	Oxyria digyna				100%	4
Monocot	Alpine Timothy	Phleum alpinum				100%	4
Fern	Alaskan Clubmoss	Diphasiastrum sitchense				100%	4
Dicot	Alpine Marsh Violet	Viola palustris				100%	3
Dicot	Mt. Cudweed	Gnaphalium supinum				100%	3
Monocot	Head-like Sedge	Carex capitata ssp. arctogena				100%	3
Monocot	Wavy bluegrass	Poa fernaldii			4%	96%	23
Dicot	Cutler's Goldenrod	Solidago cutleri			13%	88%	8
Dicot	Tea-leaved Willow	Salix planifolia			17%	83%	6
Dicot	Alpine Bitter-cress	Cardamine bellidifolia			20%	80%	5
Monocot	Heart-leaved Twayblade	Listera cordata			20%	80%	5
Monocot	Mountain Hairgrass	Deschampsia atropurpurea			20%	80%	5
Dicot	Purple Crowberry	Empetrum atropurpureum			22%	78%	18
Dicot	Alpine Azalea	Loiseleuria procumbens			22%	78%	9
Dicot	Common Butterwort	Pinguicula vulgaris			25%	75%	4
Dicot	Silver Willow	Salix argyrocarpa			25%	75%	4
Monocot	Pickerings Reed Bentgrass	Calamagrostis pickeringii			25%	75%	4
Dicot	Alpine Willow-herb	Epilobium alpinum			33%	67%	3
Dicot	Boreal Wormwood	Artemisia campestris ssp. borealis			50%	50%	4
Monocot	Black Sedge	Carex atratiformis			67%	33%	3
Fern	Alpine Cliff Fern	Woodsia alpina		9%	9%	83%	9
Dicot	Dwarf Birch	Betula glandulosa		13%	23%	65%	9
Monocot	Deer's Hair Sedge	Trichophorum cespitosum		7%	20%	73%	15
Dicot	Boot’s rattlesnake root	Prenanthes boottii		9%	18%	73%	11
Dicot	Empetrum eamesii	Empetrum eamesii ssp. atropurpureum		17%	33%	50%	6
Monocot	Small-flowered Rush	Luzula parviflora		25%	25%	50%	4
Dicot	Purple Mountain Saxifrage	Saxifraga oppositifolia		17%	50%	33%	6
Monocot	Bentgrass	Calamagrostis stricta ssp. inexpansa		11%	33%	33%	9
Fern	Appalachian Firmoss	Huperzia appalachiana		40%	20%	40%	17
Dicot	Baked Apple Berry	Rubus chamaemorus		50%	25%	25%	4
Dicot	Blake's Milk-vetch	Astragalus robbinsii var. minor		33%	33%	33%	6
Dicot	Primula mistassinica	Primula mistassinica		33%	33%	33%	3
Dicot	Purple Clematis	Clematis occidentalis var. occidentalis		33%	33%	33%	3
Dicot	Rock-cress	Draba arabisans		46%	46%	8%	10
Dicot	White Mountain-saxifrage	Saxifraga paniculata		40%	20%	40%	5
Dicot	Hyssop-leaved Fleabane	Erigeron hyssopifolius		20%	40%	40%	5
Dicot	Squaw-root	Conopholis americana		25%	75%		4
Dicot	Squirrel-corn	Dicentra canadensis		50%	50%		4
Dicot	Dwarf Willow	Salix herbacea		20%		80%	5
Monocot	Lily-leaved Twayblade	Listera convallarioides		33%		67%	3
Fern	Fir Clubmoss	Huperzia selago		33%		67%	3

Table 2. Species of any size slopes. Columns 4-7 give the % of known occurrence by size class.

Group	Common Name	GNAME	2 -25 acres	25-75 acres	75-240 acres	>240 acres	Tot#
Dicot	Bearberry Willow	Salix uva-ursi	8%	12%	12%	68%	25
Dicot	Alpine Blueberry	Vaccinium boreale	10%	12%	16%	62%	26
Fern	Green Spleenwort	Asplenium trichomanes-ramosum	13%	13%	13%	63%	8
Monocot	Bigelow's Sedge	Carex bigelowii	9%	9%	23%	60%	35
Dicot	Empetrum nigrum ssp. hermaphroditum	Empetrum nigrum ssp. hermaphroditum	12%	6%	24%	59%	17
Dicot	Lapland Diapensia	Diapensia laFernonica	7%	9%	11%	73%	32
Monocot	Northern Bentgrass	Agrostis mertensii	7%	14%	22%	57%	18
Dicot	Dwarf Rattlesnake-root	Prenanthes nana	13%	13%	25%	50%	8
Dicot	ARNICA	Arnica lanceolata	13%	13%	25%	50%	8
Monocot	Scirpus-like Sedge	Carex scirpoidea	4%	17%	39%	39%	23
Dicot	Alpine Bilberry	Vaccinium uliginosum	25%	25%	25%	25%	4
Dicot	Northern Mountain-ash	Sorbus decora	25%	25%	25%	25%	4
Monocot	Pond Reed Bent-grass	Calamagrostis lacustris	25%	25%	25%	25%	4
Fern	Fragrant Fern	Dryopteris fragrans	30%	34%	28%	7%	22
Dicot	Ginseng	Panax quinquefolius	37%	35%	16%	13%	22
Dicot	Hornemann Willow-herb	Epilobium hornemannii	21%	17%	5%	57%	14
Monocot	Highland Rush	Juncus trifidus	6%	32%	12%	50%	12
Dicot	Mountain Sandwort	Minuartia groenlandica	9%	45%	9%	36%	11
Dicot	Alpine Goldenrod	Solidago multiradiata var. arctica	15%	8%	31%	46%	13
Dicot	Northern Comandra	Geocaulon lividum	7%	7%	37%	50%	12
Bird	Peregrine Falcon	Falco peregrinus	16%	35%	30%	19%	57
Fern	Smooth Woodsia	Woodsia glabella	13%	40%	27%	20%	15
Dicot	Ciliated Willow-herb	Epilobium ciliatum	20%	40%	20%	20%	5
Reptile	Timber Rattlesnake	Crotalus horridus	38%	15%	31%	15%	13
Dicot	Silverling	Paronychia argyrocoma	20%	5%	45%	30%	15
Dicot	Mountain Avens	Geum peckii	11%		11%	79%	19
Monocot	Alpine Sweet Grass	Hierochloe alpina	4%		24%	72%	26
Monocot	Boreal Bentgrass	Agrostis borealis	14%		21%	64%	14
Monocot	Spiked Woodrush	Luzula spicata	8%		31%	62%	13
Dicot	Alpine Bearberry	Arctostaphylos alpina	11%		33%	56%	9
Monocot	Northern Reedgrass	Calamagrostis stricta	33%		33%	33%	3
Dicot	Lapland Rosebay	Rhododendron laFernonicum	7%		15%	78%	10
Dicot	Solidago simplex var. randii	Solidago simplex var. randii	43%		29%	29%	7
Monocot	White Bluegrass	Poa glauca	25%			75%	4
Dicot	Mountain Sweet-cicely	Osmorhiza chilensis	25%	25%		50%	4
Monocot	Green Adder's-mouth	Malaxis unifolia	25%	50%		25%	4
Bird	Bicknell's Thrush	Catharus bicknellii	33%	50%		17%	6
Dicot	Smooth Rockcress	Arabis laevigata	50%	50%			4
Bird	Golden Eagle	Aquila chrysaetos	67%	33%			3
Monocot	Summer Sedge	Carex aestivalis	67%	33%			3
Fern	Slender Cliffbrake	Cryptogramma stelleri	59%	25%	16%		5
Dicot	Smooth Sandwort	Minuartia glabra	38%	25%	38%		8
Monocot	Wild Leek	Allium tricoccum	33%	33%	33%		3
Fern	Goldie's Wood-fern	Dryopteris goldiana	33%	33%	33%		3
Dicot	Douglas' Knotweed	Polygonum douglasii	29%	43%	29%		7
Dicot	Pale Jewel-weed	Impatiens pallida	50%		50%		4

Results

Our goal was to identify a minimum of **20 exemplary occurrences per 19 bedrock/elevation combinations** totaling to a minimum goal of 380 total occurrences distributed across the ecoregion. After examining the distribution of larger (>25 acre) steep slope occurrences we redistributed the 20-per-type numeric goal across the geology/elevation gradients in proportion with the number of possible occurrences acres (Table 3).

We identified 829 critical occurrences, 449 more than we needed to meet our minimum goal. With one exception we met our goals for identifying sites within each bedrock/elevation combination as well and thus, the portfolio is generally sufficient with respect to steep slopes except on low moderately calcareous or mafic bedrock (Table 3).

Candidate and Supporting occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable, or poorly surveyed steep slopes that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. Many of these may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. As protected examples may serve to bolster biodiversity protection we included them in some of our analyses for context. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

The importance of recognizing the *defacto* examples was provided by the few, single-occurrence steep slope species that were known only from small occurrences (e.g. northern stick seed).

Sites and Occurrences

In this analysis a “site” could consist of either a survey site associated with an exemplary individual steep slope feature or an important natural complex comprised of many co-occurring steep slope features. In some of the latter cases, not every individual slopes met our selection criteria but most did and as an aggregate the area did as well. This allowed a few smaller slopes to qualify as “critical”.

Counting the steep slope occurrences can be deceptive. Many of the steep features occur in close proximity to each other and might be more usefully thought of as one mega-occurrence. If the portfolio is counted by survey sites instead of individual occurrences, it totals to a set of 346 sites containing not only the 829 critical occurrences but also another 1037 small occurrences. Within the survey sites this amounts to 134,198 acres of steep slope features (Appendix 1).

The selected critical occurrences accounted for 10% by count, and 27% by area, of all the steep slopes features in the ecoregion. Protected candidate occurrences account for another 30% by count and 27% by area.

Table 3: Portfolio Summary based on steep slope occurrences over 25 acres. The only insufficiencies are for moderately calcareous or mafic slopes below 800'. Legend below.

ELEV.	BEDROCK	% Goal	CU	CP	PC	OU	T	%	TC	D	S
0-800'	Sedimentary	37	83	17	52	272	424	10%	100	63	Y
	Calcareous	2	8	6	2	11	27	1%	14	12	Y
	Granitic	19	21	20	91	91	223	5%	41	22	Y
	Mod Calc/ Mafic	14	10	2	66	90	168	4%	12	-2	N
800-2500'	Sedimentary	121	227	41	131	1000	1399	32%	268	147	Y
	Calcareous	8	23	9	11	53	96	2%	32	24	Y
	Granitic	62	36	42	362	277	717	16%	78	16	Y
	Ultramafic	2	2	2		5	9	0%	4	2	Y
	Mod Calc/ Mafic	37	66	32	131	199	428	10%	98	61	Y
2500-4000'	Sedimentary	22	12	34	74	135	255	6%	46	24	Y
	Granitic	32	16	51	221	88	376	9%	67	35	Y
	Ultramafic	2	4	13		7	24	1%	17	15	Y
	Mod Calc/ Mafic	21	11	28	168	37	244	6%	39	18	Y
4000+'	Sedimentary	1	1	7	3		11	0%	8	7	Y
	Granitic	1	0	1			1	0%	1	0	Y
	Mod Calc/ Mafic	2	0	4	1		5	0%	4	2	Y
Total		380	520	309	1313	2265	4407	1005	829	449	Y

%Goal = the portfolio goal
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 25 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
TC = total critical occurrences (unprotected + protected)
D = the difference between the amount identified for the portfolio and the goal,
S = portfolio sufficiency in finding occurrences to represent this element

Current Protection Levels of Critical Features.

The critical steep slope occurrences amount to 10% by count and 27% by acreage of all the steep slope features in the ecoregion – amounting to roughly ¼ of 1% of the entire region by acreage (Table 4). Currently 64,000 acres are on lands protected for biodiversity leaving 70,250 acres remaining for active protection efforts.

Table 4. Protection levels of the portfolio by acreage and count .Legend as for Table 3.

	CU	CP	PC	PS	OU	Total
Total Acres	70,249	63,949	106,818	25,826	221,169	488,011
% Acres	14%	13%	22%	5%	45%	100%
Total Count	1272	594	1680	3868	10852	18266
% Count	7%	3%	9%	21%	59%	100%

Protection levels vary with elevation. Above 4000 ft critical slopes are virtually all protected. Below 2500 ft., slopes are mostly less than 60% protected with sedimentary, calcareous and shale occurrences being less than 30% protected. The exception is the rare ultramafic slopes that have a 90% protection level (Figure 4 & 5.).

Figure 4. Protection levels of critical occurrences by bedrock/elevation combinations

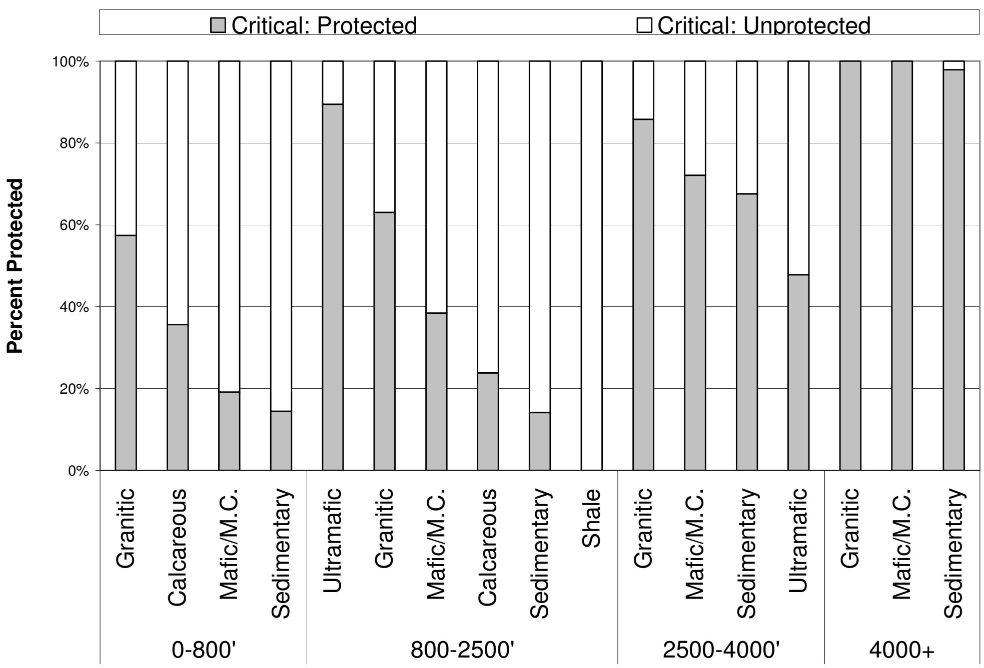
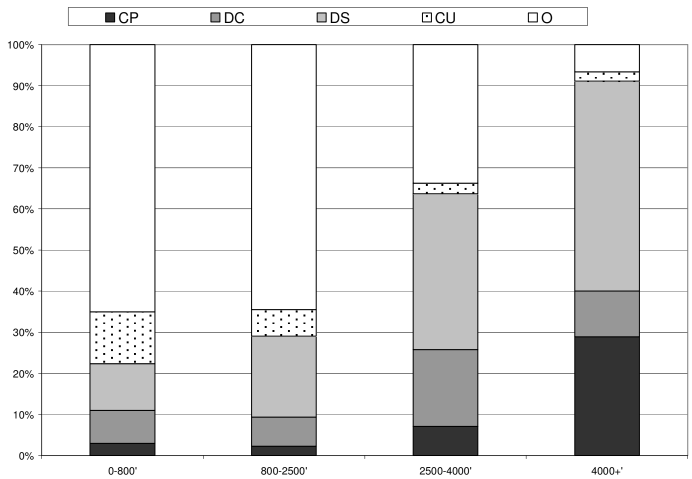
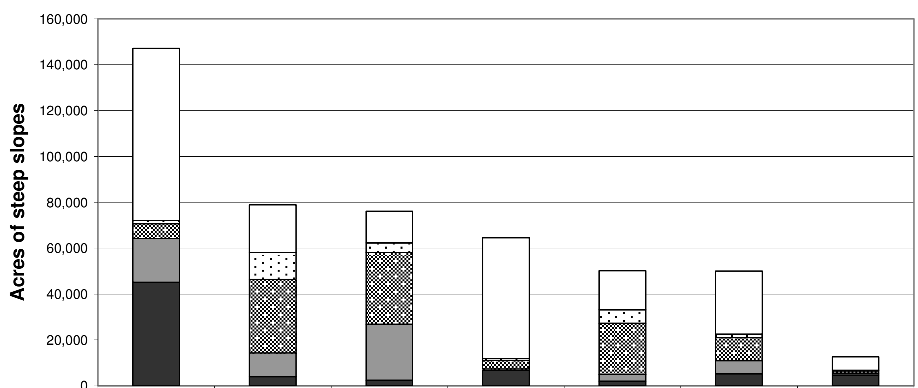


Figure 5. Correlations between Protection level and Elevation zone: over 90% of the alpine slopes are in reserves while only 21% of slopes at low elevations are protected.



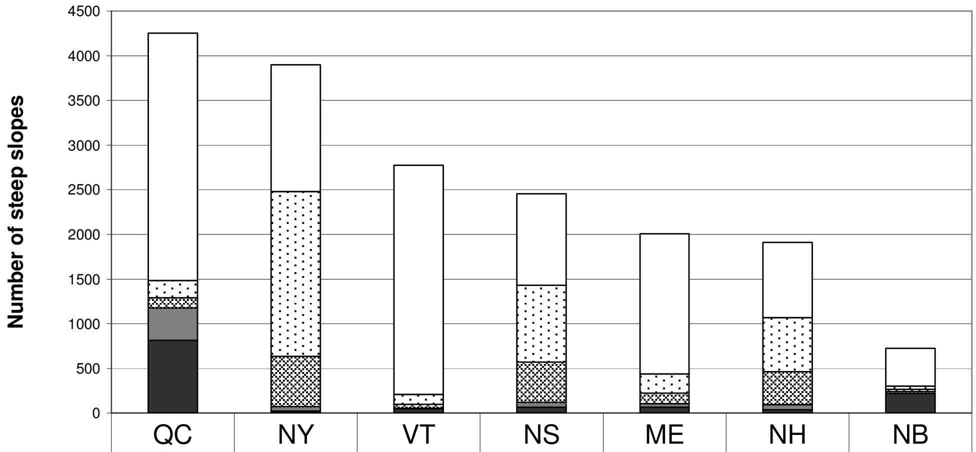
Protection levels vary by state and province in accordance with the relative amount of steep slopes present. Quebec leads the region in both acreage and protection level. New York, New Hampshire, Nova Scotia and Maine all have significant amounts of candidate site that would benefit from inventory and evaluation (Figures 6 & 7.)

Figure 6.Protection levels of critical occurrences (CU, CP) and protected candidate (DC) or protected supporting (DS) steep slope occurrences. Chart shows total acreage by state or province. Legend as for Table 3



	QC	NY	NH	VT	NS	ME	NB
OU	75,060	20,893	13,800	52,684	16,973	27,571	5,849
DS	1,364	11,726	4,212	770	5,948	1,514	292
DC	6,509	32,032	31,223	3,794	22,330	9,998	932
CP	19,043	10,370	24,361	661	2,846	5,784	885
CU	45,181	3,931	2,480	6,637	2,067	5,222	4,666

Figure 7.Protection levels of critical (CU), critical protected(CP), protected candidate (DC) or protected supporting (DS) steep slope occurrences. Chart shows total number by state or province. Legend as for Table 3



	QC	NY	VT	NS	ME	NH	NB
□ OU	2768	1419	2562	1026	1569	841	422
DS	191	1846	114	861	214	606	36
DC	117	562	40	450	118	369	24
■ CP	362	51	8	52	39	59	23
■ CU	814	21	48	67	66	36	219

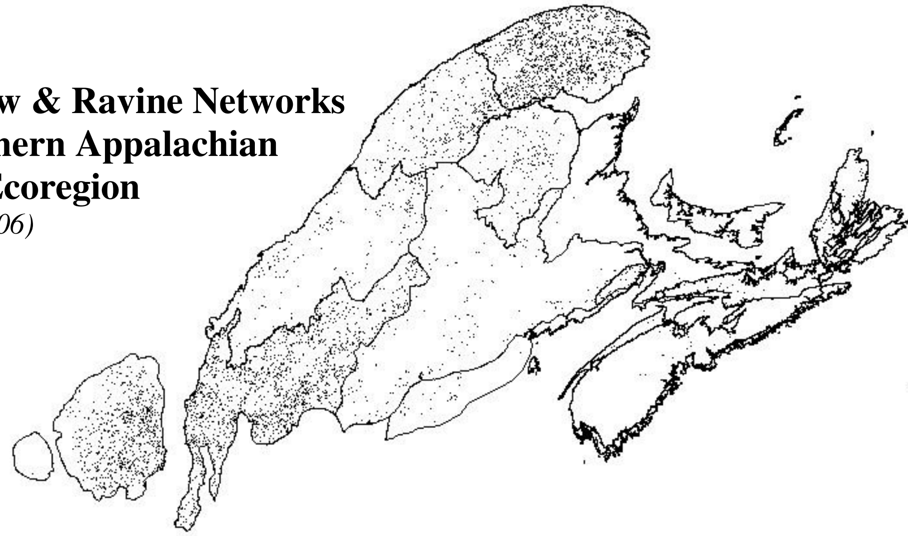
Summary

Of the half million acres of steep slopes in the ecoregion, this analysis identifies e portfolio highlights the 346 sites most critical for biodiversity conservation (10 percent by number or 27 percent by area). The key sites, are well distributed across bedrock and elevation gradients and are about 1/3 protected (3% by count /16%) by area. Conservation is needed mostly for low elevation slopes on calcareous and sedimentary features.

Sites: Site lists are found in Appendix A

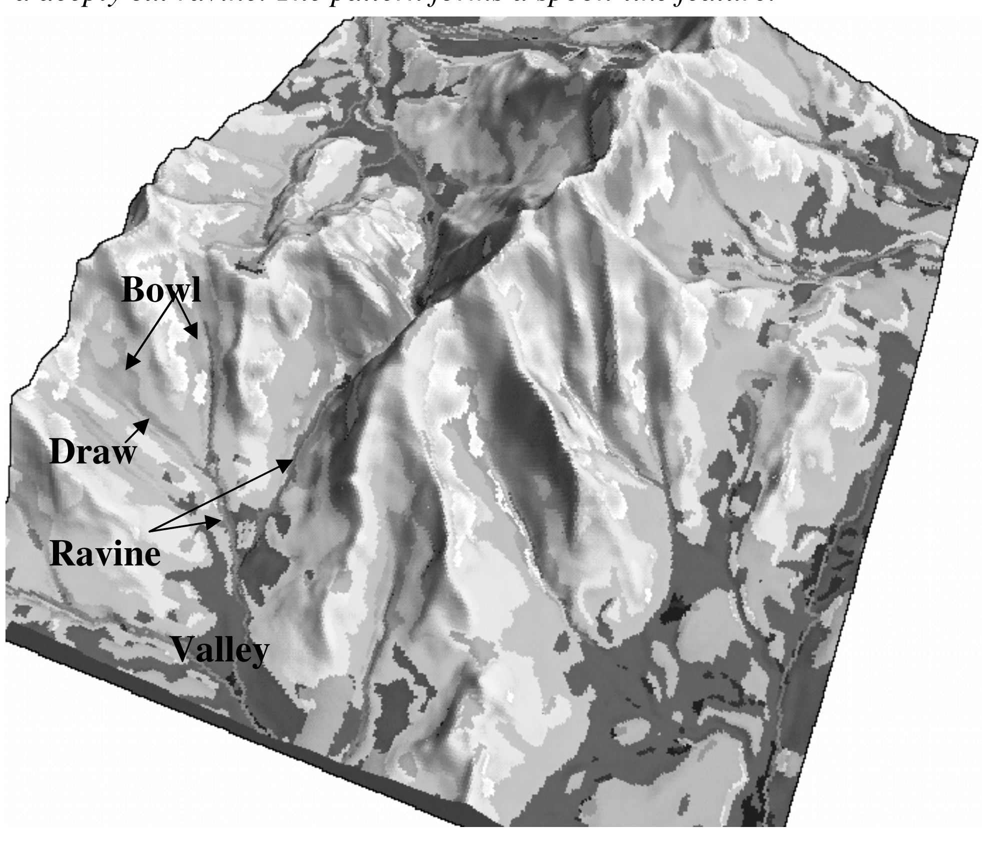
Bowl, Hollow & Ravine Networks in the Northern Appalachian / Acadian Ecoregion

(final draft 1/2006)



Bowls are shallow hillslope concavities linked by moist drainageways ("draws") that deepen into ravines. This setting provides some of the most fertile settings in the Northern Appalachian / Acadian region. These concave areas on moderate slopes (technically "head slopes" or locally "coves"or "hollows") are places were rain water converges and slopewash sediments collect. Like streams, they form multifaceted networks connected by toe-slopes. With over 200,000 in the ecoregion, it can be hard to determine where one occurrence ends and another begins.. Most are small, averaging 18 acres in size, with 88% of them being less than 25 acres. In landscapes conducive to their development, extensive intertwined networks occur. These "large examples" reflect the extent and complexity of the system more than an increase in the size of the individual components (Figure 1). Although widespread in the region, they are concentrated on harder bedrock at moderate elevation (Figure 2).

Figure 1. Enriched settings tend to form networks with small cirque-like bowls at their head (a bowl, cove or hollow) that narrow into a shallow drainageway or "draw" and often into a deeply cut ravine. The pattern forms a spoon-like feature.

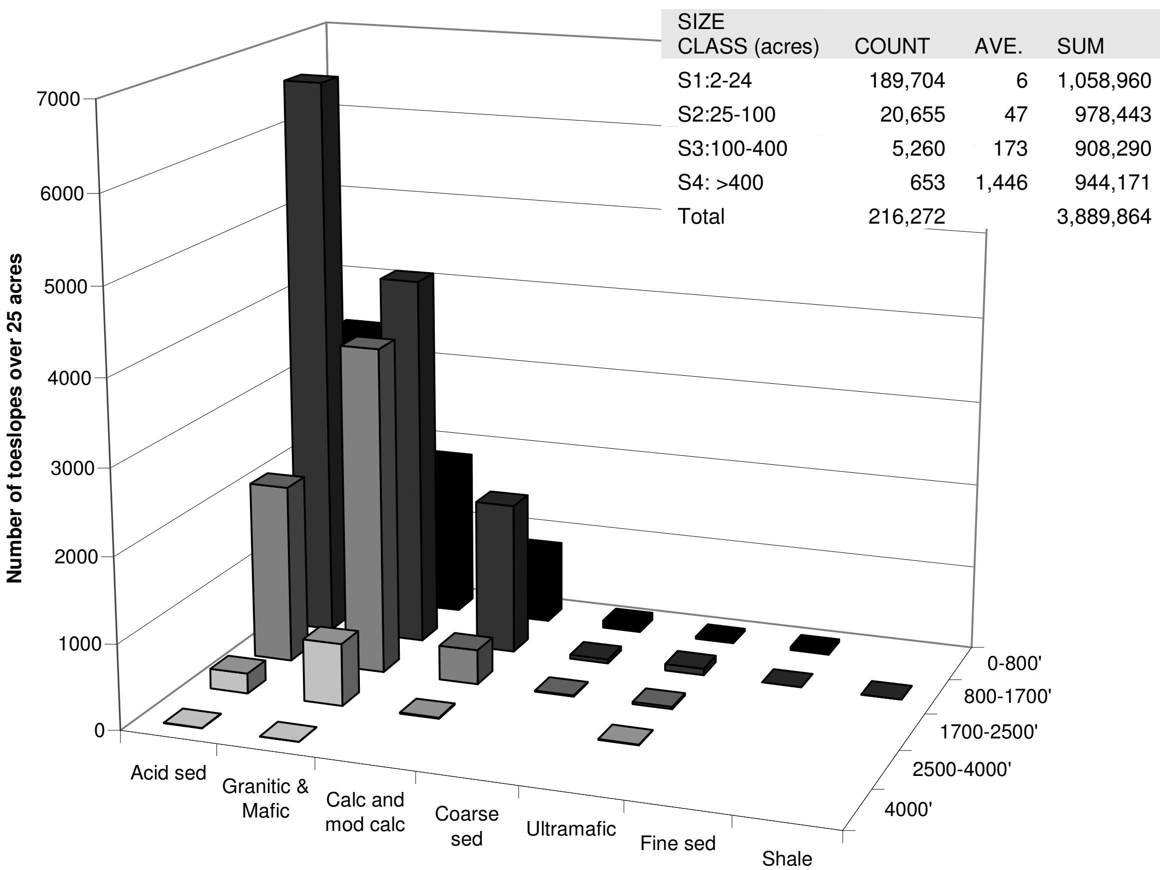


The distribution of bowl/ravine features varies among the subregions. Mountainous areas contain the most occurrences and the most extensive networks. In flatter regions these features are more discrete, fewer in number and tend to co-occur with steep slopes and summits (Table 1). Because they form just upslope of valleys, these features are most common on mid-elevation bedrock settings (Figure 2).

Table 1. The distribution of bowl and ravine features by subregions

ELC_NAME	# of Occurrences	Total Acres	Average size	Maximum size
Green & White Mountains	60,607	1,250,521	21	1,757
Gaspe Peninsula	10,521	970,067	92	53,016
Adirondacks & Tug Hill	31,283	580,246	19	1,823
Temiscouata Hills - St. John Uplands - North	17,772	303,328	17	30,151
Acadian 'Uplands'	35,057	247,155	7	264
Acadian Highlands	25,517	230,257	9	366
Estrie-Beauce Hills/St. John Uplands	16,239	178,227	11	1,185
Gulf of Maine, Bay of Fundy, Minas Basin	7,000	57,778	8	647
Nova Scotia Hills & Drumlins	5,422	25,809	5	152
Northumberland - Bras D'Or 'lowlands'	4,011	21,238	5	168
Atlantic Coast	1,176	5,420	5	220
Total	216,272	3,889,864	18	

Figure 2. Bowl and ravine networks larger than 25 acres across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion.



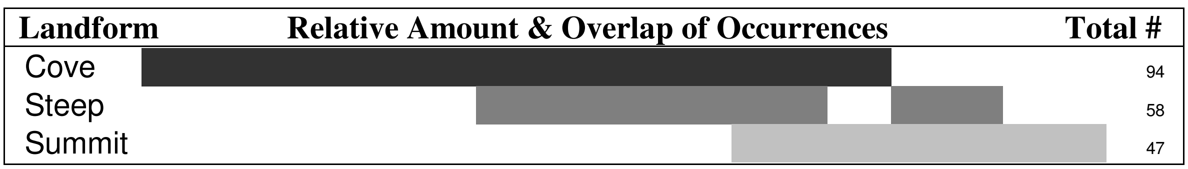
SIZE CLASS (acres)	COUNT	AVE.	SUM
S1:2-24	189,704	6	1,058,960
S2:25-100	20,655	47	978,443
S3:100-400	5,260	173	908,290
S4: >400	653	1,446	944,171
Total	216,272		3,889,864

Bowl and Ravine Biodiversity

Bowls and hollows are local repositories of nutrients and moisture (Figure 1). Rich damp soils develop in the shallow concavities and support a variety of nutrient-loving plants such as ginseng or Goldie's fern, and trees like basswood, white ash and sugar maple. The lush patches of forest that develop in these settings are known variously as "rich northern hardwood forests", "rich mesic forest", "maple-ash-basswood forest" or "cove hardwoods" and they are often sought out by botanists for their unique flora. Most commonly they occur on sedimentary till, but they can occur on any bedrock. Soils derived from calcium rich bedrock further accentuate the fertility of rich hardwood forests and remarkable understories of maidenhair fern, trilliums and pale jewelweed may result.

In this ecoregion, 78 percent of the inventoried rich hardwood forests occurred in this setting, although the local extent of those occurrences often overlapped with steep slopes and summits (Figure 3).

Figure 3. Occurrences of rich hardwood forests summarized by landform. Based on 121 occurrences provided by US NHP and CANADA CDC



Rich hardwood forests are not the only community associated with this setting. Talus slope woodlands, moist seepage forests and hemlock ravines are all characteristically found on bowl/ravine settings, particularly in steeper and more deeply cut portions (Table 3). Rare or uncommon plants are abundant (Table 4).

Table 3. Communities and species strongly associated with bowls features in NAP. Based on 1564 occurrences. Columns show the occurrence distribution across size classes.

Name	2—25 acres	26-100 acres	100-400 acres	400-1800 acres	Total EOs	Habitat preference
Rich Northern Hardwoods	17	36	36	5	94	
Talus slope woodland	8	11	28	8	55	
Forest: seepage	4	5	1	1	11	
Forest: hemlock	7	3	6	1	17	moist soil on hillsides
Panax quinquefolius	7	13	11	3	34	rich woods
Dryopteris fragrans	7	4	10	2	23	cliff crevices/limestone
Epilobium hornemannii	5	4	9	3	21	Stream banks & wet places
Geum peckii	5	4	6	5	20	damp slopes
Galium kamtschaticum		9	7	1	17	mossy woods
Forest: hemlock	7	3	6	1	17	moist soil on hillsides
Dryopteris goldiana	6	5	4	1	16	moist woods in rich soil

Table 4: Bedrock relationships for typical bowl/ravine species. These species were subsequently used to confirm portfolio examples. Data based on 1564 USHP and Canadian CDC occurrences.

STANDARD NAME	HABITAT	Sedimentary	Calcareous	Moderately Calcareous	Granitic	Mafic	Ultramafic	Coarse sediment	Total
Amerorchis rotundifolia	wet woods	100%							5
Carex bromoides	wet woods, swamps	100%							6
Carex tenera	moist or wet soil	100%							3
Dryopteris filix-mas	wooded hillsides, oft calc	100%							10
Viola selkirkii	shady ravines	100%							3
Adiantum pedatum	rich woods	67%	33%						3
Impatiens pallida	rich woods	67%	33%						3
Dryopteris clintoniana	wet woods	60%	20%				20%		5
Carex eburnea	calc soil	43%	29%	29%					7
Cystopteris tenuis	rocky forests/shaded cliffs	56%	11%		33%				9
Milium effusum	rich woods	83%			17%				6
Botrychium lanceolatum	mountain slopes	60%			40%				5
Epilobium hornemannii	stream banks	25%			75%				4
Geum peckii	damp slopes	46%			54%				13
Trillium erectum	moist woods					67%			3
Panax quinquefolius	rich woods	45%				55%			11
Tiarella cordifolia	rich woods	67%				33%			3
Allium tricoccum	rich woods	72%				21%	7%		29
Carex garberi	moist calc soil	60%	20%	10%				10%	10
Cystopteris fragilis	wooded slopes, neut. soil	72%	11%	11%	6%				18
Anemone multifida	rocky banks, calc	25%	25%		25%	25%			4
Listera auriculata	wet woods	50%	10%		20%	20%			10
Dryopteris fragrans	cliffs. shady hillsides, calc	36%			57%			7%	14
Arabis drummondii	various	21%		14%	29%	29%			14
Polystichum braunii	upland woods, calc soils	60%		13%	13%	13%			15
Polystichum lonchitis	shaded hillsides, calc.	80%		4%	8%	4%			25
Woodsia glabella	calc rocks	50%		8%	38%	4%			24
Arabis hirsute	woods & hillsides, calc.	50%	6%	13%	19%	6%			16
Listera convallarioides	wet shady woods	42%	8%	17%	25%			8%	12
Woodsia alpina	rock crevices cool sites	50%	10%	20%	15%	5%			20
Asplenium trichomanes	shaded calc. rocks	44%	4%	19%	11%	15%		4%	27
Arnica lanceolata	moist shady places, banks	75%		2%	2%	14%	5%	2%	44

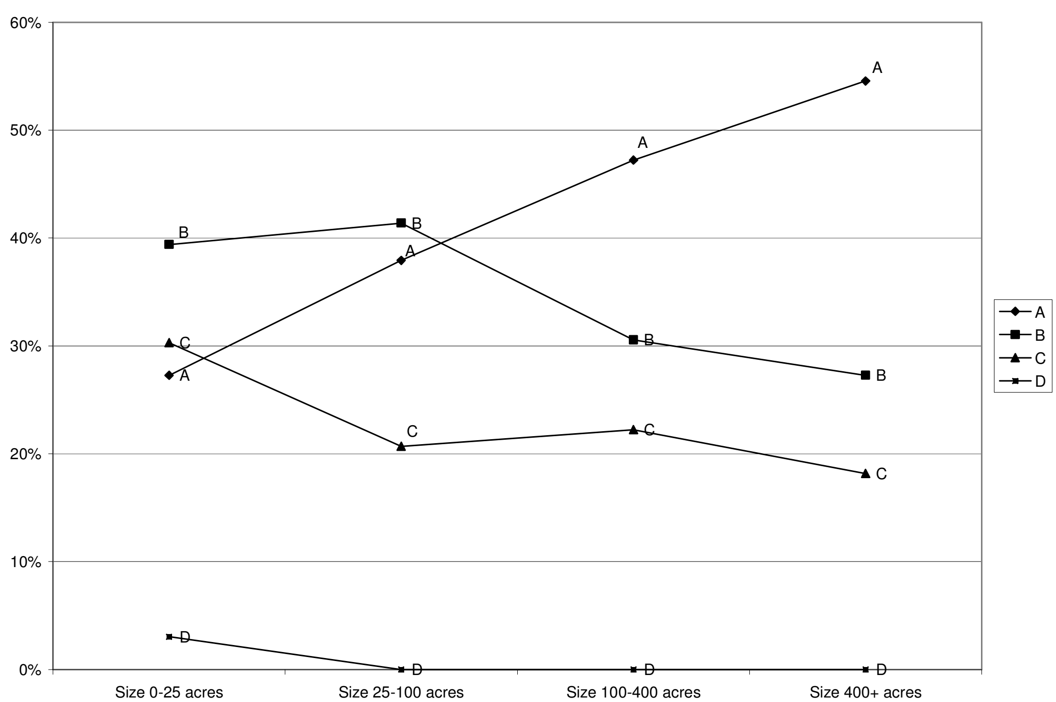
Bowl, Hollow and Ravine Portfolio Summary

The portfolio identifies the set of critical sites most important to the conservation of enriched bowl/ravine ecosystems. The screening criteria used to identify crucial portfolio occurrences required that each example:

- Was large and contiguous: over 25 acres
- Was in good landscape settings (Land Cover Index < 20)
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contained other confirmed biodiversity features (element occurrences) appropriate to the system type.

Size criteria were determined by an analysis of over a thousand survey records for species and communities occurring on bowl/ravine settings. As with other network forming features, the size of an occurrence did not appear to directly effect its function as a coarse filter for associated species. Although larger occurrences typically had more species represented, we did not find any species restricted only to small examples. A direct relationship was apparent in the ground inventoried information between the **condition** of the inventoried example and the size of the occurrence to which it corresponded (Figure 4). The 25 acre size criterion, slightly above the feature's mean size in the region, increases the likelihood of selecting high condition examples with complete biodiversity.

Figure 4. Relationship between the condition rank (A,B, C or D) of rich hardwoods, talus slopes, outcrops and other Bowl/draw related communities and the size of the modeled bowl/ravine occurrence. As the size of the feature increases the percentage of A (best) ranked examples increases.



Candidate and Supporting occurrences:

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed bowls/ravines that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them for context in some of our analyses. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Results

Insuring that the portfolio would make a lasting impact on the conservation of biodiversity requires having adequate replication and redundancy of bowl/ravine features across all important environmental gradients. Thus, we set an initial minimum number of critical occurrences to protect as **20 examples per 24 bedrock/elevation combinations**. This goal of at least 480 individual occurrences totals to less than 1 percent of all the bowl/ravine features in the ecoregion or an estimated 1% of all bowls/ravines by area (using the mean size of features over 25 acres -e.g. 107 acres). After examining the distribution of the occurrences across gradients, we redistributed the minimum goal of 480 across the bedrock/elevation classes in proportion with the number of possible occurrences, adding a minimum of two for rarer environments. This totaled to a goal of 499 (Table 5).

Our results identified 1269 critical occurrences, 770 more than the number needed to meet our minimum goals. We met or surpassed the specific minimum goals for each bedrock/elevation setting except in a few uncommon settings. Measured by area, the critical sites account for 13% percent of all bowl/ravine features, more than the expected estimate of 1% because the critical sites were consistently larger than the average size.

Occurrences, Sites and Goals

In our analysis a "site" could consist of either an exemplary individual bowl/ravine feature or a natural complex comprised of many bowls/ravines and other features in close proximity. In some of the latter cases, not all the individual examples met our selection criteria, but as an aggregate the area did. The surplus of occurrences, a rarity in the overall portfolio, reflects the tangled and intertwined nature of these networks in regions of high bowl/ravine densities. From a practical stand point they will need to be conserved as a complex in order to conserve the processes that form and maintain these fertile drainageways. Thus, although we are able to count them as individual features they are not independent at a landscape scale.

Table 5. Goals and Distribution for critical occurrences of bowls and draws. This table gives detail on the goals set for critical sites and the adequacy of the portfolio in meeting those goals.

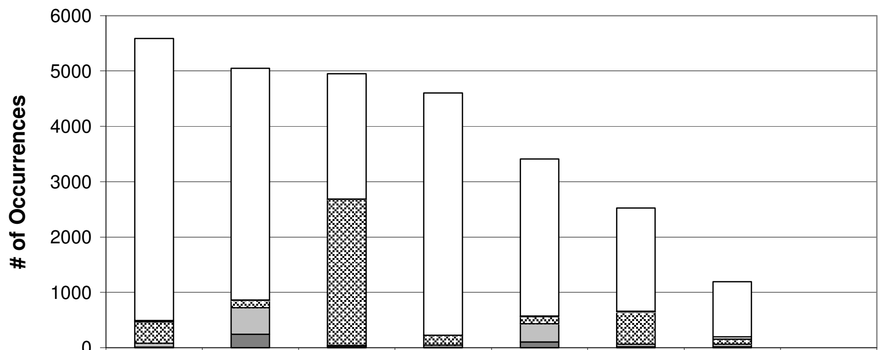
ELEV.	GEOLOGY	Goal	CU	CP	DC	OU	T	%	PA	N
	Acidic sedimentary	62	248	73	123	2966	3410	13%	Y	0
0-800'	Calc/mod calc	15	68	17	25	738	848	3%	Y	0
	Coarse sed	2	7	1	2	78	88	0%	Y	1
	Fine sed	2				35	35	0%	-2	2
	Granitic/mafic	33	77	67	169	1540	1853	7%	Y	0
	Ultramafic	2	6			20	26	0%	Y	2
800-	Acidic sedimentary	120	223	33	199	6162	6617	25%	Y	87
1700'	Acidic shale	2				4	4	0%	-2	2
	Calc/mod calc	32	30	7	28	1725	1790	7%	Y	25
	Coarse sed	2			7	42	49	0%	-2	2
	Fine sed	2			1	1	2	0%	-2	2
	Granitic/mafic	79	69	34	951	3316	4370	16%	Y	45
	Ultramafic	2	18		1	59	78	0%	Y	2
1700-	Acidic sedimentary	38	64	34	233	1769	2100	8%	Y	4
2500'	Calc/mod calc	7	5	2	12	390	409	2%	Y	5
	Coarse sed	2			9	4	13	0%	-2	2
	Granitic/mafic	70	67	56	1807	1918	3848	14%	Y	14
	Ultramafic	2	1	4		22	27	0%	Y	0
2500-	Acidic sedimentary	4	7	13	74	145	239	1%	Y	0
4000'	Calc/mod calc	2			2	11	13	0%	-2	2
	Granitic/mafic	13	12	35	498	187	732	3%	Y	0
	Ultramafic	2	1	3		5	9	0%	Y	0
	Acidic sedimentary	2			5	1	6	0%	-2	2
>4000'	Granitic/mafic	2			2		2	0%	-2	2
Grand Total		499	890	379	4148	21138	26568	100 %	770	200
Total acres			99,583	295,799	398,130	2,043,274	2,837,663			
Average size			361 ac	330 ac	96 ac	96 ac	107 ac			

%Goal = the portfolio goal
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 25 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
S = portfolio sufficiency in finding occurrences. Y = adequate or surplus
N = protection needs for portfolio occurrences

Current Protection Status of Bowl/Ravine Features.

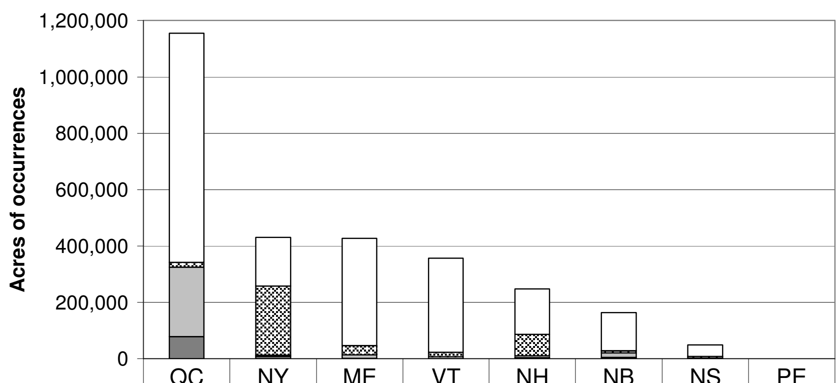
Of the almost 4 million acres of bowl/draw features we identified 13% as critical for protection, accounting for less than 1% of the whole ecoregion. Currently, 76 % of the critical occurrences lie within lands of Gap 1 or 2 protection status although that percentage reduces to 40% when examined across gradients (e.g. some types are overrepresented others underrepresented on present protected lands). Highest protection needs are for features in the 800-1700 ft. elevation zone (Table 5)..

Figure 5. The Number of bowl/ravine features and their portfolio status across all size classes. Legend as for table 5 except DC = PC and DS = PS.



	ME	QC	NY	VT	NB	NH	NS	PE
OU	5094	4181	2261	4376	2839	1864	998	1
DS	22	5	5	4	9	12	37	
DC	385	133	2641	178	130	583	96	
CU	71	480	13	42	328	46	44	
CP	14	246	29	5	107	18	20	

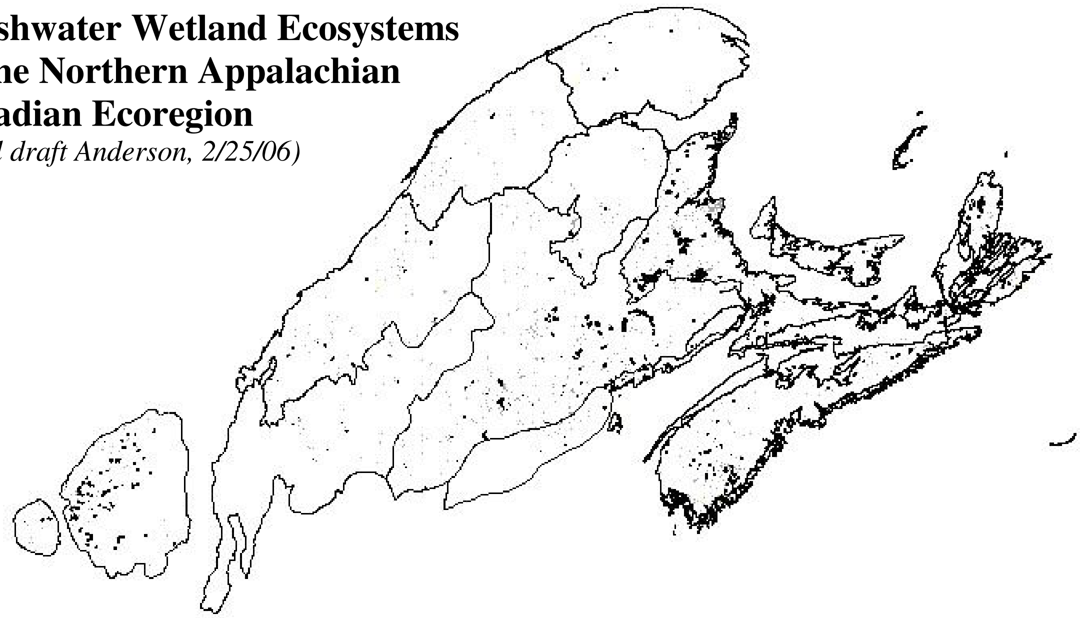
Figure 6. The acres of bowl/ravine features and their portfolio status across all size classes. Legend as for table 5 except DC = PC and DS = PS.



	QC	NY	ME	VT	NH	NB	NS	PE
OU	813,381	172,249	380,722	334,364	160,861	136,138	41,009	30
DS	38	54	148	34	94	116	394	
DC	16,577	245,134	32,301	16,186	75,910	7,209	4,684	
CU	246,320	4,187	13,192	6,677	7,137	15,669	2,560	
CP	79,018	8,772	1,425	92	3,691	5,210	806	

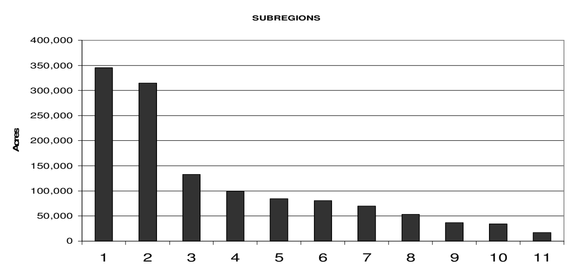
Freshwater Wetland Ecosystems in the Northern Appalachian /Acadian Ecoregion

(final draft Anderson, 2/25/06)



Much of the Northern Appalachian / Acadian region is soggy. Massive holocene glaciers left behind a legacy of deranged drainage patterns forming over a million acres of marshes, mudflats, seeps, swamps and spongy bogs. Wetlands constitute 2 percent of the ecoregion with over 29,000 discrete examples averaging 43 acres in size. They are unevenly distributed across subregions with the easternmost Acadian uplands and the Bras D'Or lowlands having more wetlands than the rest of the subregions combined (Table 1[1]). The largest wetland in the region is over 34,000 acres.

Table 1. The distribution of wetland occurrences by subregion. Chart insert shows the relative acreage by subregion.



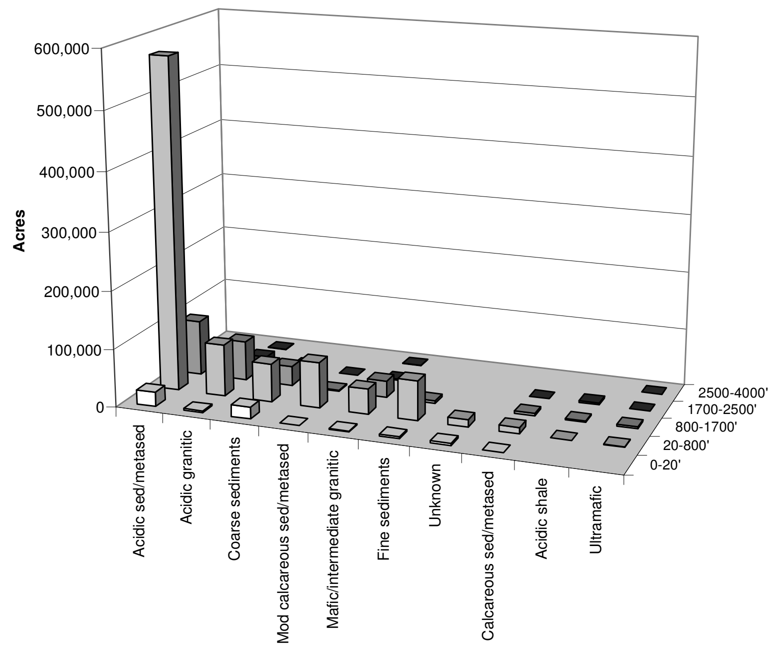
#	SUBREGION	Number of Wetlands	Total Acreage	Average Size	Maximum Size
1	Acadian 'Uplands'	6,790	345,536	51	10,910
2	Northumberland - Bras D'Or 'lowlands'	4,607	314,981	68	34,462
3	Nova Scotia Hills & Drumlins	3,683	132,938	36	2,566
4	Adirondacks & Tug Hill	2,334	99,127	42	1,843
5	Gulf of Maine, Bay of Fundy, Minas Basin	1,490	84,397	57	5,194
6	Estrie-Beauce Plateaus & Hills / St. John Uplands	3,356	80,360	24	2,386
7	Atlantic Coast	1,144	69,619	61	4,922
8	Acadian Highlands	1,467	53,430	36	2,610
9	Green & White Mountains	1,036	36,369	35	1,965
10	Temiscouata Hills - St. John Uplands - North	1,886	33,856	18	2,522
11	Gaspe Peninsula	1,311	16,626	13	1,327
	Grand Total	29,312	1,273,517	43	34,462

[1] Statistics exclude wetlands under 2 acres

Freshwater Wetland Biodiversity:

Individual wetlands occur on all substrate types and across all elevation zones however, they are six time more common at low elevations in acidic sedimentary bedrock than the next most common combination (Figure 1). Protecting examples from across the spectrum of environmental settings is important for conserving biodiversity as the species composition varies with physical factors (Table 2). Special attention was also given to representing all the variation in the common low sedimentary setting.

Figure 1. The distribution of open wetlands across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion. Low elevation wetlands on acidic sedimentary or metasedimentary till are almost 6 times more common than any other type of wetland.



Ecologists recognize about 50 distinct wetland communities in the ecoregion based on species composition and structure. The dominant vegetation structure of the various wetland types tends to be correlated with the degree of permanent saturation and may be conveniently grouped into the broad categories listed below.

Swamp: a seasonally flooded wetland with more woody plants than a marsh and better drainage than a bog. (16 types).
Marsh: a frequently inundated wetland characterized by grassy or reedy (emergent herbaceous) vegetation adapted to saturated soils. (4 types)
Bog: a peat-accumulating wetland with no significant inflows or outflows, dominated by acid tolerant mosses (sphagnum) and characteristic shrubs and herbs. (12 types)
Fen: a peat-accumulating wetland that receives drainage from surrounding mineral soils and supports grassy marsh-like vegetation dominated by sedges. (10 types)
Wet meadow: a grassland with waterlogged soil near the surface but without standing water for most of the year. (1 types)
Other wetlands: seeps, flushes, seepage forest, floodplain, river-scour, pondshore and vernal pool systems – these wetland types are discussed in separate sections on floodplain and riparian ecosystems and small fluctuating wetlands..

Relationships between communities, rare species and the wetland occurrences.

The various types of wetlands develop in slightly different environs. Some are particularly faithful to certain bedrock types while others are tolerant of a broad range of conditions (Table 2 & 3).

Table 2. Relationships between bedrock setting and plants species in open wetlands. Based on 423 US Natural Heritage element occurrence data for the Northern Appalachians

Species Name	Common name	Granitic	Sed/metary	Coarse sed.	Fine sed.	Calcareous / Mod. Calc.	Mafic
Aster nemoralis	Bog Aster	5				1	
Carex exilis	Bog Sedge	3				1	
Splachnum ampullaceum	Splachnum	2					
Carex adusta	Swarthy Sedge	2					
Betula pumila	Swamp Birch	2	11		1	1	1
Carex wiegandii	Wiegand Sedge	1	5			1	2
Juncus stygius	Moor Rush		5				
Hippuris vulgaris	Common Mare's-tail		2	1			1
Lonicera oblongifolia	Swamp Fly-honeysuckle		2				
Nymphaea leibergii	Pygmy Water-lily		2				
Carex tenuiflora	Sparse-flowered Sedge		2				
Scheuchzeria palustris	Pod Grass			2			1
Myriophyllum verticillatum	Whorled Water-milfoil			1			
Rosa nitida	Shining Rose			1			
Subularia aquatica	Water Awlwort			1			
Utricularia minor	Lesser Bladderwort			1			
Utricularia purpurea	Purple Bladderwort			1			
Calamagrostis stricta var. inexpansa	Neglected Reed Bent-grass			1			
Carex arcta	Contracted Sedge			1			
Platanthera blephariglottis	White-fringed Orchis			1			
Solidago purshii	Pursh's Goldenrod				1		
Carex chordorrhiza	Creeping Sedge				1		
Carex recta	Salt-marsh Sedge				2		
Eriophorum gracile	Slender Cotton-grass				1		
Carex oronensis	Orono Sedge					2	
Allium tricoccum	Wild Leek					1	
Oryzopsis canadensis	Canada Mountain-ricegrass					1	
Platanthera flava	Tubercled Orchis					1	
Trillium cernuum	Nodding Trillium				1	2	
Carex haydenii	Cloud Sedge			1			2
Salix pyrifolia	Balsam Willow						1
Senecio pauperculus	Dwarf Ragwort						1
Fimbristylis autumnalis	Fall Fimbry						1
Listera convallarioides	Lily-leaved Twayblade						1
Listera cordata	Heart-leaved Twayblade						1

Table3. Wetland community types occurring within the wetland models and sorted by bedrock settings. Chart shows the proportion of all occurrences that were found in each bedrock class. Based on 423 NHP inventory points

GROUP	COMMON NAME	Granitic	Sedimentary	Coarse sediments	Fine sediments	Mafic	Mod calc.	Calcareous
Swamp	Black spruce swamp	86%	14%					
Swamp	Spruce-fir-tamarack swamp	100%						
Bog	Atlantic white cedar bog	100%						
Bog	Black spruce woodland bog	100%						
Bog	Heath - crowberry maritime slope bog	100%						
Bog	Highbush blueberry bog thicket	100%						
Swamp	Spruce-fir swamp	50%						
Swamp	Red maple-tamarack peat swamp		100%					
Swamp	Hemlock-hardwood swamp		100%					
Swamp	Northern white cedar-balsam fir seepage swamp		50%	50%				
Swamp	Buttonbush swamp			100%				
Swamp	Acidic seepage swamp			100%				
Swamp	Red maple - sensitive fern swamp			100%				
Marsh	Cattail marsh			100%				
Marsh	Deep broadleaf marsh			50%				50%
Marsh	Deep bulrush marsh			50%	50%			
Bog	Moss lawn bog			83%	83%	33%		
Swamp	Calcareous seepage swamp			40%	40%	20%		
Swamp	Acidic northern white cedar swamp					100%		
Bog	Patterned peatland					100%		
Fen	Mixed tall sedge fen				50%		50%	
Fen	Northern white cedar woodland fen	50%						50%
Swamp	Alder shrub swamp	27%	27%	18%	9%	9%		
Swamp	Black spruce - larch swamp	17%	50%		17%		17%	
Fen	Low sedge - buckbean fen lawn		67%	11%			11%	11%
Bog	Eccentric bog ecosystem		40%	7%	13%		40%	
Marsh	Shallow emergent marsh	20%	40%			20%		
Fen	Sweetgale mixed shrub fen	33%	33%	33%				
Bog	Black spruce-tamarack bog	30%	10%	30%		30%		
Swamp	Sweet gale shoreline swamp	20%		40%			20%	20%
Swamp	Red maple-northern white cedar swamp	25%		50%	25%			
Bog	Huckleberry - crowberry bog	33%			33%	33%		
Bog	Coastal plateau bog ecosystem	33%			42%	25%		
Fen	Rich graminoid/shrub fen	33%	17%				17%	33%
Fen	Unpatterned fen ecosystem	5%	33%		14%	19%	24%	5%
Swamp	Northern white cedar swamp	35%	12%	12%		12%	12%	12%
Fen	Medium level fen system	25%	25%	17%	17%		8%	8%
Meadow	Tussock sedge meadow	14%	7%	43%	7%	14%	7%	
Bog	Raised level bog ecosystem	7%	7%	7%	14%	14%	50%	
Fen	Sedge - leatherleaf fen lawn	6%	50%	13%	13%	6%	6%	6%
Bog	Dwarf shrub bog	37%	9%	15%	19%	9%	6%	4%
Fen	Acidic fen	15%	33%	22%	7%	4%	4%	15%
Fen	Patterned fen ecosystem	12%	64%	2%	2%	8%	2%	4%

Further floristic differences between communities are correlated with physiognomy, pH, substrate, climate, elevation and degree of saturation. In the field, detailed discrimination of some wetland types requires a working knowledge of mosses and sedges that often exhibit habitat preferences correspond to water chemistry.

At the scale of the whole ecoregion there is a measurable and predictable separation of types corresponding to the biophysical setting (Figures 2 and 3, Table 2).

Figure 2. Classification tree analysis of 423 ground inventory points illustrating the general relationship between broad wetland type and bedrock setting.Bars that fall equally acrossboth sides of the center point (Bogs and Swanps) show no preference. Floodplains, marshes and meadows are mostly on coarse and fine surficial deposits and moderately calcareous to mafic bedrock (Node 5 left side). Fens are largely found on granite, acidic sedimentary and calcareous bedrock settings (Node 31 right side).

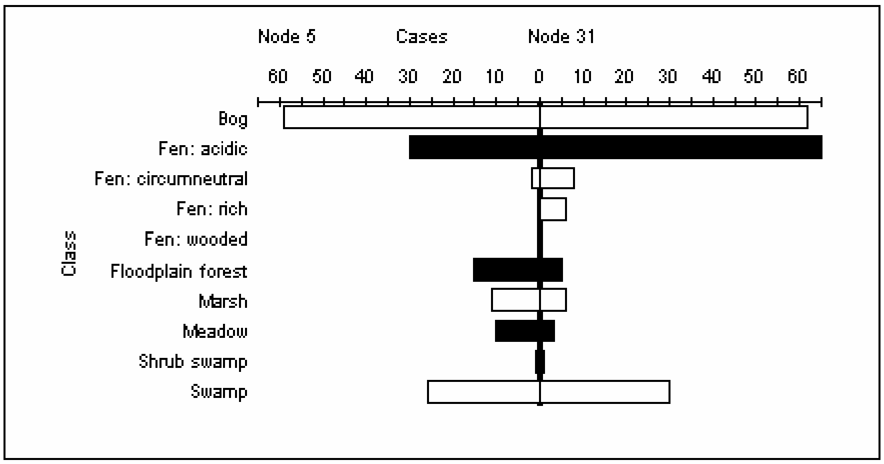
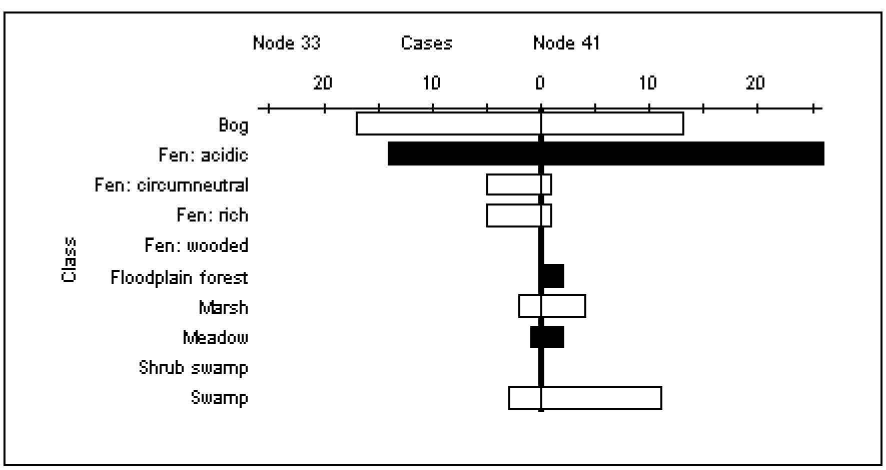


Figure 3. Classification tree analysis of 423 ground inventory points illustrating the relationship between elevation zone and wetland types. Floodplains, marshes, meadows and swamps tend to be at elevations below 800 ft. Node 41(right). Rich and circumneutral fens are mostly at higher elevations. Node 33 (left).



Freshwater Wetland Portfolio Summary

The screening criteria used to locate and identify the wetlands most critical to maintaining biodiversity required that each qualifying example:

- Was large and contiguous: over 50 acres
- Was in good landscape settings (Land Cover Index < 20)
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contained other confirmed biodiversity features (verification by element occurrences)

Many species tracked by the Natural heritage programs and Canadian CDCs were associated with freshwater wetlands (Table 4). The 50 acre size criterion was determined by an analysis of over a thousand survey records for species occurring in wetlands supplemented by a literature analysis of breeding requirements. Of 284 species recorded for these wetlands, one third were found only in wetland occurrences over 50 acres and two thirds had the majority of their occurrences in the larger wetlands (Tables 5 and 6).

Table 4. Species with over 10 tracked breeding populations in the Northern Appalachians and thier relationship to wetland size.. Bars show the proportional distribution of occurrences across wetland size classes. A random distribution would appear as roughly equal amount in class.

Standard name	Common name	2-50 acres	50- 250 acres	250- 1000 acre	1000+ acres	Total
Chlidonias niger	**Black Tern**		20%	25%	55%	20
Calopogon tuberosus	Tuberous Grass-Pink		38%	38%	23%	13
Anas Americana	**American Wigeon**	12%	35%	24%	29%	17
Betula pumila	Swamp Birch	16%	32%	20%	32%	25
Ceratophyllum echinatum	Prickly Hornwort	25%	33%	8%	33%	12
Anas acuta	**Northern Pintail**	8%	17%	33%	42%	12
Schizaea pusilla	Curly-Grass Fern	17%	17%	17%	50%	12
Anas clypeata	Northern Shoveler	9%	27%	9%	55%	11
Lysimachia thyrsiflora	Water Loosestrife	9%	9%	9%	73%	11
Carex chordorrhiza	Creeping Sedge	13%	6%	6%	75%	16
Arethusa bulbosa	Swamp-Pink	19%	38%	38%	6%	16
Platanthera blephariglottis	White-fringed Orchis	29%	25%	39%	7%	21
Geocaulon lividum	Northern Comandra	15%	23%	54%	8%	13
Haliaeetus leucocephalus	**Bald Eagle**	45%	18%	27%	9%	11
Falcipennis canadensis	**Spruce Grouse**	8%	25%	54%	13%	24
Carex wiegandii	Wiegand's Sedge	17%	25%	42%	17%	12
Utricularia geminiscapa	Hidden-Fruited Bladderwort	36%	36%	7%	21%	14
Lophiola aurea	Golden Crest	64%	14%	7%	14%	14
Glyptemys insculpta	**Wood Turtle**	50%	19%	15%	15%	26
Pandion haliaetus	**Osprey**	12%	12%	76%		17
Emys blandingii	**Blanding's Turtle**	58%	17%	25%		12
Sterna hirundo	**Common Tern**	25%	58%		17%	12
Cypripedium reginae	Showy Lady's-Slipper	36%	55%		9%	11
Salix pedicellaris	Bog Willow	18%			82%	11
Rana palustris	**Pickerel frog**	87%	13%			23

Table 5. Species partial to larger wetlands with no occurrences in wetlands under 50 acres. Based on NHP & CDC data for species with >2 occurrences in the wetland models.

Standard Name	Common Name	2-50 acres	50 - 250 acres	250 - 1000 acres	> 1000+ acres	T#
Bromus latiglumis	Broad-Glumed Brome				100%	3
Carex tuckermanii	Tuckerman Sedge				100%	4
Gratiola neglecta	Hedge-Hyssop				100%	5
Laportea canadensis	Wood Nettle				100%	3
Zizania palustris	Indian Wild Rice				100%	3
Polygonum arifolium	Halbrd-Leaf Tearthumb			25%	75%	4
Brasenia schreberi	Watershield			33%	67%	3
Carex rariflora	Loose-Flwd Sedge			33%	67%	3
Drosera filiformis	Thread-Leaf Sundew			33%	67%	9
Eriophorum gracile	Slender Cotton-Grass			33%	67%	3
Euthamia galetorum	Fragrant Goldenrod			33%	67%	3
Lobelia kalmii	Kalm's Lobelia			67%	33%	3
Nehalennia gracilis	**Sphagnum Sprite**			67%	33%	3
Vaccinium boreale	Northern Blueberry			67%	33%	3
Eleocharis tenuis	Slender Spike-Rush			75%	25%	4
Chlidonias niger	**Black Tern**		20%	25%	55%	20
Rallus limicola	**Virginia Rail**		22%	22%	56%	9
Rubus chamaemorus	Cloudberry		22%	44%	33%	9
Bartonia virginica	Yellow Screwstem		25%	25%	50%	4
Coturnicops noveboracensis	**Yellow Rail**		25%	25%	50%	4
Aythya collaris	**Ring-necked Duck**		33%	33%	33%	3
Calidris maritima	**Purple Sandpiper**		33%	33%	33%	3
Nycticorax nycticorax	Blk-crowned Night-heron		33%	33%	33%	3
Calopogon tuberosus	Tuberous Grass-Pink		38%	38%	23%	13
Siphlonisca areodromia	**Tomah Mayfly**		43%	29%	29%	7
Carex diandra	Panicled Sedge		60%	20%	20%	5
Epilobium strictum	Downy Willow-Herb		60%	20%	20%	5
Sphagnum lindbergii	Lindberg's Bog Moss		33%	67%		3
Somatochlora forcipata	**Forcipate Emerald**		67%	33%		3
Triglochin gaspensis	Gaspe arrow-grass		67%	33%		6
Carex arcta	N. Clustered Sedge		17%		83%	6
Botrychium dissectum	Cutleaf Grape-Fern		25%		75%	4
Calidris melanotos	**Pectoral Sandpiper**		33%		67%	3
Fulica americana	**American Coot**		33%		67%	3
Quercus macrocarpa	Bur Oak		33%		67%	3
Symphyotrichum laurentianum	St. Lawrence Aster		33%		67%	3
Rhynchospora fusca	Brown Beakrush		40%		60%	5
Cladium mariscoides	Twig Rush		67%		33%	3
Drosera anglica	English Sundew		67%		33%	3
Lemna trisulca	Star Duckweed		67%		33%	3
Listera convallarioides	Broad-Lvd Twayblade		67%		33%	3
Mergus serrator	**Red-brstd Merganser**		67%		33%	3
Hemidactylium scutatum	**Four-toed Salamander**		100%			3
Listera cordata	Heart-lvd Twayblade		100%			3

Table 6. Species partial to the smaller and medium sized wetlands. Based on NHP & CDC data for species with >2 occurrences in the wetland models.

Standard name	Common name	2-50 acres	50-250 acres	250-1000 acres	1000+ acres
Geum peckii	Mountain Avens	20%	80%		
Phalaropus tricolor	**Wilson's Phalarope**	25%	75%		
Picoides arcticus	**Black-backed Woodpecker**	25%	75%		
Carex lacustris	Lake-Bank Sedge	33%	67%		
Rosa nitida	Shining Rose	33%	67%		
Solidago gigantea	Smooth Goldenrod	33%	67%		
Spergularia canadensis	Canada Sand-Spurry	33%	67%		
Carex vaginata	Sheathed Sedge	40%	60%		
Decodon verticillatus	Hairy Swamp Loosestrife	40%	60%		
Monotropa hypopithys	American Pinesap	50%	50%		
Polygonum hydropiperoides	Mild Water-Pepper	50%	50%		
Stellaria humifusa	Creeping Sandwort	50%	50%		
Woodwardia areolata	Netted Chainfern	50%	50%		
Amerorchis rotundifolia	Round-Leaved Orchis	67%	33%		
Carex salina	Salt-Marsh Sedge	67%	33%		
LAMPSILIS CARIOSA	**Yellow lampmussel**	67%	33%		
Lilium canadense	Canada Lily	67%	33%		
Lycopodiella appressa	Southern Bog Clubmoss	67%	33%		
Salix pellita	Satin Willow	67%	33%		
Synaptomys cooperi	**Southern Bog Lemming**	67%	33%		
Wolffia columbiana	Watermeal	67%	33%		
Desmognathus fuscus	**Northern dusky salamander**	75%	25%		
Allium tricoccum	Wild Leek	80%	20%		
Rana palustris	**Pickerel frog**	87%	13%		
Coreopsis rosea	Rose Coreopsis	100%			
Dichanthelium spretum	Eaton's Witchgrass	100%			
Primula mistassinica	Bird's-Eye Primrose	100%			
Sabatia kennedyana	Plymouth Gentian	100%			

The correlation of many species with larger wetlands suggests these features were more likely to contain a full complement of associated species. Breeding populations of birds such as virginia rail, yellow rail, black-crowned night heron and ring-necked duck were found only in larger wetlands. In contrast to many other ecosystems however several herptiles such as pickerel frog, northern dusky salamander and Blanding's turtle were most abundant in small or medium sized wetland occurrences. Four plants (all coastal plain pond endemics) were restricted to small wetlands. **This pattern highlights a gap in our wetland analysis, namely that it did not encompass drawdown ponds and other small vernal wetland situations**. This needs to be accounted for in later iterations of this assessment.

Results

Our goal was to locate a minimum of **20 examples per 29 bedrock/elevation combination**. This goal of 580 individual occurrences totals to 2 % of all wetlands in the ecoregion or an estimated 11% of all wetlands by area (using the mean size of qualifying wetlands). After examining the distribution of large wetlands (>50acres) we redistributed the goal of 580 across the bedrock/elevation classes in proportion with the number of possible occurrences (Table 7)

Our results identified 568 critical occurrences, 12 less than the number needed to meet our overall minimum goals. We were close to meeting the proportional goals for each bedrock/elevation setting with 17 of the target combinations meeting or surpassing the goal and 13 being below the goal (Table 7). Most of the deficits were in the common types and most of the surpluses were in the more unusual types – a distribution that may be acceptable given the conservation focus on some of the rarer examples.

When measured by area, the critical sites account for 24 percent of all wetlands, more than the expected estimate of 11 % because the critical sites where consistently higher than the average size. The critical occurrences identified total to 226,713 acres of unprotected wetlands (Figure 9).

Defacto Candidate and Supporting Occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed wetlands that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them for context in some of our analyses. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Occurrences, Sites and Goals

Counting wetland occurrences was more straightforward than counting tightly networked or highly clustered ecosystems (e.g. floodplains or steep slopes). We used the numeric goal to hone our focus on the most critical sites, selecting the best from each environmental setting. Our assertion is that if we must protect all wetland biodiversity using only a quarter of the available wetlands then this is the set of sites that will have the greatest influence and the highest chances of success. The methods were designed to insure that conservation is focused on the most functional wetlands in the most intact landscapes possible. That the selected examples were scaled in size to work effectively as coarse filters for all wetland biodiversity and that the occurrences had verification as to quality by one to several sources. The latter step helped guarantee a focus on source habitat.

Table 7. Goals and Distribution for critical wetland occurrences. This table gives detail on the goals we set for locating critical sites and the adequacy of the portfolio in meeting those goals. Legend is shown below the table.

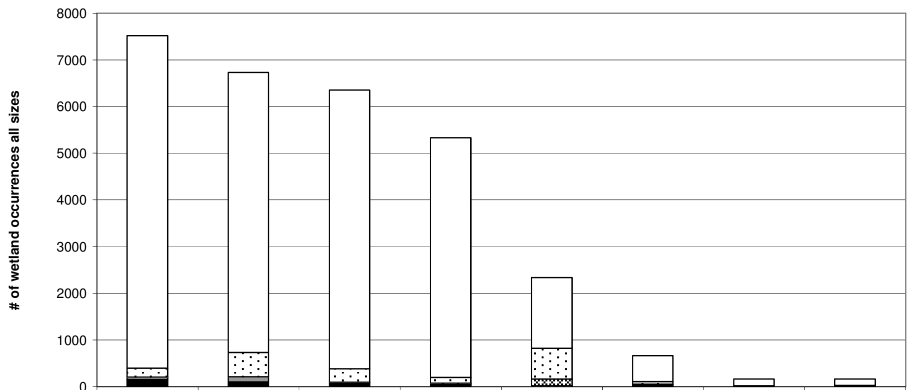
ELEV. ZONE	GEOLOGY	%Goal	CU	CP	PC	PS	OU	T	%	TC	S	D
0-20'	Sedimentary	8	10			1	43	54	0.01	10	Y	2
	Mod Calc	0					1	1	0.00	0	Y	0
	Granitic	1	4	2			4	10	0.00	6	Y	5
	Mafic	1	1				5	6	0.00	1	Y	0
	Coarse sed.	10	5	1		6	57	69	0.02	6	N	-4
	Fine sed.	2	6	2			8	16	0.00	8	Y	6
20-800'	Sedimentary	226	149	74	2	1	1,386	1,612	0.39	223	N	-3
	Calcareous	5	8				30	38	0.01	8	Y	3
	Mod Calc	34	21	4	2	1	217	245	0.06	25	N	-9
	Granitic	49	21	42	5	1	279	348	0.08	63	Y	14
	Mafic	23	20	7	1		138	166	0.04	27	Y	4
	Ultramafic	1	3				2	5	0.00	3	Y	2
	Coarse sed.	43	29	5	1	7	262	304	0.07	34	N	-9
	Fine sed.	28	22	1	3	2	174	202	0.05	23	N	-5
800-1700'	Sedimentary	52	36	6	4		327	373	0.09	42	N	-10
	Shale	1					9	9	0.00	0	N	-1
	Calcareous	3	6			1	12	19	0.00	6	Y	3
	Mod Calc	2	2				9	11	0.00	2	Y	0
	Granitic	35	24	21	44	2	156	247	0.06	45	Y	10
	Mafic	15	7	12	9	1	76	105	0.03	19	Y	4
	Ultramafic	1	1				8	9	0.00	1	Y	0
	Coarse sed.	18	8		28		94	130	0.03	8	N	-10
	Fine sed.	2			1		12	13	0.00	0	N	-2
1700-2500'	Sedimentary	3	1		9		13	23	0.01	1	N	-2
	Shale	2	3	1	1		6	11	0.00	4	Y	2
	Granitic	9	2		34		25	61	0.0cv` x1	2	N	-7
	Mafic	2			5		6	11	0.00	0	N	-2
	Coarse sediments	5			17		17	34	0.01	0	N	-5
2500-4000'	Granitic	0		1			1	2	0.00	1	Y	1
	Mafic	0					2	2	0.00	0	Y	0
	TOTAL	580	389	179	166	23	3,379	4,136	1.00	568		-12

%Goal = the portfolio goal adjusted by the percentage,
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 50 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
TC = the total # of Critical sites (protected + unprotected)
S = portfolio sufficiency in finding occurrences to represent this element
D = the difference between the amount identified for the portfolio and the goal,

Current Protection Levels of Critical Features.

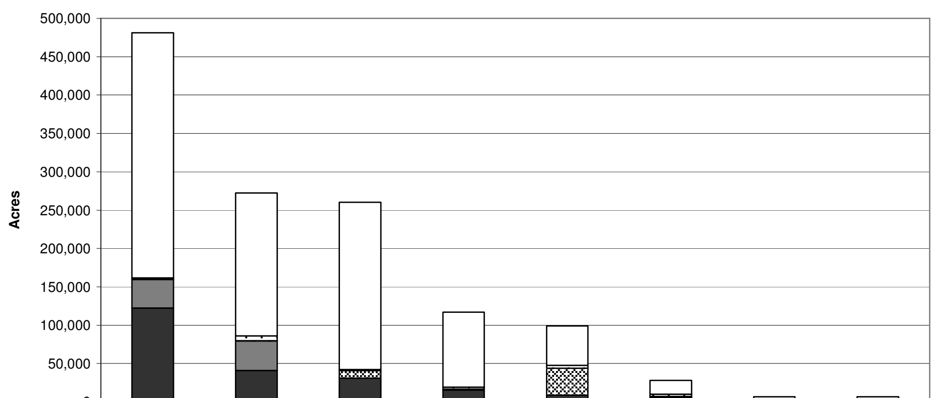
One quarter (26%) of the critical sites are currently protected on reserves with a GAP status of 1 or 2. Another 30% occur on land that is managed as GAP 3 and have restrictions on development (Figure 8). New Brunswick leads the region in number of wetlands and in acreage of protected wetlands.

Figure 8. The number of wetlands and their portfolio status across Provinces and States. Legend as for Table 7 (with slight modification DC = PC, DS = PS).



	NB	NS	QC	ME	NY	PE	NH	VT
O	7119	5998	5971	5134	1513	555	147	137
DS	192	517	290	122	656	51	6	12
DC	2	1		16	145		1	1
CP	53	114	12	2	1	14	1	
C	148	98	82	55	19	41	9	10

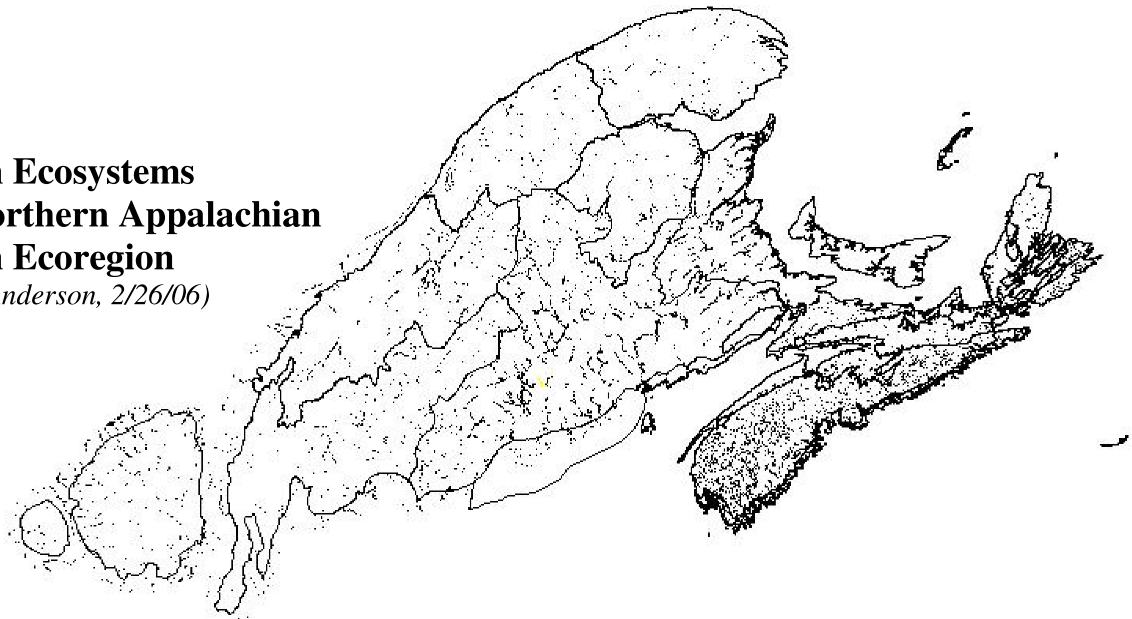
Figure 9. Acreage of all portfolio wetlands by protected status and Province or State. Legend as for Table 7 (with slight modification DC = PC, DS = PS).



	NB	NS	ME	QC	NY	PE	VT	NH
OU	319,615	186,341	218,242	97,643	51,374	18,083	4,110	3,756
DS	1,464	6,296	980	2,402	4,146	2,759	80	110
DC	318	236	10,152		35,048		60	224
CP	37,252	38,544	98	1,388	60	1,594		38
CU	122,360	40,848	30,800	15,304	8,499	5,536	2,517	2,609

Riparian Ecosystems in the Northern Appalachian /Acadian Ecoregion

(final draf Anderson, 2/26/06)



Riversides and floodplains are some of the most dynamic areas of the landscape. During spring runoff, submerged floodplains provide critical feeding and spawning areas for fish and other aquatic species. In drier seasons, the water recedes to reveal a myriad of geomorphic features, each with its own characteristic flora and fauna. Fresh silt deposits, scoured riverbanks, sand bars, alluvial meadows, depression marshes, oxbow lakes, braided stream channels and lush floodplain forests interact to form a complex system rich in biodiversity.

In the Northern Appalachians, intact riparian corridors and floodplains are linear features, averaging about 200 acres with size varying between subregion (Figure 1). About 22, 000 intact, or semi intact, examples occur in the ecoregion, accounting for 3% (2.7 million acres) of the area. Most are found at low to mid elevations on sedimentary till, coarse sands or fine silt deposits (Figure 2)

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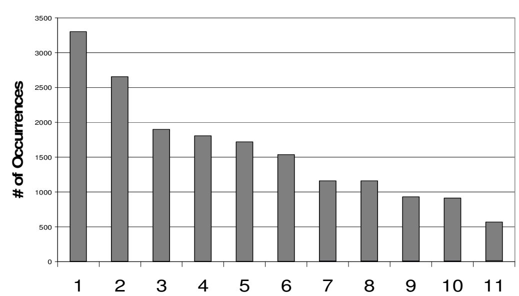
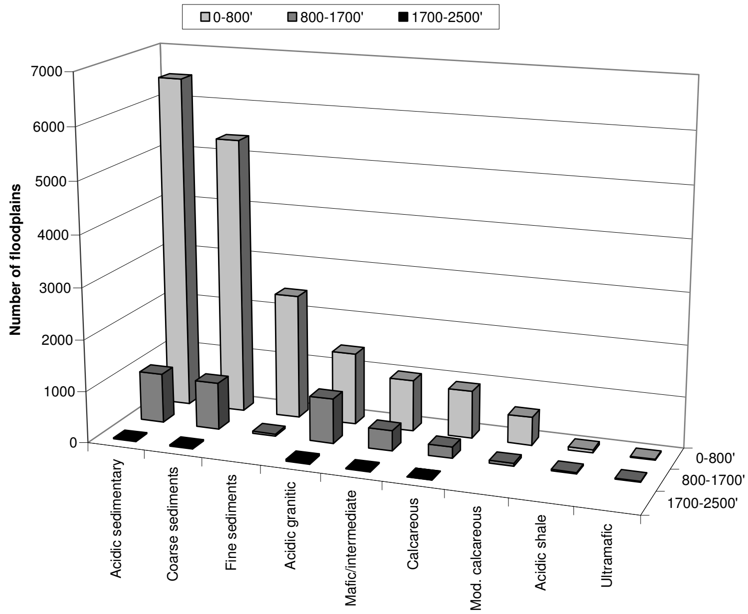
Figure 1. Intact riverside and floodplain systems: mean size by ecological subregion



	ECOLOGICAL SECTION _NAME	Count	Acres	Ave. Size
1	Acadian 'Uplands'	3,305	1,183,111	358
2	Green & White Mountains	2,655	211,640	80
3	Nova Scotia Hills & Drumlins	1,894	958,461	506
4	Gulf of Maine, Bay of Fundy, Minas Basin	1,802	144,844	80
5	Acadian Highlands	1,717	185,802	108
6	Northumberland - Bras D'Or 'lowlands'	1,529	458,694	300
7	Temiscouata Hills - St. John Uplands - North	1,154	124,248	108
8	Adirondacks & Tug Hill	1,152	176,929	154
9	Estrie-Beauce Plateaus & Hills/St. John Uplands	921	290,304	315
10	Gaspe Peninsula	903	93,131	103
11	Atlantic Coast	555	136,046	245
	Grand Total	21,834	4,382,458	201

Figure 2. The distribution of intact riverside and floodplain systems across elevation and bedrock gradients in the Northern Appalachian / Acadian ecoregion.



Floodplain and Riparian Biodiversity

Ecologists recognize a variety of community types associated with features created by riparian process. These are briefly described below (adapted from Basquill 2004, Anderson 1999).

Floodplain Forest: Forests dominated by flood tolerant trees such as Silver maple, Green Ash, American Elm and Box elder. These species rely on open exposed soil and silt deposition for regeneration. The constantly reworked soils create ideal conditions for many natives ferns and herbs, such as ostrich fern, sensitive fern, wood nettle, tall meadow rue, jack-in-the-pulpit, riverbank grape and poison ivy, but exotic species such as Japanese knotweed and moneywort also thrive under these conditions. Floodplain forests are strongly associated with coarse sediments and sandy outwash (40%), but may be found on almost any bedrock type: moderately calcareous (14%) acidic sedimentary (13%), Fine sediment (10%) mafic or granitic (9% each), calcareous (4%)

Riverside mud, sand and cobble barrens: Scraped river-shores may develop distinct, sparsely-vegetated communities with a floristic composition corresponding to sediment size. Spike rush, water purslane and false pimpernel are common on muddy shores of slow moving rivers. Sand and gravel bars tend to be colonized by Indian hemp and sandbar willow. Twisted sedge is very characteristic of cobble bars. These communities are associated with coarse sediment and, to a lesser extent, till derived from acidic sedimentary rocks.

Riverside Grasslands: Where shorelines are sheltered, beautiful open grasslands of reed canary grass, bluejoint grass, big bluestem and other tall grasses may develop. These are often associated with calcareous, moderately calcareous or sedimentary bedrock.

Riverside seeps: Particularly notable in calcareous limestones, these tiny communities form in permeable bedrock where cold springs and seepage forms a rare microhabitat. Pumpkin sedge, Kalm's lobelia, and grass of parnassus are diagnostic of this setting.

Alluvial marshes, sedge fens and shrub thickets: In regions of permanent saturation, such as oxbows or depression ponds, persistent scruffy marshes of reedy emergents and flood tolerant shrubs may develop. Depending on the microtopography, these may be dominated by a single species or they may form a structural complex of herbaceous emergents, shrub thickets and wet sedge meadows. Most are associated with coarse sediment settings.

Riverside outcrops & erosional river bluffs: Waterfalls, gorges and bedrock outcrops along major rivers tend to develop communities described under the steep slope section. Herbs and vines that root on the vertical outcrops, particularly those of a calcareous nature include harebell, wild red columbine, fringed loosestrife, Canada anemone, virgins bower and spreading dogbane. Commonly found in areas with resistant granitic bedrock, the types in calcareous settings are a unique rare community.

Relationships between communities, rare species and floodplain occurrences.

The fine scale community types co-occur and intertwine within an individual stretch of floodplain (Table 1). In the modeled occurrences developed for this assessment, there was a meaningful association between community composition and sediment type. Riparian reaches in calcareous soil tend to contain riverside grasslands, seeps and rare sedges. Floodplains in fine sediment had extensive freshwater, fresh tidal and saltwater marshes. Most of the tracked least bittern and sora breeding populations were found in the latter setting (Table 2).

Floodplain forests were most abundant (40% of all occurrences) in coarse sediment where they formed mosaics of seepage swamps, buttonbush swamps, alluvial thickets, cattail marshes, acidic fens and barrens of sand, gravel or mud. These examples harbored fowler's toad and several best known heron rookeries. Riparian areas in acidic sedimentary till also contained floodplain forests as well as riverside seeps, river beach and shoreline outcrop communities and species such as the declining wood turtle or rare furbish lousewort. Riversides in granitic settings had stagnant basin marshes and bogs as well as high energy riverbank communities like ice meadows and river-scour grasslands.

To ensure that the full diversity of riparian communities and species were represented in our portfolio, we set our conservation goals to represent examples of each bedrock-elevation combination.

Table 1. Communities with multiple occurrences within the floodplains and riparian models. The column titled "# Occ" is the amount of US Natural heritage program occurrences within the riparian setting.. Floodplain forest, riverside and shoreline communities and reptiles all had over 50% of their occurrences for the ecoregion in floodplain settings.

Group	Common or State name	#Occ.
Floodplain forest	Hardwood floodplain forest	21
	Silver maple floodplain forest	18
	Hardwood river terrace forest	10
	Silver maple-ostrich fern riverine floodplain forest	10
	Sugar maple-ostrich fern riverine floodplain forest	10
	NNE or SNE floodplain forest	11
	NNE Lake sediment terrace forest	4
	Silver maple-sensitive fern riverine floodplain forest	3
Riverside	Circumneutral riverside seep	20
	Calcareous riverside seep	8
	Acidic riverside seep	8
	Laurentian River Beach	8
	NNE high-energy riverbank community	7
	Rivershore outcrop	19
	Circumneutral shoreline outcrop	8
Swamp	Northern white cedar swamp	24
	Black spruce or spruce fir swamp	8
	Sweet gale shoreline swamp	5
	Red maple-northern white cedar swamp	4
	Red maple - sensitive fern swamp	3
	Shrub swamp	3
Meadow	Bluejoint meadow, graminoid swale, sedge meadow	18
Marsh	Deep emergent marsh or seepage marsh	6
Fen: circumneutral	Intermediate fen	6
Fen: acidic	Unpatterned Fens and small acidic fens	13
	Patterned fen ecosystem	4
Bog	Dwarf Shrub Bog & raised bog systems	18

Table 2. Reptiles, birds, mussels, insects and plants strongly associated with riparian systems and their adjacent waters (measured as the number of tracked occurrence points contained in the modeled occurrences).

Standard Name	Common name		#Occ.
Clemmys insculpta	Wood turtle	Reptile	76
Pandion haliaetus	Osprey	Bird	23
Gavia immer	Common Loon	Bird	16
Circus cyaneus	Northern Harrier	Bird	9
Haliaeetus leucocephalus	Bald Eagle	Bird	6
Podilymbus podiceps	Pied-billed Grebe	Bird	5
Aythya collaris	Ring-necked Duck	Bird	4
Ardea herodias	Great Blue Heron	Bird	3
Alasmidonta varicosa	Brook floater	Mussel	75
Lampsilis cariosa	Yellow lampmussel	Mussel	41
Leptodea ochracea	Mussel	Mussel	13
Margaritifera margaritifera	Eastern Pearlshell	Mussel	8
Alasmidonta heterodon	Dwarf Wedge Mussel	Mussel	7
Ophiogomphus anomalus	Extra-striped snaketail	Insect	35
Ophiogomphus howei	Pygmy snaketail	Insect	13
Siphlonisca aerodromia	Tomah mayfly	Insect	13
Calopteryx amata	Superb jewelwing	Insect	5
Cicindela ancocisconensis	Boulder-beach Tiger Beetle	Insect	3
Cicindela marginipennis	Cobblestone Tiger Beetle	Insect	3
Trisetum melicoides	Purple False Oats	Monocots	26
Carex oronensis	Orono Sedge	Monocots	24
Carex garberi	Garber's Sedge	Monocots	22
Muhlenbergia richardsonis	Soft-leaf Muhly	Monocots	17
Carex sterilis	Dioecious Sedge	Monocots	15
Listera auriculata	Auricled Twayblade	Monocots	14
Phleum alpinum	Mountain Timothy	Monocots	12
Allium canadense	Wild Garlic	Monocots	10
Carex atratiformis	Black Sedge	Monocots	10
Primula mistassinica	Bird's-eye Primrose	Dicots	44
Parnassia glauca	Grass-of-parnassus	Dicots	37
Pedicularis furbishiae	Furbish's Lousewort	Dicots	37
Prenanthes racemosa	Glaucous Rattlesnake Root	Dicots	29
Hedysarum alpinum	Alpine Sweet-broom	Dicots	25
Castilleja septentrionalis	Northern Painted Cup	Dicots	24
Astragalus alpinus	Alpine Milk-vetch	Dicots	23
Tanacetum bipinnatum	Huron Tansy	Dicots	20
Viola novae-angliae	New England Violet	Dicots	15
Houstonia longifolia	Long-leaved Bluet	Dicots	14
Hippuris vulgaris	Common Mare's-tail	Dicots	11
Podostemum ceratophyllum	Threadfoot	Dicots	11
Erigeron hyssopifolius	Hyssop-leaved Fleabane	Dicots	10

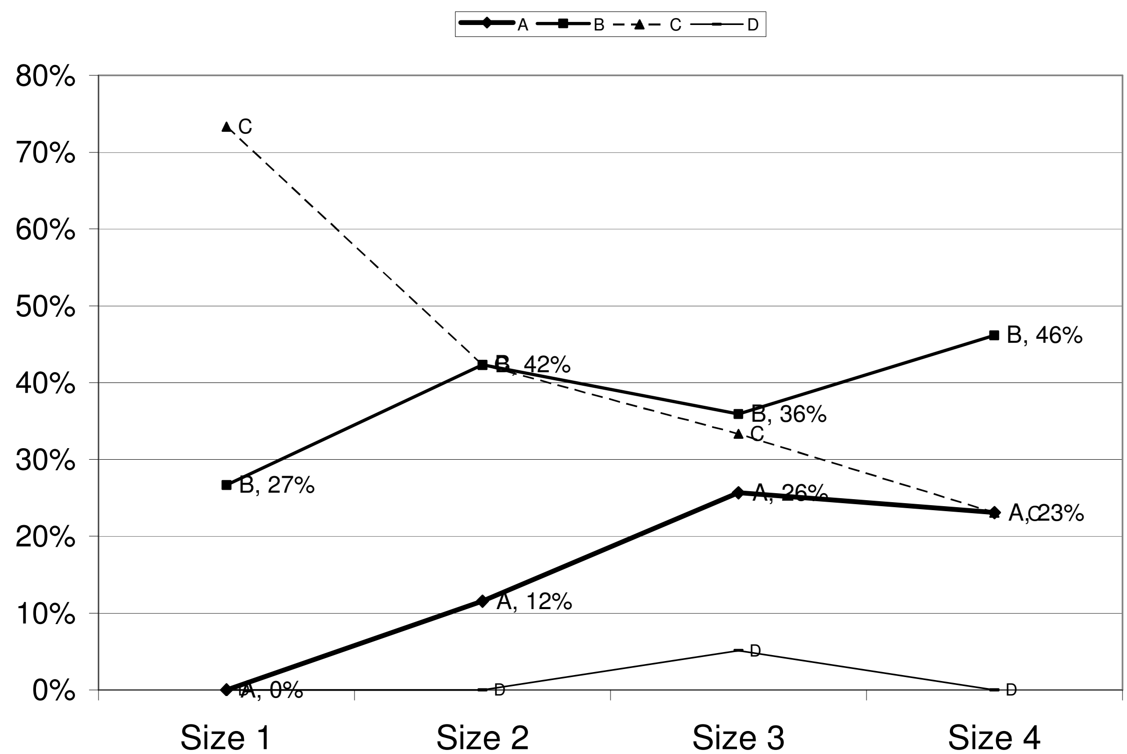
Floodplain and Riverside Portfolio Summary

The screening criteria used to locate and identify the riparian systems most critical to maintaining biodiversity required that each qualifying example:

- Was large and contiguous: over 100 acres
- Was in good landscape settings (Land Cover Index < 20)
- Was in good condition based on ground surveys and expert opinion (corroboration by at least one source, A or B quality ranks in US)
- Contained other confirmed biodiversity features (verification by element occurrences)

Size criteria were determined by an analysis of almost two thousand survey records for species and communities occurring on floodplain and riverside settings. Interestingly, size was not related to the likelihood of finding associated species as with other patch forming communities (e.g. summits, basin wetlands, etc.) probably because of the linear shape of riparian features. However, high quality examples, ranked A or B in the inventory data, of riparian communities were associated with modeled occurrences over 100 acres in size. None of the modeled occurrences under 100 acres had A-ranked communities in them. (Figure 3)

Figure 3. Relationship of floodplain forest quality rank (A,B,C or D) and modeled occurrence size category. "A" quality occurrences increase and "C" quality occurrences decrease with size. A similar trend is apparent for all riverside related communities. (data from US Heritage programs). Size categories: 1 = 0-100 acres, 2 = 100-1000 acres, 3 /4 = >1000 acres



Results

Floodplains are a large patch, linear ecosystem. Our goal was to identify a **minimum of 10 exemplary examples per each of 29 bedrock/elevation combination**. This totals to 290 occurrences distributed across the ecoregion. After examining the distribution of larger (>100 acre) floodplains occurrences we redistributed the 10-per-type numeric goal across the geology/elevation gradients in proportion with the number of possible occurrences acres (Table 3).

In all we identified 240 critical occurrences, 55 less than we needed to meet our total goal. We were slightly below our goals for most bedrock/elevation combinations with the highest deficiencies being in low elevation (20-800') coarse sediment environs where most of the floodplain forests occur (Table 3). Most of the deficient environments had candidate occurrence to evaluate and new critical one may come from that pool.

Candidate and Supporting occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable or poorly surveyed riparian ecosystems that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them for context in some of our analyses. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Sites and occurrences

The boundaries for the floodplain modeled occurrences are more approximate when compared to many other ecosystem types. This fuzziness stems from the interconnected network-like nature of floodplain systems that do not typically have clear natural breaks between examples. Although adequate for the analyses done at the ecoregional scale, more precise boundaries will likely need to be delineated by conservationists as part of the protection work on these floodplain and riparian ecosystems.

Table 3: Portfolio Summary based on all intact floodplain occurrences. Legend below.

ELEVZONE	GEOLOGY	Goal	CU	CP	PC	PS	OU	T	%	D
0-20'	Sedimentary	1			1		6	7	0%	-1
	Sedimentary	4				3	47	50	1%	-4
	Calcareous	1					1	1	0%	-1
	Coarse sed.	3	3			1	32	36	1%	0
	Fine sed.	2					32	32	1%	-2
	Mafic	1					7	7	0%	-1
	Mod calcareous	1					2	2	0%	-1
20-800'	Granitic	19	13	1	21	1	228	264	7%	-5
	Sedimentary	102	70	7	79	4	1239	1399	35%	-25
	Shale	0					2	2	0%	0
	Calcareous	10	9	3	1		124	137	3%	2
	Coarse sed.	44	27		3	1	571	602	15%	-17
	Fine sed.	20	17		1		257	275	7%	-3
	Mafic	19	16		28		224	268	7%	-3
	Mod calcareous	8	10		1	1	105	117	3%	2
	Ultramafic	1					6	6	0%	-1
800-1700'	Granitic	13	8	3	41	3	123	178	4%	-2
	Sedimentary	19	14	1	23	2	216	256	6%	-4
	Shale	0					1	1	0%	0
	Calcareous	2	3		3		15	21	1%	1
	Coarse sed.	14	19	2	22		153	196	5%	7
	Fine sed.	1	5				5	10	0%	4
	Mafic	6	4		11		69	84	2%	-2
	Mod calcareous	1	1				3	4	0%	0
	Ultramafic	1					4	4	0%	-1
1700-2500'	Granitic	1		2	5		9	16	0%	1
	Sedimentary	1					6	6	0%	-1
	Coarse sed.	1		2	1		5	8	0%	1
	Mafic	1			3		3	6	0%	-1
Grand Total		295	219	21	244	16	3495	3995	100%	-55

%Goal = the portfolio goal
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences larger than 25 acres,
% = percent of the total occurrences in this bedrock/elevation combination,
TC = total critical occurrences (unprotected + protected)
D = the difference between the amount identified for the portfolio and the goal,

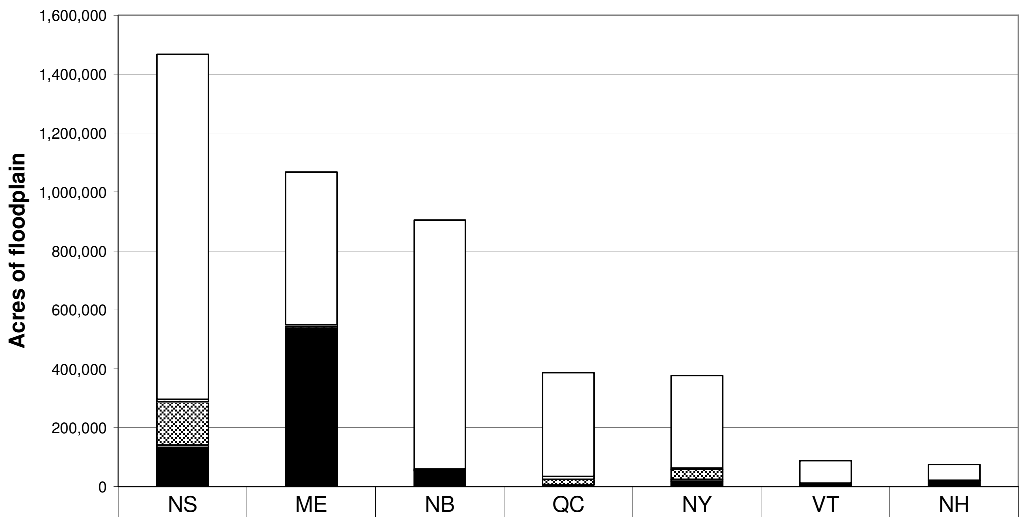
Current Protection Levels of Critical Features.

Critical floodplain and riparian occurrences amount to 3% by count and 18% by acreage of all the floodplain features in the ecoregion – thus amounting to roughly one half percent of the entire region by acreage (Table 4). Currently 27,000 acres are on lands protected for biodiversity leaving 776,951 acres remaining for active protection efforts.

Table 4. Overall floodplain & riparian portfolio protection levels by acreage and by count.

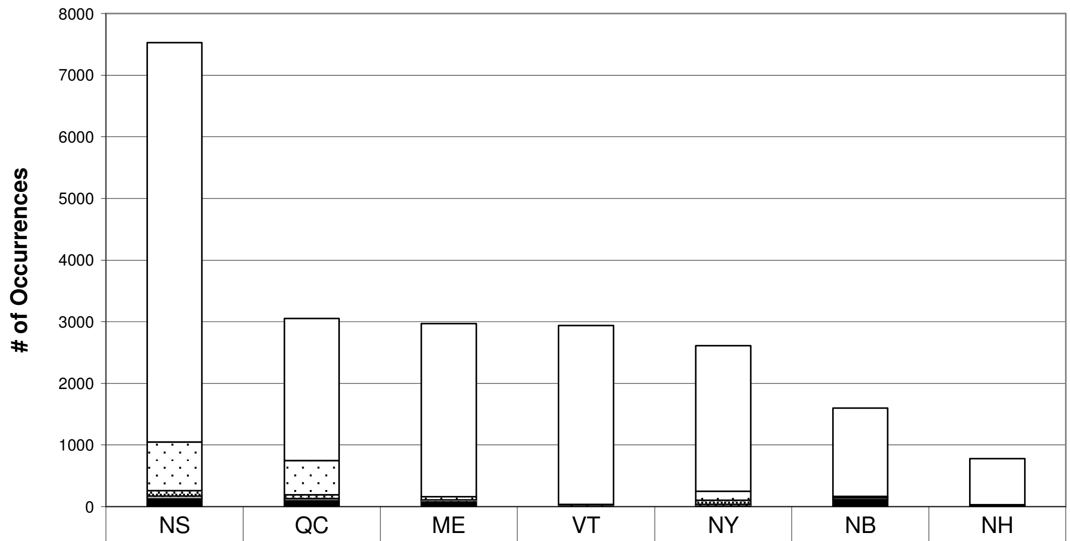
	CU	CP	PC	PS	OU	T
Acres	776,951	26,502	211,605	24,347	3,343,053	4,382,458
%acres	18%	1%	5%	1%	76%	100%
Count	502	152	244	1,573	19,363	21,834
%count	2%	1%	1%	7%	89%	100%

Figure 5.Protection levels of critical and defacto floodplain occurrences. Chart shows ***total acreage*** *by state or province. Legend as for Table 3(with modification PC = DC and PS = DS).*



	NS	ME	NB	QC	NY	VT	NH
OU	1,170,567	517,222	845,222	353,171	313,813	75,565	53,533
DS	8,608	926	446	8,827	4,512	636	148
DC	146,362	7,781	4,659	19,624	32,843		
CP	10,207	5,673	1,188	452	7,620		298
CU	131,666	535,718	53,304	5,375	18,042	11,482	21,356

Figure 6.Protection levels of critical and defacto floodplain occurrences. Chart shows ***total number*** *by state or province. Legend as for Table 3(with modification PC = DC and PS = DS).*



	NS	QC	ME	VT	NY	NB	NH
OU	6479	2303	2812	2901	2362	1430	750
DS	789	557	51	10	145	14	3
DC	89	60	13		73	8	
CP	47	38	5		8	33	1
CU	124	93	92	26	26	112	28

Sites: Site lists are found in Appendix A

Coastal Shores and Wetland Ecosystems in the Northern Appalachian / Acadian Ecoregion

(final draft Anderson 3/31/06)

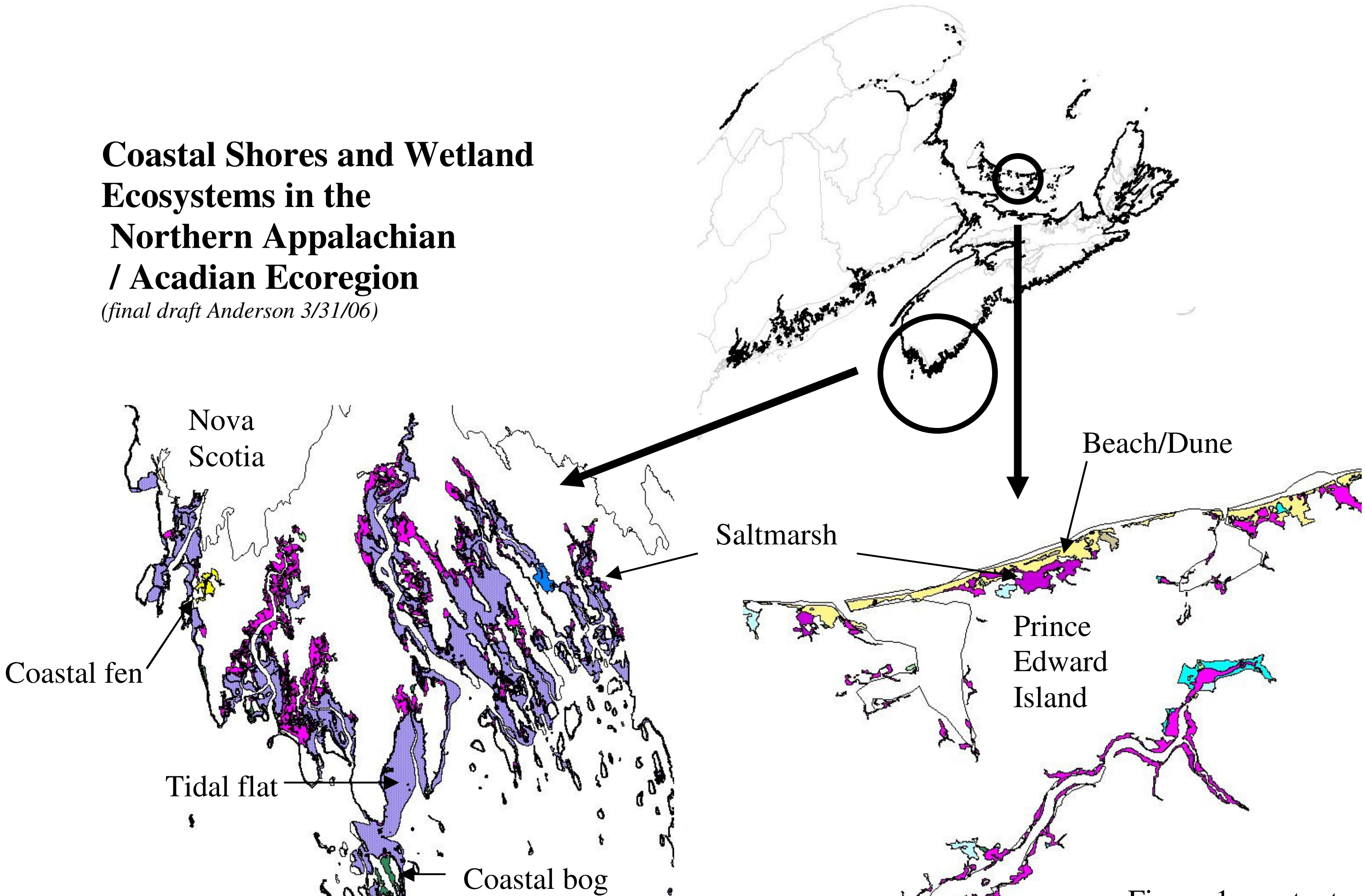


Figure 1. see text

The coastline of the Northern Appalachian /Acadian ecoregion extends for 7,453 miles[1] and is rich with almost 24,000 examples of beaches, salt marshes, tidal flats and distinctive rocky shores. Although coastal wetlands and shores cover less than 1% of the ecoregion (926,664 acres -Table 1) they are one of the most critical habitats in the region for biodiversity. Their importance to rare species, shore birds, and offshore fisheries is well known but population trends and conservation needs of the thousands of specialized organisms, (crabs, shellfish, amphipods and other macro/micro invertebrates) are not clearly understood.

The distribution of coastal features within the ecoregion is correlated with shoreline orientation, exposure and complexity and tidal range. The complicated south-facing shorelines of Maine and Nova Scotia have extensive tidal flats and salt marshes tucked into nearly every cove and harbor (Figure 1). In contrast, the simpler shorelines that flank the Bay of Fundy have fewer examples of these features but terminate with massive tidal flats in the Cobequid Bay and Minas Basin region reflecting a tidal range that is the largest in the world. The east facing shores of New Brunswick and PEI have extensive barrier beaches and dunes while Quebec's beaches and dunes are almost entirely located on the Magdalen Islands. (Table 1, Figure 2).

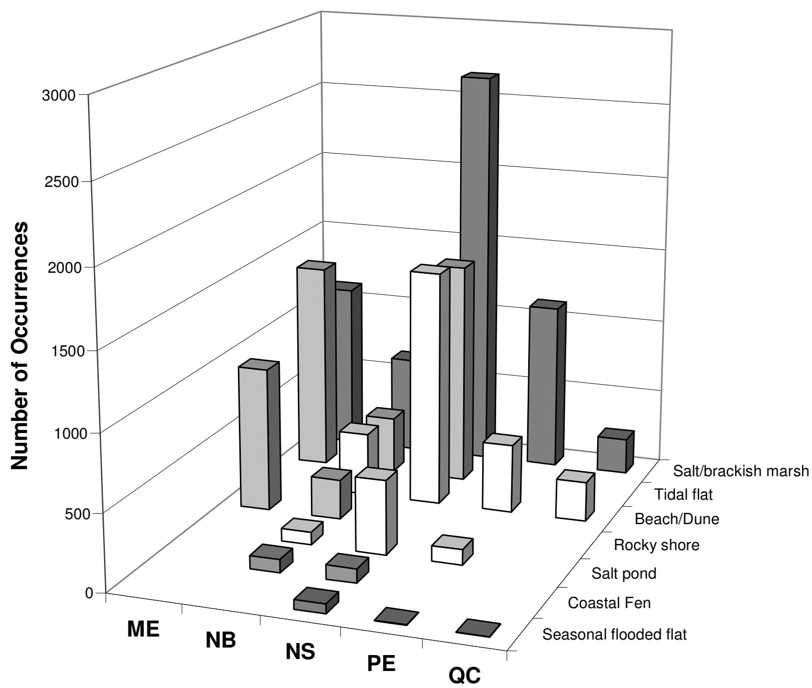
[1] Including the coastline of Prince Edward Island and the Magdalen Islands

Table 1. The amount and size of coastal features within the ecoregion (features under 2 acres are excluded).

Coastal Features	Count	Total Acres	Ave. Size	Min	Max	AV ME	AV NB	AV NS	AV PE	AV QC
Coastal Shores										
Beach/Dune	2,745	47,992	17	0.1	1,095		24	10	19	48
Rocky Shore & Cliff	1,892	15,718	25	0.0	407	3	21	18		
Coastal Wetlands										
Coastal Bog	706	51,513	73	0.1	5,077	?	220	48	58	57
Salt pond	674	16,016	24	0.1	715		31	23	23	
Salt/brackish marsh	6,818	138,384	20	0.0	4,427	6	38	16	15	143
Misc. fresh wetlands	3,409	34,534	101	0.0	749	6	40	67	5	2
Tidal flat	4,039	596,898	148	0.0	49,404	25	114	329		
Aquatic bed	3,469	25,330	7	0.1	205	7	29			
Grand Total	23,950	926,644	39	0.0	49,404	9	52	77	15	90

(Final numbers are in D/NAP/targets/models/90m/coastal/wetnap_cst705.xls
It contains integrated USCANADA data as well as US and Canada separate columns)

Figure 1. The distribution of coastal features by state and province.



Biodiversity and Coastal features

The coastal zone extends landward from the submerged aquatic beds just beyond the low tide line to the terrestrial margin where headlands, cliffs and dunes are found. The latter zone is marked by a definite change in material, physiographic form or a line of permanent vegetation, indicating the limit of the highest storm waves. Ecologists group the coastal shore and wetland features into a number of broadly defined ecosystem types based on structure, processes and composition as described below.

Coastal Shores

Headlands, Cliffs and Rocky shores: The rockbound coast of the ecoregion consists of bedrock shores punctuated by sandy interludes of beaches and dunes. Headlands with steep cliff faces jutting out into the sea are common. Subject to salt spray and wave pounding, headlands can be dramatic features while the related horizontal intertidal zone is the haven of algae, barnacles, snails and limpets. Coastal cliffs and isolated rocky islands are the preferred nesting habitat of black guillemot, black-legged kittiwake, razorbill and common murre. The lower shore zone subject to long periods of tidal inundation forms the habitat of rockweeds and brown seaweeds, mussels and Irish moss.

Mapped examples of rocky shores and cliffs total to 904 miles of linear shoreline. Occurring in almost 2,000 distinct narrow segments averaging 25 acres in area, rocky shoreline is most abundant in areas of granite or mafic bedrock but may be found throughout the coastal region.

Unconsolidated Beach and Dune Complexes: - Beaches are thick accumulations of unconsolidated water-borne, well-sorted sand and pebbles deposited on a shore, or in active transit along it. Dunes are transient mounds of loose, windblown sand, sometimes stabilized with vegetation. Beaches and dunes are ecologically linked but form distinct habitats, the former being periodically inundated and the latter dry and distinguished by vegetation adapted to constant sand burial. Typical plant species of beaches and dunes include: beach grass, sea rocket, sea-beach sandwort, seaside spurge, dusty miller, sea oats, seaside goldenrod, beach heather and bayberry. Although several of these species have wide ranges along the Atlantic coast they are otherwise narrowly restricted to this extremely specific and uncommon habitat. Beach nesting birds such as plovers and terns rely on exposed scrapes and isolation to prevent predation by mammals and other birds. Many are in decline due to loss of breeding habitat.

Beaches cover almost 2249 miles of coast, although contiguous examples are small with two-thirds of the 2745 beach/dune occurrences being less than 10 acres in extent and 82% covering less than 20 acres. In several places, elongate barrier beaches have formed that parallel the shoreline but remain separated from it by a lagoon or marsh. Hog Island, a 1,100 acre barrier beach of Prince Edward Island boasts piping plovers, common terns, beach pinweed and broom crowberry, and is the largest example in the ecoregion.

Coastal Wetlands and Marshes

Tidal flat – Tidal flats are extensive, horizontal tracts of unconsolidated clays, silts, sands and organic materials that are alternately covered and uncovered by the tide. Most are sparsely vegetated but during low tide, shorebirds congregate in tidal flats, sometimes in vast numbers, to feast on their abundant burrowing invertebrates. Tidal flats make up 64% of the coastal wetlands mapped in the ecoregion. The largest example, 49,000 acres in the Minas Basin, is a huge and globally significant stopover site for migratory shore birds

Salt and Brackish marsh – Like tidal flats, salt marshes are flat, poorly drained areas subject to periodic inundation by salt water but salt marshes are covered with a thick mat of grassy salt-tolerant plants. These marshes may be further classified into saline marshes and brackish marshes depending on the salinity of the overwash water. Here they are treated as one system because our mapping units could not reliably separate the two. Brackish marshes typically occur in areas where there is a mixing between fresh and salt water such as at the mouth of a large river. .

Salt and brackish marshes are important to many of our rarest birds such as the salt marsh sparrow and willet. Specialized vegetation, exemplified by the dominant spartina grasses, have evolved mechanisms to resist desiccation and maintain salt balance in this extreme setting. Rare or declining plant species include seaside dock, saltmarsh sedge, seashore saltgrass, creeping alkali grass, American sea-blite, and small spikerush.

There are over 6000 discrete salt and brackish marshes in the region ranging in size from 1 to 4000 acres. They occur in all parts of the coastline and amount to 140,000 acres in total. One of the largest (2,288 acres) occurs in the John Lusbie National Wildlife area in Cobequid Bay and is recognized as a globally significant bird area.

Salt pond – Salt ponds are bodies of salt water in a marsh or swamp along the seacoast. They often have distinct shoreline vegetation such as seaside flatsedge and seaside crowfoot.

Tidal marsh – Tidal marsh is a broad term used in this report to encompass both marshes and tidal flats. It refers to any extensive level marsh or flat regularly inundated by high tides.

Coastal Bog – Cool maritime conditions favors the development of extensive bogs and fens in the coastal zone. Much like their inland counterparts these are areas of waterlogged, spongy ground, consisting primarily of mosses, containing acidic, decaying vegetation, such as sphagnum or sedges, which may develop into peat. Coastal bogs tend to be dominated by species such as broom crowberry and cottongrass that are minor components of inland systems. A number of rare orchids and carnivorous plants are found in this environment.

Coastal Zone and Important Bird Areas.

The unique importance of coastal shores, marshes, offshore waters or isolated islands to shorebirds has long been recognized. Many places in the ecoregion have been ranked globally and/or nationally significant for shorebird or seabird concentrations and threatened species. Some of the most important include:

- Northeast Coastal Maine (ME)
- Country Island Complex (NS)
- Sable Island (NS)
- Eastern Cape Sable Island (NS)
- Cobequid Bay (NS
- Malpeque Bay (PEI)
- Southern Bight, Minas Basin (NS)
- Brier Island (NS)
- PEI National Park (PEI)
- Iles-de-la-Madeleine (QU)

Coastal Shore and Wetland Portfolio Summary

The screening criteria used to locate and identify coastal shore and wetland features most critical to maintaining biodiversity required that each qualifying occurrence:

- Was contiguous and met size criteria:
  - Salt/Brackish marsh over 50 acres or part of a complex over 100 acres
  - Beach/dune over 20 acres
  - Coastal bogs over 75 acres
  - Tidal flats over 100 acres or part of a larger complex
  - Rocky shores and cliffs that were 2 acres minimum and part of a complex including some of the above features
- Were in good landscape settings (Land Cover Index < 30)
- Were in good condition based on ground surveys and expert opinion (corroboration by at least one source)
- Contain other confirmed biodiversity features (element occurrences)

Size criteria for the respective systems were determined by a literature analysis of minimum area requirements for the characteristic breeding species as well as information on the scale of specific disturbances (Tables 2 and 3, Figure 2). Additionally, we examined survey records for species and communities with documented occurrences in Northern Appalachian / Acadian coastal wetland complexes (Figures3-5).

We used different minimum size criteria for different features. For salt marshes both the literature and evidence from ground surveys suggested that occurrences over 50 acres were more likely to contain rare plant and bird species than smaller examples (Figures 2 and 3). For beach/dune ecosystems the evidence suggested that 20 acres was adequate to ensure that the occurrence could serve as a coarse filter for characteristic beach breeding species such as piping plover (Figure 4). Similarly intertidal flats of 100 acres of greater appear to be adequate in size to serve the needs of many typical species (Figure 5).

Unlike the literature analysis, the patterns derived form the inventory data are correlative and do not imply cause. Additionally, our method of examining size relationships tended to underestimate the size of the whole wetland. For example a tidal marsh dissected by a tidal creek may be registered in our analysis as two discrete occurrences on either side of the creek. A breeding species occurring on one side will be associated only with the size of that half. To get around this limitation we developed a map of coastal complexes based on physical features that unified marsh, tidal flat, beach and salt ponds into a single wetland complex. When the size of the complex is examined relative to associated species the data suggest that many species prefer larger complexes and that those sizes are greater than the minimums derived from each feature individually (Figure 5).

We adjusted our selection criteria to take into account the size of the entire wetland complex as well as the sizes of the individual occurrences within the complex. This allowed some smaller features to be included in the portfolio if they were part of a large wetland mosaic.

Table 2. Birds that appeared to favor small coastal features were species that breed on rocky coastal islands and cliffs or unusual winter sightings. Data are based on USHP and Canadian CDC occurrences but many of these species are not thoroughly or consistently tracked by their respective programs. Only species with 3 or more observations and high level of locational precision are shown.

Common name	Habitat	Average Features size (acres)	Average Size of the wetland complex (acre)
Black Guillemot	rocky cliffs on coastal shores/islands	25	42
Razorbill	coastal islands	23	23
Leach's Storm-Petrel	coastal islands	8	18
Atlantic Puffin	coastal islands	11	14
Brant	winters in sheltered bays	10	10
Gyrfalcon	winters occ along open coast	3	3

Table 3: Birds in relation to coastal feature sizes. Occurrences of these species were used to confirm portfolio examples of coastal shore or wetland features (see data caveats in Table 2)

G_comnam	**Habitat**	**Total observations**	**% on 0-100 acres**	**% on 100-500 acres**	**% on 500-1000 acres**	**% on 1k-10k acres**	**% on 10k-50k acres**	**Ave Feature size**
Black-legged Kittiwake	pelagic gull, nest on sea cliffs	3					100	16,683
Red Knot	migrant, tidal flats, beaches	3				67	33	1,379
Semipalmated Sandpiper	migrant, mudflats	4		25	25	25	25	431
Nelson's Sharp-tailed Sparrow	salt marshes	2		50		50		201
Willet	nests in coastal marshes	3		67		33		267
Arctic Tern	breeds on coastal beaches	14	43	14		29	14	4,673
Piping Plover	breeds on coastal beaches	49	6	16	2	53	22	1,453
Common Tern	nests on islands or beaches	82	22	17	4	40	17	3,048
Roseate Tern	offshore islands w pebbly beach	12	42	25		25	8	3,262
Black-headed Gull	coastal marshes, lakes	4	50			50		926
Gadwall	fresh, occ brackish marsh	4	25	50		25		235

Figure 2. Minimum dynamic area for disturbance processes and minimum area requirements for breeding species in Northern Appalachian salt marshes.

SALT MARSH

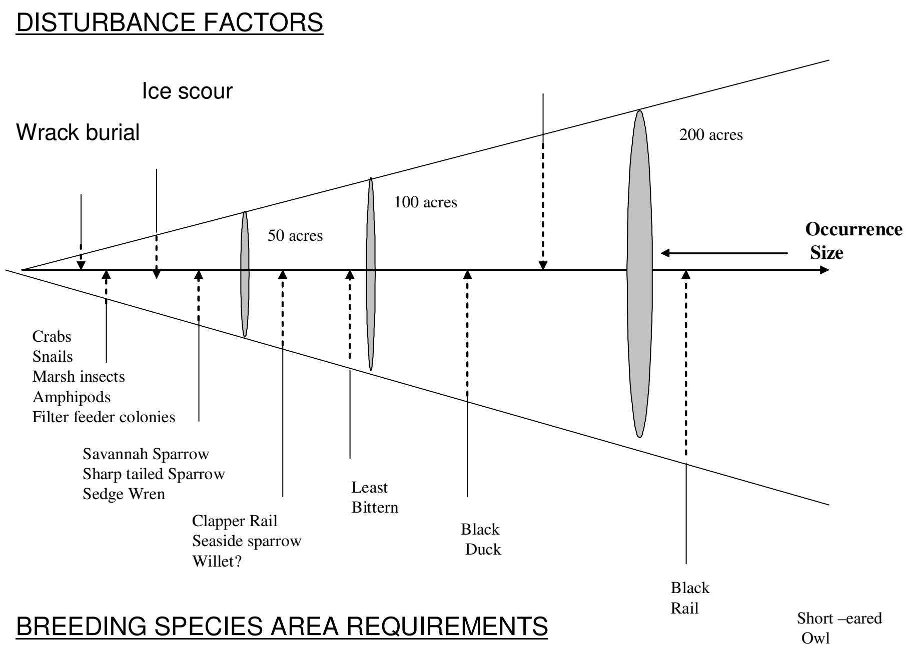


Figure 3. The average size of the tidal marshes and coastal bogs where confirmed occurrences of characteristic species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0 to 3. Yellow rail had an average marsh size of 1523 acres, Arctic tern had an average of 47 acres. The grand average was 188 acres.

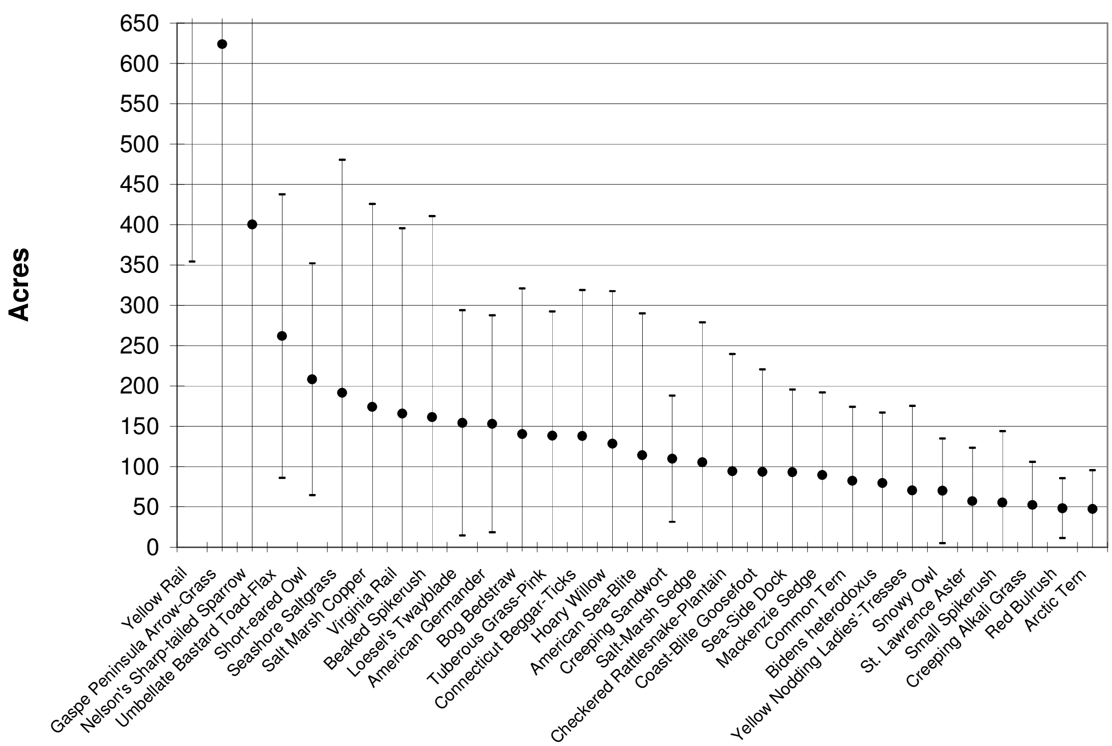


Figure 4. The average size of the beaches and dunes where confirmed occurrences of beach/dune specific species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0-3. At the two extremes, beaches where the occurrences of beach pinweed (*Lechea maritima*) were located averaged 632 acres in size, those for the Nova Scotia false foxglove (*Agalinis neoscotica*) averaged 19 acres.

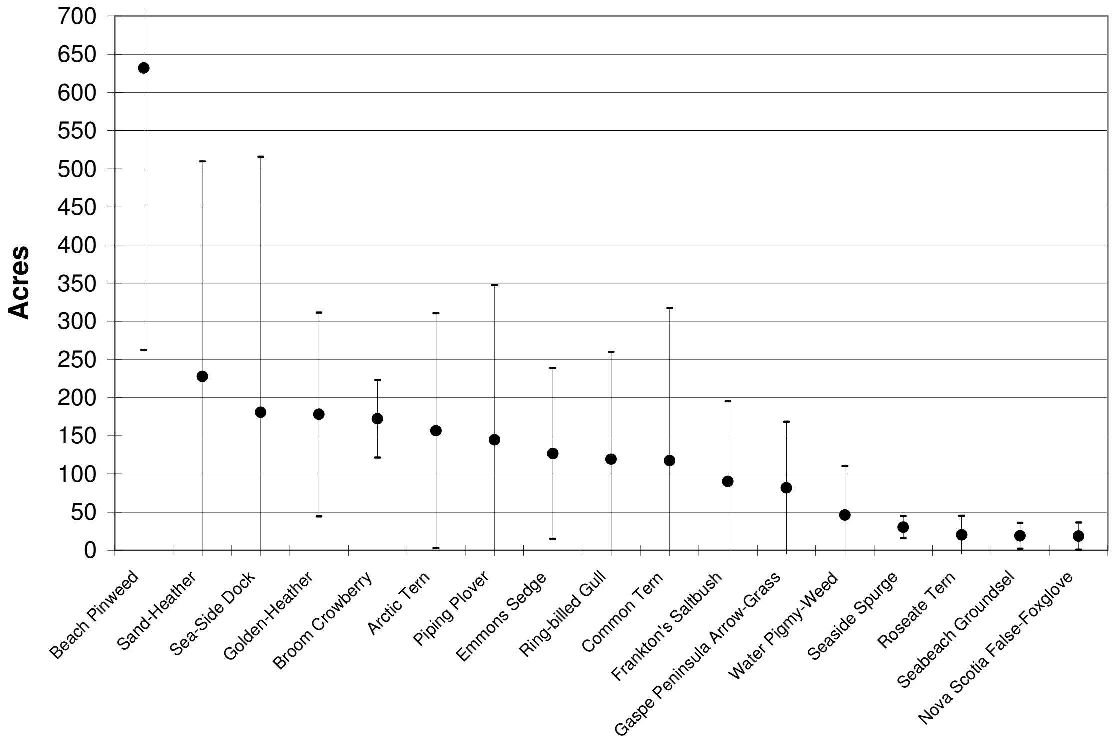
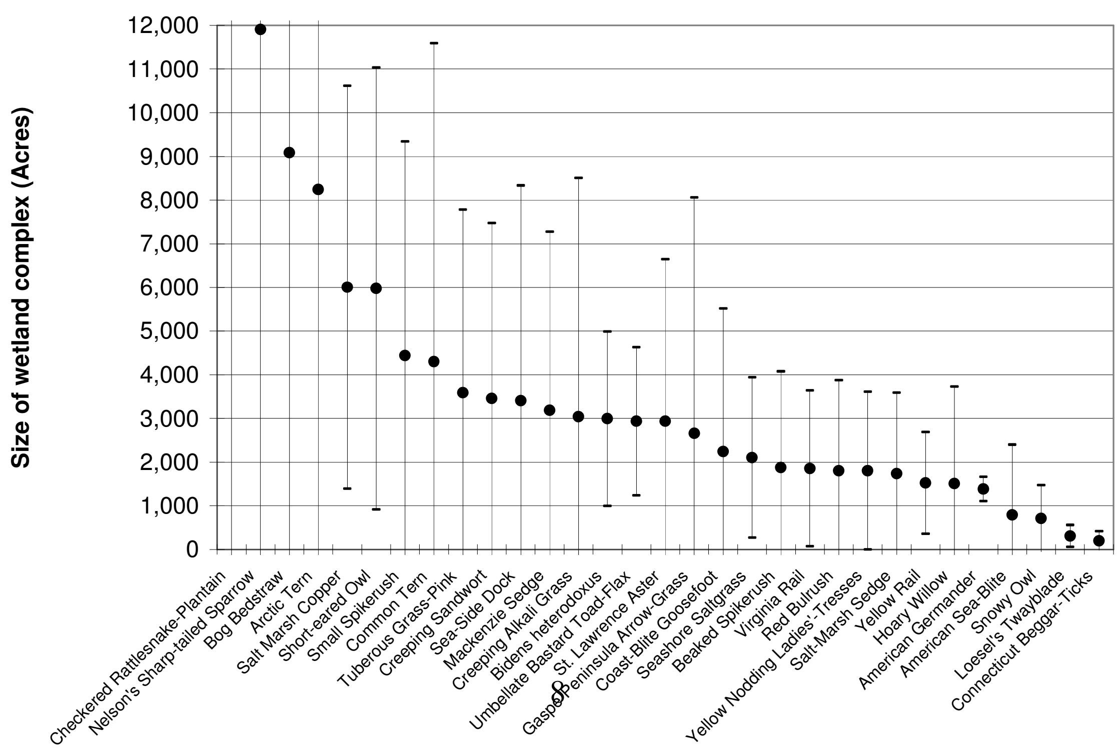


Figure 5. The average size of the coastal wetland complexes where confirmed occurrences of characteristic species were observed. Data from CDC and Maine Natural Heritage program, restricted to species with 3 or more occurrences and a location precision of 0 to 3.



Results

Our goal was to identify a minimum of **40 examples per sub-region in which they occur**. This goal of 1440 individual occurrences totals to about 13 percent of all the coastal features in the ecoregion or an estimated 17% of all features by area (using the minimum size criteria). After examining the distribution of the occurrences across gradients, we redistributed the goal of 1440 across the sub-regions in proportion with the number of possible occurrences. (Table 4)

We identified 2311 critical occurrences in 90 key complexes. This is more than the number needed to meet our minimum goal, however many of these occurrences are sub-units of a larger complexes. We met or surpassed the specific goals for each sub- region except for beach/dune features in the Acadian Highlands, and Nova Scotia Hills.

Candidate and Supporting occurrences

In addition to the critical occurrences, this analysis encompassed a large number of less notable, or poorly surveyed coastal shores and wetlands that did not meet our screening criteria for being a critical feature. We accounted for their potential contributions to biodiversity by sorting them into two categories and totaling the amounts of each.

- *Candidate occurrence:* A feature that met the criteria for size and landscape context but for which we had no verification or corroboration as to their condition and biodiversity contribution. These may be added to the portfolio after ground verification and are a logical place to focus inventory efforts.
- *Supporting occurrence:* A feature that did not meet the criteria for size and landscape context but may play a supporting role in supplementing the critical sites.

Many of the candidate and supporting occurrences already occur on protected reserves and thus are part of the *defacto* conservation picture for the region. Because conserved examples of these occurrences may serve to bolster biodiversity protection we included them in some of our analyses for context. However, c*andidate and supporting occurrences were not counted as contributing to the portfolio goals.*

Occurrences, Sites and Goals

When measured by area, the critical sites account for 44 percent of all coastal features, more than the estimated13 percent because the critical sites were consistently larger than the average or minimum size.

As discussed in the introduction, we have no certainty that it is possible to protect all coastal biodiversity using only a proportion of the landscape. We used numeric goals to hone our focus on the most critical sites. The methods were designed to insure that conservation is focused on the most functional examples in the most intact landscapes possible. They are scaled in size to work effectively as coarse filters for all biodiversity and the occurrences have verification as to quality by one to several sources. By these criteria, this is the set of sites that will have the greatest influence and the highest chances of protecting biodiversity over centuries.

Table 4a. Goals and Distribution for critical occurrences of coastal features except for tidal flats.

Feature	ELC_name	Goal	TC	CP	CU	PC	PS	OU	T	S
Dune	Acadian Highlands	7	31	8	23		2	26	59	24
	Acadian 'Uplands'	9	1	0	1		7	61	69	-8
	Atlantic Coast	118	220	35	185	3	60	665	948	102
	GoM, BoF, Minas Basin	34	27	7	20		20	222	269	-7
	Northumberland - Bras D'Or	161	371	105	266	4	70	841	1286	210
	Nova Scotia Hills & Drumlins	14	0	0	0		9	105	114	-14
Beach/Dune Total		343	650	155	495	7	168	1920	2745	307
Bog	Acadian Highlands	0	3	0	3			1	4	3
	Acadian 'Uplands'	0	0	0	0			3	3	0
	Atlantic Coast	55	111	10	101	2	8	323	444	56
	GoM, BoF, Minas Basin	3	4	1	3		1	19	24	1
	Northumberland - Bras D'Or	25	69	17	52		6	128	203	44
	Nova Scotia Hills & Drumlins	3	1	0	1		1	26	28	-2
Coastal Bog Total		88	188	28	160	2	16	500	706	100
Cliff and Rocky Shore	Acadian Highlands	3	8	3	5	2		10	20	5
	Acadian 'Uplands'	58	20	0	20		9	437	466	-38
	Atlantic Coast	16	56	13	43		3	67	126	40
	GoM, BoF, Minas Basin	105	140	45	95		62	645	847	35
	Northumberland - Bras D'Or	6	4	1	3		2	43	49	-2
	Nova Scotia Hills & Drumlins	3	0	0	0		1	24	25	-3
Cliff and Rocky shore Total		191	228	62	166	2	77	1226	1533	37
Salt Pond	Acadian Highlands	1	7	0	7			1	8	6
	Acadian 'Uplands'	3	0	0	0			23	23	-3
	Atlantic Coast	30	47	3	44		8	187	242	17
	GoM, BoF, Minas Basin	1	1	0	1		1	8	10	0
	Northumberland - Bras D'Or	45	66	21	45	1	22	273	362	21
	Nova Scotia Hills & Drumlins	4	0	0	0		2	27	29	-4
Salt Ppond Total		84	121	24	97	1	33	519	674	37
Salt Marsh	Acadian Highlands	8	45	1	44		1	22	68	37
	Acadian 'Uplands'	49	58	0	58		10	323	391	9
	Atlantic Coast	143	284	40	244	2	53	804	1143	141
	Gaspe Peninsula	5	11	1	10		1	26	38	6
	GoM, BoF, Minas Basin	139	323	38	286		24	764	1112	184
	Northumberland - Bras D'Or	322	389	63	326	6	106	2075	2576	67
	Nova Scotia Hills & Drumlins	63	13	2	11	1	11	477	502	-50
	Temiscouata Hills - St. John Uplands - North	5	1	0	1			42	43	-4
Salt/brackish marsh Total		733	1124	145	980	9	206	4533	5873	391
	Grand Total	1440	2311	414	1898	21	500	8698	11531	871

Goal = the portfolio goal
TC = total number of critical occurrences identified and located.
CU = Critical occurrences that occur on lands managed for extraction or are unprotected.
CP = Critical occurrences that occur on lands explicitly protected for biodiversity.
PC = Candidate occurrences that occur on lands explicitly protected for biodiversity.
PS = Supporting occurrences that occur on lands explicitly protected for biodiversity.
OU = Other occurrences that occur on lands managed for extraction or are unprotected.
T = total # of occurrences. **S** = portfolio sufficiency

Table 4b. Goals and Distribution for critical occurrences of tidal flats. Legend as for 4a

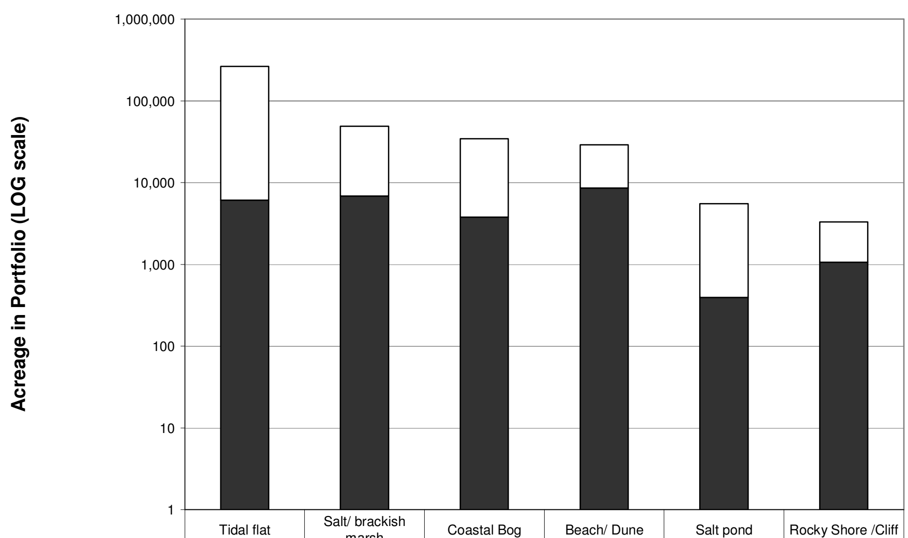
Group	ELC_name	Goal	TC	CP	CU	PC	PS	OU	T	S
Tidal flat	Acadian Highlands	1	9	0	9			9	18	
	Acadian 'Uplands'	52	163	0	163		2	592	757	-1
	Atlantic Coast	76	60	6	54	6	53	983	1102	
	Gulf of Maine, Bay of Fundy, Minas Basin	63	177	3	174	1	19	716	913	-1
	North Atlantic Coast Ecoregion	51	502	0	502			243	745	-4
	Northumberland - Bras D'Or 'lowlands'	23	78	15	63	3	13	244	338	-
	Nova Scotia Hills & Drumlins	11	2	0	2		1	163	166	
	Tidal Flat Total	**280**	**991**	**24**	**967**	**10**	**88**	**2950**	**4039**	**-7**

Distribution and current protection status of the coastal feature portfolio.

Our portfolio identifies 90 key sites of critical shoreline encompassing 423,052 acres and 1720 features - each site being composed of either a single outstanding feature or a complex mosaic of many features. Collectively they constitute only one half of one percent of the ecoregion (excluding off-shore tidal flats that are outside the mapped ecoregion boundary) Our focus was on critical rocky shores/cliffs, beaches, salt marshes, tidal flats and coastal bogs, but the sites encompass other shoreline features.

Tidal flats form such a large percentage of the area they tend to obscure patterns formed by the smaller features. Because of this, Figure 6 is shown on a log scale and the two subsequent figures (Figure 7 and 8) show the distribution of coastal features excluding tidal marshes. The land protection status of critical tidal flats is shown in relation to all other features in Figure 9.

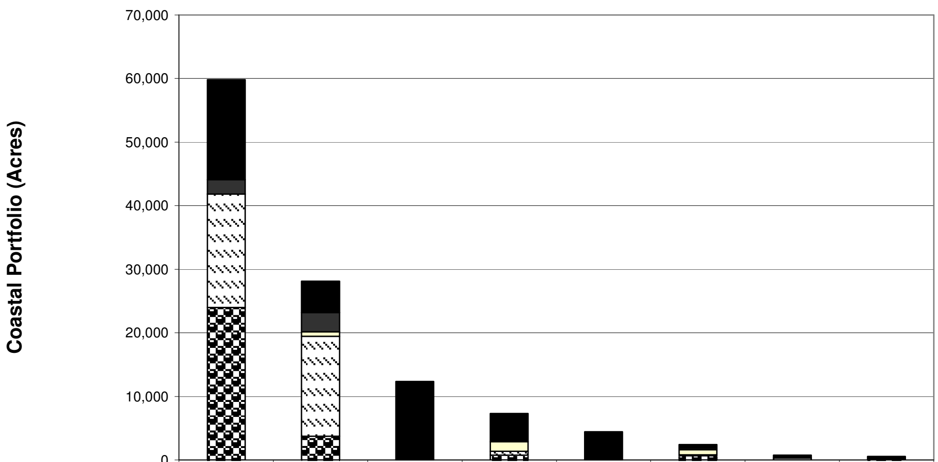
Figure 6 the amount of each coastal feature captured by the 90 wetland complexes identified in this analysis. A log scale is used to smooth out the discrepancies in amount from over 300,000 acres of tidal marsh to 1000 acres of rocky shore and cliff. The amount on protected land (GAP status 1 or 2) is shown in black.



	Tidal flat	Salt/ brackish marsh	Coastal Bog	Beach/ Dune	Salt pond	Rocky Shore /Cliff
Grand Total	263,884	49,023	34,574	29,152	5,508	3,313
□ UNPROTECTED	257,771	42,157	30,809	20,594	5,113	2,253
■ GAP1/2	6,113	6,866	3,765	8,558	395	1,060

The portfolio is distributed across subregions to reflect the natural distributions of features across gradients (Figure 7). The Northumberland coast of New Brunswick and Nova Scotia have more than twice the number of portfolio occurrences than any other region. The fact that the Gaspe and Temiscuouta Hills primarily feature salt marshes may reflect data limits. Further research is needed on other features in these subregions

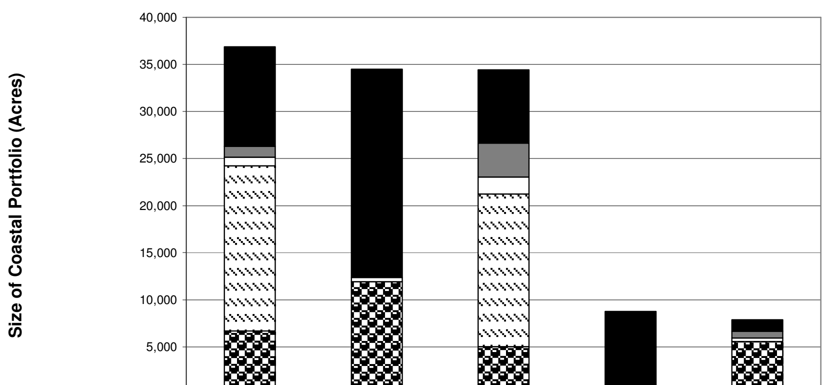
Figure 7. Coastal Portfolio across subregions (tidal flats excluded)



	Northumberland - Bras D'Or 'lowlands'	Atlantic Coast	Gaspe Peninsula	Gulf of Maine, Bay of Fundy, Minas Basin	Temiscouata Hills - St. John Uplands	Acadian Highlands	Nova Scotia Hills & Drumlins	Acadian 'Uplands'
Salt/brackish marsh	15,724	4,942	12,376	4,408	4,427	532	467	481
Salt pond	2,266	3,017		7		219	0	0
Rocky cliff/shore	34	727	0	1,523	0	833	0	89
Bog	17,803	15,684		597		175	315	0
Beach/Dune	23,992	3,744		756		636	0	24

The portfolio is unevenly distributed by province and state with New Brunswick, Quebec and Nova Scotia having the bulk of the portfolio and some states (NH, VT, NY) not having any coastal shoreline in this ecoregion.

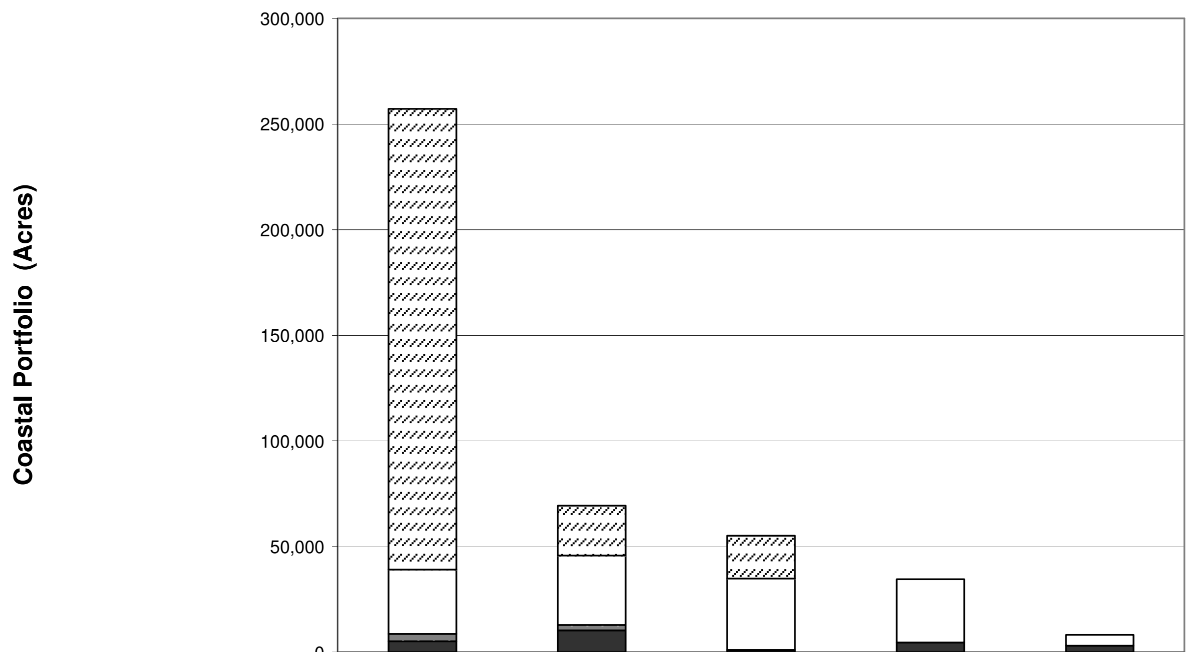
Figure 8. The coastal portfolio by state and province (tidal flats excluded).



	NB	QC	NS	ME	PEI
Grand Total	36,862	34,481	34,425	8,763	7,880
Salt/Brackish marsh	10,556	22,126	7,789	8,160	1,235
Salt pond	1,187		3,614		708
Rocky shore/cliff	911		1,799	603	
Coastal Bog	17,528	453	16,206		386
Beach/Dune	6,681	11,902	5,017		5,552

Examination of the current land protected status indicates that New Brunswick is furthest along on protecting coastal features with over 13,000 acres of the critical portfolio occurrences being on land with a GAP 1 or 2 status. Our analysis does not account for coastal zone legal policies which are one of the primary conservation tools for coastal features.

Figure 9. Land protection status of tidal flats and other coastal features in the Northern Appalachian /Acadian ecoregion by state and province. Tidal flats are separated from all other critical occurrences (salt marshes, beach dune systems, coastal bogs, rocky cliffs and shores) that are aggregated in this figure because of the inequities of size.



	NS	NB	ME	QC	PE
Tidal flat: unprotected	218,088	23,560	20,208	0	0
Critical occurrences: Unprotected	30,420	32,763	33,778	29,940	5,129
Tidal flat: GAP 1/2	3,481	2,675	89	0	0
Critical occurrences: GAP 1/2	5,169	10,354	1,038	4,541	3,073

Sites: Site lists are found in Appendix A

NORTHERN APPALACHIAN–ACADIAN SPECIES TARGETS

06/28/2006

Definitions and Planning Methods

Species targets in ecoregional planning

Species targets consist of a heterogeneous set of species warranting priority 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 fewer than 100 known populations (G1-G3)1
- endemic to the ecoregion
- currently in demonstrable decline
- extremely wide ranging individuals, thus requiring conservation of habitat at larger scales
- designated as threatened or endangered by federal or state authorities

Primary species targets

A subset of the above species was defined as primary species targets. The implication of a species being identified as a ***Primary target*** was that its conservation needs need to be addressed **explicitly** in the ecoregional plan because its habitat needs are unlikely to be adequately addressed via the coarse filter approach of comprehensive conservation of representative ecosystems. This means that for each primary target the science team: 1) set a quantitative goal for the estimated number and distribution of local populations necessary to conserve the species, 2) compiled information on the location and characteristics of known populations/habitats in the ecoregion, and 3) assessed the viability of each local population with respect to its size, condition, landscape context and ultimately its probability of persistence over the next century all in order to select specific sites for conservation for that species.

Viable examples of local populations ("occurrences") were spatially mapped and their locations given informal "survey site" names. The number and distribution of viable occurrences were 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 from the above pool and in some cases additional species viewed as vulnerable based on the life history, distribution and demographics of the species. Secondary targets are species of conservation concern in the ecoregion due to many of the same reasons as the Primary

[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).

targets except that either no clear locations can be identified where their habitat can or must be conserved, or the threat to them does not arise so much from habitat loss within this ecoregion as other issues, such as poaching of wood turtles for instance, or we have reasonable confidence that they can be conserved through the "coarse-filter" conservation of ecosystems (see the section on Ecosystems Targets).

The compiled list of secondary targets was used in three ways to inform the ecoregional plan/conservation blueprint. First, habitat needs of secondary target species were used in developing viability criteria and number and distribution goals 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 minimum size and condition factors for conifer forest matrix ecosystems. This ensures that the conservation of these forest ecosystems would be designed in such a way as to ensure the protection of the characteristic species that breed in this habitat. Second, known occurrences of secondary targets were used to guide selection of examples of ecosystems that were chosen for the portfolio and prioritized for conservation action. Third, the secondary target species were used to highlight information gaps and conservation concerns that go beyond land conservation.

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 and provincial conservation databases, Partners-in-Flight and American Bird Conservation lists for corresponding ecoregions, literature sources and solicited expert opinion. The database searches began with all species occurring in the ecoregion for which there are fewer than 100 known populations anywhere (G1-G3G4 and T1-T3). Commoner species (G4, G5) were nominated for discussion by each of the state or provincial programs and by other experts based on considerations of their vulnerable status within the ecoregion with particular attention paid to vulnerable disjunct populations and to wide-ranging species such as Canada lynx.

The exhaustive initial list was whittled down to a smaller final set through input from technical teams of scientists familiar with the species in the ecoregion. In the Northern Appalachian/Acadian region we developed separate international teams for mammals, birds, herptiles, fish, invertebrates and plants. The results were then compiled to create the final species target list. The justifications for including each target species is archived in ecoregional databases.

Primary vs. Secondary Targets

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 ranks for the latter species need to be updated. Some were moved from primary to secondary because it was felt they would be adequately addressed through a careful coarse filter approach. Among species for which distribution information was considered to be inadequate, several were retained on a potential target list for future consideration. However, at a minimum, any species considered globally endangered at either the species or subspecies level (G1-2 or T1-2) or legally protected as endangered at the national level were kept as Primary target species.

Setting Minimum Conservation Goals for Species Targets

The minimum conservation goal for a primary target species in an ecoregional plan is 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 goals

Our conservation goals had two components: numeric and distributional. The *numeric* goal assumed that a global *minimum* number of at least 20 local populations or metapopulations 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 an 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 (Table SPP 1). 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.

Table SPP 1. Conservation goals based on distribution categories and global rarity rank (G rank). Numbers refer to the minimum number of viable populations targeted for protection.

CATEGORY	DEFINITION	G1	G2	G3-G5
Restricted (endemic)	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

To highlight the importance of the ecoregion to the species, each primary target species was assigned to one of four range-wide distribution categories – Restricted, Limited, Widespread, Peripheral – all measured relative to the ecoregion (Table SPP 1). 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 goal 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. This default algorithm was followed most closely for plants somewhat less so for animals. In practice, for most of the primary targets there were many fewer known occurrences than the minimum goal.

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 subregion[2] of the ecoregion where the species occurred historically, i.e. where there is or has been habitat for the species. The conservation goal is met for a species when both the numerical and stratification standards are met.

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

[2] Subregions are geographic sub-units defined for the Northern Appalachian-Acadian ecoregion. See report chapter on "Ecoregion and Subregion Boundary Development" and the following references: Bailey et al (1994), Keys et al (1995).

iteration ecoregional plans, species target goals should be assessed, reevaluated and adjusted. Range-wide planning should eventually be undertaken for all primary 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 and Canadian Conservation Data Center 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 EO specs 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 usually contain sufficient information on its size, condition and

[3] An Element Occurrence, or EO, is a geo-referenced 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 database records.

The synthesized priority ranks (EO rank) currently assigned by the state Heritage Program 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. In fact, very few EO ranks were available except for plant and natural community EOs in the US part of the ecoregion as well as for plants and animals in the Quebec part of the ecoregion. Thus, for viability estimation the EO rank was supplemented by the raw tabular information on size, condition and landscape context and as often as possible by the knowledge of biologists familiar with the taxon and the locations. Additionally, information on each EO was further augmented with a spatial GIS assessment of the land cover classes and road densities located in a 1,000 acre proximity of the occurrence's central point. The latter served as an objective indicator of landscape context.

All known occurrences for each primary target species were assembled at ECS from the state Heritage Programs and provincial CDCs 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, provincial and divisional scientists.

Species Results

Each taxonomic group has been reviewed by external reviewers coordinated by the technical team (Maillet, Vickery, Gratton, Gorman, Anderson & see below).

MAMMALS, REPTILES, AMPHIBIANS, FISH (NON AVIAN VERTEBRATES)

Team leader: Josette Maillet
Reviewers:
Maritimes: Tom Herman, Mark Elderkin, Dwayne Sabine
Québec: Jacques Jutras, Claude Daigle, Nathalie Desrosiers, Walter Bertacchi, Norman Courtemanche, Alain Demers
US: Merry Gallagher, Fred Kircheis, Ken Sprankle, Phillip deMaynadier, Michale Glennon, Mark Ferguson, Rose Paul, John Roe

The selection of mammalian primary conservation targets (Table SPP 2) did not stray significantly from the criteria used for primary target selection in that they were either globally ranked as rare (G1-G3), were disjunct, endemic or wide-ranging. An exception to this is the Rock Vole which was selected because of its scattered, small, localized populations. However, it has been suggested that this species may be more common than previously thought and may eventually be placed on the secondary target list. Also, Long-tailed Shrew and Gaspé Shrew are thought to be a single species and molecular genetics research is underway to resolve this question.

Table SPP 2. Summary of primary target mammals in the ecoregion.

SCIENTIFIC NAME	COMMON NAME	G RANK	COMMENTS
MAMMALS			
Myotis leibii	Eastern Small-Footed Myotis	G3	**Widespread** but spotty distribution, rarely in large numbers, hibernacula are key
Sorex gaspensis	Gaspé Shrew	G3	**Restricted** Local **endemic.**
Myotis sodalis	Indiana Or Social Myotis	G2	**Peripheral.** Critically imperiled throughout its range. Within NAP occurs only in NY and Vt. Vulnerable to human disturbance
Sorex dispar	Long-Tailed or Rock Shrew	G4	**Widespread** but limited to Appalachian Mountains
Sorex maritimensis	Maritime Shrew	GNR-unranked	Regional **endemic, Restricted** to NB (S3) and NS (S3)
Synaptomys borealis	Northern Bog Lemming	G4	Widespread, localized populations; not common anywhere
Microtus p. shattucki	Penobscot Meadow vole	G5T1T3Q	Newly recognized **sub-species, endemic** to ME
Microtus chrotorrhinus	Rock Vole	G4	**Widespread** Scattered in SE Canada, NE US, and Appalachian Mountains, relatively uncommon
Rangifer tarandus (Gaspé population)	Woodland Caribou	G5T1Q	**Disjunct and Restricted** population ~250 individuals in isolated population on high peaks of Chics Chocs and McGerrigle Mountains
Lynx canadensis	Lynx	G5	**Widespread**, a large-area requiring species; Gaspe population is important source for rest of ecoregion where it is either extirpated or S. Listed as Threatened under US Endangered Species Act. Wide ranging.

All fish species also met the standard criteria used in the selection of species targets. Only local endangered populations of Atlantic Salmon were considered to be primary targets.

Only two reptiles were selected as primary targets: the disjunct Blanding's Turtle in Nova Scotia and the disjunct Maritime populations of the Eastern Ribbon Snake. The Wood Turtle was also suggested as a primary target but their decline is associated with the pet trade rather than habitat loss so it was eventually placed on the secondary target list. No amphibians were selected as primary targets (Table SPP 3).

Table SPP 3. Summary of primary target herptiles and fish in the ecoregion.

SCIENTIFIC NAME	COMMON NAME	G RANK	COMMENTS
REPTILES & AMPHIBIANS			
Emys blandingii	Blanding's Turtle	G4	**Disjunct** in Kejimkujik National Park, does not occur in US part of ecoregion although it does occur as a rare species in the adjoining Lower NE ecoregion
Thamnophis sauritus	Eastern Ribbon Snake.	G5	**Peripheral** to ecoregion, occurs in

	Maritime populations		NY and NE where specific populations are not tracked. Populations in Maritimes are **disjunct**
FISH			
Acipenser oxyrhynchus	Atlantic sturgeon	**G3**	**Widespread.** Atlantic and Gulf coasts, depleted populations
Coregonus huntsmani	Atlantic Whitefish	**G1**	**Restricted.** NS only, in a few areas, impacted by dams
Osmerus sp. 1	Lake Utopia Dwarf Smelt	G?	NB **endemic**
Salvelinus alpinus oquassa	Landlocked Arctic Charr (Blue Backed Trout)	G5T2Q	Subspecies, **endemic** to ecoregion. Extirpated from NH, VT; found in ME
Acipenser brevirostrum	Shortnose Sturgeon	**G3**	**Peripheral.** Special concern; viable populations found in NB, ME; vulnerable to pollution and habitat alteration
Salmo salar (anadromous)	Atlantic Salmon (local populations of Gulf of Maine, Bay of Fundy)	G5	Wide-ranging species but declining, at risk local subpopulations so viewed as **Limited**, listed as Endangered by US ESA. Wide ranging.

Canada Lynx

It is a recommended practice to include some wide ranging species as primary targets in ecoregional assessments. Of the wide-ranging species that once occupied this ecoregion, wolf and mountain lion were not selected because they are extirpated. Caribou was included as a primary a target but is now so restricted in range that it can no longer be considered wide ranging. We thought the habitat needs of pine marten could be adequately addressed through selection of matrix forests. The Canada lynx was chosen as a primary target because it is a wide-ranging and large area requiring species that was once reasonably common but is now either extirpated from or rare and vulnerable in most of the ecoregion. The USFWS has declared the contiguous US distinct population segment of the Canada lynx as Threatened. It has a similar status in NB and NS and has been extirpated from PEI. The USFWS has identified a large part of northern Maine as Critical Habitat for this species. The Gaspe peninsula population in Quebec is large enough currently to sustain harvest by trapping and is an important source population for the rest of the ecoregion. Recovery of the New England population is thus strongly dependent on retaining connectivity between Gaspe and northern New England habitat. (Carroll, 2003)

Lynx are dependent on boreal forest structure with significant areas of regenerating forest, robust populations of snowshoe hare and enough snow depth to retain their competitive advantage against coyotes, bobcat and fisher. As these conditions are not uncommon, we worked with partners to model the locations of potential source and sink areas in the ecoregion to focus conservation aimed at maintaining a thriving lynx population throughout their ecoregional range (Carroll 2005, Figure 1). The results illuminate some key locations and important connections between Quebec, New Brunswick and Maine.

Figure 1. Source – Sink model for Canada Lynx. Dark gray areas show probable source regions. Light gray areas show probable sink regions. Adapted from Carroll 2005[4], used with permission.

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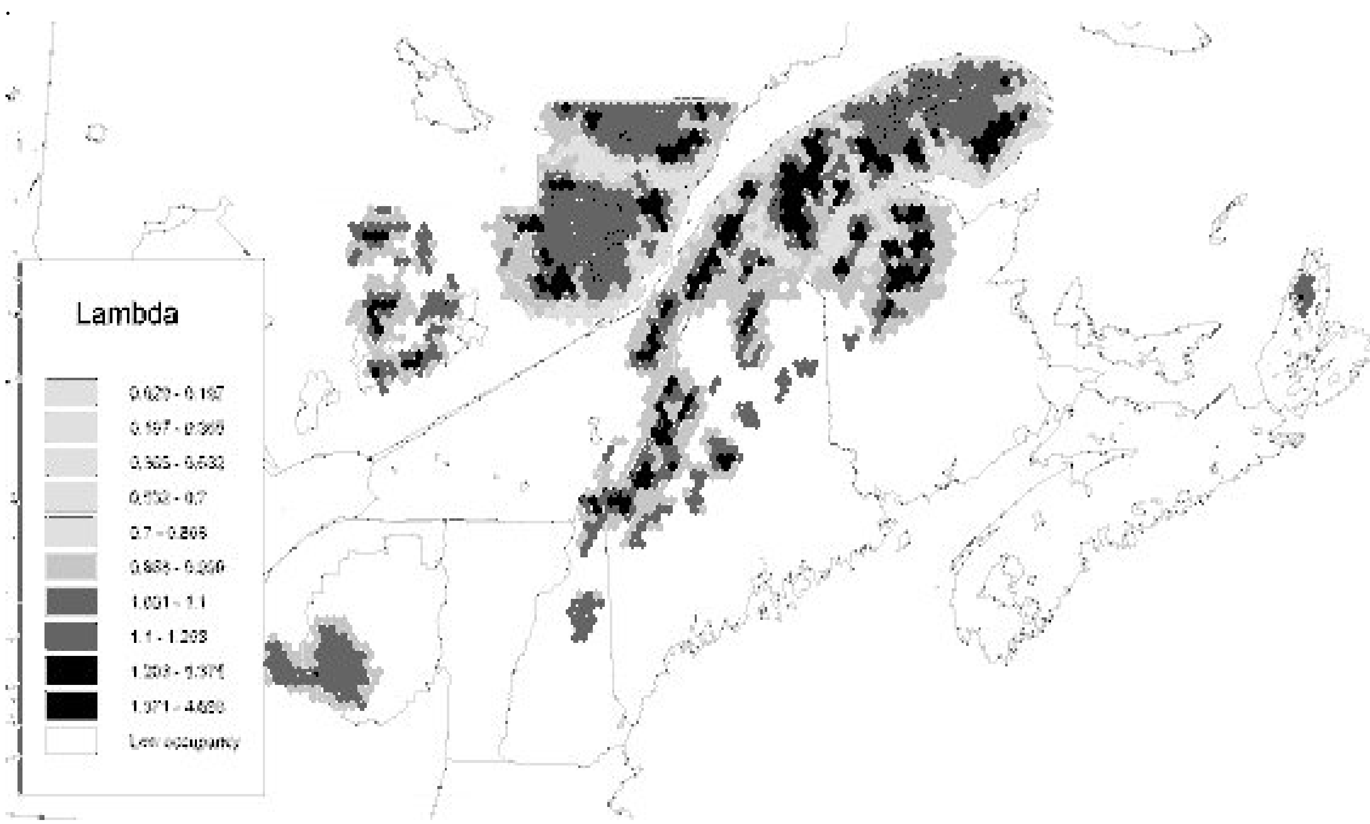


[4] Carroll, Carlos. 2005. Carnivore Restoration in the Northeastern U.S. and Southeastern Canada: A Regional-Scale Analysis of Habitat and Population Viability for Wolf, Lynx and Marten (Report 2: Lynx and Marten Viability Analysis). Wildlands Project Special Paper No. 6. Richmond, VT: Wildlands Project/ 46 pp.

Guided by this work, and because of the nature of their habitat needs, individual sites were not selected for lynx in this plan. Rather, the conservation goals for lynx are to:

1) Maintain large areas of suitable breeding habitat in Gaspe, New Brunswick, and Maine.
2) Ensure that Gaspe population levels remain high enough that it can continue to serve as source population for adjacent areas.
3) Maintain habitat connectivity sufficient to allow dispersion and population interchange between core habitat areas in Gaspe, and those of nearby NB, Maine and points west. More research will be needed to determine what are the key obstacles to lynx travel and where are the key geographic links. However, for now we assume that the more forest cover and the fewer roads and houses the more likely they will disperse and sustain local populations successfully.

The lynx research adds perspective to site-based conservation planning suggesting that we consider the habitat needs of lynx when managing forests in areas that overlap with source regions.   Additionally, the models highlight important landscape connections providing guidance on where to focus policies aimed at maintaining forest cover and preventing conversion to development. Models for other species (marten and wolf) illustrate with clarity how species of contrasting sizes and life histories use the landscape in different ways (Carroll 2005).

BIRDS

Team leader: Barbara Vickery

Reviewers:

Experts who provided input to this list include Kate Bredin, ACCDC, Dan Busby, CWS, Richard Elliot, CWS, Tony Erskine, CWS, Mark Elderkin, NSDNR, Dwayne Sabine, NBDNR, Tom Hodgman, MDIFW, Peter Vickery, ME, Nancy Sferra, METNC, Paul Novak, NY, Pam Hunt of NH Audubon Society, John Roe, Rose Paul and Mark Ferguson of TNC VT and from Quebec, Josée Tardif of CWS.

Additional information regarding specific locations for primary target birds was provided by Diane Amirault, Andrew Boyne, Yves Aubry, François Shaffer all of CWS, Francois Morneau of QC, Robert Houston of USFWS, Lindsay Tutor and Brad Allen of MDIFW, Barbara Louks NY, Margaret Fowle of VT, Michael Amaral of USFWS and Dan Lambert of VINS

The bird target list (Table SPP 4) differs from the other species targets in some important ways. First, since most of our bird species are migratory there are potential concerns at several parts of their life cycles; some are included on the list because of the importance of habitats in NAP/Acadia ecoregion for breeding, some for wintering habitat, and some for migrant stopover concentration areas. Some are listed not because there are few individuals but because the places they breed or stop over in migration are so few. (In Table SPP 4, note modifier after the species common name regarding wintering or migrant concentrations.)

Table SPP 4: Summary of primary target birds in the ecoregion

SCIENTIFIC NAME	COMMON NAME	G RANK	COMMENTS
Aquila chrysaetos	Golden Eagle	G5	**Disjunct,** Although common to the west, very rare

			in ecoregion
Bucephala islandica	Barrow's Goldeneye, Eastern pop. (Wintering)	G5	Does not breed within ecoregion, but ecoregion is important for concentrated wintering populations
Catharus bicknelli	Bicknell's Thrush	G4	**Endemic** to ecoregion, restricted to high elevation spruce forests
Histrionicus histrionicus pop 1	Harlequin Duck, Eastern population (Wintering)	G4	At risk throughout. This ecoregion has large proportion of population in winter at relatively few locales
Passerculus sandwichensis princeps	Ipswich Sparrow	G5T2	**Endemic** to ecoregion. Only one breeding location of the subspecies known, Cape Sable, NS
Falco peregrinus anatum	Peregrine Falcon	G4T3	**Widespread**, Recovering but still rare throughout ecoregion.
Charadrius melodus	Piping Plover	G3	Globally rare; **Widespread** but population small Occurs in Quebec, NB and NS, but no occurrences in US part of ecoregion
Alca torda	Razorbill, breeding and wintering	G5	Breeds in small numbers on very few islands of ME, NB and NS; also major wintering concentration in Bay of Fundy
Sterna dougallii	Roseate Tern	G4	**Widespread** but Breeds in very few locations on Maine coast islands and NS
Cistothorus platensis	Sedge Wren	G5	**Peripheral**. Was once common in parts of this ecoregion, now very rare
Calidris pusilla	Semi-palmated Sandpiper, fall migrants	G5	A very high proportion (75%) of the global population passes through this ecoregion in migration, concentrating at relatively few sites
Bartramia longicauda	Upland Sandpiper	G5	**Peripheral**. Breeds in very few locales throughout ecoregion, listed as S1 to S3 in all but Quebec where it occurs only outside this ecoregion

Second, it includes marine/pelagic species, while these were not included in the mammal list. For some species listed there may be no known locations that could appropriately be targeted for portfolio site status, e.g. Red-necked Phalarope. This ecoregional assessment acknowledges the concern for the species, but there are no terrestrially linked sites for their conservation or management. In the end, such species will be much better addressed through a marine ecoregional assessment that we hope will occur in the near future.

Third, Primary and Secondary Bird targets were chosen based on North American Bird Conservation Initiative (NABCI) Atlantic Northern Forest Bird Conservation Region (BCR) 14 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. This list places greater emphasis on the relative importance of the ecoregion to the species overall than with other taxonomic groups. This is the key difference between the Atlantic Northern Forest Bird Conservation Region priority list and a list derived from General Status as used in the Canadian provinces. All Atlantic Northern Forest Conservation Region priority species are included on at least the secondary species list. Thus, there are a number of species listed as secondary targets that are still common and for which there is no evidence of decline within our ecoregion, but because such a high proportion of the species' breeding area lies within the ecoregion it was felt it should be acknowledged as a conservation target at some level.

A final difference for birds vs. other species groups is that the passerines at least, especially those associated with our matrix forming forests, rarely occur as discrete "occurrences" or "local populations." Thus, they need a different approach in portfolio design.

This list includes some species as Primary that are not globally rare but are listed as S1 or S2 in all of the states or provinces in the ecoregion in which they occur (e.g. Golden Eagle, Black Tern). These are often disjunct or peripheral to our ecoregion, that is, although they may be secure in other parts of their range, they reach the limit of their range within our ecoregion. Many reviewers felt it was important to ensure conservation of populations of these species within this ecoregion. On the other hand, this list does not include species so peripheral that they are really only accidental or incidental within this ecoregion (e.g. Cerulean Warbler).

There are a number of species listed as secondary included primarily because there is so little information about their current status or trends in the region; examples would include long-eared owl, purple sandpiper and greater shearwater.

The list of Primary targets includes species of nearly all major habitat types. However, it is notably lacking in freshwater wading birds or waterfowl. It would be appropriate to add an ecoregional" target" not specifically aimed at one species, but at areas significant for the diversity and abundance of breeding waterfowl and/or wading birds they support. These wetlands should be picked up by the coarse filter approach but for some managed wetlands frequency with which they are actively managed (for water level for instance) may have prevented them from being selected as good examples of the natural community or system type in natural condition. This condition should be examined in the next iteration.

INVERTEBRATES (Mussels, Odonates, Lepidoptera and Tiger beetles)
Team leaders: Barbara Vickery (2003), Josette Maillet (2004)
Reviewers: Input from the following reviewers was included in this compilation: Paul Brunelle, Mark Elderkin, Dwayne Sabine, Reg Webster, NB, Phillip DeMaynadier, ME, Paul Novak, NY, John Roe, Rose Paul and Mark Ferguson of Vt. To date little input has been received from Quebec or NH.

We perceive this list as particularly provisional because relatively few invertebrate taxa have received inventory attention across the ecoregion. We chose to include only mussels, odonates, lepidoptera and tiger beetles because these had had relatively more field inventory. However, knowledge of even these taxa is spotty at best. Thus, this remains a provisional list subject to additional inventory and expert input (Table SPP 5).

We received the most comprehensive review information from two neighboring areas, Maine and Maritime Canada. Yet often their perspective on the species was divergent. Additional input from Quebec and other US states is needed. However, when the taxon was not globally imperiled we usually opted to list the species as a secondary target to be captured via the coarse filter if its *habitat* was widespread, reasonably abundant and not particularly vulnerable, even if viewed as rare in one jurisdiction or another. Similarly, we listed high mountain species that occur in multiple locations as secondary, thinking that with those habitats the coarse filter would be effective.

Note that since the ecoregional assessment does not yet extend to aquatic environments in Canada, as it does in the US parts of the ecoregion, it may be unrealistic to think aquatic species will be captured by the coarse filter approach in the near term. However, we are hopeful that a comprehensive ecoregional aquatic system analysis will follow eventually so we left many aquatic invertebrates as secondary targets.

Table SPP 5. Summary of primary target invertebrates in the ecoregion.

SCIENTIFIC NAME	COMMON NAME	G RANK	COMMENTS
	Insects		
Cicindela ancocisconensis	A Tiger Beetle	G3	**Limited.** Globally rare. Within in ecoregion occurs only in NH, VT, NY and Quebec
Cicindela marginipennis	Cobblestone Tiger Beetle	G2G3	**Peripheral**. Globally rare. Within ecoregion occurs only in NH, VT, NY and NB.
Siphlonisca aerodromia	Tomah Mayfly	G2	Ecoregional **endemic**, only in NY, Maine and Quebec
Lycaena dorcas claytoni	Clayton's Copper	G5T1	Subspecies is **endemic**, restricted to relatively few cinquefoil fens
Oeneis polixenes Katahdin	Katahdin Arctic	G5T1	Ecoregional **endemic**. Only global location for subspecies is Mt. Katahdin in Maine
Coenonympha nipisiquit	Maritime Ringlet	G1	Ecoregional **endemic**, only occurs at few locations on the Baie de Chaleur, Quebec and New Brunswick
Boloria frigga	Frigga Fritillary	G5	**Peripheral/Disjunct**, newly

			discovered in ME, not previously known from ecoregion or northeastern NA.
Somatochlora brevicincta	Quebec Emerald	G3	**Limited** to few ecoregions of northeastern NA, fewer than 20 known occurrences in NA
Ophiogomphus howei	Pygmy Snaketail	G3	**Peripheral.** one record for NB, rare in the Maritimes and in northern New England - acidic, slow, lotic
Neurocordulia obsoleta	Umber shadowdragon	G4	Poorly known in ecoregion, only one documented record in NB-large, slow lotic waters
	Mussels		
Alasmidonta varicosa	Brook Floater	G3	**Limited.** Globally rare and declining, S1 in NS, NH, VT, and NY, S3 in Maine
Alasmidonta heterodon	Dwarf Wedgemussel	G1G2	**Peripheral.** Globally rare and declining, S1 in NH, VT and NY and SH in NB, unknown in Maine
Lampsilis cariosa	Yellow Lampmussel	G3G4	**Limited**. Declining in much of range, healthiest populations appear to be within this ecoregion, S1 in NS, S2 in ME, SX or SH in NH and VT and S3 in NY

Summary of Portfolio Results for Animals

The working group addressed terrestrial and freshwater avian, mammal, fish, herptiles and macro-invertebrate targets. Some targets (particularly bird species or suites of species) 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.

The group selected 44 primary targets, including

- 16 G1-G3 species (G3-G4 included),
- 3 taxa for which global ranks have not been assigned ,
- 6 globally rare subspecies or subpopulations and
- G4 and G5 species of selected taxonomic groups either endemic to the ecoregion or restricted portion of it, with disjunct populations in this ecoregion, or wide-ranging and large area requiring, such as the Canada lynx.

In addition, the group selected secondary target species which were factored into selection of matrix forest and other systems examples when specific locations were known and should be factored into site conservation planning. These species include those which are actively tracked by at least one jurisdiction in the ecoregion and are listed as endangered, threatened, or of special concern by at least one jurisdiction.

The portfolio identifies the following viable occurrences and their surrounding survey sites for primary targets: 176 breeding bird locations; 25 wintering or migrant bird concentration areas; 13 hibernacula for bats; 25 locations for 6 small mammal species; 13 lakes for target fish species; 7 rivers for salmon, and 5 for Shortnose sturgeon (but note that this does not include US data); two metapopulations including 58 location records for Blandings Turtle and 3 for Ribbon Snake, all in the Maritimes; 50 sites for target terrestrial invertebrates; and 32 rare mussel populations or metapopulations. For one animal target, the Quebec Emerald Dragonfly, there were no known viable EOs but three that were identified as possibly viable were included in the portfolio as "maybes."

Few mammals, insects or reptiles had enough viable occurrences to meet numeric goals. On the other hand, goals were met for the three target mussel species. There were enough occurrences that met viability criteria to meet numeric and distribution goals for 6 out of 12 bird targets. The default numeric goals might appear to have been substantially exceeded for some bird species, but when one remembers that the minimum goal for animals is intended for populations or even metapopulations rather than sites it is evident that the goal is almost certainly not met for species such as peregrine falcon or piping plover that nest singly or in very small populations.

Viability was difficult to assess because EO ranks had been assigned for very few animal occurrences in the ecoregion. In general, occurrences were discarded if the date last seen was more than 20 years ago and if the location information was too general. For some bird species with federal endangered or threatened species status we simply adopted the occurrences that had been selected by CWS or USFWS biologists through recovery plan or similar processes. All specifically known sites for non-avian animal targets that were considered viable were included in the portfolio. It should be noted that the standard protocol for animal EOs is that they represent a breeding population or migrant or wintering concentration. However, there were many records in the Heritage and CDC databases that were simply records of individual sightings. Where possible these were grouped post hoc into presumed populations, each counting as a single EO.

About one third of the viable locations for primary target birds occur on land that is managed for biodiversity (Gap 1 or 2). By far the majority of the key habitats for Caribou and Blandings Turtle are similarly protected. By contrast only 3 out of 54 viable sites for target insects are on protected land.

Still to be assessed is the degree to which connecting forest, selected matrix forest blocks and selected systems would conserve adequate habitat for secondary species.

PLANTS

Team Leaders: Louise Gratton and Josh Royte

Reviewers: Jacques Labrecque, Gildo Lavoie (Ministère de l'Environnement du Québec); Louise Gratton (Nature Conservancy of Canada, Quebec); Josh Royte (The Nature Conservancy, Maine); Maureen Toner (NBDNR); Sean Blaney (Atlantic CDC) **;** Marian Munro (Nova Scotia Museum of Natural History), Gart Bishop (B&B Botanical), Dwayne Sabine (NBDNR), Mark Elderkin (NSDNR), Kate MacQuarrie (Island Nature Trust)

The group reviewed all G1 to G3 species as well as all others species (G4, G5, T1 to T5) either legally listed in a country, province or state, endemic, restricted and disjunct with less than five (5) known occurrences in the ecoregion. All other vulnerable plant species in the region were considered to also capture all:

- significant disjunct species (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
- ecoregional endemics known to be vulnerable and in decline.

This first listing of 254 species also 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.

The group then selected 113 target species that met either rarity or vulnerability criteria. Of these, 77 are **primary** targets (G1 through G3G4 species or subspecies, varieties or distinct populations of equivalent global rarity (22 taxa) with known EOs in the ecoregion). The exceptionally high number of primary plant targets in this ecoregion stems from the facts that more than half (43) are either:

species, subspecies or varieties endemic to this ecoregion or parts of this ecoregion (e.g. Gulf of St. Lawrence, Gaspe Peninsula) known to be important centers of endemism for the flora of Eastern North America (Morrisset 1971; Mosquin 1971; Argus and Mitchell 1974) including species associated with serpentine outcrops, freshwater intertidal marshes; or, species that have significantly disjunct populations from those of Northern Canada or the Rocky Mountains because of climatic and ecological conditions that have persisted after the glacial retreat, such as in the alpine habitats of the Chic-Chocs Mountain Range in the Gaspe Peninsula.

Primary plant targets are listed in Table SPP 6. All primary targets are listed in the Appendix "Primary Target Species Occurrences and their Attributes," and more detailed information is provided in the Supporting Documents.

Table SPP 6. Summary of primary target plants in the ecoregion

SCIENTIFIC NAME	COMMON NAME	G RANK	COMMENTS
Adiantum viridimontanum	Green Mountain Maidenhair-Fern	G2	**Restricted;** endemic to Northeastern America (Labrecque et Lavoie 2002); it is known only from serpentine outcrops in the southern portion of Quebec's Appalachian Range and could probably occur the in US portion of ecoregion
Agalinis neoscotica	Nova Scotia False-Foxglove	G4	**Restricted;** recently down listed from G2 because of evidence of increase in Maritime Canada, May be moved to secondary target with further documentation of occurrences throughout the ecoregion
Agoseris aurantiaca	Orange-flowered False-dandelion	G5	**Disjunct** from Northern Quebec; it is found only in the Gaspe peninsula
Arabis boivinii	Boivin's Rock-Cress	G4?	**Disjunct** from Northern Quebec; it is found only in the Temiscouata

			Hills and the Gaspe peninsula
Arabis holboellii var. *secunda*	Holboell's Rock-cress variety secunda	G5T5	**Disjunct**; only found in the Temiscouata Hills
Arnica griscomii subsp. *griscomii*	Griscom's Arnica subspecies griscomii	G5T5	**Restricted;** endemic to the Gulf of St.Lawrence (Labrecque et Lavoie 2002); it is legally designated in Quebec.
Arnica lanceolata	Hairy Arnica	G4	**Limited;** More common in maritime provinces, may be moved to secondary
Astragalus australis	a Milkvetch	G5	**Disjunct** from Northern Quebec; it is found only in the Gaspe peninsula
Astragalus robbinsii var. *minor*	Robbin's Milkvetch	G5T5	**Restricted;** endemic to Northeastern America (pers. comm. S. Blaney)
Bidens eatonii	Eaton's Beggar-Ticks	G2	**Limited;** found in brackish marshes of estuaries in New Brunswick and in similar habitat in adjacent ecoregions
Bidens heterodoxa	Connecticut Beggar-ticks	G2	**Restricted;** endemic to Northeastern America (Labrecque et Lavoie 2002); it is absent in US part of the ecoregion
Botrychium lineare	a Moonwort	G1	**Disjunct;** found only in the Temiscouata Hills and the Gaspe peninsula
Botrychium mormo	a Moonwort	G3	**Disjunct;** it is found only in the Temiscouata Hills
Botrychium pallidum	Pale Moonwort	G2G3	**Limited;** found only in the Temiscouata Hills and the Gaspe peninsula
Botrychium rugulosum	Rugulose Grape-Fern	G3	**Peripheral** may be at risk in Quebec and New-Brunswick
Botrychium spathulatum	Spoon-leaf Moonwort	G3	**Limited;** may be at risk in Quebec; this small fern is found only found only in the Temiscouata Hills
Carex deweyana var. collectanea	Dewey's Sedge variety collectanea	G5THQ	**Restricted;** variety only known from historic locations in Quebec ,
Carex petricosa var. *misandroides*	Rock Sedge variety misandroides	G4T1T2	**Restricted;** endemic of Northeastern America (Labrecque et Lavoie 2002); it is found only in the Gaspe peninsula
Carex schweinitzii	Schweinitz'S Sedge	G3G4	**Limited;** an S1 to S3 in all jurisdictions where present; it is known only from Vermont and more common in adjoining ecoregions.
Carex viridula var. saxilittoralis	Little Green Sedge variety saxilittoralis	G5T1	**Restricted;** endemic to the Bay of Fundy, New-Brunswick
Cerastium cerastioides - Gaspé population	Starwort Chickweed - Gaspe population	G4	**Disjunct** from Ungava, Quebec; only historical occurrences of this rare sedge are from the Gaspe peninsula.
Cirsium muticum var. *monticolum*	Swamp Thistle variety monticolum	G5T?	**Restricted;** endemic only known from the Gaspe Peninsula
Cochlearia tridactylites	Limestone Scurvy-grass	G3G5	**Limited;** from Newfoundland; only known occurrences in Nova Scotia

Coreopsis rosea	Rose Coreopsis	G3	**Peripheral**; listed endangered in Canada (COSEWIC); legally designated in Nova Scotia; it is one of the classic coastal plain plants and found on a few lakes in the Tusket River system.
Cypripedium arietinum	Ram's-Head Lady'S-Slipper	G3	**Limited;** sporadic distribution; legally designated in Quebec and may be at risk in Nova Scotia
*Draba peasei (*Syn. *Draba incerta var. Peasei)*	Pease's Draba	GXQ	**Restricted;** extinct endemic; it was known only in the Gaspe peninsula
Draba pycnosperma	a Draba	G1	**Restricted;** endemic to the Gulf of St. Lawrence (Labrecque et Lavoie 2002); it is known to more than a dozen locations in the Gaspe Peninsula but only one in Cape Breton, Nova Scotia
Eriocaulon parkeri	Parker's Pipewort	G3	**Limited**; in New Brunswick this brackish marsh species is found only found in the Miramichi estuary and is legally designated ; it is also known in Quebec and Maine but in adjacent ecoregions; it is also legally designated Quebec.
Erysimum inconspicuum var*. coarctatum*	Small-flower Prairie Wallflower variety coartatum	G5?T2	**Limited**; endemic of the Gulf of St. Lawrence Gulf (Labrecque et Lavoie 2002); it is only found in this ecoregion in the Gaspé Peninsula.
Festuca altaica	Rough Fescue	G4	**Disjunct** from Northern Quebec; it is found in the southern part of the Quebec Appalachian range and in the Gaspe peninsula
Festuca baffinensis	Baffin Fescue	G5	**Disjunct** from Northern Quebec; it is found in the Gaspe peninsula
Gentianella propinqua subsp. *propinqua*	Four-part Gentian subspecies propinqua	G5T4	**Disjunct** from Northern Quebec; it is found in the Gaspe peninsula
Gentianopsis procera subsp. macounii var. *macounii*	Four-part Gentian subspecies macounii	G5T5	**Disjunct**; legally designated in QC; it is found in the Gaspe peninsula
Geum peckii	Mountain Avens	G2	**Limited;** endemic **l**isted endangered in Canada (COSEWIC); in Canada, it is only known to occur in Nova Scotia and legally designated in that province.
Hieracium robinsonii	Robinson's Hawkweed	G2	**Limited**; it is only known to Quebec and Nova Scotia; in the latter case most locations are historical.
Hieracium scabrum var. *leucocaule*	Sable Island Rough Hawkeed	G5T1	**Restricted;** endemic to this ecoregion and Sable Island, Nova Scotia (pers. comm. S. Blaney).
Isoetes acadiensis	Acadian Quillwort	G2G3	**Restricted; t**his is relatively recently described taxon.
Isoetes prototypus	Prototype Quillwort	G1?	**Restricted; t**his pteridophyte was recently discovered and described; it is legally designated in New Brunswick

Juncus caesariensis	New Jersey Rush	G2	**Disjunct** from more southern populations; it is listed of special concern in Canada (COSEWIC) and legally designated in Nova Scotia.
Lechea maritima var. *subcylindrica*	Gulf of St.Lawrence Beach Pinweed	G5T1	**Restricted**; endemic to this ecoregion
Listera auriculata	Auricled Twayblade	G3G4	**Peripheral** and at risk throughout
Lophiola aurea	Golden Crest	G4	**Restricted**; listed threatened in Canada (COSEWIC); legally designated in Nova Scotia
Minuartia marcescens	Serpentine Stitchwort	G2	**Restricted**; endemic to this ecoregion and Northeastern America (Labrecque et Lavoie 2002); legally designated in Quebec but only 2 occurrences known in the Gaspe Peninsula
Moehringia macrophylla	Large-leaved Sandwort	G4	**Disjunct** from Northern Quebec; associated with serpentine outcrops
Oxytropis deflexa var. *foliolosa*	Pendent-pod Crazyweed	G5T?	**Disjunct;** it is found in New Brunswick and Quebec
Oxytropis viscida	Sticky Crazyweed	G5	**Disjunct** from Northern Quebec; it is found only in the Gaspe peninsula
Packera cymbalaria	Dwarf Arctic Groundsel	G5	**Disjunct** from the Northwestern America; legally designated in Quebec and found only in the Gaspe peninsula
Panax quinquefolius	American Ginseng	G3G4	**Peripheral;** Globally infrequent; listed endangered in Canada (COSEWIC); legally designated in Quebec and found only in the southern part of the Appalachians in Quebec.
Pedicularis furbishiae	Furbish Lousewort	G2	**Restricted**; endemic to this ecoregion and the St. John River; listed endangered in Canada (COSEWIC); legally designated in New Brunswick and Maine
Platanthera leucophaea	Eastern Prairie White-Fringed Orchid	G2	**Disjunct** in Maine; legally designated in US
Poa laxa subsp. *fernaldiana*	Wavy Bluegrass	G5?	**Restricted**; endemic to Northeastern America (Labrecque et Lavoie 2002); it is found only in the Gaspe peninsula
Poa secunda	Curly Bluegrass	G5	**Disjunct** from Northern Quebec; it is known to the Lower St.Lawrence and the Gaspé peninsula
Polemonium vanbruntiae	Jacob's Ladder	G3	**Limited**; listed as threatened in Canada (COSEWIC); legally designated in Quebec and found only in the southern part of the Appalachians in Quebec.
Polystichum scopulinum	Mountain Holy-fern	G5	**Disjunct**; legally designated in Quebec and found only in the Gaspe peninsula
Potamogeton hillii	Hill's Pondweed	G3	**Limited**; globally infrequent
Potentilla robbinsiana	Robbins' Cinquefoil	G1	**Restricted**; endemic; legally designated in New Hampshire

Prenanthes boottii	Boott's Rattlesnake-Root	G2	**Limited;** globally rare
Pterospora andromedea		G5	**Restricted**; legally designated in New Brunswick and Quebec
Ranunculus allenii	Allen's Buttercup population	G3G4	**Disjunct**; globally infrequent; found only in the Gaspe peninsula
Rudbeckia laciniata var. *gaspareauensis*	Gaspereau Cut-leaved Coneflower	G5TNR	**Restricted**; endemic to this ecoregion
Sabatia kennedyana	Plymouth Gentian	G3	**Peripheral;** listed as threatened in Canada (COSEWIC); legally designated in Nova Scotia
Sagittaria montevidensis subsp. *spongiosa*	Long-lobed Arrow-head subspecies spongiosa	G5T4	**Disjunct**; legally designated in Quebec; only one occurrence known in the Gaspe peninsula
Salix chlorolepis	Green-scaled Willow	G1	**Restricted**; endemic to the Gulf of St. Lawrence (Labrecque et Lavoie 2002); it is found only in the Gaspe peninsula; legally designated in Quebec.
Saxifraga gaspensis	Gaspe Saxifrage	G2	**Restricted**; endemic to Northeastern America (Labrecque et Lavoie 2002); it is found only in the Gaspe peninsula
Schoenoplectus x steinmetzii	Steinmetz's Bulrush	G1Q	**Restricted**; globally rare hybrid
Scirpus longii	Long's Bulrush	G2	**Limited**; listed of special concerned in Canada (COSEWIC); legally designated in Nova Scotia
Solidago simplex subsp. *simplex* var. *chlorolepis*	a Goldenrod	G5T1	**Restricted**; endemic of this ecoregion and the Gulf of St. Lawrence (Labrecque et Lavoie 2002); legally designated in Quebec and only found on serpentine in the Gaspe peninsula
Solidago simplex subsp. *simplex* var. *simplex*	a Goldenrod	G5T5	**Disjunct**; it is only found in the Gaspe peninsula
Spiranthes casei var. *novaescotiae*	Nova Scotia Case's Ladies-Tresses	G4T?	**Restricted**; endemic to Nova Scotia (S. Blaney)
Suaeda rolandii	Roland's Sea-Blite	G1G2Q	**Restricted**; taxonomy questionable, poorly known saltmarsh taxon of Nova Scotia
Symphyotrichum anticostense	Anticosti Aster	G2Q	**Restricted**; taxonomy questionable; endemic to the Gulf of St. Lawrence (Labrecque et Lavoie 2002); listed as threatened in Canada (COSEWIC); legally designated in Quebec and New Brunswick
Symphyotrichum laurentianum	St. Lawrence Aster	G2	**Restricted**; endemic of this ecoregion and the Gulf of St. Lawrence (Labrecque et Lavoie 2002); listed of special concern in Canada (COSEWIC) status; legally designated in New Brunswick and Quebec; only a few large population of this specie are found in the Magdalen Islands and Prince Edward Island
Symphyotrichum subulatum (Bathurst	Bathurst Aster	G5T1	**Restricted**; endemic to this ecoregion; listed as threatened in Canada

population)			(COSEWIC); legally designated in New Brunswick
Symphyotrichum subulatum (non-Bathurst population)	Annual Saltmarsh Aster	G5T5	**Restricted**; endemic to this ecoregion; listed as threatened in Canada (COSEWIC); legally designated in New Brunswick
Taraxacum latilobum	a Dandelion	G2Q	**Restricted**; taxonomy questionable; endemic to Northeastern America (Labrecque et Lavoie 2002); only historical occurrences are known from the Gaspe peninsula
Woodsia oregana var. *cathcartiana*	Oregon Woodsia (Tetraploid)	G5T5	**Disjunct** from the Laurentians (Cody and Britton, 1989); it is found only in the Temiscouata Hills
Woodsia scopulina subsp*. laurentiana*	Rocky Mountain Woodsia variety laurentiana	G5T?	**Disjunct**; it is known only in the Temiscouata Hills and the Gaspe peninsula

Setting conservation goals for plant targets

Each primary plant target was assigned to one of four range-wide distribution categories relative to the ecoregion based on available sources and expert advice from each jurisdiction. The group used the same numerical conservation goals for the primary plant targets as for the primary animal targets based on their global rarity rank (G rank) and range-wide distribution categories as described in the table 1. These numbers are initial minima recognizing that conservation biology literature suggests that even 20 occurrences of a rare species may not ensure its long term survival. Actually, few plant targets attained the numerical goal assigned to its distribution category. Nevertheless, conserving even a small number of viable populations of a species until the real number is determined, was thought to be making progress in the right direction. In future iterations of this conservation blueprint, goals will need to be reassessed and perhaps, restoration considered as the only option for some of these species. In others cases, scarcity of the habitat combined with high vulnerability, specific measures of protection may be the only means of insuring the species' survival.

Summary of portfolio results for plants

Occurrences of the primary target species that met the viability criteria were selected for inclusion in the portfolio. However, after applying the viability screening criteria to the occurrences, only 12 of the 77 primary plant targets had the minimum number of occurrences needed to meet its numerical conservation goal. Likewise only 38 of the primary target species met the distributional goal of having a viable occurrence in each subregion in which the species naturally occurs. For 26 plant targets no occurrences met the viability screen.

For plant target occurrences of the Maritime Provinces no EO ranks had been attributed and available data could not permit an equivalent assessment from specifications applied to occurrences in the US or Quebec. For many of these targets viability was ranked as "Maybe" based on last date of observation, precision, redundancy of observation, and understanding of population quality from expert's advice. Best available occurrences were included in the portfolio (with appropriate caveats) as we saw no other realistic option.

Approximately 100 out of 500 of the qualifying plant occurrences are on land managed for biodiversity (Gap 1 or 2). An additional 60 occur on land secured from conversion to development (Gap 3). More than 200 plant occurrences fall within Tier 1 matrix blocks. While not tabulated it is certain that many more were nested within systems that were selected for the portfolio. An uncalculated number (hundreds) of secondary plant target occurrences are included in selected ecosystems occurrences or selected matrix blocks.

SPECIES TARGET SUMMARIES WITH MAPS

The following summaries of the primary species targets chosen in the Northern Appalachian – Acadian ecoregional assessment offer a quick view of their distribution within the ecoregion. As such, this document accompanies the "Species Targets" chapter of the NAP report, which provides the details of assessment methods and results.

For each species, of the populations or *occurrences* that were evaluated, the number that met the selection criteria and the number that did not are given and are shown in black and grey, respectively, on an outline map of the ecoregion. In the case of plants, because so many species were selected, we summarize only those ranked G1 through G3.[1]

The summaries follow the order in which results are reported. Follow the links below to go directly to each section:

Non Avian Vertebrates: Mammals, Reptiles, Amphibians, Fish

Birds

Invertebrates: Insects and Mussels

Plants

[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.

Non-Avian Vertebrate Species Targets in the Northern Appalachian – Acadian Ecoregion

Mammals, Reptiles, Amphibians and Fish

Distribution Maps

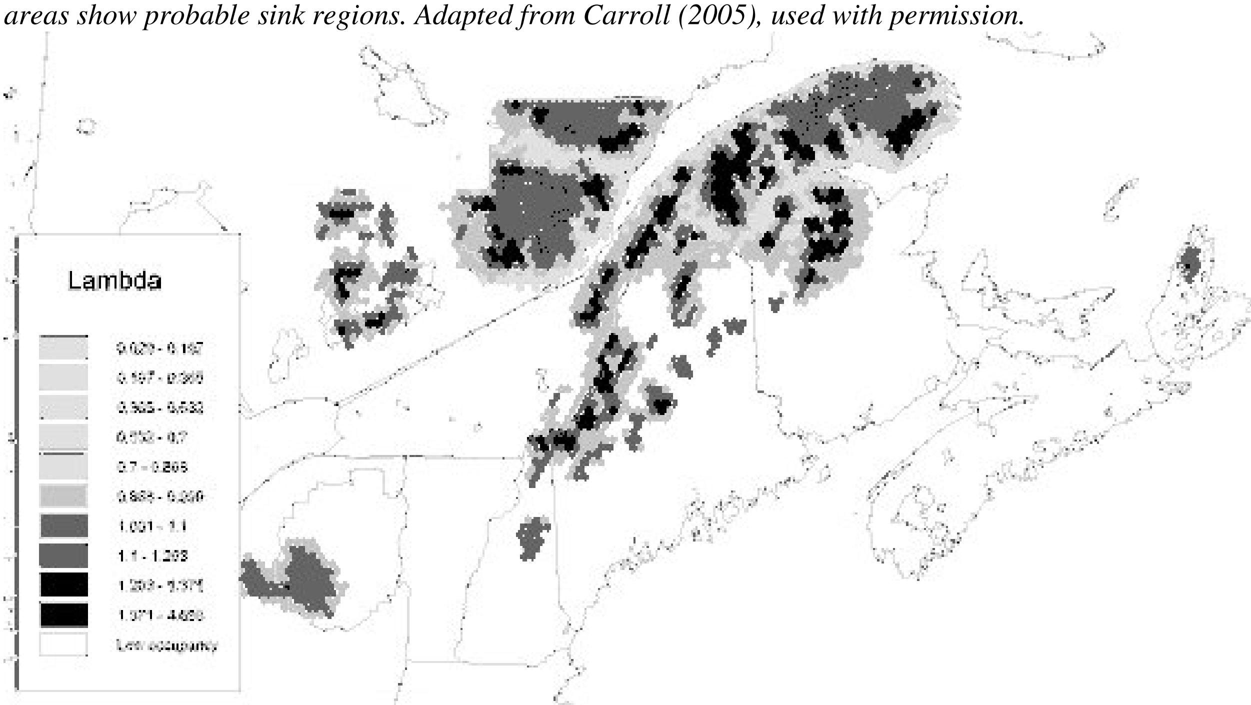
(Portfolio examples shown in black)

MAMMALS

Lynx (Lynx canadensis)

A large cat with prominent ear tufts that favors old growth boreal forests with a dense undercover of thickets and windfalls. Wide-ranging and requiring large-areas, the Gaspe population is an important source for the rest of the ecoregion where it is either extirpated or S1. Listed as Threatened under US Endangered Species Act. Occurrences were not used to develop a plan for this target. Instead we worked with partners to develop a source-sink model.

Fig 1. Source – Sink model for Canada Lynx. Dark gray areas show probable source regions. Light gray areas show probable sink regions. Adapted from Carroll (2005), used with permission.



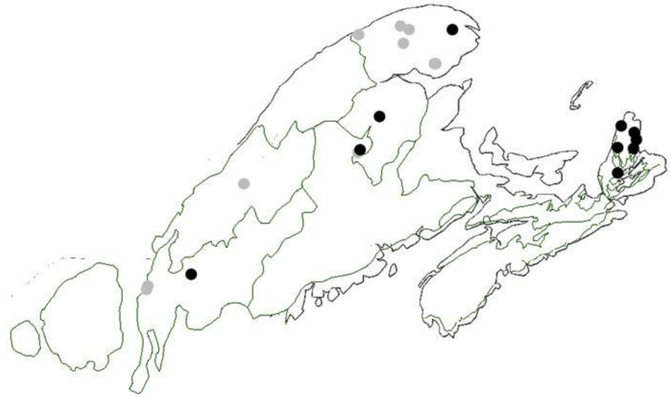
Rock vole (Microtus chrotorrhinus)

A medium-sized, short-tailed, brown mouse with a yellow-orange snout inhabits cool, damp, coniferous and mixed forests at higher elevations and mossy rocky areas throughout Canada. Scattered in SE Canada, NE US, and Appalachian Mountains, uncommon.

21 populations assessed

10 met criteria as critical occurrences (black)

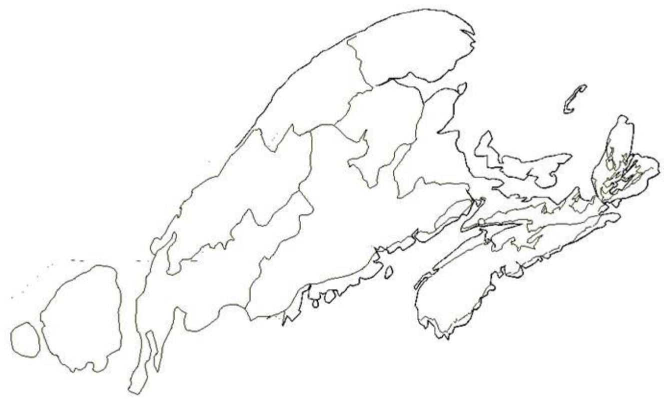
11 below criteria (grey)



Penobscot meadow vole (Microtus p. shattucki)

Newly recognized sub-species, endemic to ME.

0 populations assessed



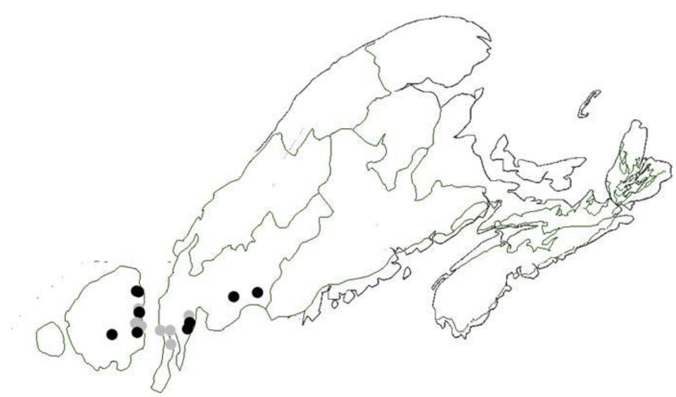
Eastern small-footed myotis (Myotis leibii)

Small bat with a dark mask and dark ears. Inhabits hilly or mountainous areas, in or near forest, sometimes in open farmland. Spotty distribution, rarely in large numbers, hibernacula are key.

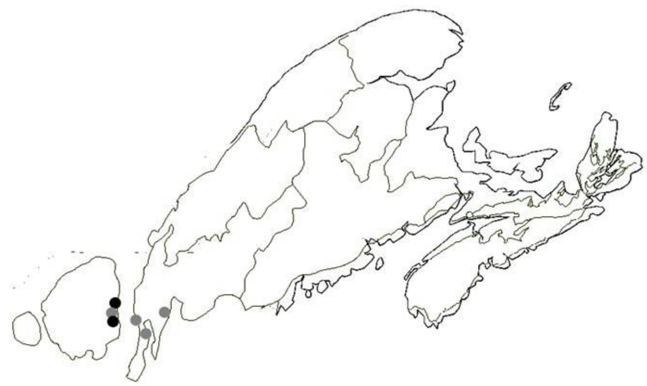
22 populations assessed

11 met criteria as critical occurrences (black)

11 below criteria (grey)



Indiana or Social myotis (Myotis sodalis)



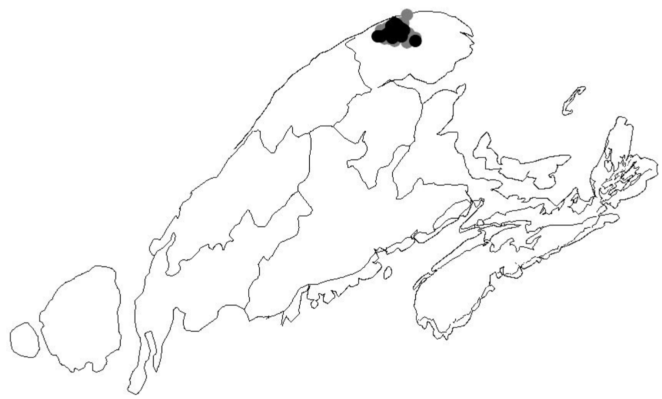
A small dull gray bat with pinkish white underparts. In hibernation, limestone caves with pools are preferred. Roosts are usually in the coldest part of the cave. Nine priority hibernacula house 75% of population, vulnerable to human disturbance.

6 populations assessed

2 met criteria as critical occurrences (black)

2 below criteria, 1 maybe, 1 blank (grey)

Woodland caribou (Gaspé population) (Rangifer tarandus)



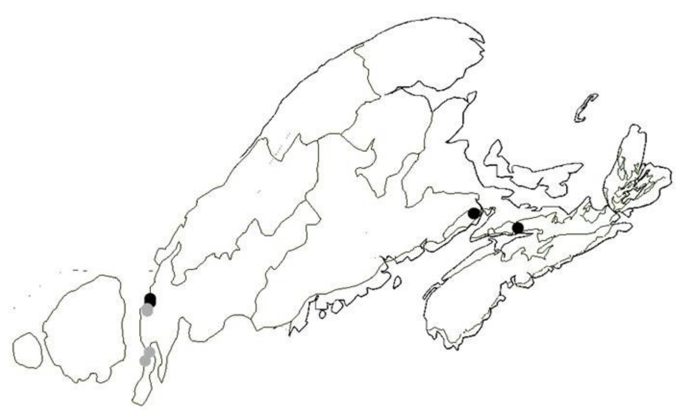
A distinct subpopulation distinguished by a coat that is mostly brown in summer and more grey in winter, and a creamy white neck, mane, shoulder stripe, underbelly, underside of the tail, and patch just above each hoof. Both sexes have antlers. Disjunct population ~250 individuals in isolated population on high peaks of Chics Chocs and McGerrigle Mountains

79 occurrences assessed

35 met criteria as critical occurrences (black)

44 below criteria (grey)

Long-tailed or Rock shrew (Sorex dispar)



Medium-sized grey shrew with a long tail and pointed snout. Prefers talus slopes in cool damp forests. Found in VT, NB, NS.

9 populations assessed

5 met criteria as critical occurrences (black)

4 below criteria (grey)

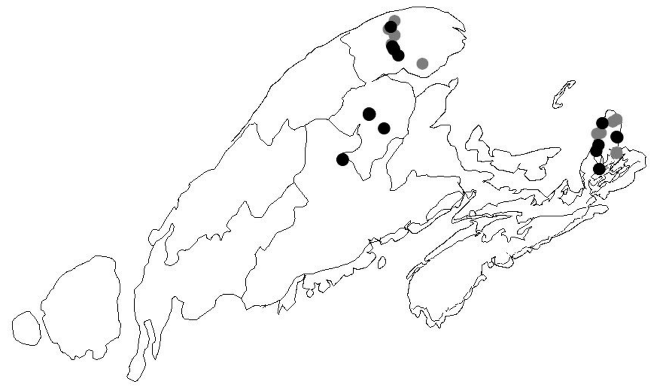
Gaspé shrew (Sorex gaspensis)

A local endemic, this small, light grey shrew with a pointed snout prefers steep rocky slopes near streams. Related to the somewhat larger Long tailed shrew (Sorex dispar).

31 populations assessed

18 met criteria as critical occurrences (black)

12 below criteria, 1 unknown (grey)



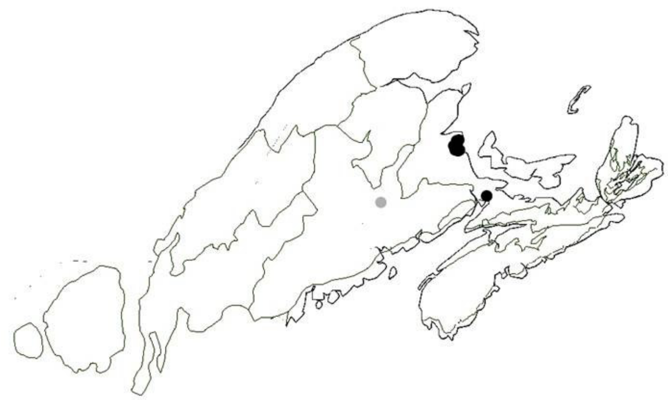
Maritime shrew (Sorex maritimensis)

A regional endemic, restricted to NB and NS, this shrew exhibits a dark band along the upper body, which runs from nose to tail; the sides are brown; fading to a pale greyish underneath. Found in grass-sedge marshes, wet meadows, and other moist openings in and adjacent to boreal forest.

15 populations assessed

14 met criteria as critical occurrences (black)

1 below criteria (grey)



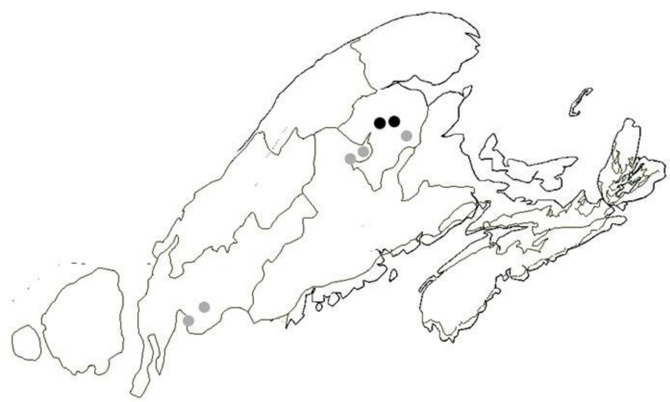
Northern bog lemming (Synaptomys borealis)

A small, short-tailed lemming. Occurs in sphagnum bogs, wet meadows, moist mixed and coniferous forests, alpine sedge meadows, krummholz spruce-fir forest with dense herbaceous and mossy understory, mossy streamsides. Widespread but localized; not common anywhere.

8 populations assessed

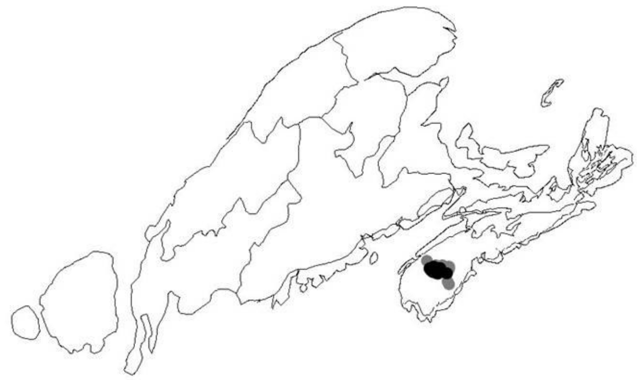
2 met criteria as critical occurrences (black)

5 below criteria, 1 maybe (grey)



REPTILES & AMPHIBIANS

Blanding's turtle (Emys blandingii)



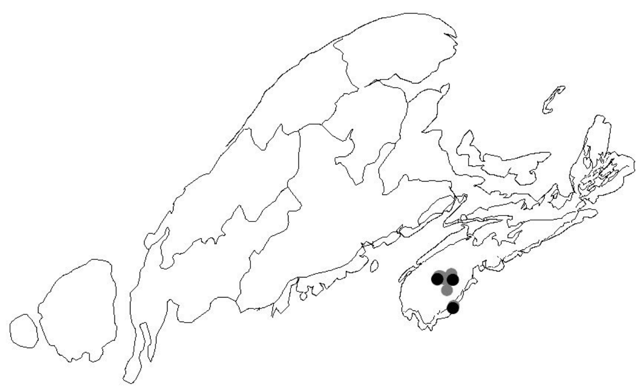
A medium-sized turtle with a yellow chin and throat, and a long neck. Occurs in marshes, ponds, swamps, lake shallows, backwater sloughs, shallow slow-moving rivers, protected coves and inlets of large lakes, and pools adjacent to rivers. Disjunct in Kejimkujik National Park, it does not occur in U.S. part of ecoregion although it occurs as a rare species in adjoining ecoregion.

110 populations assessed

58 met criteria as critical occurrences (black)

24 below criteria, 24 maybe, 28 unknown (grey)

Eastern ribbon snake (Thamnophis sauritus)



A large black or brown snake with three yellow to orange stripes – reaches to almost a meter in length. Wet meadows, marshes, bogs, ponds, lake shorelines, swamps, and shallow slow streams. Peripheral to ecoregion, occurs in NY and NE but populations in Maritimes are disjunct.

14 populations assessed

3 met criteria as critical occurrences (black)

11 below criteria (grey)

FISHES

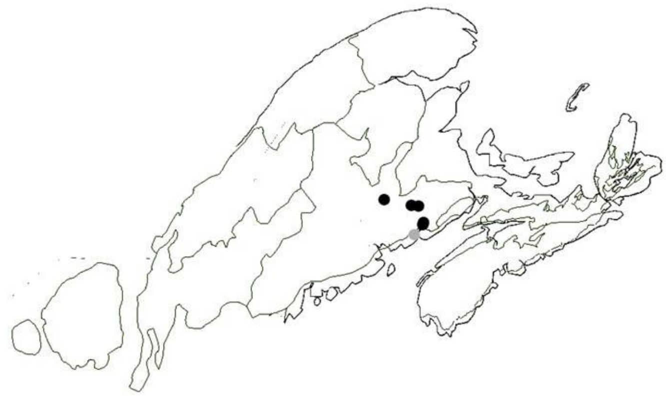
Shortnose sturgeon (Acipenser brevirostrum)

A large fish, up to one meter in length, inhabits rivers, estuaries, and the sea although most abundant in estuaries. Special concern; viable populations found in NB, ME.

6 occurrences assessed

5 met criteria as critical occurrences (black)

1 below criteria (grey)



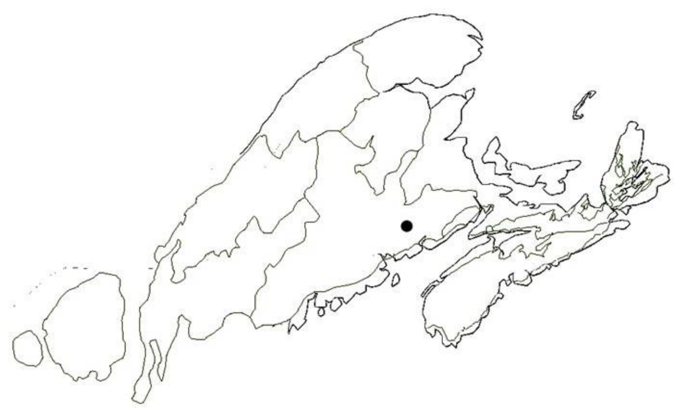
Atlantic sturgeon (Acipenser oxyrhynchus)

A large fish, up to 4.3 meters in length, is primarily marine, but stays close to shore when not breeding; migrates to rivers for spawning. Occurs in Atlantic and Gulf coasts – depleted populations.

1 occurrence assessed

1 met criteria as critical occurrence (black)

0 below criteria (grey)



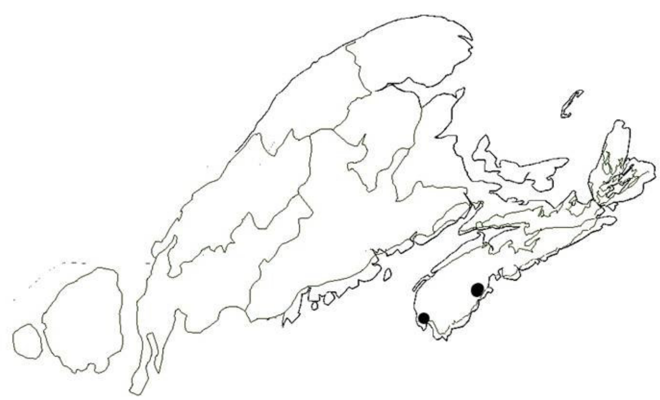
Atlantic whitefish (Coregonus huntsmani)

A fish with silvery sides and a forked caudal fin, up to 40 cm long. Occurs in lakes, small to large rivers, estuaries and near shore coastal waters in NS - only in a few areas.

4 occurrences assessed

4 met criteria as critical occurrences (black)

0 below criteria (grey)



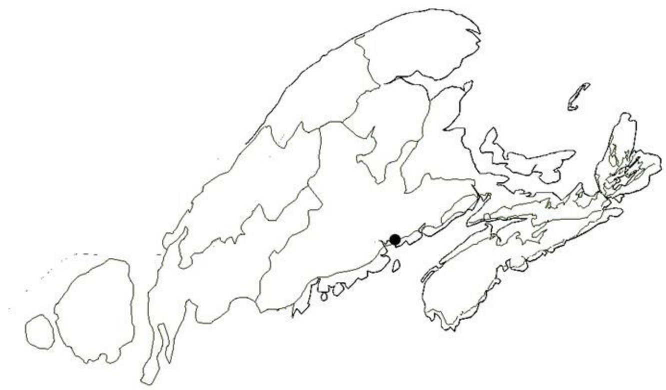
Lake Utopia dwarf smelt (Osmerus sp. 1)

A ecoregion endemic, this 12 centimeter long smelt varies in hue from pale green to dark blue on its back; its silvery sides have a blue, purple and pink sheen. It occurs only in Lake Utopia, a coldwater lake in New Brunswick.

1 occurrence assessed

1 met criteria as critical occurrence (black)

0 below criteria (grey)



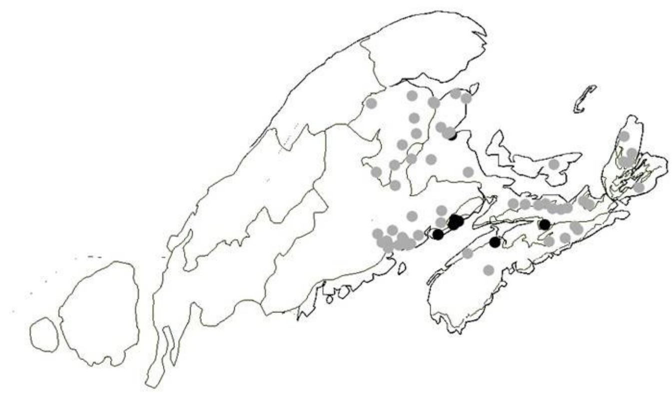
Atlantic salmon (anadromous) (Salmo salar)

This medium sized fish averages 60 cm in length and requires clean, cool, flowing water free from chemical or organic pollution, natural stream channels with rapids and pools, a gravelly bottom. Wide-ranging species but declining, subpopulations at risk, listed as Endangered by US ESA; Inner Bay of Fundy populations listed as endangered by COSEWIC.

61 occurrences assessed

7 met criteria as critical occurrences (black)

54 below criteria (grey)



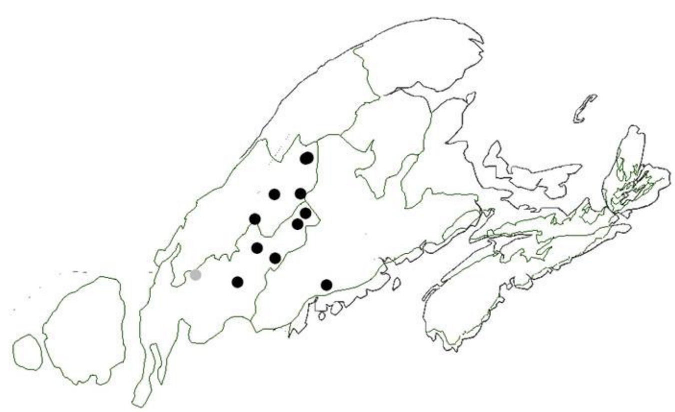
Landlocked arctic charr (Blue backed trout) (Salvelinus alpinus oquassa)

This subspecies, endemic to the ecoregion, ranges from white/silvery to bright orange with cream-colored spots during spawning but non-breeding individuals are usually pale and non-descript. They occur in deep cold ponds and lakes. Extirpated from NH, VT.

14 occurrences assessed

13 met criteria as critical occurrences (black)

1 below criteria (grey)



Bird Species Targets in the Northern Appalachian – Acadian Ecoregion Distribution Maps

(Portfolio examples shown in black)

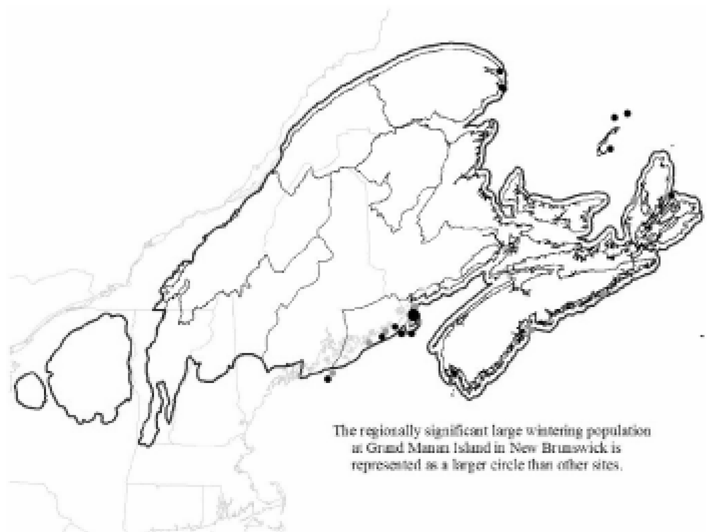
Razorbill (Alca torda)

This chunky alcid breeds in small numbers on a few islands off the coasts. It nests on rocky cliffs, and winters in large groups on the ocean. The mapped points are breeding locations; the exception is a major wintering concentration, on Grand Manan Island in New Brunswick.

29 occurrences assessed

13 met criteria as critical occurrences (black)

16 below criteria (gray)



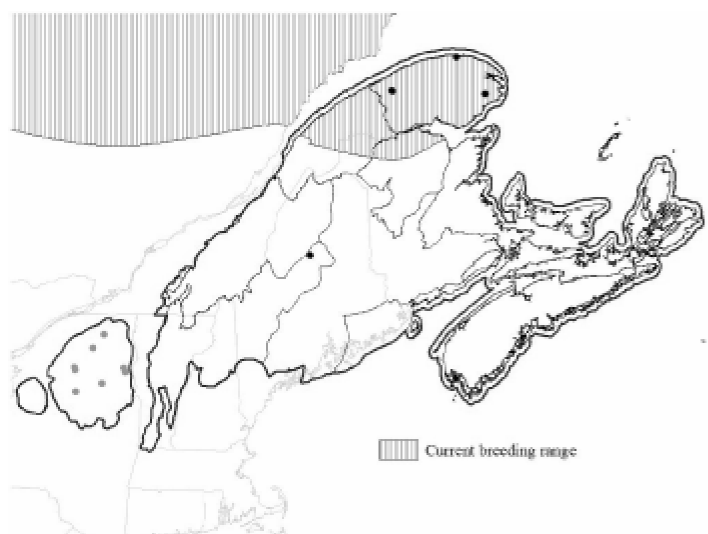
Golden eagle (Aquila chrysaetos)

This large raptor is rare in the ecoregion. It inhabits cliffs and mountaintops, especially near wetlands. The four nest sites in the Gaspé are the only ones known to be currently producing young in the ecoregion— all but one of the Adirondack occurrences are historic.

13 occurrences assessed

6 met criteria as critical occurrences (black)

7 below criteria (gray)



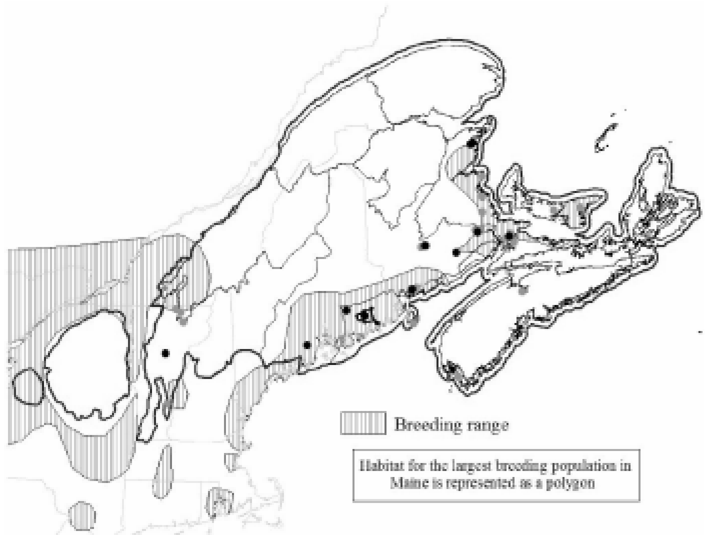
Upland sandpiper (Bartramia longicauda)

Breeding sites are few in the ecoregion, which is peripheral to this species' core distribution. Upland sandpipers nest in large upland fields, natural grasslands, and extensive blueberry barrens. Disruption to and loss of these habitats pose serious threats.

31 locations assessed

11 met criteria as critical occurrences (black)

20 below criteria (gray)



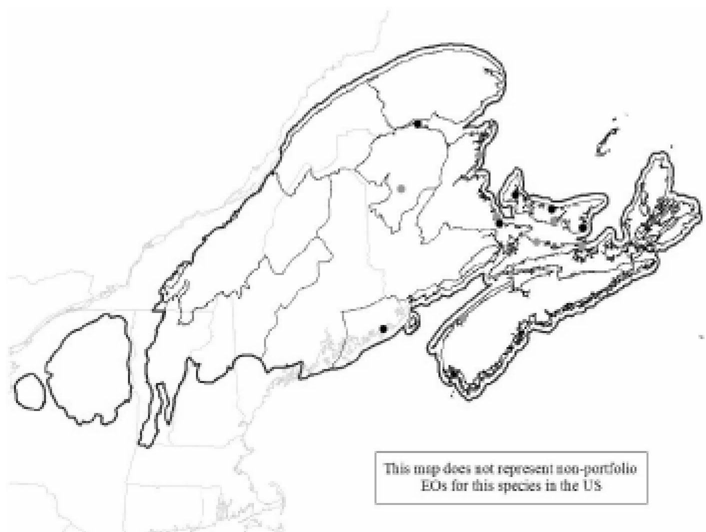
Barrow's goldeneye, Eastern population (Wintering) (Bucephala islandica)

This sea duck does not breed within the ecoregion, but bays and estuaries and rivers that remain ice-free in winter offer important shelter for large over-wintering eastern populations.

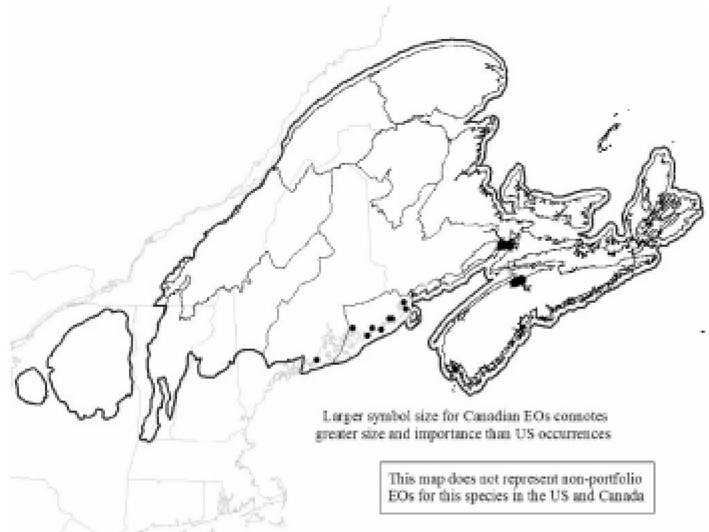
16 populations assessed

6 met criteria as critical occurrences (black)

10 below criteria (gray)



Semipalmated sandpiper, migrant concentrations (Calidris pusilla)



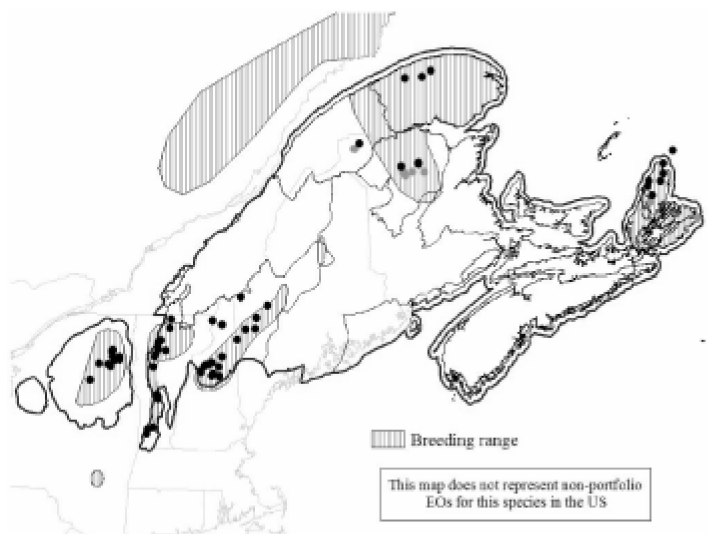
Points on this map represent autumn stopover sites in the Gulf of Maine and the Bay of Fundy, where this shorebird feeds and roosts on extensive mudflats. A high proportion (75%) of the global population passes through this ecoregion in migration, concentrating at relatively few sites, usually with many other shorebird species.

15 sites assessed

15 met criteria as critical occurrences (black)

0 below criteria

Bicknell's thrush (Catharus bicknelli)



Endemic to the ecoregion this thrush nests in thick stunted spruce forests at high elevation, and is difficult to detect, except by song. It is also at risk from loss of habitat on its wintering range on the island of Hispaniola.

66 occurrences assessed

59 met criteria as critical occurrences (black)

7 below criteria (gray)

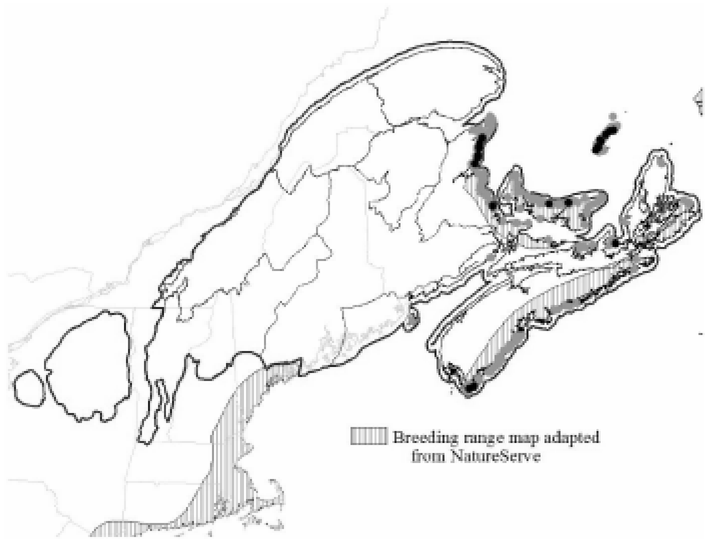
Piping plover (Charadrius melodus)

This globally rare small shorebird nests on sand beaches, where it is particularly vulnerable to human disruption, predators, and high tides. Within this ecoregion it occurs only on Canadian shores.

365 occurrences assessed

23 met criteria as critical occurrences (black)

342 below criteria (gray)



Sedge wren (Cistothorus platensis)

Once common in this ecoregion, this small, inconspicuous wren is now rare. It nests in wet grassy meadows or sedge-dominated marshes.

13 occurrences assessed

7 met criteria as critical occurrences (black)

6 below criteria (gray)

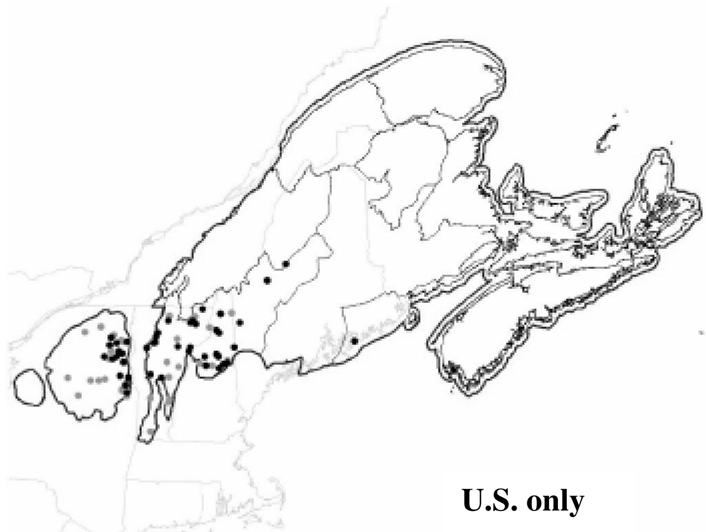
Peregrine falcon (Falco peregrinus anatum)

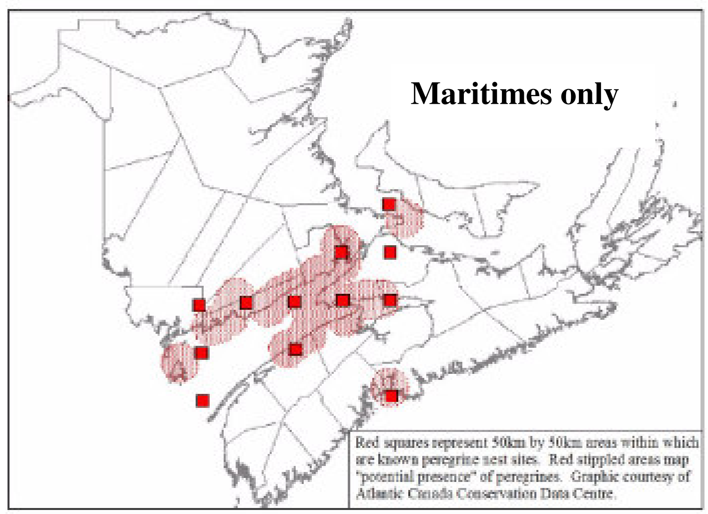
The peregrine is recovering from severe decline due to pesticide impacts on breeding success. It is rare throughout the ecoregion where it nests on cliffs near open areas, seabird colonies or heronries.

113 occurrences assessed

63 met criteria as critical occurrences (black)

50 below criteria (gray)





Harlequin duck, Eastern population (Wintering) (Histrionicus histrionicus pop 1)

At risk throughout its eastern range. Large concentrations of this sea duck overwinter in relatively few locations on exposed rocky coastlines, where it feeds on mussels.

41 wintering locations assessed

10 met criteria as critical occurrences (black)

31 below criteria (gray)

Ipswich sparrow (Passerculus sandwichensis princes)

Endemic to the ecoregion. This is a subspecies of Savannah Sparrow. There is only one breeding location known, Sable Island, Nova Scotia, where it nests on open dunes and grasslands.

1 population assessed

1 met criteria as critical occurrence (black)

0 below criteria

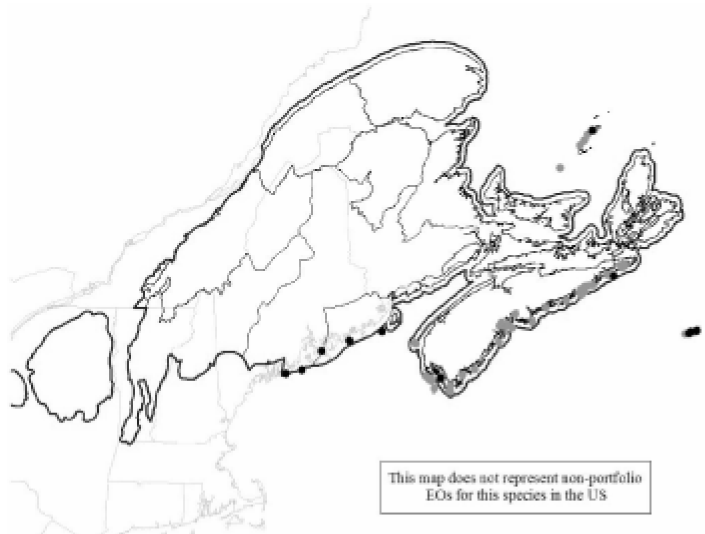
Roseate tern (Sterna dougallii)

Limited to this and adjacent ecoregions, the roseate tern is entirely maritime. It breeds on coastal islands or rocky or sandy beaches in Maine and Nova Scotia.

65 breeding locations assessed

11 met criteria as critical occurrences (black)

54 below criteria (gray)



Invertebrate Species Targets in the Northern Appalachian – Acadian Ecoregion

Distribution Maps

(Portfolio examples shown in black)

INSECTS

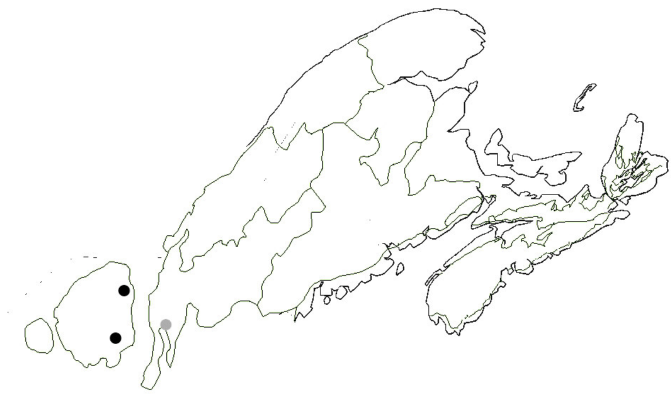
A Tiger beetle (Cicindela ancocisconensis)

A globally rare, habitat specialist. Prefers open sand or a matrix of sand and cobble along permanent streams or medium-sized rivers. Within ecoregion occurs only in NH, VT, NY and Quebec.

3 populations assessed

2 met criteria as critical occurrences (black)

1 below criteria (grey)



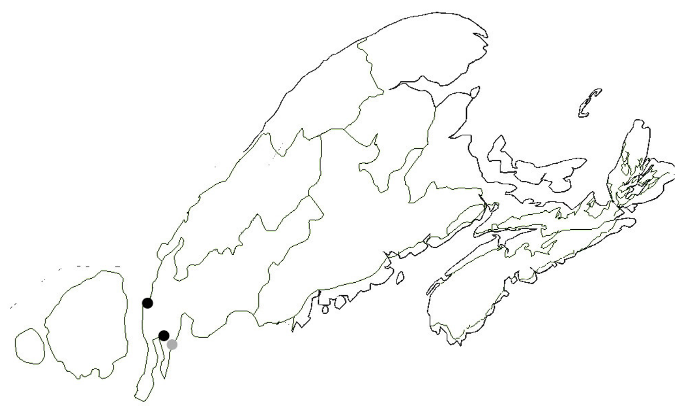
Cobblestone tiger beetle (Cicindela marginipennis)

A globally rare, large, dark tiger beetle with whitish markings. Habitat is almost always cobblestone islands in rivers. Within ecoregion occurs only in NH, VT, NY and NB.

3 populations assessed

2 met criteria as critical occurrences (black)

1 below criteria (grey)



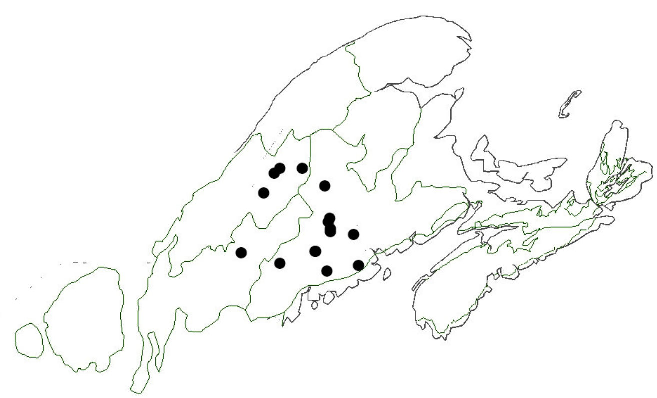
Tomah mayfly (Siphlonisca aerodromia)

Ecoregional endemic, only in NY, Maine and Quebec. Benthic - low gradient, pool riverine habitat; also in bogs, fens.

16 populations assessed

16 met criteria as critical occurrences (black)

0 below criteria (grey)



Maritime ringlet (Coenonympha nipisiquit)

An ecoregional endemic, this dark ochre to ochre-brown butterfly lives exclusively in salt marshes. It only occurs at few locations on the Baie de Chaleur, Quebec and New Brunswick.

5 populations assessed

5 met criteria as critical occurrences (black)

0 below criteria (grey)

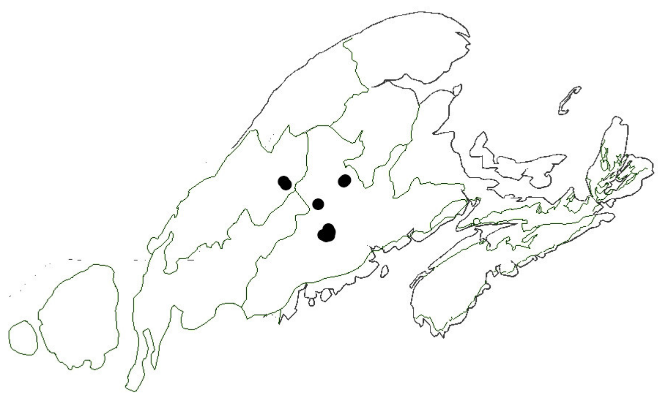
Clayton's copper (Lycaena dorcas claytoni)

An endemic subspecies, this small, orange-brown butterfly prefers calcareous fens or streamside shrublands. Known populations are restricted to a few cinquefoil fens.

11 populations assessed

11 met criteria as critical occurrences (black)

0 below criteria (grey)



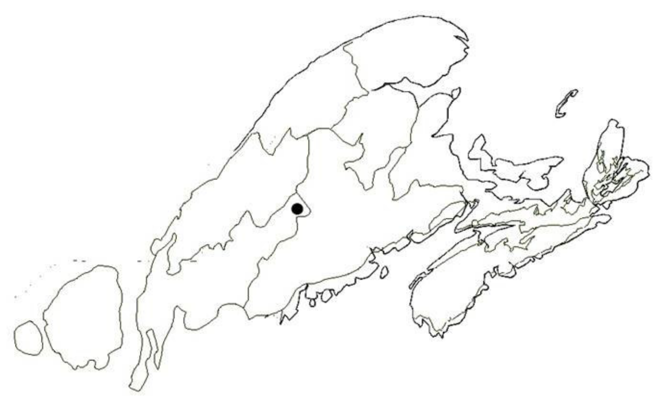
Katahdin arctic (Oeneis polixenes katahdin)

An ecoregion endemic, this grey-brown, translucent butterfly inhabits moist true arctic and arctic-alpine tundra, windswept summits, ridges, well above and north of timberline. Only global location for subspecies is Mt. Katahdin in Maine.

1 population assessed

1 met criteria as critical occurrence(black)

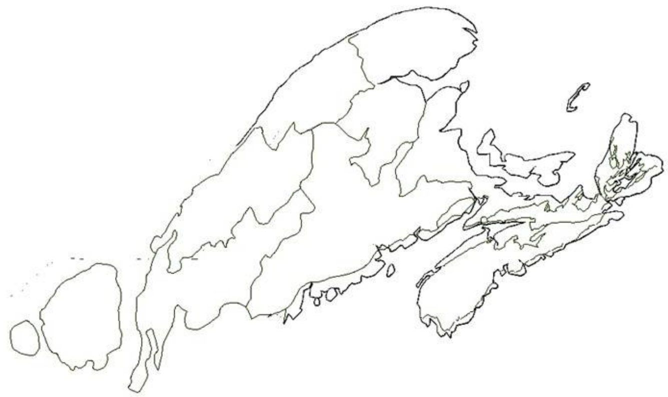
0 below criteria (grey)



Umber shadowdragon (Neurocordulia obsolete)

Brown and dull yellow dragonfly. Poorly known in ecoregion, only one documented record in NB - large, slow lotic waters.

0 populations assessed



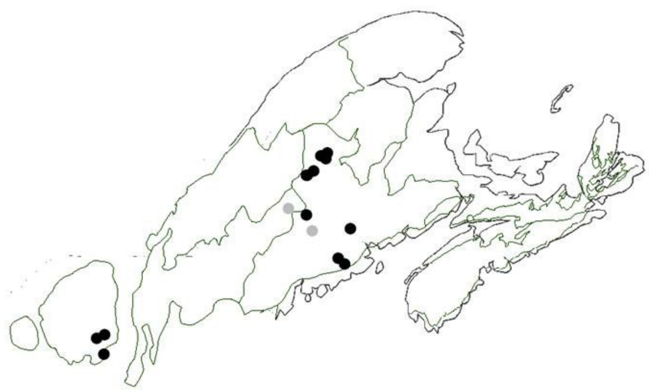
Pygmy snaketail (Ophiogomphus howei)

A small, stocky dragonfly that prefers clear rivers with strong current over coarse cobbles and with periodic rapids sections. One record for NB, rare in the Maritimes and in northern New England.

15 populations assessed

13 met criteria as critical occurrences (black)

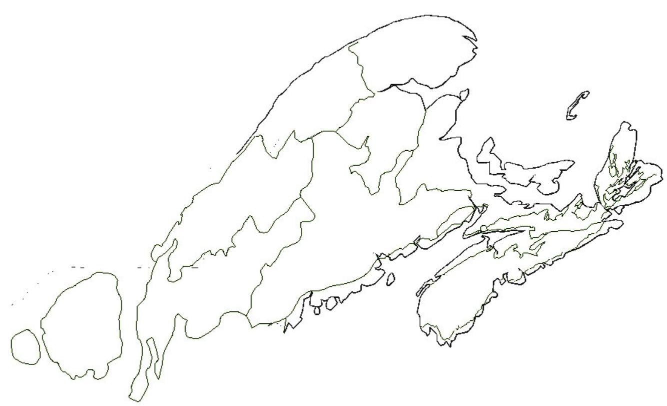
1 below criteria, 1 maybe (grey)



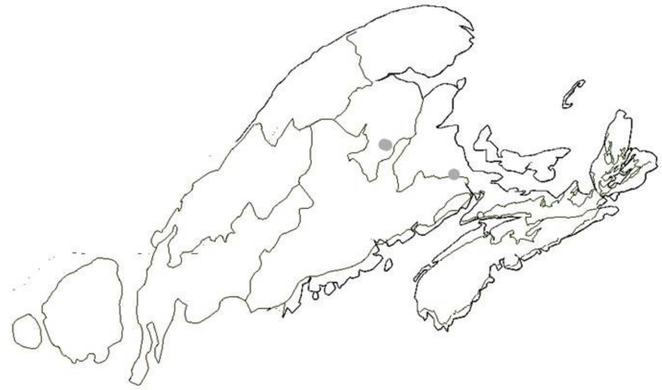
Frigga fritillary (Boloria frigga)

A butterfly with orange-brown wings spotted with black markings and darker bases. Sedge and sphagnum bogs, arctic tundra. Peripheral/disjunct, newly discovered in ME, not previously known from ecoregion or northeastern NA.

0 populations assessed



Quebec emerald (Somatochlora brevicincta)



A moderate sized dragonfly, distinguished by a metallic green thorax with one lateral light stripe and a black dorsal abdomen. Habitat is predominantly bogs, fens, and heaths. Limited to a few ecoregions of northeastern NA and less than 20 known occurrences.

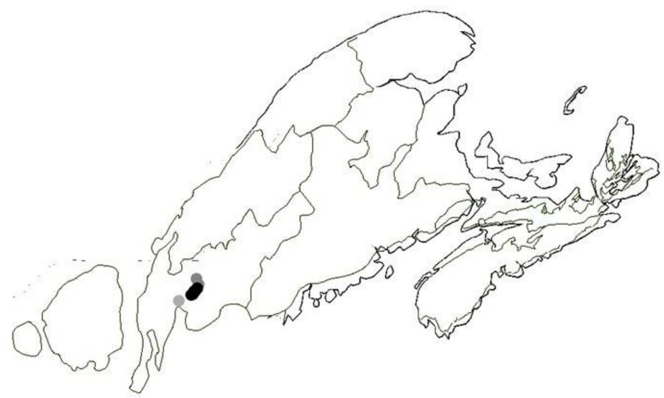
3 populations assessed

0 met criteria as critical occurrences (black)

3 maybe below criteria (grey)

MOLLUSKS

Dwarf wedgemussel (Alasmidonta heterodon)



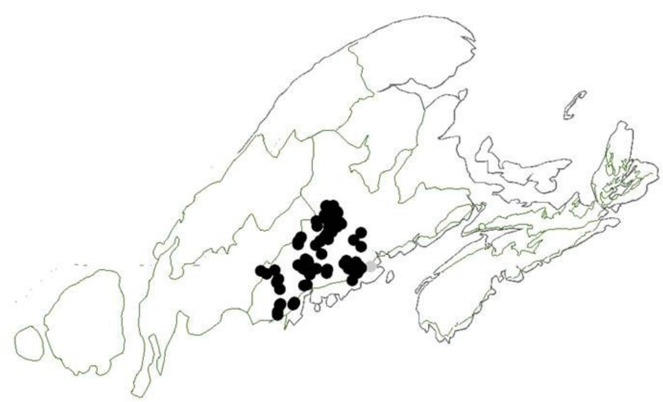
A small freshwater mussel with a trapezoidal-shaped shell found in shallow to deep quick running water on cobble, fine gravel, or on firm silt or sandy bottoms. Globally rare and declining, S1 in NH, VT and NY and SH in NB, unknown in Maine.

9 occurrences assessed

5 met criteria as critical occurrences (black)

1 below criteria, 1 maybe, 2 unknown (grey)

Brook floater (Alasmidonta varicosa)



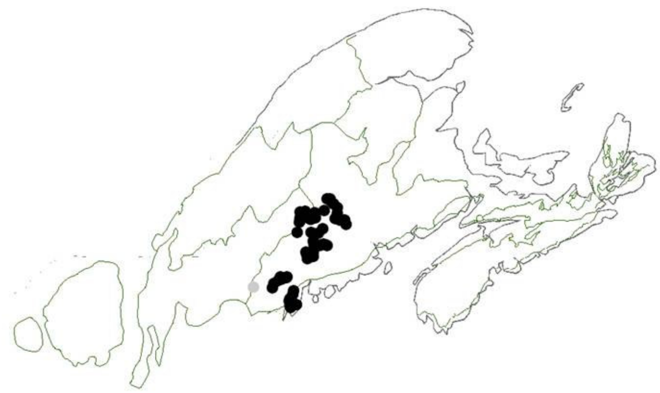
Freshwater mussel with a kidney-shaped shell. Occurs in creeks and small rivers where it is found among rocks in gravel substrates and in sandy shoals. Globally rare and declining, S1 in NS, NH, VT, and NY, S3 in Maine.

84 occurrences assessed

83 met criteria as critical occurrences (black)

1 below criteria (grey)

Yellow lampmussel (Lampsilis cariosa)



A medium-sized freshwater bivalve with rounded inflated shell. Considered to be a species of larger streams and rivers, typically found in sand and gravel where good current exists. Declining in much of range, healthiest populations appear to be within this ecoregion.

63 occurrences asessed

62 met criteria as critical occurrences (black)

1 below criteria (grey)

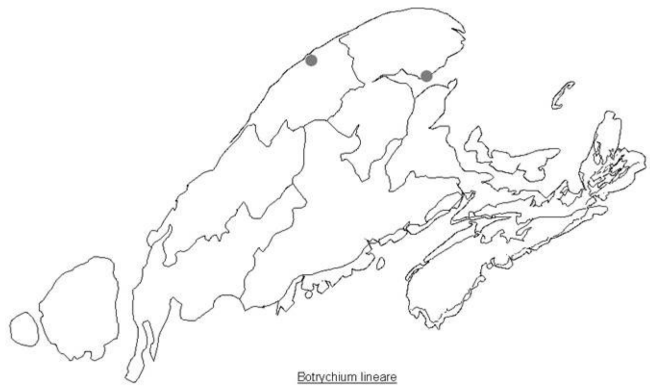
Plant Species Targets in the Northern Appalachian-Acadian Ecoregion
Distribution Maps
(Portfolio examples shown in black)

G1 Ranked Plant Targets

Botrychium linearae (a Moonwort)

Grank: G1

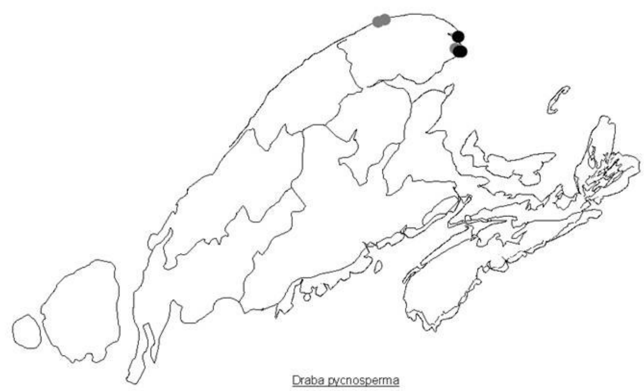
- 2 populations assessed
- 0 met criteria as critical occurrence (black)
- 2 below criteria (grey)



Draba pycnosperma (a Draba)

Grank: G1

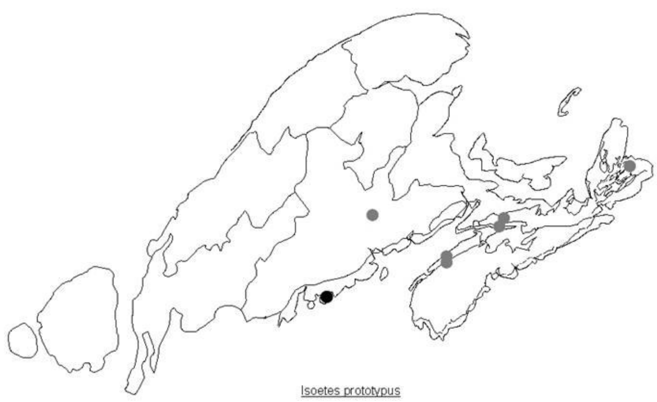
- 12 populations assessed
- 4 met criteria as critical occurrences (black)
- 4 below criteria (grey)



Isoetes prototypes (Prototype Quillwort)

Grank: G1?

- 7 populations assessed
- 1 met criteria as critical occurrence (black)
- 6 below criteria (grey)



Potentilla robbinsiana (Robbins' Cinquefoil)

Grank: G1

2 populations assessed

2 met criteria as critical occurrences (black)

0 below criteria (grey)

Potentilla robbinsiana

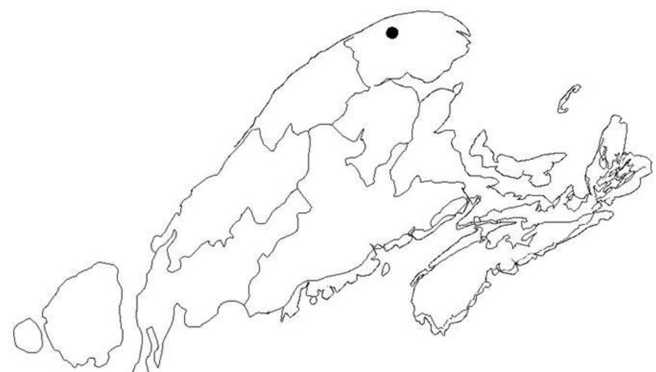
Salix chlorolepis (Green-scaled Willow)

Grank: G1

1 populations assessed

1 met criteria as critical occurrence (black)

0 below criteria (grey)



Salix chlorolepis

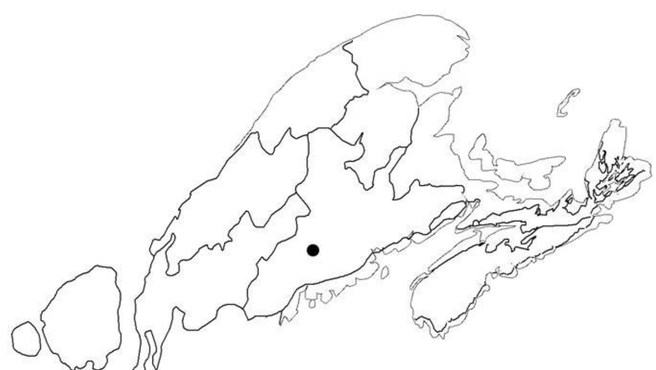
Schoenoplectus x steinmetzii (Steinmetz's Bulrush)

Grank: G1Q

1 populations assessed

1 met criteria as critical occurrence (black)

0 below criteria (grey)



Schoenoplectus x steinmetzii

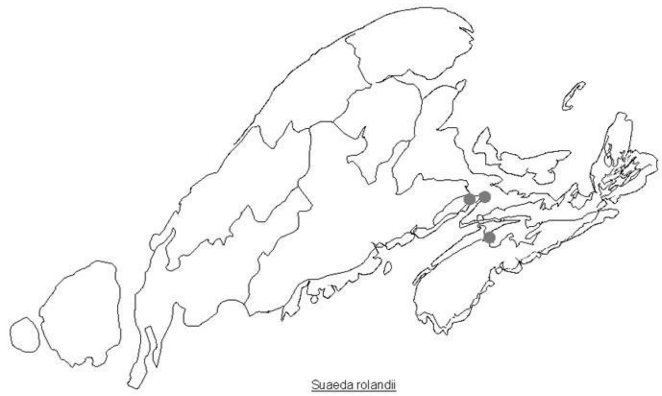
Suaeda rolandii (Rolands's Sea-Blite)

Grank: G1G2Q

3 populations assessed

0 met criteria as critical occurrence (black)

3 below criteria (grey)



G2 Ranked Plant Targets

Adiantum virdimontanum (Green Mountain Maidenhair Fern)

Grank: G2

35 populations assessed

18 met criteria as critical occurrences (black)

16 below criteria, 1 unknown (grey)

Bidens eatonii (Eaton's Beggar-Ticks)

Grank: G2

4 populations assessed

2 met criteria as critical occurrences (black)

1 below criteria, 1 blank (grey)

Bidens heterodoxa (Connecticut Beggar-ticks)

Grank: G2

20 populations assessed

5 met criteria as critical occurrences (black)

8 below criteria, 7 maybe (grey)

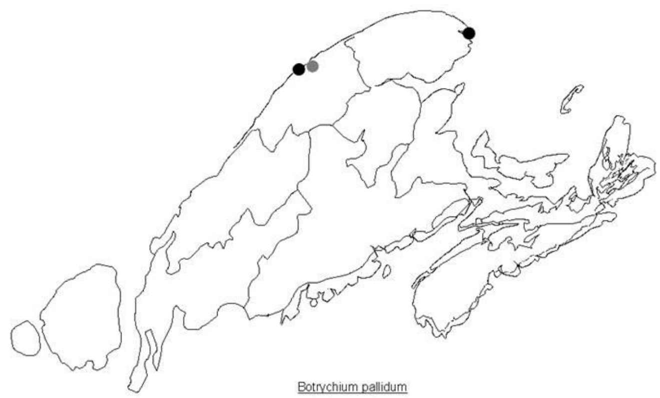
Botrychium pallidum (Pale Moonwort)

Grank: G2G3

3 populations assessed

2 met criteria as critical occurrences (black)

1 below criteria (grey)



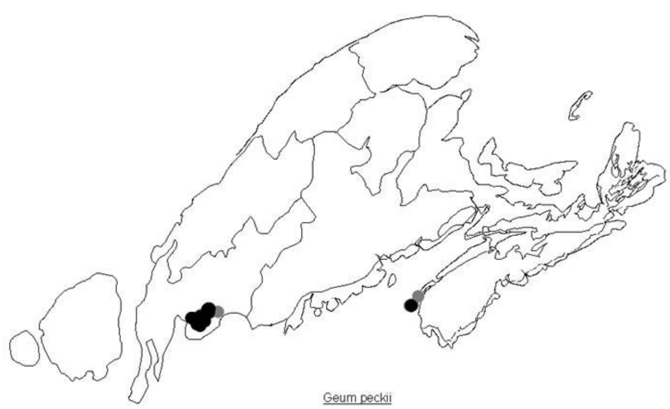
Geum peckii (Mountain Avens)

Grank: G2

53 populations assessed

24 met criteria as critical occurrences (black)

20 below criteria, 7 maybe, 2 unknown (grey)



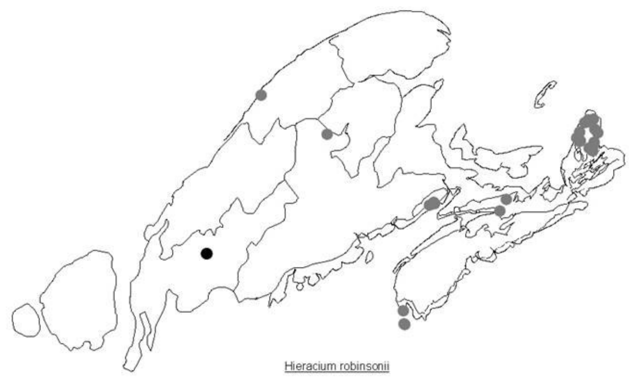
Hieracium robinsonii (Robinson's Hawkweed)

Grank: G2

25 populations assessed

1 met criteria as critical occurrence (black)

21 below criteria, 3 maybe (grey)



Hieracium robinsonii

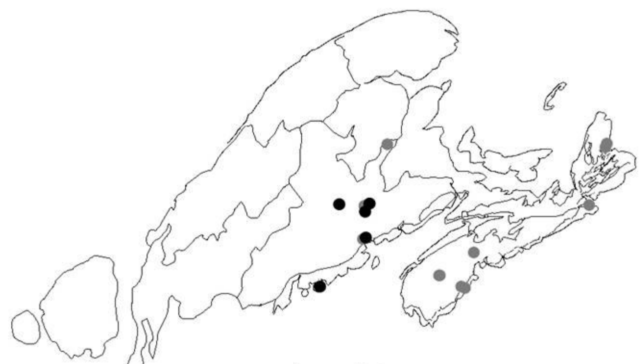
Isoetes acadiensis (Acadian Quillwort)

Grank: G2G3

16 populations assessed

5 met criteria as critical occurrences (black)

8 below criteria, 3 maybe (grey)



Isoetes acadiensis

Juncus caesariensis (New Jersey Rush)

Grank: G2

25 populations assessed

1 met criteria as critical occurrence (black)

8 below criteria, 16 maybe (grey)

Juncus caesariensis

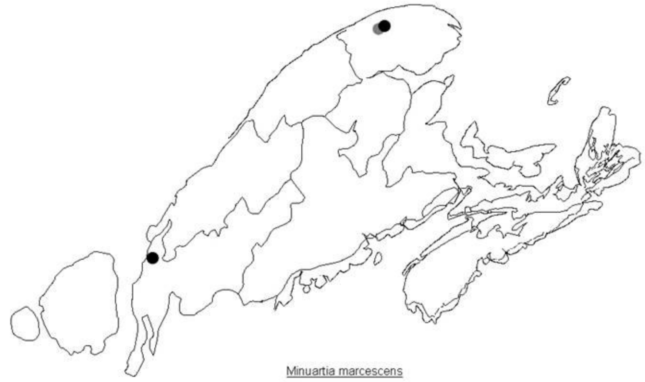
Minuartia marcescens (Serpentine Stitchwort)

Grank: G2

3 populations assessed

2 met criteria as critical occurrences (black)

1 below criteria (grey)



Minuartia marcescens

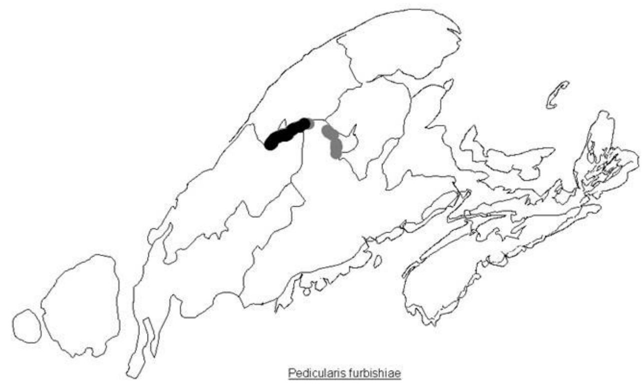
Pedicularis furbishiae (Furbish Lousewort)

Grank: G2

44 populations assessed

16 met criteria as critical occurrences (black)

24 below criteria, 2 unknown, 2 blank (grey)



Pedicularis furbishiae

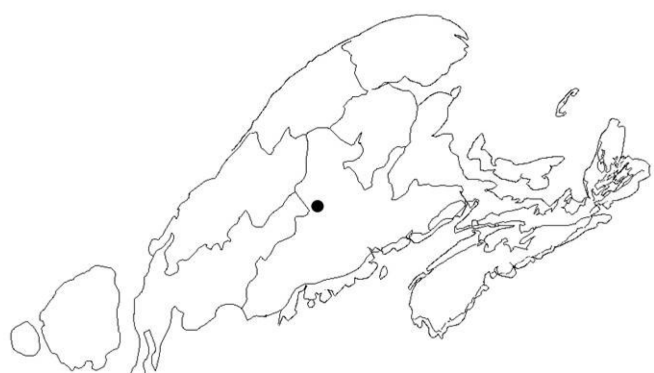
Platanthera leucophaea (Eastern Prairie White-Fringed Orchid)

Grank: G2

1 populations assessed

1 met criteria as critical occurrence (black)

0 below criteria (grey)



Platanthera leucophaea

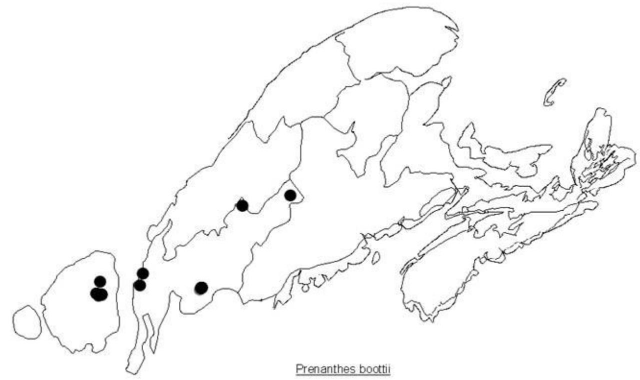
Prenanthes bottii (Boott's Rattlesnake-Root)

Grank: G2

16 populations assessed

15 met criteria as critical occurrences (black)

1 below criteria (grey)



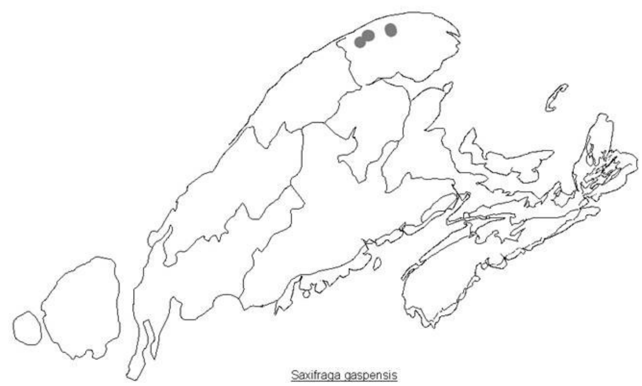
Saxifraga gaspensis (Gaspe Saxifrage)

Grank: G2

5 populations assessed

0 met criteria as critical occurrence (black)

5 below criteria (grey)



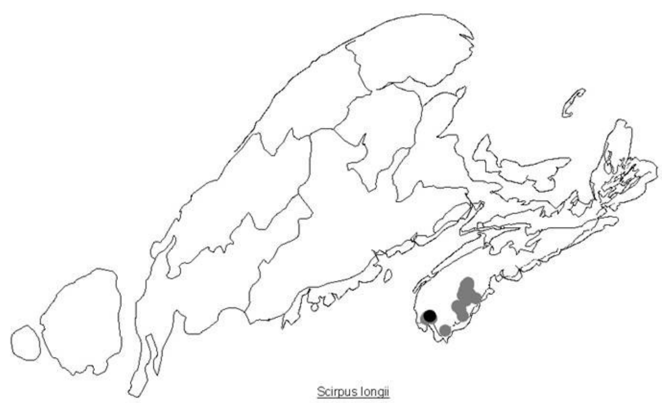
Scirpus longii (Long's Bulrush)

Grank: G2

29 populations assessed

1 met criteria as critical occurrence (black)

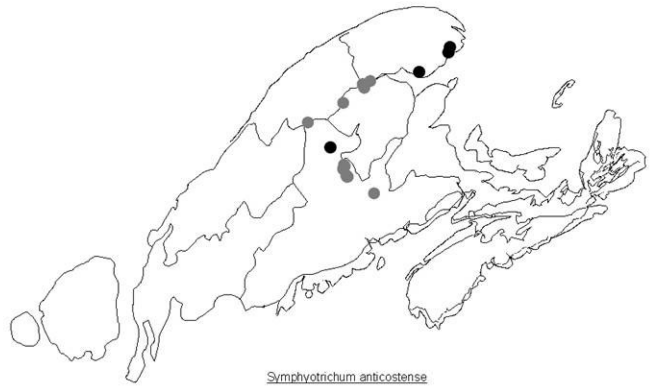
23 below criteria, 5 maybe (grey)



Symphyotrichum anticostense (Anticosti Aster)

Grank: G2Q

- 20 populations assessed
- 4 met criteria as critical occurrences (black)
- 1 below criteria, 15 unknown (grey)



Symphyotrichum laurentianum (St. Lawrence Aster)

Grank: G2

- 34 populations assessed
- 5 met criteria as critical occurrences (black)
- 5 below criteria, 24 unknown (grey)

Taraxacum latilobum (a Dandelion)

Grank: G2Q

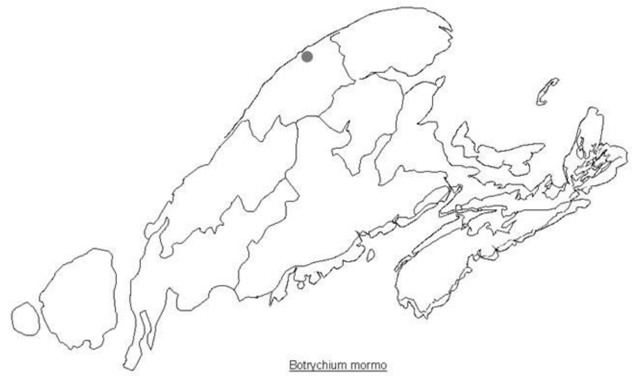
- 3 populations assessed
- 0 met criteria as critical occurrence (black)
- 3 below criteria (grey)

G3 PLANT TARGETS

Botrychium mormo (a Moonwort)

Grank: G3

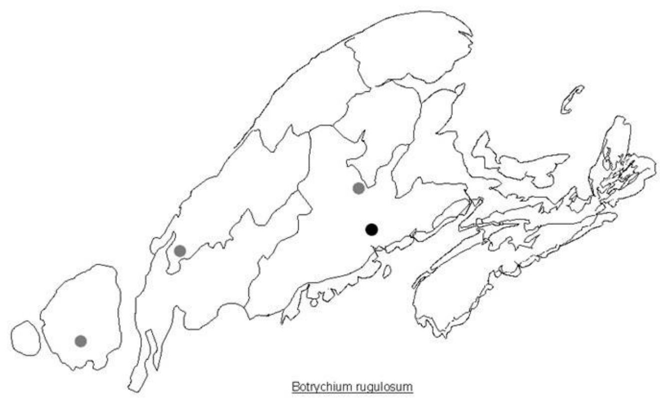
1 populations assessed
0 met criteria as critical occurrence (black)
1 below criteria (grey)



Botrychium rugulosum (Rugulose Grape-Fern)

Grank: G3

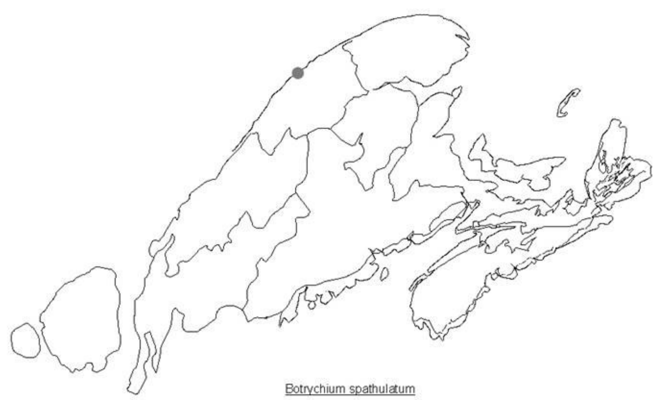
4 populations assessed
1 met criteria as critical occurrence (black)
3 below criteria (grey)



Botrycium spathulatum (Spoon-leaf Moonwort)

Grank: G3

1 population assessed
0 met criteria as critical occurrence (black)
1 below criteria (grey)



Carex schweinitzii (Schweinitz’s Sedge)

Grank: G3G4

3 populations assessed

1 met criteria as critical occurrence (black)

2 below criteria (grey)

Carex schweinitzii

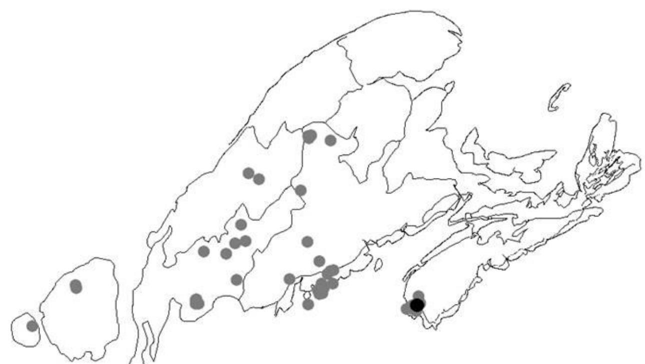
Coreopsis rosea (Rose Coreopsis)

Grank: G3

80 populations assessed

14 met criteria as critical occurrences (black)

66 below criteria (grey)



Coreopsis rosea

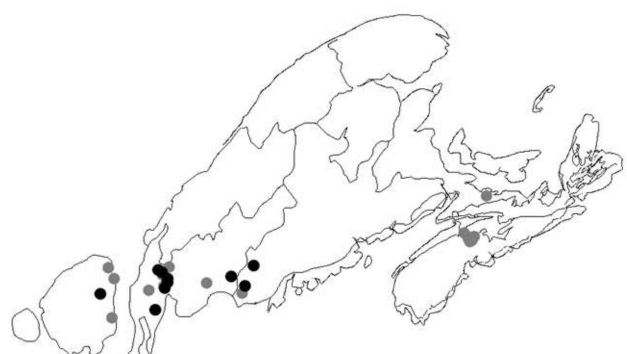
Cypripedium arietinum (Ram's-Head Lady's Slipper)

Grank: G3

33 populations assessed

10 met criteria as critical occurrences (black)

23 below criteria (grey)



Cypripedium arietinum

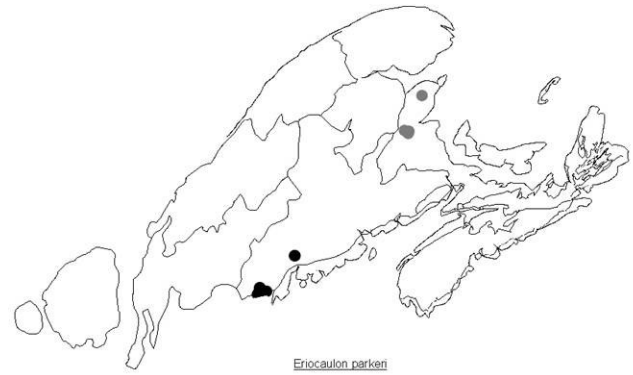
Eriocaulon parkeri (Parker's Pipewort)

Grank: G3

13 populations assessed

6 met criteria as critical occurrences (black)

7 below criteria (grey)



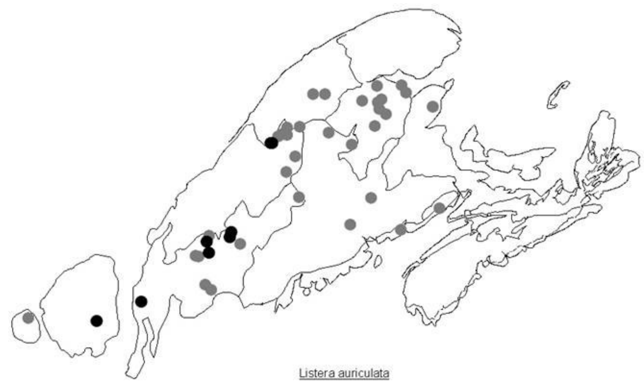
Listera auriculata (Auricled Twayblade)

Grank: G3G4

43 populations assessed

8 met criteria as critical occurrences (black)

35 below criteria (grey)



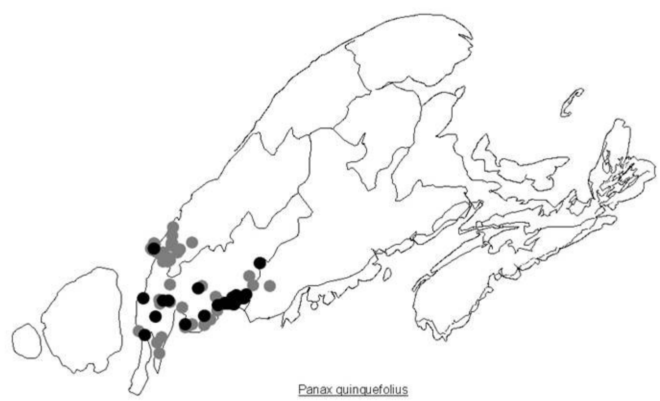
Panax quinquefolius (American Ginseng)

Grank: G3G4

75 populations assessed

21 met criteria as critical occurrences (black)

54 below criteria (grey)



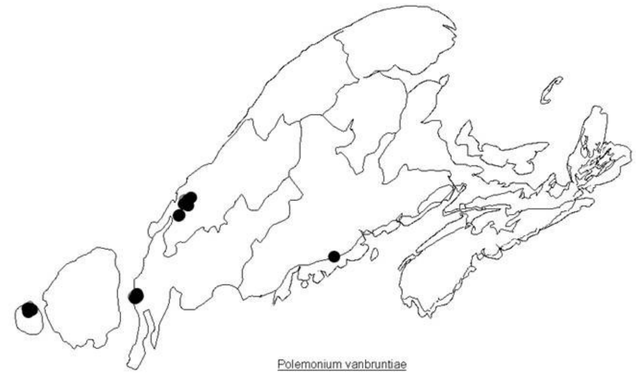
Polemonium vanbruntiae (Jacob's Ladder)

Grank: G3

30 populations assessed

24 met criteria as critical occurrences (black)

6 below criteria (grey)



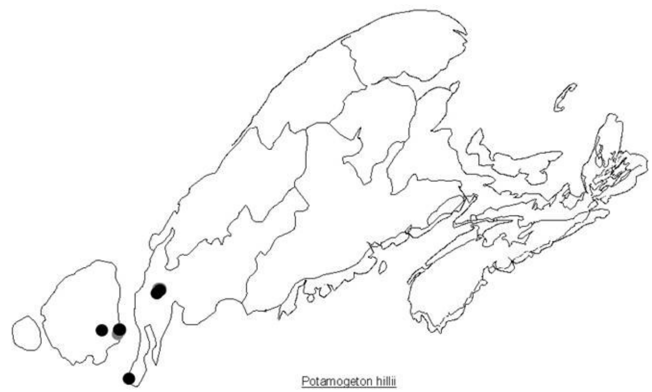
Potamogeton hillii (Hill's Pondweed)

Grank: G3

14 populations assessed

6 met criteria as critical occurrences (black)

8 below criteria (grey)



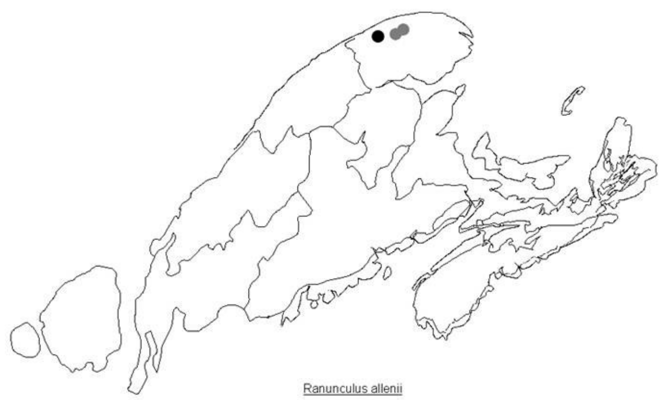
Ranunculus allenii (Allen’s Buttercup)

Grank: G3G4

3 populations assessed

1 met criteria as critical occurrence (black)

2 below criteria (grey)



Sabatia kennedyana (Plymouth Gentian)

Grank: G3

158 populations assessed

29 met criteria as critical occurrences (black)

129 below criteria (grey)

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

Introduction

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

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

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

Geographic Framework for Aquatic Assessments

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

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

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

[1] Abell et al. 2000.
[2] Maxwell et al. 1995

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

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

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

Finer-Scale Classification of Aquatic Ecosystems and Networks

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

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

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

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

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

Primary Classification Variables

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

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

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

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

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

[12] Vannote et al. 1980

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

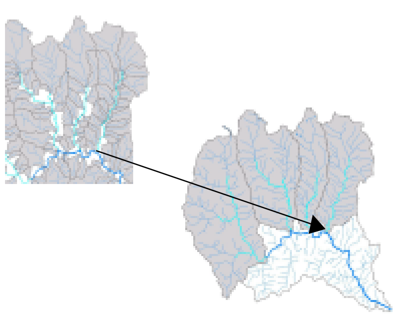
Table 1: Generalized Stream Size and Community Relationships

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

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

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

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



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

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

[13] Anderson 1999

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

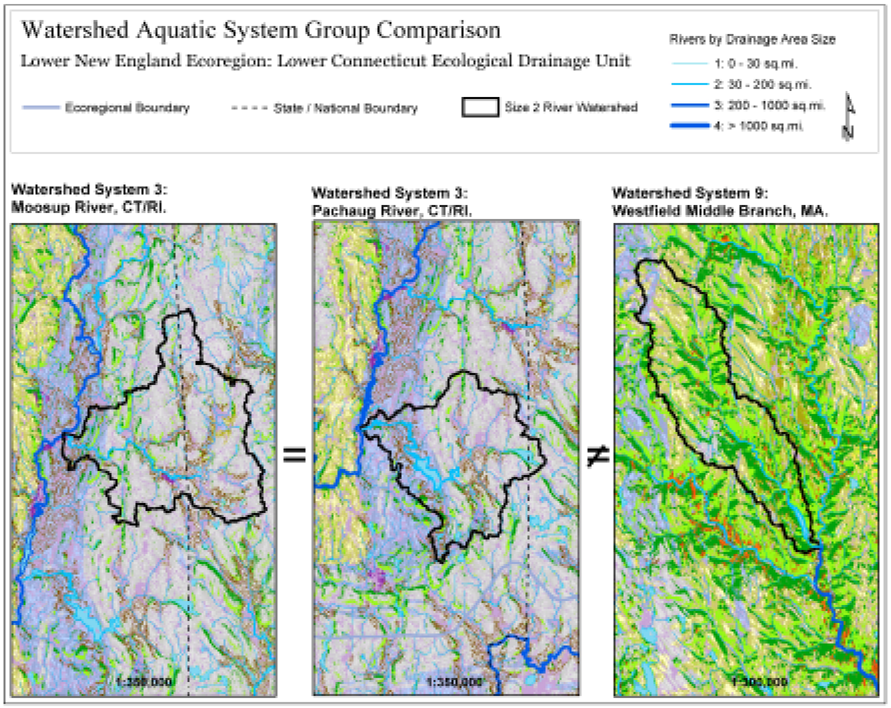


Figure 2: Watershed Aquatic System Group Comparison

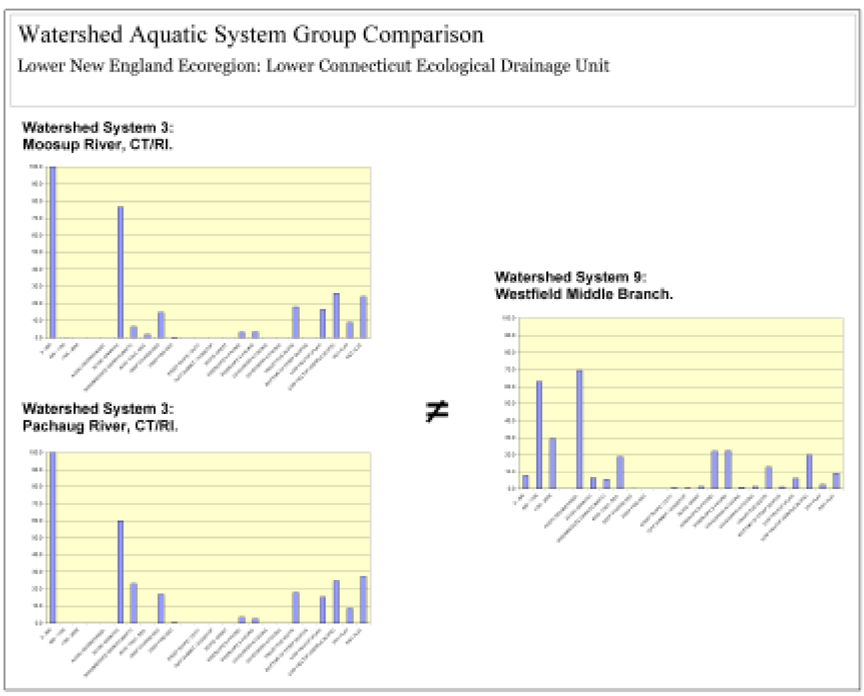


Figure 3: Watershed Aquatic System Component Summary

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

Table 2 : Macrohabitat Classification

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

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

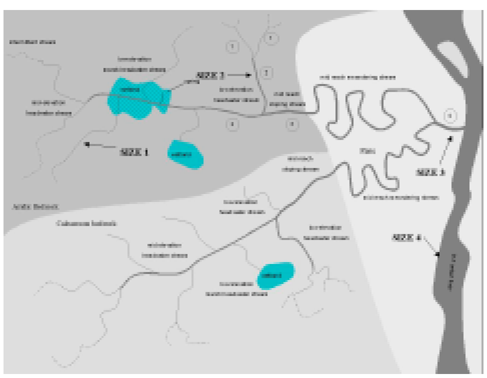


Figure 4: Anatomy of a Stream Network Macrohabitat Model

Selecting Aquatic Targets

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

[15] The macrohabitat model is based on work done by Seelbach et al. 1997, Higgins et al. 1998, and Missouri Gap Valley Segment Classification 2000.
[16] See the documentation on TNC Freshwater Initiative web site's science page (www.freshwaters.org) or the methods section of Olivero 2003 for more information on the GIS tools and scripts used to develop these attributes.
[17] Breaks from ecoregional ELU analysis

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

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

Setting Goals

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

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

Representation Goals

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

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

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[18] Fausch et al 2002

Connectivity Goals

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

Assessing Viability

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

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

Quality Assessment

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

[19] Moyle and Randal 1998

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

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

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

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

Table 3: Watershed Landscape Context Ranking

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

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

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

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

Assembling the Portfolio

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

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

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

Table 4: Portfolio Type Code

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

Table 5: Confidence Code

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

AQUATICS APPENDIX 0

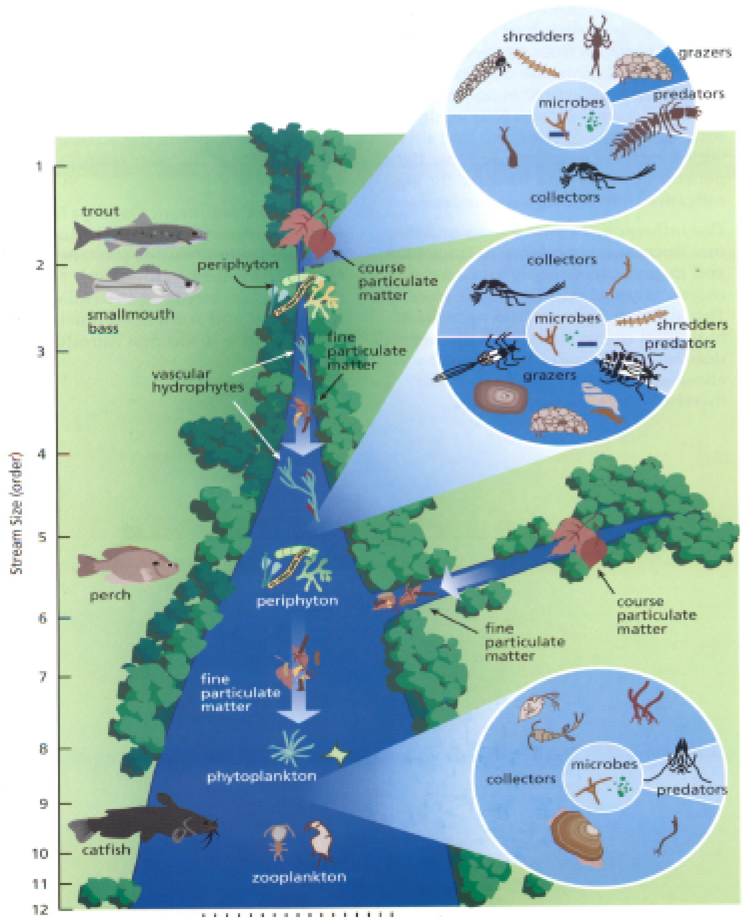


Figure 1: River Continuum in Size

AQUATICS APPENDIX 1

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

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

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

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

AQUATICS APPENDIX 2

Specific Information on Nominated Areas of Aquatic Biological Significance

Expert Name(s):

____

Site Code:

____

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

Site Name:

____

Describe any current Conservation Work being done at this site:

____

____

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

Name _____________________________

Agency/Address___________________________________

Email ________________________ Phone ____

Name _____________________________

Agency/Address___________________________________

Email ________________________ Phone ____

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

____

____

____

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

____

____

____

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

Habitat destruction or conversion

B. Habitat fragmentation

C. Habitat disturbance

D. Altered biological composition/structure

E. Nutrient loading

F. Sedimentation

G. Extraordinary predation/parasitism/disease

H. Modification of water levels; changes in flow

I. Thermal alteration

J. Groundwater depletion

K. Resource depletion

L. Extraordinary competition for resources

M. Toxins/contaminants

N. Exotic species/invasives

O. Other: ______________________________

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

A. **Agricultural** (Incompatible crop production, livestock, or grazing practices)
B. **Forestry** (Incompatible forestry practices)
C. **Land Development** (Incompatible development)
D. **Water Management** (Dams, ditches, dikes, drainage or diversion systems, Channelization, Excessive groundwater withdrawal, Shoreline stabilization)
E. **Point Source Pollution** (Industrial discharge, Livestock feedlot, Incompatible wastewater treatment, Marina development, Landfill construction or operation)
F. **Resource Extraction** (Incompatible mining practices, Overfishing)
G. **Recreation** (Incompatible recreational use, Recreational vehicles)
H. **Land/Resource Management** (Incompatible management of/for certain species)
I. **Biological** (Parasites/pathogens, Invasive/alien species)
J. **Other:**

____

Further description of stresses or sources of stress:

____

____

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:

____

____

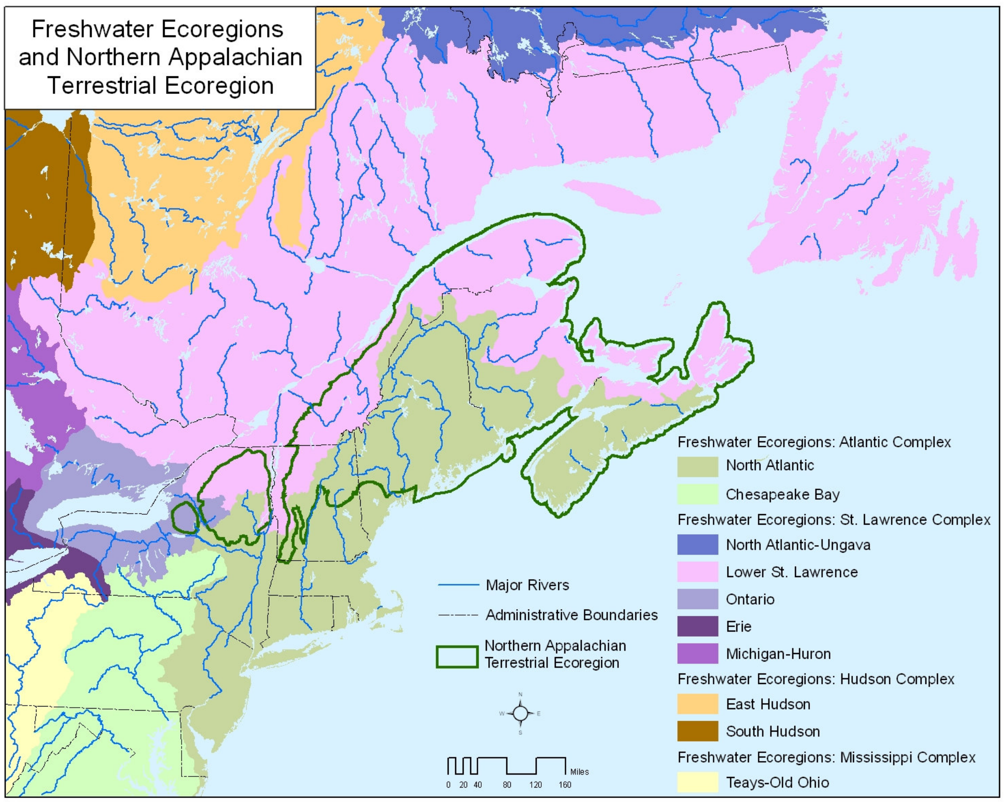
Northern Appalachian Freshwater Stream Ecosystems

3rd Draft 3/15/2006, Anderson: 1/19/2006 A. Olivero

1. Northern Appalachian / Acadian: Freshwater Ecoregions and Basins

The Northern Appalachian / Acadian ecoregion is as well known for its aquatic features as for its mountains and coast. With snowy winters and humid summers, the once glaciated region boasts over 18,000 miles of streams and over 14,000 lakes. Split by the Appalachian mountains, large scale patterns of freshwater diversity correspond to huge drainage basins, the North Atlantic draining south and the St. Lawrence draining north, which have internally similar climatic and historical freshwater linkages.[1] A portion of a third, the Lake Ontario basin, drains west from the Tug Hill plateau in New York (Figure 1).

Figure 1. Map of Freshwater and Terrestrial ecoregions



The North Atlantic Major Drainage Basin: Draining southward, this basin cover half of the ecoregion (81% of the U.S.) and is noted for high quality temperate coastal rivers, numerous lakes, and significant runs of anadromous fish such as Atlantic salmon, shad, and herring. Endangered aquatic fauna include the dwarf wedge and brook floater mussels, Atlantic and shortnose sturgeons and the ringed boghaunter dragonfly. Major rivers include the St. John, St. Croix, Penobscot, Kennebec, Androscoggin, the upper portions and headwaters of the Connecticut, Hudson and Merrimack and the Medway, St. Mary's, and other southerly draining smaller coastal rivers of Nova Scotia.

The St. Lawrence Major Drainage Basin: Draining northward from the mountains to the St Lawrence River, this half of the region (21% of the U.S. portion) has a more cold tolerant fauna and lower freshwater species richness than the North Atlantic drainage (Abell et al. 2002).

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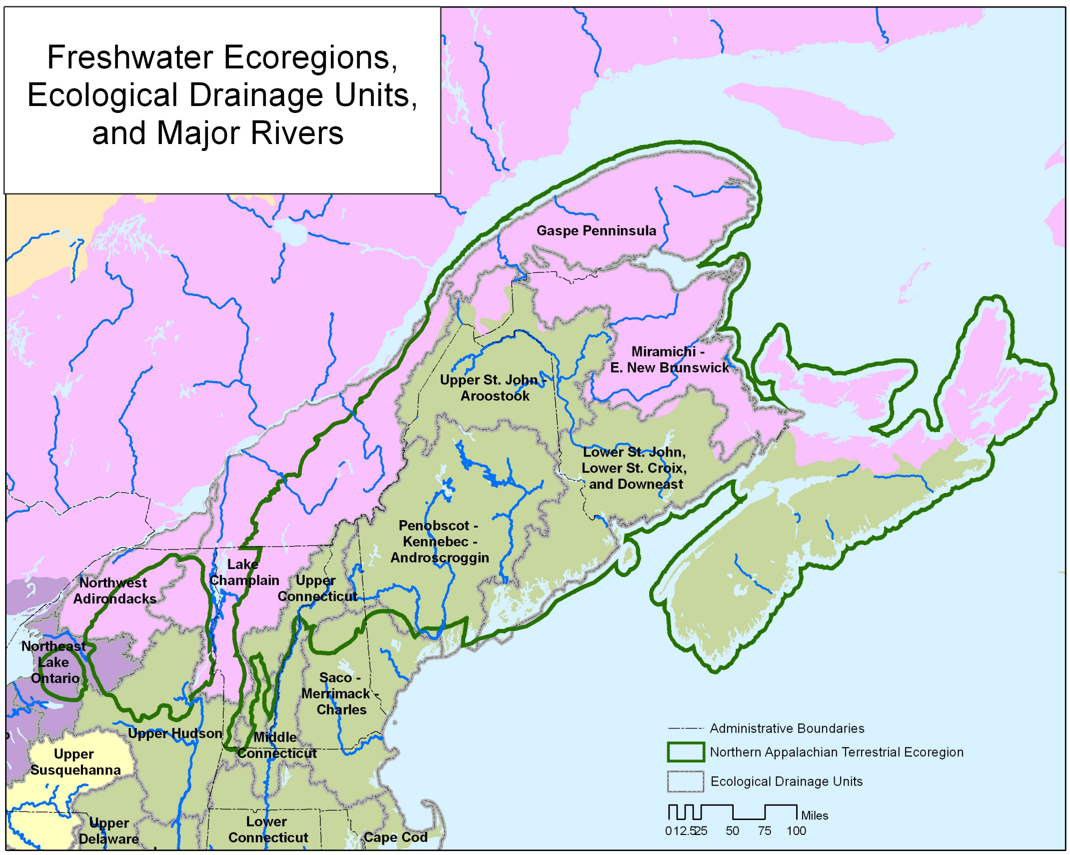
[1]These "freshwater ecoregions" were developed by the World Wildlife Fund (Abell 2002) and make more ecological sense for assessing freshwater features than terrestrially based "ecoregions" .

It is known for numerous lakes including Lake Champlain, Lac Saint-Jean, and Lake Manicouagan, and their large tributaries such as the Missisquoi, Lamoile, Winooski, Otter, Ausable, and Great Chazy along with other rivers draining northwest out of the Adirondacks such as the St. Regis, Raquette, Grass, Osweegatchie, and Indian. Significant self-sustaining runs of anadromous Atlantic salmon occur in the Canadian portion of the basin, which also includes the Upper Saint-Francois, Chaudiere, Rimouski, Matane, Casapedia, and Saint-Jean in Quebec and the Nepisiguit and Miramichi Rivers in New Brunswick.

The Ontario Major Drainage Basin: A small part of the New York Tug Hill region defined by the watershed of Lake Ontario, this basin includes the headwaters of the Black, Saimon-Sanity and Oneida Rivers.

Within the major drainage basins, 12 large watershed units, termed **ecological drainage units** (EDUs) were defined by ecologists based on faunal and geomorphic similarities and used for coarse level freshwater stratification of the region (Figure 2). Note that some, e.g. Merrimack and Middle Connecticut, cover only a small portion of the ecoregion.

Figure 2. Map of Ecological Drainage Units



Watershed Groups within Ecological Drainage Units

Our conservation objective was to conserve the full diversity of riverine species in the ecoregion by focusing on the protection of whole stream ecosystems. Thus, we strove to identify multiple, high-quality examples of each stream type across biogeographic and environmental gradients within the ecoregion (Anderson and Olivero, 2002). To allow for this, we developed a watershed characterization and classification scheme within each EDU, to enable us to identify distinct biophysical settings. Using watershed groups ensured that we could locate streams representing a full spectrum of biophysical settings increasing the likelihood of including all biodiversity in our portfolio networks.

To develop the watershed classification scheme, medium watersheds (30-200 sq.mi. drainage area) and large watersheds (200-1000 sq.mi. drainage area)in the US portion of the ecoregion were assessed as to the abundance and distribution patterns of geologic settings, elevation zones, and landform types within the watershed. Subsequently we grouped the medium watersheds into 49 different watershed groups and the large watersheds into 33 watershed groups. We referred to the watershed groups as “system types” as each delineate geographic areas that are similar in their biophysical structure and, presumably, their ecological processes and associated biodiversity (Figures 3 and 4). The total number of system types (82) is similar to the number of aquatic systems targets in other ecoregions. Details on each watershed system are in Appendix 4.

Figure 3. Map of medium size watersheds in the Northern Appalachian Ecoregion, US portion.

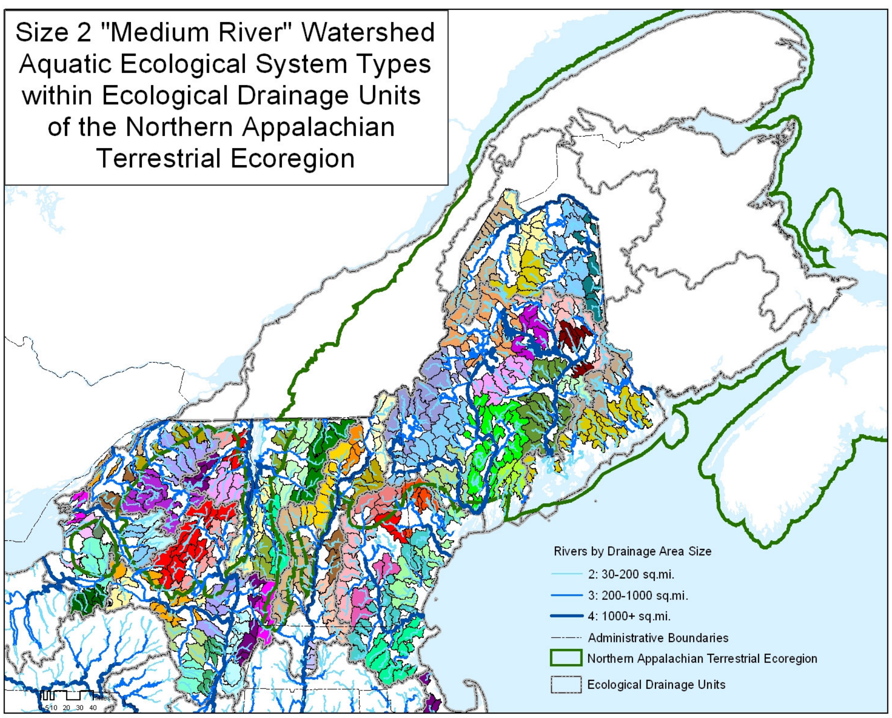
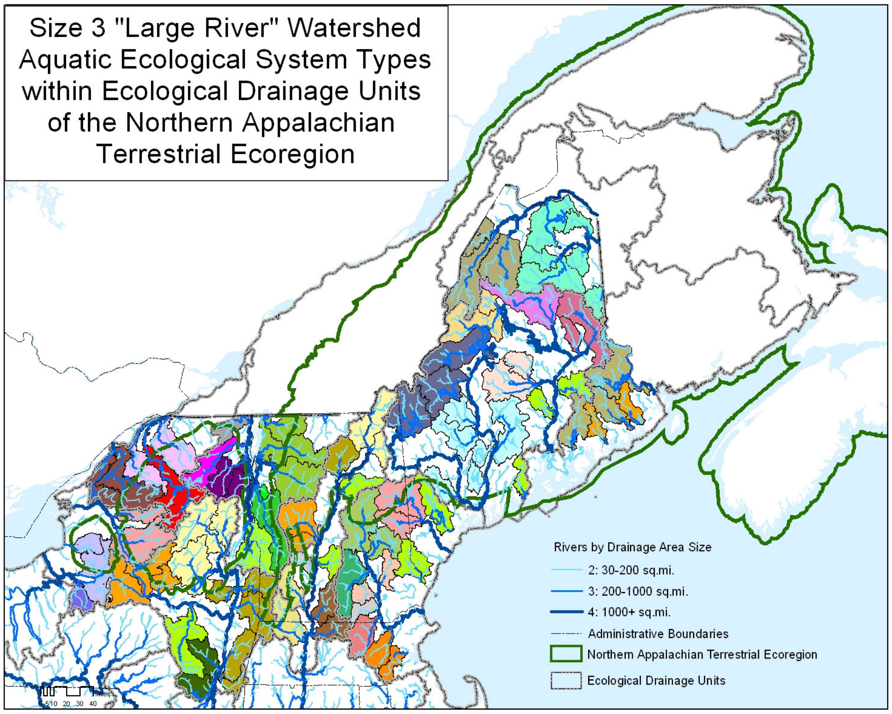


Figure 4. Map of large watersheds in the Northern Appalachian Ecoregion, US portion.



2. Freshwater Biota of the Northern Appalachian / Acadian region

Freshwater rivers, streams, lakes and ponds are diverse, multifaceted systems with a permanent biota comprised of fish, amphibians, crayfish, mussels, worms, sponges, hydras, hydromorphic plants, mosses, algae, insects, diatoms and microscopic protists. Evidence suggests that freshwater communities are organized at many scales corresponding to broad climatic and historic factors as well as local factors such as waterbody size, depth, water velocity, bottom substrate, light penetration, pH, and dissolved oxygen concentrations.

This region's freshwater fauna is estimated to include between 12-20 species of mussels, 6-9 crayfish species, 26-40 herpetofauna, and 90-110 fish species (Abell 2002). Three species of fish (Atlantic whitefish, Blueback trout, and Lake Utopia dwarf smelt) are endemic to the region (Abel et al. 2002. and see Species chapter) Analysis of distribution data suggests that over half of the fish species are widely distributed across all the drainage basins, while others occur only within two (20% of fish species) or one (32% of fish species) of the basins (Appendix 1).

The present freshwater biota results from a relatively recent recolonization of the region following massive extinctions during glaciation (10,000-15,000 years ago). These northern watersheds were disconnected from the species rich southern refugia of the Mississippi basin and there were salt-water barriers to recolonization along the Atlantic slope. Presently freshwater faunal richness is lower than in southern and western North American regions. In contrast, the total number of aquatic plant species is higher in the Northeast U.S. (145 species) than in the Southeastern U.S. (122 species) or in Central America (120 species). Most of this diversity is in the sedge (cyperaceae) and water milfoil (halogoraceae) families (Crow, pers. com.).

Rare Species: Primary and Secondary Targets

Rare and declining species dependent directly on aquatic features in the region include 40 species, mostly plants, but also 6 fish, 3 mussels, and 6 dragonfly species. These have been determined to require individualized protection plans due to their declines or absolute rarity (e.g. they are considered **primary targets**). Another 23 species were identified as **secondary targets,** species of concern that we hope to protect by protecting stream ecosystems rather than individual conservation plans for each species (Appendix 2 – and see the Species section).

Diadromous Fish Species

The ecoregion supports 7 of the 10 diadromous fish species occurring along the northeastern coast between New Brunswick and Cape Hatteras. Although populations of diadromous fish have undergone significant declines across their range, the North Atlantic drainages of this region are noted for containing excellent habitat and a high percentage of the remaining sustaining runs. Atlantic salmon, shortnose sturgeon, and Atlantic sturgeon were considered primary targets and blueback herring, alewife, and American shad were considered secondary targets. American eel, which occurs throughout the region, was not considered a target, but recent declines across their range suggest a reevaluation of this species in future iterations of the plan is warranted.

3. Freshwater Stream Communities

Characteristic Riverine Biota in the Northern Appalachians

The species composition of freshwater streams is correlated with changes in stream size, gradient, elevation, ph, and substrate characteristics. Based on these patterns we recognized five major stream and river types in four size classes (Appendix 3). The size classes were:

- Size 1: 0-30 sq mile watersheds. Bankfull width 0-10 ft. Headwaters and feeder streams
- Size 2: 30-200 sq mile watersheds. Bankfull width 10-20 ft. Moderate-sized streams, often confined.
- Size 3: 200 – 1000 sq mile watersheds. Bankfull width 20-40 ft. Large streams, usually unconfined, meandering
- Size 4: 1000+ sq. mile watersheds; Bankfull width 40 – 100 ft. Large deep rivers

These 4 size classes correspond closely to the following 5 stream types typical of the ecoregion, allowing for overlap particularly between the size 2 and 3 types (modified from Hunt 2003).

1. *Rocky Headwater Stream*: Small, size 1 (order 1-3), cold water streams with high to medium gradients. Predominance of coarse rocky substrate riffle habitat over run habitat. Good aeration and relatively high velocity. Acidic and circumneutral variants. Bryophytes and epilithic green algae predominate. Macroinvertebrates include leaf shredders, and algae shredders. Cold water fish communities. (e.g. Brook Trout, Brook Trout – Slimy Sculplin, Brook Trout-Slimy Sculpin-Blacknose Dace)

2. *Marsh Headwater Stream*: Small, size 1 (order 1-3), meandering streams with very low gradients. Predominance of run habitat over riffle habitat. Fine mucky substrate, poor aeration, low velocity; usually surrounded by wetland communities, typically shrub swamp, emergent marsh or fen. Acidic and circumneutral variants. Cold-cool- warm water. Submergent vascular plants predominate. Macroinvertebrates include characteristic marsh and pool species including

water surface dwelling (neuston) fauna and possibly lake outlet fauna. Possible fish assemblages spanning all microhabitats from cold/cool to warm. (Brook Trout, Slimy Sculpin, and Blacknose Dace, Fallfish, Longnose Dace, Creek Chub, Longnose and White Sucker, Common Shiner, Fathead and Bluntnose Minnow)

3. *Moderate to Large Confined Stream/River*: Size 2 or occasionally larger shallow stream/river (orders 5 to 6) with steep sideslopes in riparian areas that confine the river. Generally moderate to low gradient system with few meanders;. Contains well defined pattern of riffle, run and pool microhabitats with an abundance of riffle microhabitat. Typically cobble shore or riverside sand-gravel bar, coarse substrate (cobble or sand), good aeration, relatively high velocity, prominent erosion and minimal deposition. Circumuentral to moderately acidic pH. Usually without a profundal (dark zone) or hypolimnion or associated obligate species. Epilithic green algae predominate. Plankton assemblages relatively sparce. Macroinvertebrates include algae shredders and neuston fauna in pools and abundant riffle specialist fauna; fauna characteristic of pools and soft bottoms at low abundance. Mussel diversity is generally poor. Fish diversity is typically moderate to high with cool to warm water communities (Brook trout- Slimy Sculpin, Brook Trout – Blacknose Dace, Blacknose Dace-Common Shiner-Bluntnose, Minnow-Creek Chub, Pumpkinseed-Bluntnose Minnow-Tessellated Darter, and White Sucker.

4. *Moderate to Large Unconfined Stream/River*: Size 3 or occasionally larger (orders 5-6), shallow, meandering stream with predominance of run microhabitat and paucity of riffle microhabitat. rivers, The shallowness and absence of a profundal (dark) zone and a hypolimnion separate these rivers from the deep rivers described next. Very low gradient, fine substrate (typically silt), poor aeration, relatively low velocity, circumuentral to moderately acidic pH, prominent deposition and minimal erosion; usually surrounded by wetland communities, typically floodplain forest, often with levees. Vascular plants may be abundant in slower sections, epilithic green algae and phytoplankton may be abundant. Characteristic macroinvertebrates include odonates typical of floodplains. Warm water fish community more dominant: Fish include Blacknose Dace-Common Shiner, Pumpkinseed-Bluntnose Minnow-Tessellated Darter, and White Sucker

5. *Deepwater River:* Size 4 river or very large stream (order 8 or higher) with high discharge, low adjacent canopy cover. Relatively deep (often with portions greater than 4 m deep) and wide (average width over 2 meters) and separated from smaller rivers by the presence of dark profundal zone and possibly a hypolimnion zone hosting corresponding obligate species. Principal nutrient source originating within the stream system (autochthonous). Abundant coarse woody debris, temperature warm; often with lateral erosion, braided channels and substantial deposition. Biota include profundal obligates, bryophytes absent or confined to banks and exposed surfaces, well developed plankton community, fish diversity high to moderate.

Mapping and Characterizing Stream Reaches:

To apply the classification system, and thus map and assess streams throughout the US portion of the ecoregion, we used GIS techniques to characterize every stream reach by its size, gradient, elevation, bedrock, local connectivity and by the biophysical properties of its watershed. (see Olivero 2002 for details)[2].

Distribution patterns were highly skewed towards smaller streams with size 1 streams being five times more common than any other stream type. They were also distributed across all gradient and elevation classes (Figures 3 and 4). In contrast, larger streams were nearly all very-

[2] Further information on our methods in Seelbach et al. 1997, Higgins et al. 1998, and the Missouri Gap Valley Segment Classification 2000)

low gradient features at elevations below 1700 feet (Figure 5 and 6). Large streams were more apt to encounter many bedrock settings while size 1 streams often crossed only one bedrock type.

Figure 5. Streams by Size Class and Gradient Class. Size 1 tributary rivers were distributed across all gradient classes while larger rivers (size 2, 3, 4) are nearly exclusively very low and low gradient systems.

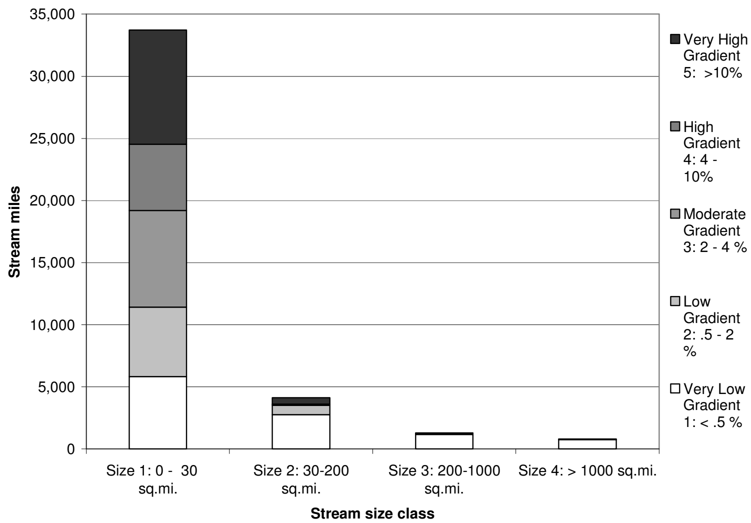
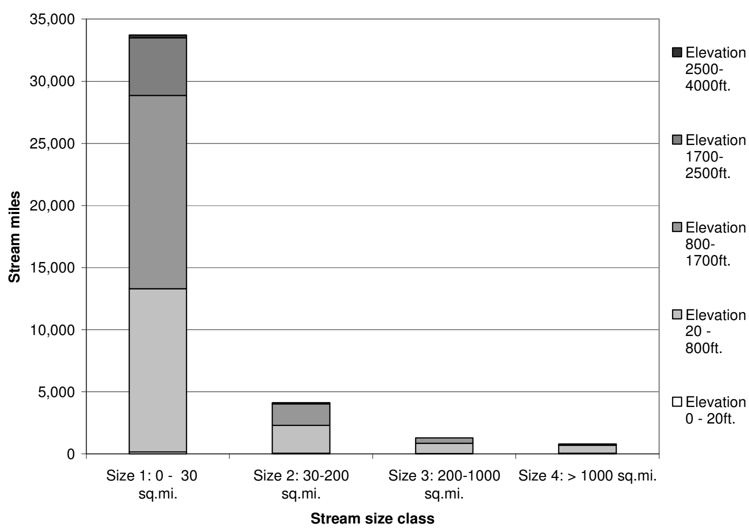


Figure 6. Streams by Size Class and Elevation Class. **S**ize 1 tributary rivers in NAP were distributed across all elevation classes, most are found at < 1700 ft. Larger rivers of size 2, 3, and 4 were found nearly exclusively at elevations < 1700ft.



5. Condition Assessment of Streams and Watersheds

Human activities have had a negative effect on the biotic integrity of aquatic systems. Intensified agriculture, road building, timber harvest, draining of wetlands, river channelization, removal of riparian vegetation, introduction of non-indigenous species and the release of harmful chemicals into aquatic environments each play a role in the compounding degradation of aquatic habitats. Their effects on streams include chemical contamination, increased sediment loads, and magnified nutrient levels while natural flow and flooding cycles have been disrupted by the construction of dams and other barriers.

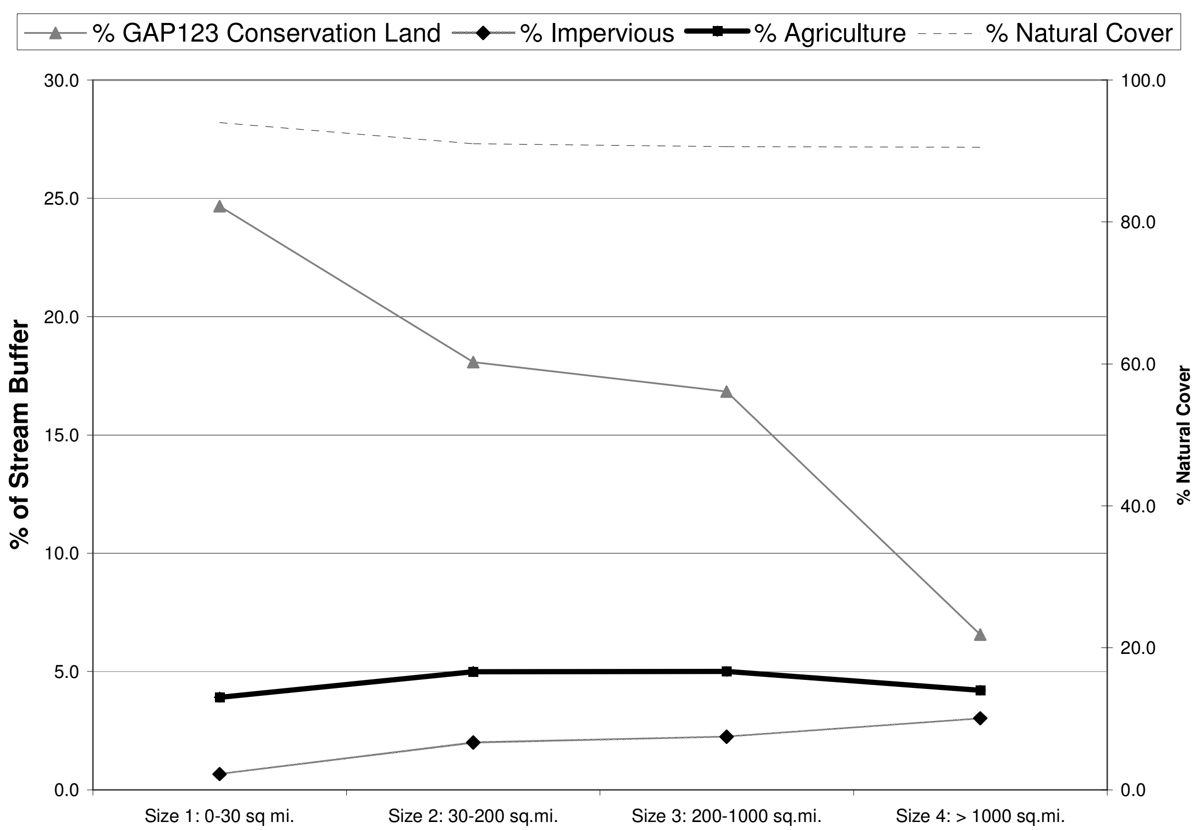
We evaluated the current condition of every stream and watershed in the US portion of the ecoregion using both an expert interview review process and a quantitative analysis of impairment (Anderson and Olivero, 2002). The latter required the compilation of spatially explicit information on roads, land cover, dams*, hydrologic alteration, point source pollution, exotics, stocking, and logging history impacts. These attributes were assembled and tabulated for a 200 meter buffer region around each stream and for its watershed (Appendix 5). Expert information and opinions on the condition of each stream was collected through a sequence of interview sessions conducted state-by-state using a standardized questionnaire. (Appendix 6).

Human land use impacts on streams in this region are small relative to other northeastern ecoregions; streams average over 90% natural cover in their buffer zones and watersheds (Table 1, Figure 7). Impacts vary with river size. Estimates of impervious surfaces increase directly with size class but based on this factor's relationship to biotic integrity, the majority of streams fall into the "no to very mildly impacted" category (CWP2003) Agricultural lands peak at 5% for mid-sized rivers while the amount of conservation land surrounding the streams decreases dramatically from 25% for small streams to 6% for large rivers (Figure 7).

Table 1. Ecoregional averages for a 200m riparian buffer area and full watersheds of size 2 streams. For dams, the stream buffer figure gives the % of watersheds for which there are no dams directly on the rivers while the watershed figure show the % of watershed that have no dams anywhere within the watershed. Dams under 6ft are excluded. .

Unit	Natural Cover	Impervious Surface	Agriculture	% Size 2 with no Dams	% Size 3 with no Dams
Stream or buffer	>90%	2.0%	4.0%	72%	33%
Watershed	90%	0.6%	6.7%	46%	14%

Figure 7. Changes in four condition variables with respect to stream size. Impervious surfaces (lowest) increases from 0.7 to 3.0 %, Agriculture, dams and landcover by stream size



Dams

Dams impair stream functions by creating barriers to upstream and downstream migration, altering in-stream temperature and water clarity, and disrupting the flood regimes necessary to maintain riparian and floodplain communities.

In the US portion of this region streams are modified by almost 1000 dams, with impairment estimates ranging from moderate to severe and becoming greater as the river size increases (Figure 8). No large rivers are completely free from dams in their watershed, but 14% have no dams on their mainstems. Among size 3 rivers 8% have no dams in their watershed and 33% have none on their mainstems. Size 2 rivers are in better condition with 39% having no dams in their watershed and 65% having none on their mainstems. Collectively headwaters are relatively unimpacted by dams with 93% having no dams in their watersheds (Figure 8)

The type and height of dams is equally important with the number of dams in evaluating the effect of dams on stream function. Large hydroelectric dams are the most common type (36%) and most of these are on our larger streams (71%). Recreational dams are the next most common (34%) and these are mostly on small size 1 streams (47% - Figure 9). To put this in context, a worldwide study of large northern rivers, rated the Hudson as moderately affected by dams while the St. John (particularly the lower section-within new Brunswick), Penobscot, Kennebec, Androscroggin, and Connecticut were rated in the lowest category of strongly affected (Dynesius and Nilsson 1993).

Figure 8 Dams By River Size 1, 2, 3, and 4 River Class

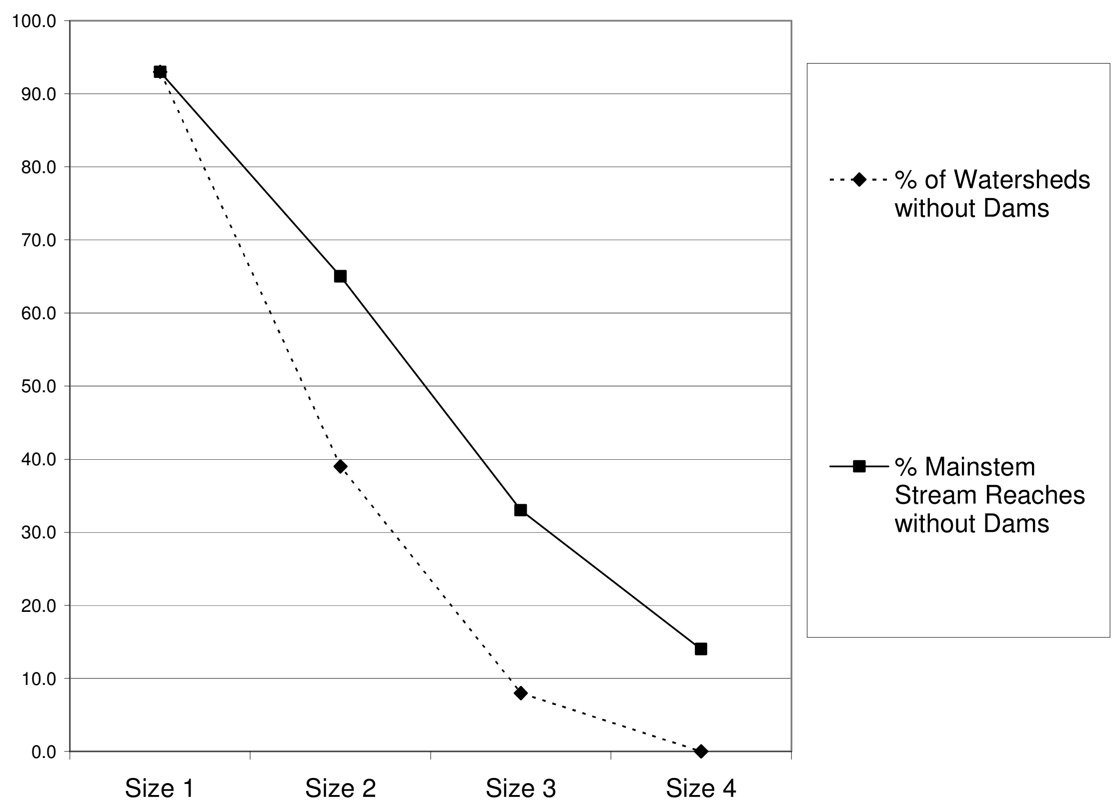
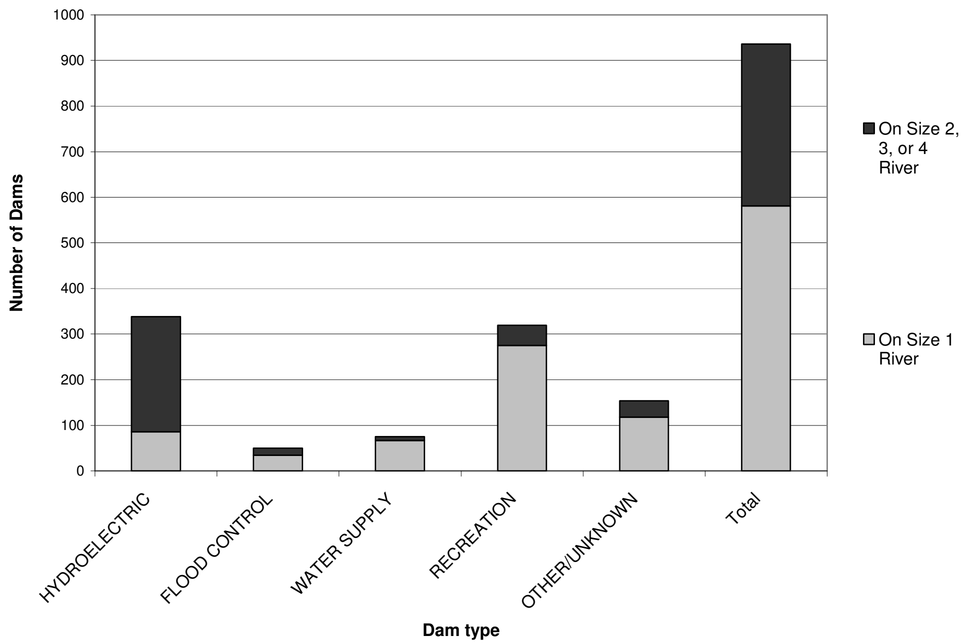


Figure 9. Number of Dams in NAP by Type and Size of River



6. Building a Portfolio of Crucial Stream Networks and Freshwater Lakes

Our objective was to identify a few high-quality examples of each stream type distributed across a spectrum of ecological settings and connected together into functional stream networks. To accomplish this we set specific objectives pertaining to:

- representation across biophysical settings
- stream quality
- connectivity to other stream reaches.

The criteria and minimum goals for each of these three dimensions are discussed below:

Representation Goals

Consider a moderate-sized stream at low elevation on calcareous bedrock contrasted with a similar stream type found at high elevations on granite. Although the two streams share common fish species they host dissimilar invertebrate and microinvertebrate communities due to differences in chemistry and temperature. Differences in the fauna may be subtle and poorly understood, or the stream biota may not be distinct enough for us to classify the two streams as separate types. To ensure that our portfolio encompassed these nuanced differences we set goals for identifying replicate samples of each stream type across a spectrum of biophysical settings (e.g. watershed groups within ecological drainage units as described previously).

Specifically, we set a minimum goal of selecting one example of each stream type within each corresponding watershed group. This guaranteed that a set of streams representing the diversity of aquatic features was identified for each watershed group. The ecoregional expert teams used their professional judgment to add additional examples to this minimum when 1) the team had finer-scale information suggesting that more examples were needed to represent the diversity within the watershed type or 2) there were equally intact interchangeable units for which the relative rank one or the other could not be decided.

An exception were the huge size 4 streams which, due to their scarcity and outstanding biotic importance, were all considered automatically a part of the portfolio with no enforced stratification. The team could choose to exclude certain sections of a given size 4 river (e.g. parts of the Androscoggin) if they were highly altered. Commonly they were included for connectivity purposes only (labeled 9c).

We set no representation goals for size 1 headwater/feeder streams. This was not due to a lack of importance of those brooks and creeks, rather, with over 100,000 examples to choose from we decided this would be more efficiently approached *after* prioritizing the larger size 2, 3, and 4 rivers. Additionally, many headwater streams were implicitly included in the portfolio because they:

1) were nested within a forest matrix site
2) are necessary for the conservation of selected larger streams
3) contain rare aquatic species targeted by the "species portfolio"

We accepted exemplary size 1 streams nominated by aquatic experts for their outstanding qualities. The result was that thousands of size 1 streams were implicitly identified by the selection process even though size 1 streams were not systematically classified and selected with representation goals in mind. We expect that any further work on the representation of size 1 streams will begin with a gap analysis of what was already captured.

Ranking and screening for quality

Within each biophysical setting, the set of available streams were ordered from best to worst using condition information and expert knowledge. Information was compiled systematically for each stream reach and consisted of the number and types of dams, the amount of developed land, agriculture and quarries, the presence of toxic release points, the density and proximity of roads and road-stream crossings. Expert knowledge was collected state-by-state through guided interviews with appropriate academics or representatives from Fish and Wildlife agencies.

We rejected streams with impervious surface estimates over 15% or with sizes less than 1 mile total, but these conditions were rarely found in the ecoregion and thus did not have a large influence on portfolio selection. More often, we encountered cases where an important stream network included a stream reach in very poor condition but that was positioned in a crucial place for maintaining connectivity. In these situations we included the reach as part of the portfolio network but labeled it with a code (9c) indicating that its role in the network was for connectivity only, not for its inherent biodiversity values.

Connectivity Goals

In riverine systems connectivity between stream reaches is of critical importance for periodic movements of stream organisms and for maintaining processes dependent on water volume and flooding. Ecoregional **design guidelines** were developed to maximize the connectivity of the stream networks selected for the portfolio. We set a minimum goal of identifying at least one connected network of streams from headwaters to coast for each size 3 watershed group and to maximize the connections between other selected stream reaches to provide movement options for potadromous fish.

To accomplish this we structured the portfolio assembly process to begin with the selection of size 3 streams. Subsequently we examined the condition characteristics of the size 2 stream options for that watershed group and, all else being equal, we prioritized streams that were connected to chosen size 3 stream. Stream networks gained prominence as more streams were selected that formed a connected system. In places where there were no viable stream options, or conversely, exemplary unconnected stream reaches, we did not force the system to comply but instead allowed for gaps in connections and for isolated, but outstanding, stream reaches to be part of the portfolio. In some cases we identified reaches that were selected solely for their connectivity value, these were specially coded (9c) to reflect this fact (Table 2). Priority networks did not necessarily have to be currently functional, as the teams sometimes identified the best potential rivers to target for restoring connectivity.

Table 2. Coding conventions for stream-reaches.

1c	Priority 1c: Best available example of a stream/river system type and part of a regional or intermediate scale connected stream network
1	Priority 1: Best available example of a stream/river system type but disjunct, not part of a focus connected stream network
9c	Necessary Connector. Considered in the portfolio only as a connector segment in a stream network. Usually found on lower mainstem reaches that are highly altered but needed for connectivity.

7. Stream Portfolio Summary

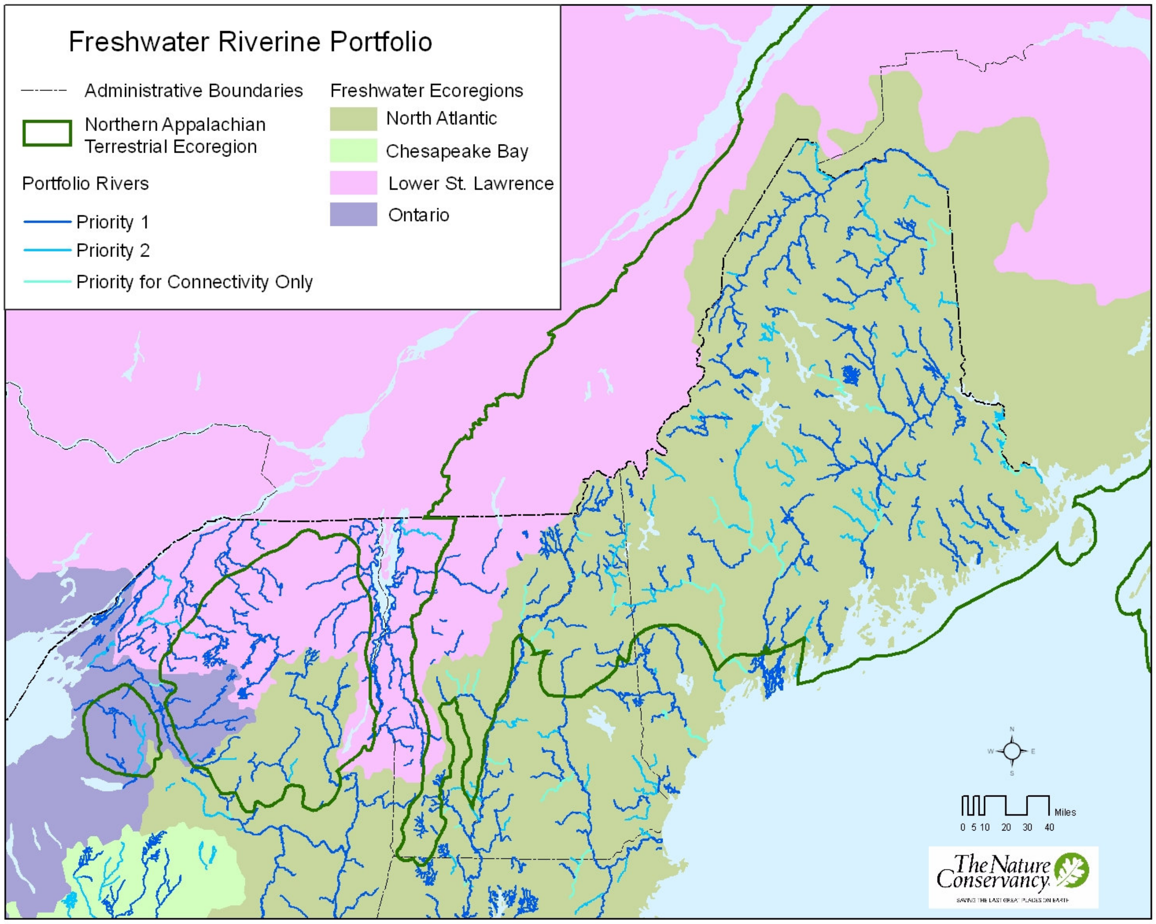
The portfolio selection process resulted in 3407 miles of high quality, mostly connected, medium to large river systems. The highest priority, Priority 1 and 1c rivers, included 3,407 miles. Additionally, 380 miles of stream reaches identified for connectivity purposes only were identified, along with 871 miles of potential alternatives to the top ranking portfolio streams (coded 2 and 2c). In all, we identified slightly more than half of the medium and large rivers in the region as necessary for conservation (size 1 rivers excluded). This ratio was somewhat higher for size 3 streams (51% of all size 2s, 68% of all size 3s and 53% of all size 4 rivers).

In aggregate, the selected portfolio rivers and their "connectivity only" reaches met our representation and connectivity goals (Table 3, Figure 10 and Appendix 5).

Table 3: Miles by River by Size, Portfolio Status, and State

River Size Class	Portfolio Priority	ME	NH	NY	VT	Total
Medium River (size 2)	1	101	0	15	17	133
	1c	1102	180	557	135	1975
	2	120	5	0	0	125
	2c	444	34	52	14	543
	9c	24	14	0	53	92
Medium River Priority 1 Total		1203	180	573	152	2108
Medium River Total		1791	232	625	219	2868
Large River (size 3)	1	38	0	0	0	38
	1c	499	52	216	70	837
	2	18	0	0	0	18
	2c	44	9	8	0	61
	9c	31	21	1	18	70
Large River Priority 1 Total		538	52	216	70	876
Large River Total		631	81	225	88	1025
Very Large River (size 4)	1c	355	40	29	0	424
	2	30	0	0	0	30
	2c	51	43	0	0	94
	9c	206	12	0	0	218
Very Large River Priority 1 Total		642	95	29	0	766
NAP Total		3064	409	879	307	4658
NAP Priority 1 Total		2095	272	818	222	3407

Figure10. Map of the Stream Portfolio for the Northern Appalachians. Portfolio (priority 1) rivers are in deep blue, alternates and "connectivity only" reaches are in lighter blue.



8. Portfolio Statistics: Current Condition and Conservation Status

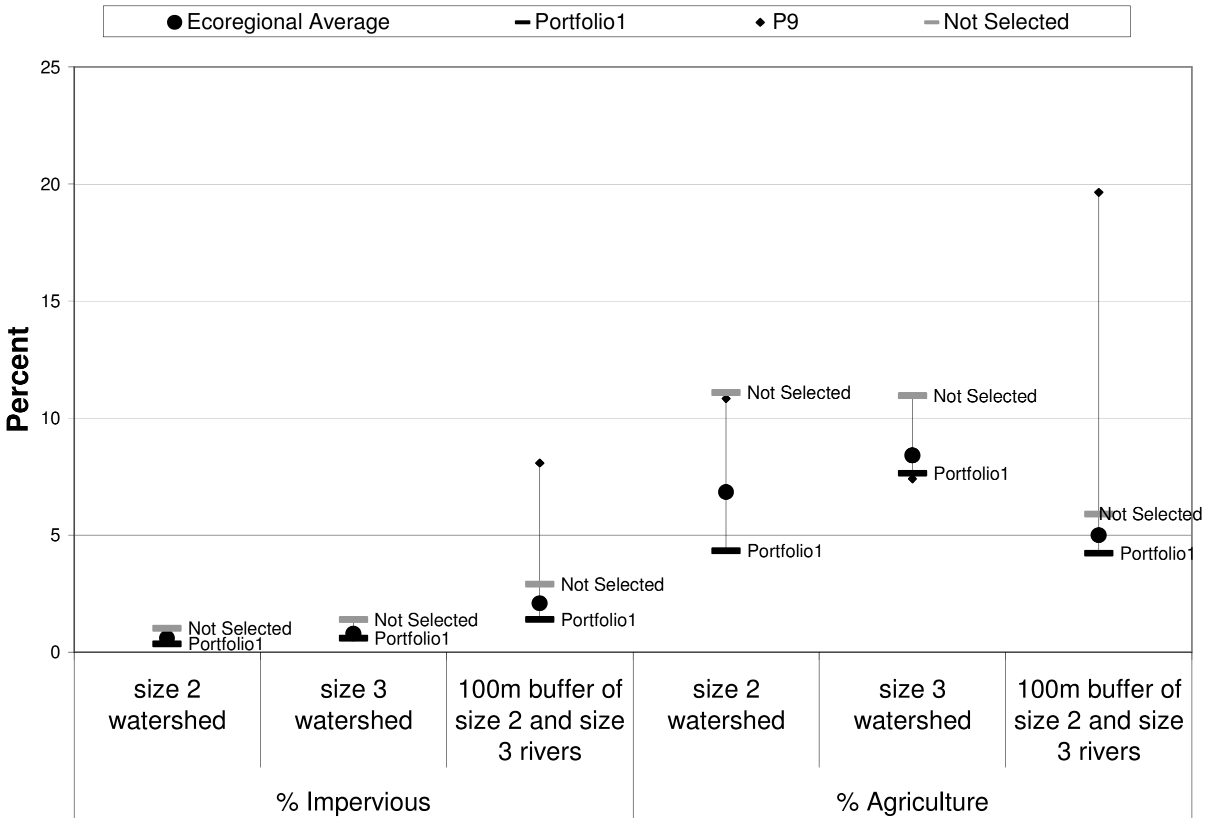
The status of portfolio rivers in terms of key measures of land use impacts, level of conservation protection, and dam impacts are presented below, contrasted against the non-portfolio rivers. Statistics are organized and reported by:

1) Watersheds of medium size rivers (size2)

2) Buffer area (100m) around all portfolio streams (excluding size 1).

We expect the portfolio streams to be in better condition over all than the ecoregional average - indeed they are (Figure 11).

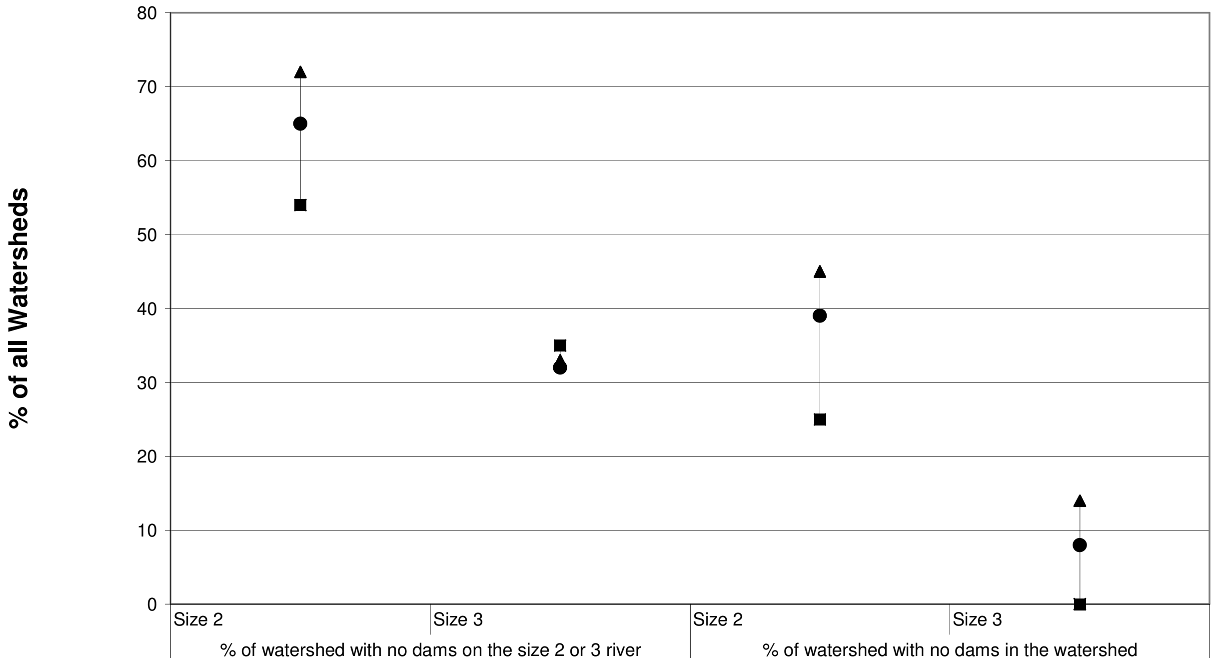
Figure 11. Impairment variables for all streams in the ecoregion. Selected portfolio streams (P1), unselected non-portfolio streams, and reaches for "connectivity only" (P9) are contrasted. For all variables, portfolio streams have a lower percentage of impervious surfaces or agriculture than non-selected streams. Percentages are given relative to watershed area or stream buffers.



On average, the selected portfolio streams contain 155 dams on their mainstems or 1 dam for every 56 stream miles - slightly better than the ecoregional average of 1 per 54 miles. Selected size 2 streams have fewer dams (1 per 62 miles) while size 3 streams have more (1 per 43 miles). Deep size 4 rivers are about equal to the average (1 per 54). The majority of dams on the portfolio streams are for hydroelectric purposes (72%). Perhaps the size 3 rivers have been the target of most dam building because of their moderate 20-40ft, widths.

The distribution of dams is not evenly distributed but tends to be concentrated on certain streams. Many portfolio streams have no dams while others have one to several. Almost three-quarters (72%) of the selected size 2 streams have no dams on their mainstems while one-third of the selected size 3 are also free from dams (Figure 12). Among those portfolio streams that *have* dam on their mainstem, they average 1 dam / 10 stream miles while the "connectivity reaches" have an average of about 3 dams per 10 stream miles.

Figure 12. Dam-free watersheds. This figure gives the percent of all watersheds in the ecoregion that are completely free of dams. The left half is based on calculations using dams found only on the stream itself. The right half is based on calculations for the whole watershed including all the size 1 headwater and feeder streams. Contrasts of the portfolio and non-portfolio streams are given against the ecoregional averages.



	Size 2	Size 3	Size 2	Size 3
	% of watershed with no dams on the size 2 or 3 river		% of watershed with no dams in the watershed	
● Ecoregion	65	32	39	8
▲ P1	72	33	45	14
■ Not selected	54	35	25	0

Connectivity to the Ocean:

Few portfolio rivers (again, the analysis was only done for the US portion) have unobstructed access to the ocean and are thus accessible to anadromous and potadromous fish (Table 4). These include the lower-most mainstems of the Androscoggin, Kennebec, and Penobscot (size 4); the Machias, East Machias, and St. George (size 3) and Pleasant, Sheepscot, Northern, Eastern, Tunk, Ducktrap, Cathance, Chandler, Dennys, Medomac, and Togus (size 2). (Although a few more portfolio rivers may actually be accessible due to fish ladders, comprehensive information on the functionality of fish ladders for our target fish was not available and dams with ladders are still considered obstructions to some fish species depending on the type of ladder and how it is maintained/run).

Table 4. Selected size 3 rivers with the least fragmentation (oc = desired ocean connectivity, Lc or c = desired local connectivity).

Major Drainage	River Name	Portfolio	No dams	No dams on size 2 or 3 mainstem	No dams on size 3 mainstem
Maine Coastal	MACHIAS R	S1oc	X	X	X
Penobscot: Mattawamkeag	MOLUNKUS STR	S1oc	X	X	X
Penobscot: Piscataquis	PLEASANT RIVER	S1oc	X	X	X
Upper St. John	ST JOHN R	S1Lc	X	X	X
Upper St. John	BIG BLACK R	S1Lc	X	X	X
Aroostook	MACHIAS R	S1Lc	X	X	X
Lower Penobscot	PASSADUMKEAG R	S1oc		X	X
Maine Coastal	E MACHIAS R	S1oc			X
St. George-Sheepscot	ST GEORGE R	S1oc			X
Meduxnekeag	MATTAWAMKEAG R, W BR	S1oc			X
Aroostook	Presque Isle Stream	S1Lc			X
Ausable	BOUQUET R	S1c			X
Oneida	FISH CR	S1c			X
White	WHITE R	S1c			X
West	WEST R	S1c			X
Salmon-Sandy	S SANDY CR	S1c, GLK portfolio			X
Salmon-Sandy	SALMON R	S1c, GLK portfolio			X
English-Salmon	SALMON R	Sxc			X
Aroostook	AROOSTOOK R, ST CROIX STR	S2Lc			X
Fish	FISH R	S2Lc			X
Lower Kennebec	CARRABASSET R	S2			X
West Branch Penobscot	CAUCOMGOMOC STR				X
Black-Ottauquechee	BLACK R				X
Meduxnekeag	MEDUXNEKEAG R				X

9. Conclusion

Our portfolio identifies the most significant and intact stream networks, representing all stream types and biophysical settings within eight major drainage basins (EDU) within the US portion of the ecoregion. The comprehensive classification and review of all size 2 and 3 watersheds and stream examples should help conservationists become more comfortable considering entire watersheds as the focus for conservation strategies rather than focusing only on aquatic species. Given the dynamic connectedness of aquatic ecosystems at multiple scales and critical terrestrial-aquatic ecosystem linkages, this approach will hopefully lead to more comprehensive, representative, and ultimately successful aquatic conservation planning.

Due to the intactness of the ecoregion, a number of alternative or interchangeable portfolio examples of certain system types were included in the data because they met our screening criteria based on review of the condition and coincident biodiversity features. Using the datasets that have resulted from this planning effort, queries can be made to highlight watersheds or stream reaches that share certain biodiversity and condition attributes such as higher % agriculture in the riparian buffer or dam impacts. In turn, this information can focus strategies around sets of watersheds and rivers sharing similar needs for restoration, increased preservation, or maintenance of current preservation efforts.

This work was completed only for the US portion of the ecoregion. Future iterations of the NAP Ecoregional plan should address the following issues which we were not able to incorporate into this iteration of the plan:

1. Inclusion of rivers and streams in Canadian portion of the ecoregion
2. Inclusion of a unified lake classification and portfolio assembly across the U.S. and Canadian sections of NAP (A lake classification and selection was completed in Maine, see appendix)
3. More data compilation and analysis of connectivity patterns, including small dams and documented fish passage structures
4. Full analysis of migratory fish targets across their range, see recommendations included in the new iteration of NAC plan
5. Integrated thresholds for metrics that can be used as surrogates of viability as more research on freshwater system viability thresholds becomes available

Aquatics NAP Team

Barbara Vickery	ME
Josh Royte	ME
Kathy Jensen	ME
Peter Vaux	ME
Doug Bechtel	NH
Bill Brown	NYADK
Dirk Bryant	NYADK
Craig Cheeseman	NYADK
David Hunt	NYADK
Mark Anderson	ERO
Arlene Olivero	ERO

NORTHERN APPALACHIAN — ACADIAN ECOREGION
Ecoregion and Subregion Boundary Development

(Gorman 2005, Anderson 2006)

Development of the Ecoregion Boundaries

The namesake and unifying feature of the Northern Appalachian-Acadian (NAP) Ecoregion is the Northern Appalachian Mountains which, along with the marine and coastal influences, have helped to define the ecological and cultural history of the Northeast. The NAP ecoregion extends from Tug Hill and Adirondack ranges of New York, across the Green Mountains of Vermont and the White Mountains of New Hampshire, then into the North Woods and Down East parts of Maine and Maritime Canada. It includes all the provinces of New Brunswick, Nova Scotia, and Prince Edward Island and extends to Îles-de-la-Madeleine (Magdalene Islands) and the part of Quebec extending from the Gaspé Peninsula, southwesterly through the Appalachian complex of eastern Quebec to the United States border, south of Sherbrooke.

The geographic boundaries of the ecoregion were derived and modified from ecological land classification (ELC) frameworks that are standard references in Canada and the US. An ecological land classification identifies and categorizes enduring features and their associated ecological processes at various scales (e.g., global, continental, regional, local), using indicators related to climate, geology, elevation, relief, soils and biota. In Canada, an ecological land classification (Wilken 1986) was defined as:

> "a process of delineating and classifying ecologically distinctive areas of the Earth's surface…[that have] resulted from the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water, and human factors….The holistic approach to land classification can be applied incrementally on a scale-related basis from site-specific ecosystems to very broad ecosystems."

The US national hierarchical framework was similarly described (ECOMAP 1993) as:

> "a regionalization, classification, and mapping system for stratifying the Earth into progressively smaller areas of increasingly uniform ecological potentials. Ecological types are classified and ecological units are mapped based on associations of those biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients which regulate the structure and function of ecosystems. These factors include climate, physiography, water, soils, air, hydrology, and potential natural communities."

There are many interpretations and adaptations of these and other ELC frameworks in circulation, with their associated nomenclature and conceptual foundations. We recognize and are building on the primary sources noted above that are also linked to the international framework defined by the North American Commission on Environmental Cooperation (CEC, 1997).

The NAP Ecoregion was cross-referenced to the North American, Canadian and US frameworks noted above, as well as other classifications for the Eastern US, New Brunswick, Nova Scotia and Quebec. Internationally, the NAP Ecoregion is referred to as the Atlantic Highlands and a Level II subdivision of the Ecological Regions of North America (Commission for Environmental Cooperation, 1997). It is also known as the Atlantic Northern Forest (Bird Conservation Planning Region 14) in the North American Bird Conservation Initiative (NABCI) and in the US as the Eastern Spruce-Hardwood Forest (Physiographic Area 28) by the Partners-in-Flight Land Conservation Program (http://www.blm.gov/wildlife/pl_28sum.htm). The Canadian portion of the NAP Ecoregion is referred to as the Atlantic Maritime Ecozone in the National Ecological Framework for Canada (Ecological Stratification Working Group, 1996) and "province naturelle" in the ecological framework for Québec (Li and Ducruc, 1999). In the US, it is recognized as a division in the USFS Ecological Regions of the United States (Bailey, 1994) and, reflecting the CEC framework, a Level II subdivision in the USEPA Ecoregions of the Conterminous United States (Omernik et al, 1987).

Development of the Subregions

The NAP Ecoregion is equivalent in scale to a Canadian ecozone, a Quebec "province naturelle" and a USFS division. Since a unified finer-scale classification of the NAP Ecoregion was not available, we created an intermediate level classification ("Subregion") to stratify, relate and integrate sub-regional classification systems across jurisdictional boundaries. Subregions are provisionally defined as equivalent to Canadian ecoprovinces, Quebec "région naturelles" and USFS sections.

Development of the subregions begin with an international meeting, in which Canadian scientists, following established methods (Li and Ducruc 1999) laid out a single proposed scheme for the whole region based on biophysical data (geology, topography, elevation) compiled by their US counterparts. Once agreement was reached on the basic geographic patterns and the *approximate* boundaries of the subregions, US and Canadian scientists worked independently to link the subregion boundaries to already established subregional boundary lines.

In the US portion of the ecoregion, precise subregion boundaries were adopted from subsection boundaries defined in the National Hierarchical Framework (Bailey et al, 1994, Keys et al. 1995). Previously TNC and USFS scientists had grouped fine-scale subsections into larger regions based on quantitative similarities in ecological communities and biophysical characteristics (Anderson 1999). Cross-walking to the proposed subregions was straightforward.

In Canada, ecological units were aggregated from ecoregions and ecodistricts in provincial Ecological Land Classifications for Nova Scotia (Neily et al, 2003) and New Brunswick (Ecosystem Classification Working Group, 2003) and "region naturelles" in Quebec (Li and Ducruc, 1999). The National Ecological Framework (ESWG, 1996) was used in Prince Edward Island and Îles-de-la-Madeleine. Lists of the ecological units were assigned to the NAP subregions during a series of meetings and discussions between ELC experts and Core Team members from Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Maine. These relatively coarse groupings (e.g., highlands, uplands, lowlands, coastal) were based on a review of jurisdictional classification schemes as well as biophysical data (climate, bedrock and surficial geology, topography, ELUs, vegetation cover) and expert knowledge.

The last step consisted of merging comparable ecological units along provincial or state borders at the sub-region level. Often we were working with several slightly different units (US Subsection, the NBELC Ecodistrict and the Quebec's "Région Naturelle") the boundaries of which did not line up. For these decisions we were guided by the results of the initial evaluation of geographic patterns at the scale or the whole ecoregion, and we adjusted the boundaries appropriately.

Results

Our methods resulted in the recognition of eleven sub-regions (Figure 1). These were aggregated from 23 sub-regional units (containing 83 subsections) based on a broad uniformity and zonation of climate, elevation, relief, surficial geology and vegetation. Examples where we modified boundaries which crossed provincial or state borders based on overarching geographic patterns combined with finer-scale data and expert input include the following:

1. Gulf of Maine-Bay of Fundy-Minas Basin Subregion: USFS 212Cb (Maine Eastern Coastal subsection and NBELC 4-1 Fundy Coastal Ecoregion, Fundy Coastal Ecodistrict were joined via St. George-Bayside and does not include the inner Passamaquoddy Bay.

2. Northumberland/Bras D'Or Lowlands Subregion: NBELC 6-7 Eastern Lowlands Ecoregion, Petitcodiac Ecodistrict was joined with NSELC 550 Northumberland-Bras D'Or Ecoregion. Tantramar Marshes Ecodistrict was joined near Fort Lawrence, NS.

3. Saint John Uplands that extended into Quebec and New Brunswick was broken into smaller units consisting of Northern and Central components, and the NB portion was grouped with the NS Highlands and renamed the Acadian Highlands.

Figure 1. The eleven subregions of the Northern Appalachian- Acadian ecoregion.

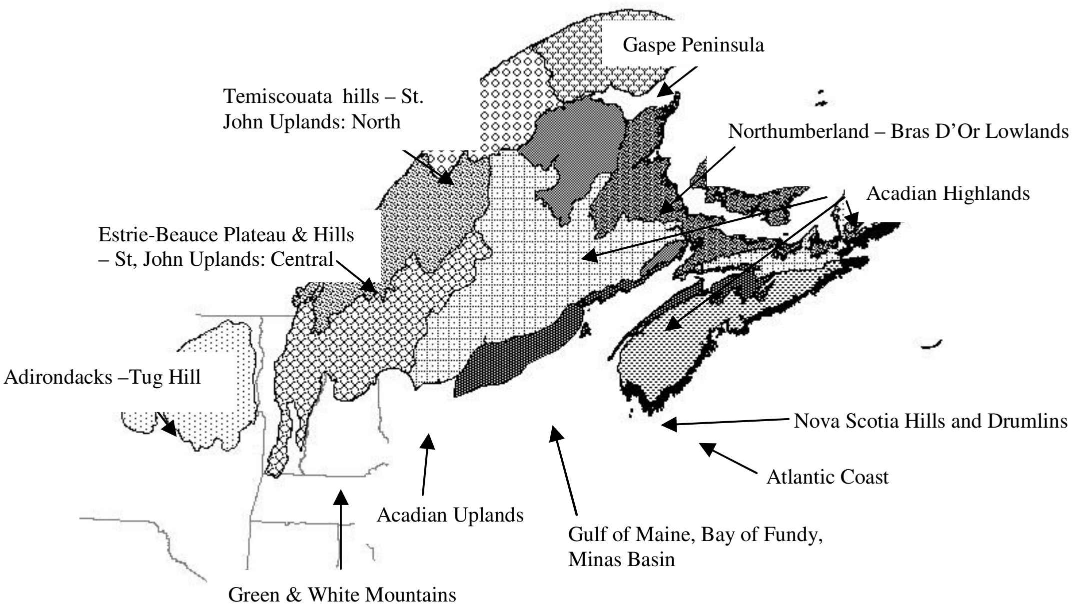
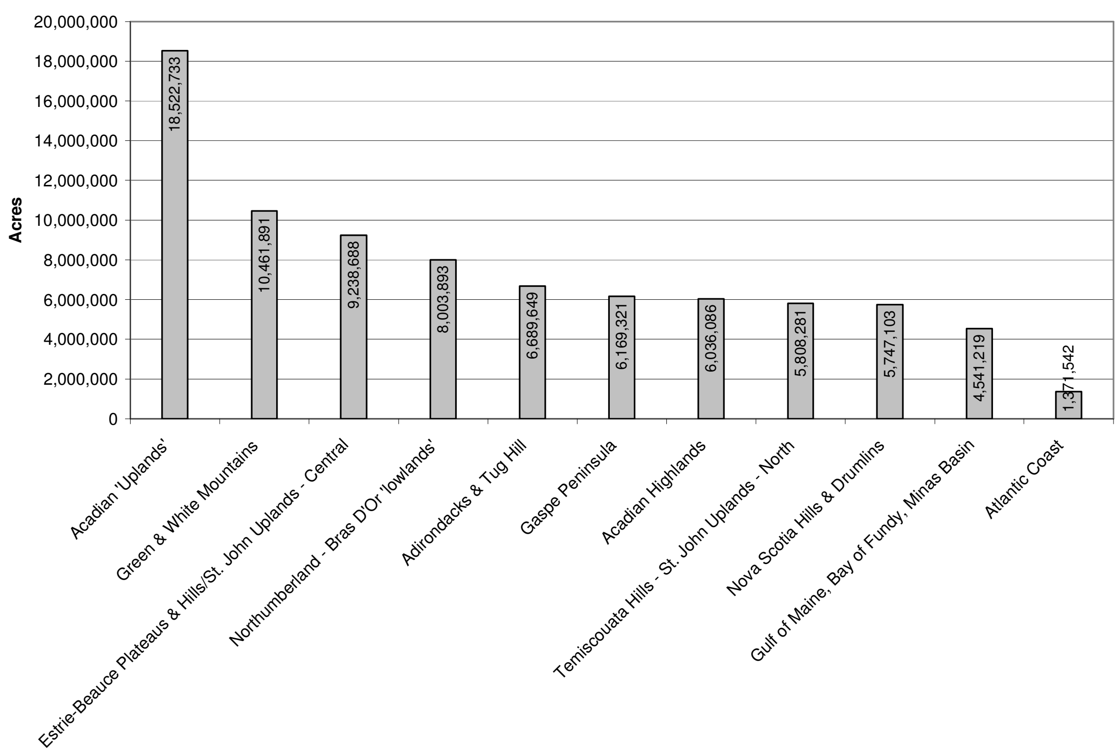


Figure 2. The relative size in acres of the eleven subregions



Threats in the Northern Appalachian–Acadian Ecoregion

NAP 10/15/05 Bill Ginn Draft 2.1 with additions by Josette Maillet and edits by Shyama Khanna and Susan Bernstein

The Northern Appalachian/Acadian Ecoregion was first settled by Europeans in the early 1600s and has had extensive, and in some places intensive, use for 4000 years. Probably less than 5% of the NAP forest remains in pre-settlement condition. While most of the area remains forested, the trend in recent years has been for landowners to increase the area of softwood plantations and reduce the rotation length between harvests. This has resulted in a simplified, less biodiverse forest. Overall, however, the current condition of the Northern Appalachian Ecoregion is remarkably good given its history and the close proximity of the region to major urban centers to the south (the Boston- New York-Washington, DC corridor) and major Canadian cities to the north (Montreal, Québec City, Toronto and Ottawa). The region has benefited from historic investments in conservation (Adirondack State Forest, Acadia National Park, two national forests, six Canadian National Parks and many Canadian provincial protected areas) as well as current investments. Over 2.5 million acres have been protected through fee and easement purchases on the US side in the last decade. An additional 2.5 million acres are in protected areas on the Canadian side. Provincial authorities have been active, most notably in New Brunswick and Nova Scotia where many significant areas have been designated for protection on crown lands in recent years.

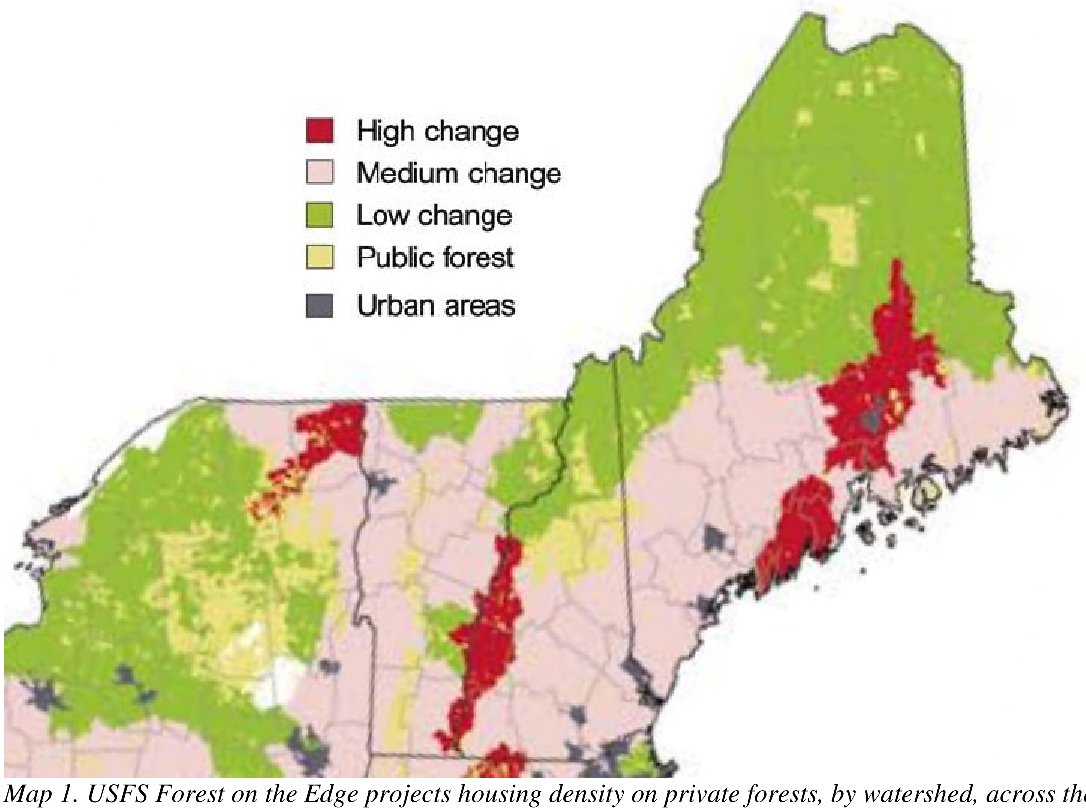
Nevertheless, the region is undergoing dramatic change and it is unlikely historic conditions will be the best indicator of future conditions. In the US, the sale of over 10,000,000 acres of timberlands by long term industry owners to investors has raised the potential for development and unsustainable forest practices. Parcelization and related fragmentation is also increasing, especially in the US, as land is sold for second home development. In addition, the ecoregion as a whole is being significantly impacted by atmospheric pollution that threatens a wide range of plant and animal populations and is reducing the productivity of the regions forests. The region is also vulnerable to introduced pests and pathogens, some of which, if unchecked, could create widespread species loss and cascading community effects rivaling the Chestnut blight and Dutch elm disease of earlier eras. Finally, climate change over the next 100 years is predicted by some models to dramatically alter forest composition as spruce-fir trees shift northward and hickory-oak forest types increase in the southern portion of the region. These changes have the potential for major ecological as well as economic impacts. The traditional timber products backbone of the region already faces major market changes even without these other potential impacts.

A map of landowners over the last 100 years would be remarkably unchanged until the early 1990's when traditional integrated forest product companies began a process of divestiture of company lands to a new breed of timber investors. While Canada's high percentage of crown owned land has largely insulated it from these types of sales, all of the US states have undergone dramatic forest land ownership changes. In rapid succession, Great Northern, Boise Cascade/ Mead, Scott Paper, Georgia Pacific, International Paper, Champion, James River and many other smaller companies sold off most or all of their lands to timber investors. In Maine, only Canada's Irving Company, itself a relatively recent owner in the US, remains as an integrated mill-forestland owner.

Over 10 million acres or 50% of the state has seen an ownership change–and in some cases several–as early timber investors such as Hancock Timber Resources have already resold lands purchased in the early 1990's.

The change in ownership reflects a larger global marketplace wherein this region is competing as never before with paper mills and timber production in Russia, South America, New Zealand and Indonesia. The older and higher cost mills of the region have not faired well with bankruptcies effecting 4 mills in Maine and two in New Hampshire in past several years. Domtar Industries has recently announced the curtailment of pulping capacity at its Cornwall mill and many eastern Canadian mills are struggling for survival. Without an economic rationale for owning and managing forests, the pressures of development and fragmentation will likely accelerate and the impact on rural communities will be severe. Forest dependent communities, while often at odds with environmentalists, can be natural allies for maintaining the sustainable management of forests. Economic viability and stability contributes to strengthening rural communities.

Recently, the US Department of Agriculture released the findings of a multi year study of eastern forests. Of the top 15 watersheds with dramatically increase housing density predicted, 4 are all or partially within the NAP/Acadia ecoregion.[1] Map 1 shows the USFS's predictions for the US portion of the region.



Map 1. USFS Forest on the Edge projects housing density on private forests, by watershed, across the conterminous United States, in an effort to improve understanding of the processes and thresholds associated with increases in housing density in private forests and likely effects on the contributions of those forests to timber, wildlife and water resources.

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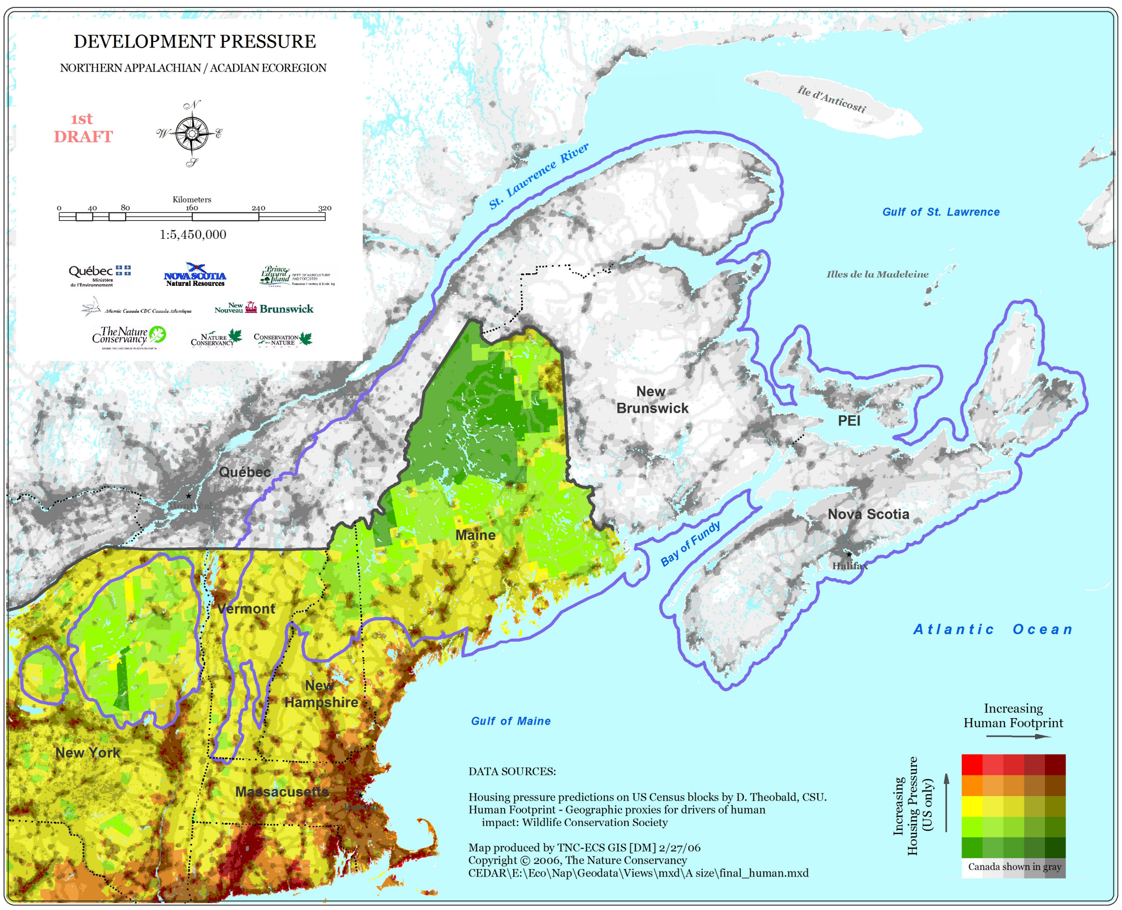
[1] Forests on the Edge: Housing development on America's private forests GTR PNW-GTR-636 May 2005 Stein, Susan et al. p7.

In Maine alone, since 1982 nearly 200,000 acres of commercial forestland were lost to other uses—mostly conversion to recreational development. There are indications that this trend is accelerating. Of note is Plum Creek's proposal to develop 1000 new second homes in the Moosehead region of Maine and many other smaller proposals throughout the region. Using housing data and projections developed by the Wilderness Conservation Society and David Theobald of Colorado State University, Map 2 shows a potential projection of development pressure over the next 50 years in the region if unabated by conservation investments. Most of the pressure will occur in coastal areas and along major waterways with particular impacts to coastal systems. Urbanization and coastal development, especially in the Maritimes, has resulted in shoreline degradation including the destruction of wetlands and the hardening and erosion of shorelines. Greater access to sensitive areas has also resulted in an increase in recreational impacts. Coastal areas have become increasingly popular locations for recreational uses, especially the use of all-terrain vehicles (ATVs) and tourist activities including poorly managed nature-tourism operations.

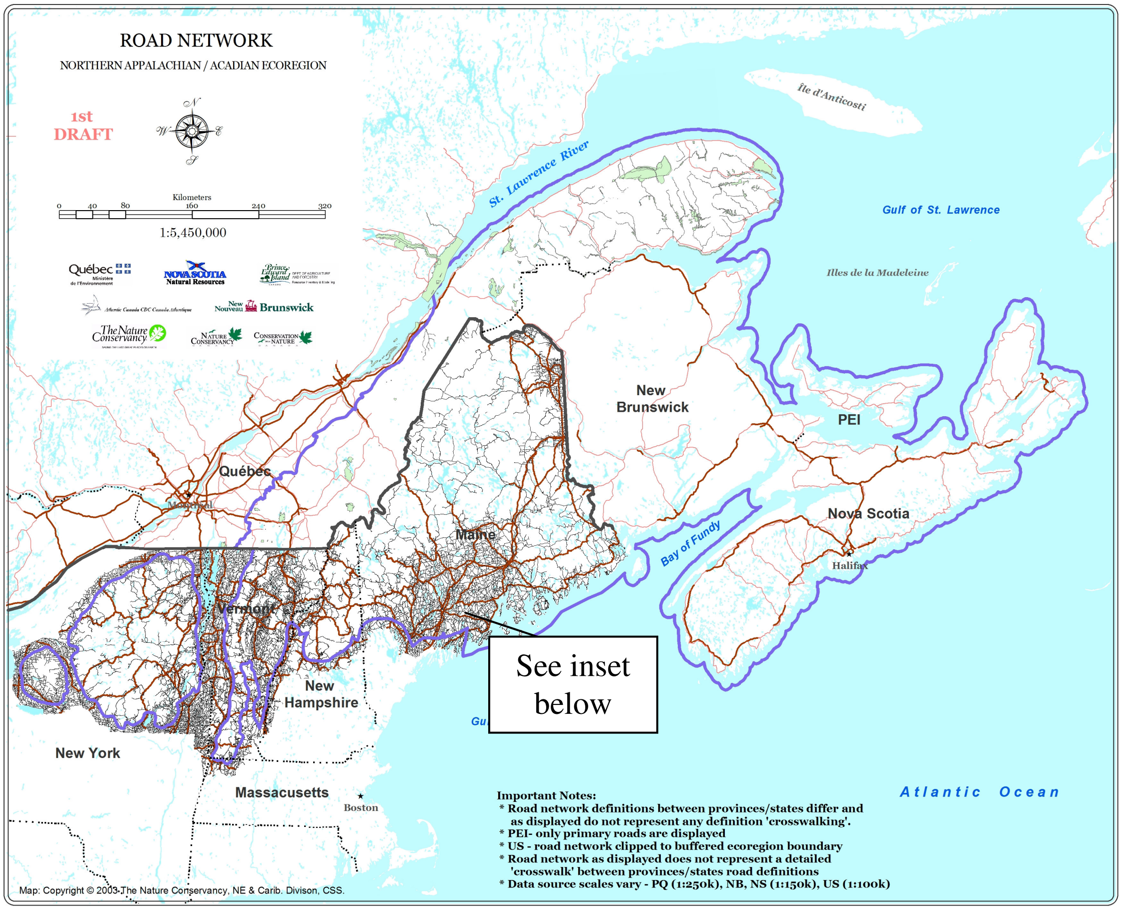


MAP 2: Projected population density and sprawl in NAP.

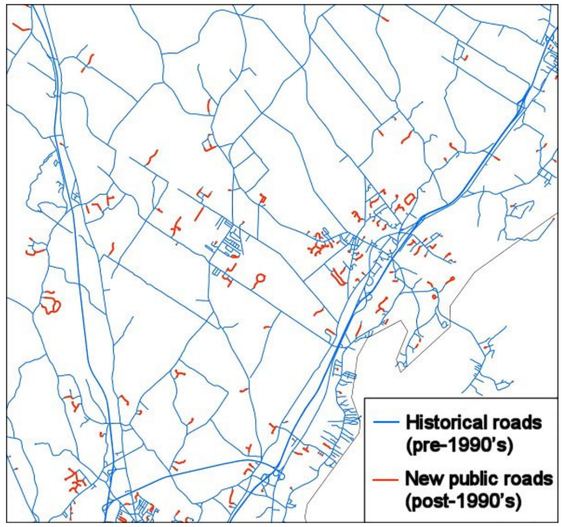
Even in those areas where timber production is likely to continue over the next 100 years, the type of forest management is affecting the biodiversity of the region. Marketplace changes continue to favor smaller diameter wood production (as engineered products replace whole lumber). This, along with increased pressure for improved financial returns is expected to favor shorter rotation lengths in managed forests in the region.

Ecologically, as opposed to silviculturally mature stands are likely to disappear from the landscape unless explicitly protected. In New Brunswick, 75% of the forests were 80 years or older in the early 70's. Today that number has declined to 45%.

In addition, the area is now extensively connected with woods roads built since the end of water transport of logs in the late 1960's (see Maps 3a and 3b). The extensive road network opens access to lakes and rivers, increasing development pressure and recreational use and also increases the potential for non-native species introductions.



Map 3a. Road network in NAP.



Map 3b. Map by R. Baldwin; Two Countries, One Forest

A more insidious threat to the region comes from atmospheric pollution—mostly from the burning of coal in the Midwest, but also from automobile pollution. Researchers at Hubbard Brook have carefully documented the impacts of many of these changes and have found acid precipitation has altered soils in areas of the Northeastern US and eastern Canada.

- Acid deposition has increased the leaching of base cations from soils — elements such as calcium and magnesium that are important plant nutrients and help soils counteract negative effects of acid precipitation. High levels of sulfuric and nitric acids in precipitation have resulted in accumulation of sulfur and nitrogen in forest soils across the region.
- Acid deposition has increased the concentration of dissolved inorganic aluminum in soil water. Dissolved inorganic aluminum is an ecologically harmful form of aluminum. At high concentrations, aluminum can hinder the uptake of water and essential nutrients by tree roots.
- Soils that are affected by acid deposition are less able to neutralize additional amounts of acid deposition, provide poorer growing conditions for plants, and delay ecosystem recovery.

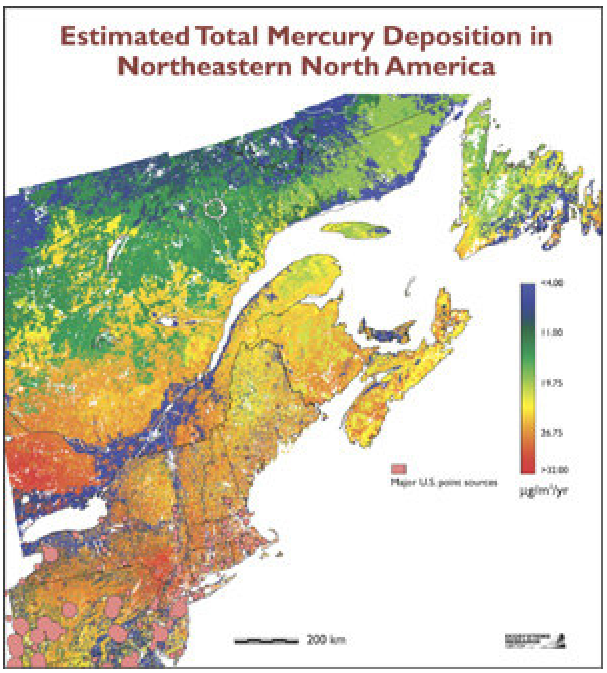
These changes have resulted in significant new stresses to trees in areas of the Northeast. Recent research shows that acid deposition has contributed to the decline of red spruce trees throughout the eastern U.S. and sugar maple trees in central and western Pennsylvania. Instances of dieback and deterioration have been noted in White Birch in southeastern New Brunswick as a result of acid fog. Symptoms of tree decline include poor tree crown condition, reduced tree growth, and unusually high levels of tree mortality.

Acid deposition has also impaired the water quality of lakes and streams in three important ways: lowering pH levels (i.e., increasing the acidity); decreasing acid-neutralizing capacity (ANC); and increasing aluminum concentrations. High concentrations of aluminum and increased acidity have reduced the species diversity and abundance of aquatic life in many lakes and streams in the Northeast. Recent water quality data show that 41 percent of lakes in the Adirondack Mountain region of New

York and 15 percent of lakes in New England exhibit signs of chronic and/or episodic acidification, while 30% of the lakes in the Maritimes have become acidified as a result of acidic deposition.[2]

Other studies have raised concerns about impacts on humans and wildlife from atmospheric deposition of pollutants. Several states including Maine have health warnings on consuming wild fish because of levels of mercury and other pollutants. The Biodiversity Research Institute in Falmouth has been studying mercury levels in loons since 1994. 20 to 25 percent of loons in Maine have high mercury levels, high enough, in fact, that they are at risk of neurological and behavioral problems; those loons fledge 40 percent fewer young. And some tree swallows in Acadia National Park are more mercury-contaminated than birds at a Superfund site in Massachusetts.[3]

"Hotspots" where soil, elevation and other site conditions create increased potential for mercury accumulation have been mapped by the Center for Biodiversity and many of these sensitive areas are within Northern Appalachians.



MAP 4. From page 20 in "The extent and effects of mercury pollution in northeastern North America," a new report that summarizes the information in the Ecotoxicology journal papers, http://www.briloon.org/mercury/index.htm.

Worldwide, invasive species are one of the most significant contributors to species loss. In forested systems the threats are particularly significant from introduced pests and pathogens on dominant forest trees. The phenomenon is not new in the region. The chestnut blight removed the American chestnut from forests of the region in the 19th century. Dutch elm disease largely extirpated American elm although the impacts were mostly felt in urban areas. Gypsy moth is now a regular cyclical feature of northern

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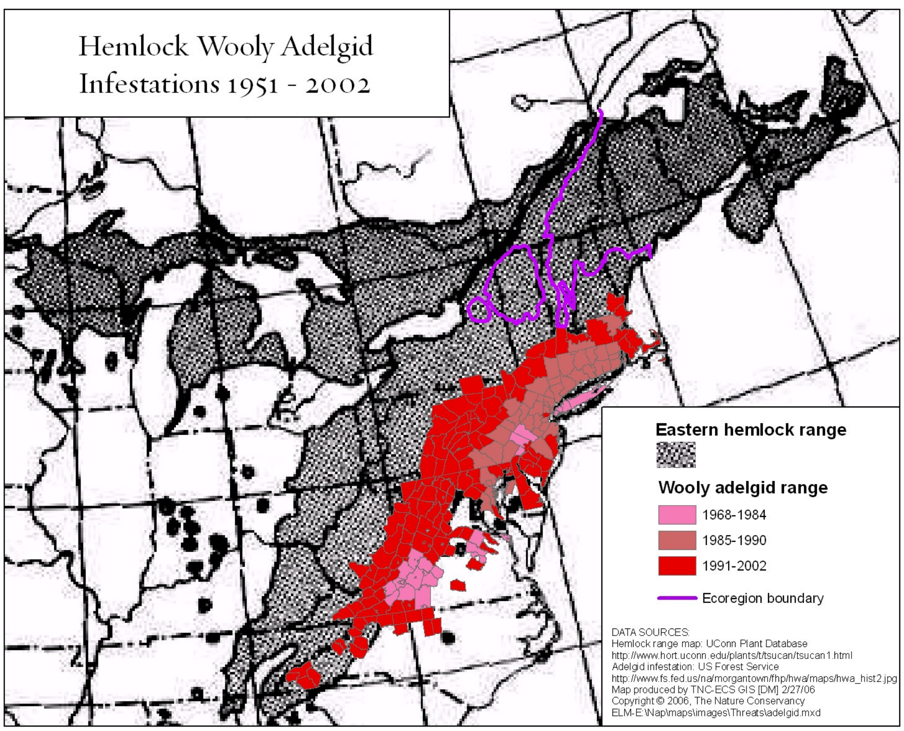
[2] For detailed information on Hubbard Brooks findings visit: http://www.hubbardbrook.org/education/SubjectPages/AcidRainPage.htm

[3] **You're being poisoned,** Jennifer Lunden, Portland Phoenix, http://www.portlandphoenix.com/features/top/ts_multi/documents/03595677.asp

hardwoods, with significant outbreaks occurring every 10-15 years. Beech bark disease has now spread from the Maritime Provinces throughout New England. While stressed trees often die from these outbreaks, the impact is limited. However, several new and potentially much more aggressive pests are posed to impact the region. Hemlock Woody Adelgid, introduced from Asia, has no known natural predator in North America and is usually 100% fatal to infected trees. While so far severe winter climate seems to be keeping it from spreading into the ecoregion the likelihood of milder winter conditions and the ability of insect populations to rapidly adapt to new conditions make it likely it will move north. Hemlocks are a tree of major economic importance to the region and their loss if this pest becomes widespread would have serious ecological and economic ramifications (see Map 5).

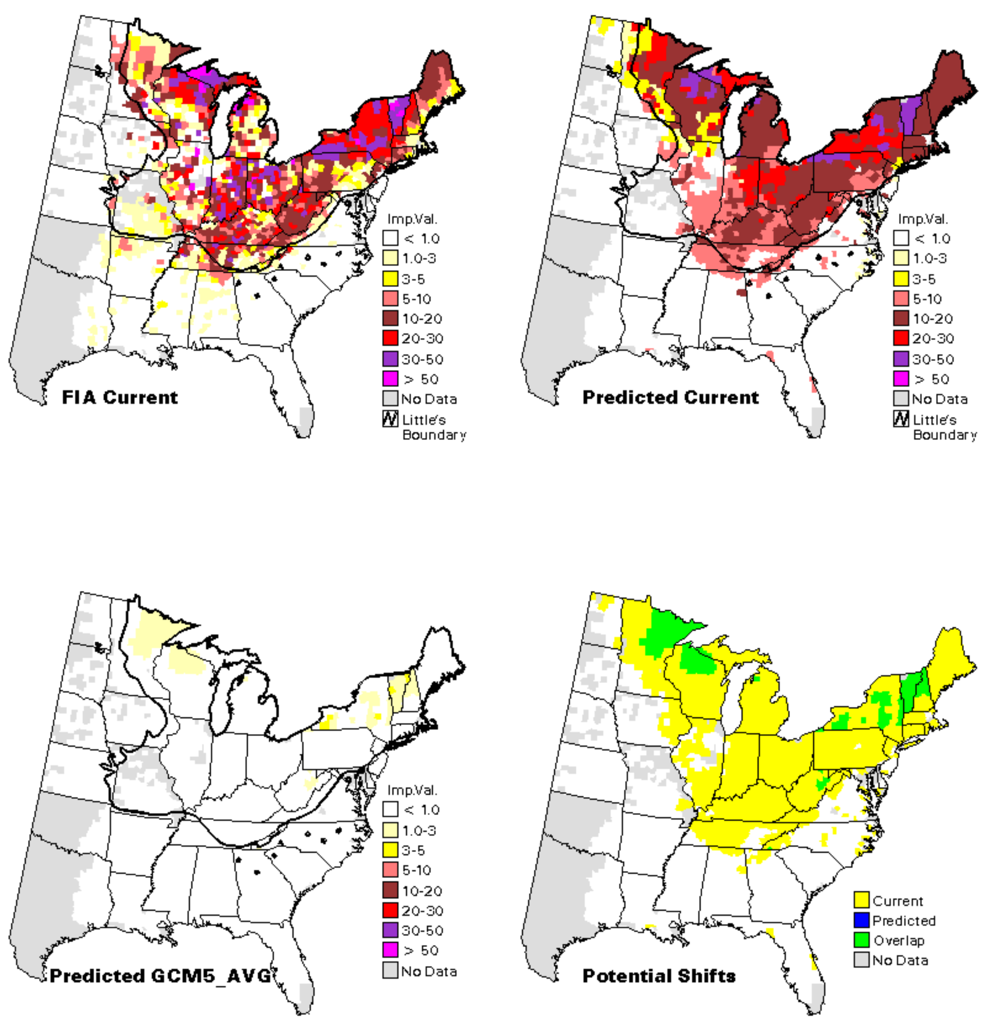
In the summer of 2000, Point Pleasant Park in Halifax was infested with the European brown spruce longhorn beetles. By March 2002, more than 2,600 spruce trees in the park had been destroyed by authorities to control the insect, and another 1,600 outside the park boundaries. At present, the only control action thought to be effective is to quarantine infested or potentially infested areas and burn the trees. Should quarantine and control efforts fail, the brown spruce longhorn beetle could spread throughout most of the softwood forests of Canada and northeastern US.



Map 5. Susceptibility to loss from Hemlock Wooly Adelgid.

Climate change represents yet another potential for major change in the region over the next 100 years for several reasons. First, temperature changes will favor new species over time and that will change the ecological context of many parts of the region. Second, climate change is predicted to increase disturbances across the region (hurricanes, for example) that could change the dynamics of stand replacement events such as wind throw and ice storms. Climate change will also contribute to sea level rise, ocean temperature changes and shifts in major currents which will bring significant changes to coastal and marine ecosystems and the species that depend on them. Finally, it is likely that precipitation levels will change. These changes have a high degree of uncertainly about them but it is clear that temperatures will be warmer. Extensive modeling of climate change impacts on forests has been conducted using various models of change. The consensus model covering the US portions of the region highlights the potential dramatic changes (see Map 6).

Acer saccharum



Map 6. Predicted Global Climate Models: Side by side comparison maps of predicted potential future species distribution (i.e., potential suitable habitat), using all 5 global change model scenarios (GCMs) with the modeled current. One can read from these maps the sensitivity of the species to its current environment, and deduce which species might potentially require more migration to persist in a globally changed climate. Note: these maps of potential change imply no barriers to migration. http://www.fs.fed.us/ne/delaware/atlas/gc_atlas318.htm; see also http://www.fs.fed.us/ne/delaware/atlas/pubatlas_help.htm

If change anything like this occurs in the region, the economic implications on the forest products industry will be profound and, ecologically, entirely different forest types will result in significant changes in species and plant communities. At the same time climate change will bring significant changes to coastal and marine ecosystems as well from sea level rise, ocean temperature changes and shifts in major currents. These may have profound impacts on the food availability for shorebirds and seabirds that migrate through and nest in the ecoregion. It is highly likely that these changes will affect Canada similarly.

Additional threats affect aquatic and coastal ecological systems, especially in Maritime Canada. For example, there are 20 tidal barriers in the inner Bay of Fundy alone. Tidal barriers either stop tidal flow up river or freshwater flow down. Not only do they impede the migrations of large numbers of fish, they have and continue to alter the dynamics and distribution of sediments in the Bay of Fundy and have resulted in serious ecological changes. The Bay of Fundy is also the location of one of the greatest concentrations of salmon aquaculture operations in the world, raising concerns about increased nutrient pollution and interactions with the now-endangered Bay of Fundy population of wild Atlantic salmon.

Shipping and transport practices result in chronic oil contamination of offshore and nearshore environments and increase the likelihood of damaging accidental spills. Pulp and paper mills in the Gulf of St. Lawrence region discharge effluents which severely degrade water quality. Mining and smelting operations in New Brunswick and Nova Scotia discharge toxic heavy metals and air emissions that degrade environmental quality. Food processing operations discharge nutrient rich, oxygen demanding effluents that degrade receiving waters and coastal habitats. Liquid effluents released from fish processing plants also contribute to localized water quality problems. Peat mining is an important economic activity, especially in New Brunswick. Peat mining can also be a significant threat, especially in Northeastern New Brunswick where some bogs are over 8,000 years old. Mining not only destroys habitat directly, but it also creates peat dust which can cause estuaries to become so clogged that filter feeders can no longer thrive. When peatlands are drained for development, the drainage waters change the quality of streams flowing out of bogs, thus affecting fish and invertebrates downstream. All-terrain vehicle traffic in bogs destroys the vegetation, causing long-lasting scars on the surface.. Extensive use of ATVs for recreation can disturb wildlife and severely damages wetland and coastal habitats.

Since many of the threats have a direct or indirect impact on aquatic ecosystems of the Maritimes, the development of an aquatics portfolio for the Canadian side is a necessary next step to assess the severity of the threats, determine the level of urgency and prioritize aquatic ecosystems for conservation action.

In sum, the region faces many major threats. Some of them are land use in nature and can be addressed by protecting and conserving important areas such as those outlined in this ecoregional assessment. Others are much more insidious and can only be addressed by concerted action at many sites (pests and pathogens, for example), at a policy level (climate change, atmospheric deposition, for example), and by concerted stewardship of protected natural areas (management of recreation, for example). Even the most effective land conservation programs will be insufficient to insure the maintenance of the biological diversity of the region without attention to a broader array of threats and strategies well beyond land protection.

APPENDIX: INTRODUCTION – CREDITS AND ACKNOWLEDGEMENTS

NAP Partner Organizations

Core Team

Technical Teams

Partner Organizations

The US-based Nature Conservancy (TNC) collaborated with the Nature Conservancy of Canada (NCC), the Atlantic Canada Conservation Centre (AC CDC), provincial and federal governments, land trusts and other partners to prepare this assessment.

Links to Partner Organization Web Sites

The Nature Conservancy

Nature Conservancy of Canada / Conservation de la Nature Canada

Atlantic Canada Conservation Data Centre

NatureServe

Environment Canada

Québec Ministère du Développement durable, de l'Environnement et des Parcs and Ministère des Ressources naturelles et de la Faune

Nova Scotia Environment and Labour and Natural Resources

New Brunswick Natural Resources

Prince Edward Island Environment, Energy and Forestry

Core Team

Our team structure consisted of seven key scientists and planners, three from the US-based Nature Conservancy (TNC) and four from the Nature Conservancy of Canada (NCC), each of whom contributed a portion of their time. We had no single individual whose time was solely allocated towards completing this project. However, it is the charter of The Nature Conservancy's Eastern Conservation Science team to coordinate the maintenance and revision of ecoregional assessments.

The Core Planning Team was convened in 2003 by TNC's Regional Director of Conservation Science, Dr. Mark Anderson, and communicated monthly via a team conference call. Three country leaders, Barbara Vickery for the U.S., Martha Gorman for Maritime Canada and Louise Gratton for Québec, were essential in getting the work completed. Technical services were provided by Greg Kehm, Charles Ferree, and Arlene

Olivero from TNC's Eastern regional office (ERO) and by Josette Maillet, Kasia Rozalska and Margo Morrison, from the Atlantic Canada Regional Office of NCC.

Additional core team members included Kara Brodribb and John Riley of NCC, Vince Zelazny of the New Brunswick DNR, Rosemary Curley, Bill Glen and Mary Lynn McCourt from Prince Edward Island DAF, David MacKinnon and Robert Cameron of Nova Scotia DEL, Peter Neily of Nova Scotia DNR and Sean Basquill of ACCDC.

Technical Teams

Each team assembled a panel of experts to identify conservation targets, contribute information, develop viability criteria, and review the results of occurrence selection.

Mammals, Reptiles, Amphibians, Fish (Non-avian Vertebrates)

Team leader: Josette Maillet

Reviewers:

Maritimes: Tom Herman, Mark Elderkin, Dwayne Sabine

Québec: Jacques Jutras, Claude Daigle, Nathalie Desrosiers, Walter Bertacchi, Norman Courtemanche, Alain Demers

US: Merry Gallagher, Fred Kircheis, Ken Sprankle, Phillip deMaynadier, Michale Glennon, Mark Ferguson, Rose Paul, John Roe

Birds

Team leader: Barbara Vickery

Reviewers:

Experts who provided input to this list include Kate Bredin, ACCDC, Dan Busby, CWS, Richard Elliot, CWS, Tony Erskine, CWS, Mark Elderkin, NSDNR, Dwayne Sabine, NBDNR, Tom Hodgman, MDIFW, Peter Vickery, ME, Nancy Sferra, METNC, Paul Novak, NY, Pam Hunt of NH Audubon Society, John Roe, Rose Paul and Mark Ferguson of TNC VT and from Quebec, Josée Tardif of CWS.

Additional information regarding specific locations for primary target birds was provided by Diane Amirault, Andrew Boyne, Yves Aubry, François Shaffer all of CWS, Francois Morneau of QC, Robert Houston of USFWS, Lindsay Tutor and Brad Allen of MDIFW, Barbara Louks NY, Margaret Fowle of VT, Michael Amaral of USFWS and Dan Lambert of VINS

Invertebrates (Mussels, Odonates, Lepidoptera and Tiger beetles)

Team leaders: Barbara Vickery (2003), Josette Maillet (2004)

Reviewers: Input from the following reviewers was included in this compilation: Paul Brunelle, Mark Elderkin, Dwayne Sabine, Reg Webster, NB, Phillip DeMaynadier, ME, Paul Novak, NY, John Roe, Rose Paul and Mark Ferguson of VT. To date little input has been received from Quebec or NH.

Plants

Team Leaders: Josh Royte / Louise Gratton

Reviewers: Jacques Labrecque, Gildo Lavoie (Ministère de l'Environnement du Québec); Louise Gratton (Nature Conservancy of Canada, Québec); Josh Royte (The Nature Conservancy, Maine); Maureen Toner (NBDNR); Sean Blaney (Atlantic CDC) ; Marian Munro (Nova Scotia Museum of Natural History), Gart Bishop (B&B Botanical), Dwayne Sabine (NBDNR), Mark Elderkin (NSDNR), Kate MacQuarrie (Island Nature Trust).

Matrix Forest, Terrestrial, Palustrine and Estuarine Ecosystems

Team Leader: Mark Anderson

Reviewers: Louise Gratton (QC); Vince Zelazny and Judy Loo (NB); Sean Basquill (Atlantic CDC); Peter Neily (NSDNR); Kate MacQuarrie and Jon Hutchinson (PEI); Eric Sorenson and Liz Thompson (VT); David Hunt (NYADK); Greg Edinger (NY); Doug Bechtel and Dan Sperduto (NH); Stephanie Neid (NatureServe); Sue Gawler, Andy Cutko, and Josh Royte (ME).

Freshwater Stream Networks and Lakes (U.S.)

Team Leader: Arlene Olivero

Reviewers: Barbara Vickery, ME; Josh Royte, ME; Kathy Jensen, ME; Peter Vaux, ME; Doug Bechtel, NH; Bill Brown, New York Adirondack (NYADK); Dirk Bryant, NYADK; Craig Cheeseman, NYADK; David Hunt, NYADK; Mark Anderson, ERO

Secured Lands

Team Leaders: Martha Gorman / Greg Kehm

Reviewers:

TNC and Natural Heritage Programs: Craig Cheeseman, Bill Brown, Tim Tear, Michelle Brown, David Hunt (NY); Sarah Wakefield, John Roe, Eric Sorenson, Liz Thompson (VT); Lora Gerard, Mark Zankel, Doug Bechtel, Dan Sperduto (NH); Dan Coker, Barbara Vickery, Joshua Royte, Nancy Sferra, Sue Gawler (ME)

ERO: Mark Anderson, Charles Ferree, Dan Morse

NCC and provincial agencies: Louise Gratton (QC); Kasia Rozalska (Atlantic Canada); Vince Zelazny (NBDNR); Rosemary Curley, Bill Glen, Mary Lynn McCourt (PEI DAF); David MacKinnon (NSDEL), Peter Neily (NSDNR)

Ecoregion Boundaries

Team Leaders: Martha Gorman and Mark Anderson

Reviewers: Ting Li, Vince Gerardin, and Guy Jolicoeur (QC); Vince Zelazny (NBDNR), Connie Carpenter (USDA Forest Service NH); Peter Neily (NSDNR); Greg Kehm (ERO)

DRAFT: COMPARISON TABLE FOR IUCN AND GAP CONSERVATION STATUS (adapted from WRI, 2002, p. 7): Draft Nov/02, revised Feb/04 M.Gorman, NCC		
IUCN Categories and Definitions: Guidelines (International Union for Conservation of Nature 1999)	**Comparable Jurisdictional designation**	**GAP Analysis Status Classification Scheme (Crist 2000)**
KEY CONCEPT (Guidelines for Protected Area Management Categories): http://www.iucn.org/themes/wcpa/pubs/pdfs/pacategories.pdf: A protected area is "an area of land and/or sea ***especially dedicated to the protection and maintenance of biological diversity***, and of natural and associated cultural resources, and managed ***through legal or other effective means***" (emphasis added).		**KEY CONCEPT** (GAP Handbook, Stewardship Chapter, Intro): http://www.gap.uidaho.edu/handbook/Stewardship/default.htm GAP goal is "***to provide an assessment of the management status for certain elements of biodiversity*** (vegetation communities and animal species)…and to provide land stewards with information on the representation of these elements on their land so they can make informed decisions about their management practices regarding biodiversity" (emphasis added).
I. Subdivided into Categories 1a and 1b. Strict Nature Reserve or Wilderness Area: Protected areas managed mainly for science or wilderness protection. (Key provisions: system-wide, highest protection)	**US**: National Park, National Monument, Wilderness Area, Nature Reserve/Preserve, Research Natural Area **Canada (ecoregional equivalent)**: Wilderness area, Ecological Reserve, Protected Natural Area, Representative Protected Area, Conservation Area, Wildlife Area, Natural Area (Crown or private), Park Reserve, Nature Preserve, Site of Ecological Significance, Special Place, sites designated under Endangered Species Act; in Quebec: Wildlife Habitat (e.g., inaccessible bird colonies on cliffs); Threatened or vulnerable species habitat	**1**. Areas with permanent protection from conversion. Management Plans should maintain the natural state; natural disturbance events are either allowed to proceed without interference or mimicked through management (Key provisions: legislated/binding authority, < 5% conversion, total system protected, natural processes maintained throughout. NOTE: in US NApps, fire suppression was ignored, guideline applied was limited intervention, i.e., wildland status)
II. National Park: Protected areas managed mainly for ecosystem protection and recreation. (Key provisions: system-wide, limited recreational development)	US: National Park, National Monument, Wilderness Area, Natural Reserve/Preserve, Research Natural Area **Canada (ecoregional equivalent)**: National Park, Provincial Park (natural, not recreation), Linear Park, Natural Area (Crown or private); in Quebec: Marine park; Wildlife Habitat (Caribou habitat north of the 52nd parallel); Migratory bird refuge;	
III. Natural Monument: Protected area managed mainly for conservation of specific natural features. (Key provisions: feature-oriented)	**US**: National Park, National Monument, Wilderness Area, Natural Reserve/Preserve, Research Natural Area **Canada (ecoregional equivalent)**: ecological reserve, special place, Natural Area (Crown or private); Migratory Bird Sanctuary (PEI), Protected Beach; in Quebec: Regional Park; Wildlife habitat; Wildlife refuge; threatened or vulnerable species habitat; Migratory bird refuge; **historic site?**	**2**. Areas with permanent protection from conversion. However, management plans may include activities that degrade the quality of existing natural communities, including the suppressing of natural disturbance regimes. (Key provisions: legislated/binding authority, <5% conversion, partial system protected, allows some management or degradation of natural processes) Guideline: enter as Gap 2 and move to Gap 1, as appropriate;
IV. Habitat/Species Management Area: Protected area managed mainly for conservation through management intervention. (Key provisions: species- and management-oriented)	**US**: State Parks, State Recreation Parks, National Wildlife Refuges, National Recreation Area, Area of Critical Environmental Concern, Wilderness Study Area, Conservation Easement, Private Conservation land, National Seashore **Canada (ecoregional equivalent)**: National Wildlife Area, Migratory Bird Sanctuary, Game Sanctuary; Wildlife Management Area (hunting/trapping managed by regulation, extraction permitted, rarely used in NB); Wildlife Park, Eastern habitat Joint Venture sites (NS), sites designated under Endangered Species Act; Natural Area (Crown or private); Municipal Park; in Quebec: Regional Park; Wildlife habitat; Wildlife refuge	
V. Protected Landscape/Seascape: Protected area managed mainly for landscape/seascape conservation and recreation. See IUCN: http://www.iucn.org/themes/wcpa/pubs/pdfs/categoryv.pdf (Key provisions: multi-use landscape)	**US**: State Parks, State Recreation Parks, National Wildlife Refuges, National Recreation Area, Area of Critical Environmental Concern, Wilderness Study Area, "forever wild" Conservation Easements, Private Conservation land, National Seashore **Canada (ecoregional equivalent, PROVISIONAL)**: Provincial Park, Wildlife Management Area, In Quebec: Regional Park; Private protected area; Wildlife habitat; Wildlife refuge; National Wildlife Reserve; Threatened or vulnerable species habitat; Migratory bird refuge; historic site; Salmon river	
VI. Managed Resource Protected Area: Protected area managed mainly for the sustainable use of natural ecosystems. (Key provisions: sustainable use-oriented)		
GAP 3 sites are not protected areas, by IUCN definition and criteria	**US**: BLM Holdings, Military Reservations, National Forests, State Forests, Wildlife Management Areas, Game and Fish Preserves, Fish Hatcheries, State Commemorative Area, Access Area, National Grassland, Army Corp of Engineers Holding **Canada (ecoregional equivalent, PROVISIONAL)**: old growth, habitat or biodiversity conservation areas that are established/administered/managed through legislation or planning regime, including environmentally significant areas, special management zones, working forest easements, "certified" working forests?	**3**. The majority of the area has permanent protection from conversion. However, the area is subject to extractive activities of either a broad, low-intensity type or a localized, intense type. Protection is granted to federally listed endangered and threatened species throughout the area. (Key provisions: legislated/binding authority or equivalent agreement or management plan, minimal conversion, allows low-intensity or localized extractive uses. NOTE: Status 4 has no institutional mandate/authority and conversion permitted throughout. Conversion = development, not modification. Guideline: enter as Gap 3 and move to Gap 2, as appropriate)

APPENDIX X: **Towards a lake portfolio for the Northern Appalachian Ecoregion**

NAP 2nd iteration Lacustrine Target Progress

NAP ecoregional planning included a revised lake macrohabitat key and descriptions (Appendix 3, Hunt 2003) and a GIS based lake classification and condition assessment in Maine (2003-2004) and New Hampshire (2004-2005). Although a comprehensive GIS based classification and portfolio assessment of all lakes and ponds in NAP was not completed, lacustrine work in this iteration made strides in the areas of GIS based classification and condition assessment methodology, linkages with the lacustrine macrohabitat keys, and resulted in a draft statewide prioritization of lakes in Maine.

A GIS based classification was developed in Maine and New Hampshire in an effort to develop a methodology which could be applied to all lakes in the region to adequately classify them into basic ecological types which would represent the diversity of lake natural communities across key structuring ecological gradients that exist. Experts were engaged in Maine in 2003-2004 and in New Hampshire 2004-2005, and their feedback led to the selection of key classification variables such as lake size, depth, sinuosity, local geology/acid neutralizing capacity, elevation, and hydrologic connectivity to streams. Although experts agreed all these variables affect the structure of expected lacustrine communities, Maine and New Hampshire ultimately combined these measured variables and formed “lake type” classes somewhat differently. For example, Maine attempted to use more elevation classes and a connectivity class in a basic “GIS lake type” because they felt these were also really critical structuring factors. New Hampshire instead focused on developing a very simple classification using only using lake size, a depth, and acid neutralizing capacity which they could relate well to known biological sample data. Although New Hampshire did chose to focus on the major structuring variables of size, depth, and acidity, they did however also explore and report that elevational and connectivity differences did exist and likely influenced the natural community composition particularly for very high elevation ponds and disconnected, headwater, or flow-through pond/ lake systems. The acid neutralizing capacity variable was also calculated differently between Maine and New Hampshire due to the availability of additional statistical software (CART) which allowed better modeling of the ANC levels in lakes for New Hampshire. Although both states recognized lake communities vary with the size of the lake and proportion of different habitats available, no critical size threshold beyond the commonly accepted pond (<10 acres) and lake (> 10 acres) split could be agreed upon. Size classes were thus felt best represented by a logarithmic scale grouping together lakes 10-100 acres, 100-1,000 acres, 1000-10,000 acres, and > 10,000 acres until further research proves another grouping is more appropriate.

A GIS based lake condition assessment in Maine and New Hampshire was also performed in 2004-2005 to measure key variables related to watershed and lake buffer land cover, isolation of the lake from roads, presence of dams, current level of conservation protection in a lake buffer, and presence of rare species, stocking, and exotics species. Expert interviews in Maine were completed and a detailed review of the GIS and expert information resulted in a draft lake prioritization for Maine. Goals in Maine were set to stratify selected lakes across EDU and HUC10 system type groupings. Numeric goals used included selecting a minimum of 10 occurrences of each lake type per EDU/HUC10 group for lake types where lake size was > 10,000 acres, 20 occurrences of lake types per EDU/HUC10 group where the lake size was 100-1000 acres, and 40 occurrences where EDU/HUC10 group when the lake type was 10-100 acres. Rare lakes types where there were < 5 examples per EDU/HUC10 type were also automatically nominated for portfolio and included if passing viability review. Because the larger lakes were much rarer than the smaller lakes, the above goals resulted in the desired outcome to more heavily represent in conservation those rarer lake types. New Hampshire also performed a GIS based condition ranking of lakes to select the 10 "most intact" and 10 "least intact" lakes in each of their classes, however New Hampshire had no expert review of the condition and viability of lake systems.

Further work will be necessary to synthesize which classification variables and thresholds, linkages to biological communities, and distribution goals are most appropriate to use in NAP ecoregional planning. Please see the New Hampshire State Wildlife Grant Report (Bechtel and Olivero, 2005) and the Maine Lake Classification and Portfolio Assessment documents (Olivero and Vaux 2005) for more information on these processes. Please also review 7 simple suggested NAP lake macrohabitat types synthesized and some general statistics on lakes within the entire U.S. NAP region below.

Characteristic Lacustrine Communities in NAP

The species composition of lakes is correlated with changes by lake morphometry, acid neutralizing capacity/pH, and hydrologic connectivity (Maxwell et al. 1995). Lake morphometry variables that drive ecological processes within lakes include lake surface area, depth, shoreline complexity, volume, and maximum length or fetch. Based on these patterns we recognized 7 major lake types in 3 size/depth groups (Hunt 2003, Olivero and Bechtel 2005):

- Ponds: Waterbodies less than 10 acres in size

- Shallow Lakes: Waterbodies over 10 acres in size and less than 30ft in depth.

- Deep Lakes: Waterbodies over 10 acres in size and greater than 30ft deep.

Ponds

1. *Very acidic ponds*. Size < 10 acres with very low pH and low ANC. Associated with acidic bedrock types and more common at higher elevations. Characteristics such as tannic, brown water, very low biological productivity (dystrophic), shallow depths, and where tannic, low light penetration. Typically mucky peat with organic material but occur over a range of substrates.. Characterized by low species richness; fish species may be absent in the most acidic examples. Where fish do occur, they likely are similar to the brown bullhead-golden shiner assemblage with only brown bullhead in the most acidic ponds. Acid tolerant plants and macroinvertebrate fauna.

2. *Acidic ponds*. . Size < 10 acres and acidic, but not as likely to have pH's low enough to exclude fish as Type #1. Most common in middle elevations and are predominantly associated with acidic bedrock types. They share other acidic characteristics with Type #1 and occur on a range of substrates, including sandy and rocky substrates, as well as mucky peat. Characterized by relatively low species richness. Fish assemblages are likely similar to the "Brown bullhead-golden shiner assemblage", with brown bullhead in the most acidic ponds, and golden shiner, rainbow smelt, burbot and possibly stocked trout (brook, brown, rainbow) in others. Acid tolerant plants and macroinvertebrate fauna.

3. *Neutral ponds*. Size < 10 acres with primarily neutral pH's and higher ANC's. Most prevalent on calcareous bedrock types, but also often found in association with marine clays. They are potentially more productive and species-rich, with occasional alkaline, highly nutrient rich ponds. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types. They likely have a range of substrates, including silty, sandy, and rocky substrates. Ponds may have pondshore emergent marshes with higher species richness.

Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna present.

Shallow Lakes

4. *Acidic shallow lakes*. Size > 10 acres, maximum depth < 30ft, and predominantly associated with acidic bedrock types. They are found both high and in the middle of their watersheds and relatively few are non-connected to a river system. They are primarily acidic, but not likely to have pH's low enough to exclude fish. They share many characteristics with other acidic types. (e.g. low pH and low ANC). Typical of a range of substrates, including sandy and rocky substrates, as well as mucky peat. These lakes are unlikely to be stratified in summer (dimictic). Characterized by moderate species richness. Fish assemblages are likely similar to be dominated by chain pickerel, golden shiner, pumpkinseed, largemouth bass, with brown bullhead, yellow perch, white sucker as well. Acid tolerant plants and macroinvertebrate fauna present and acid intolerant plant and macroinvertebrates absent.

5. *Neutral shallow lakes*. Size > 10 acres, maximum depth < 30ft, with primarily neutral pH's and higher ANC's. Potentially more productive and species-rich biota, with occasional alkaline, nutrient rich examples. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types. Typical of silty, sandy, and rocky substrates. These lakes are unlikely to be stratified in summer (dimictic). Shallow lakes may have lakeshore emergent marshes with higher species richness. Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna.

Deep Lakes

6. *Acidic deep lakes*: Size > 10 acres and depth > 30ft maximum depth, predominantly associated with acidic bedrock types. They are primarily acidic, but not likely to have pH's low enough to exclude fish. They share characteristics acidic types (e.g. low productivity, low pH, ANC). Typical of sandy and rocky substrates, as well as mucky peat. These lakes are stratified in summer (dimictic). With extensive deeper water columns, they provide an abundance of habitat for cold water fisheries. This type is characterized by high-moderate fish species richness. Fish assemblages are likely similar to be dominated by chain pickerel, golden shiner, pumpkinseed, largemouth bass, with brown bullhead, yellow perch, white sucker as well. Cold water habitat support lake trout, rainbow smelt, burbot, landlocked Atlantic salmon, and brook trout. Acid tolerant plants and macroinvertebrate fauna.

7. *Neutral deep lake*. Size > 10 acres, maximum depth > 30ft., primarily neutral, with moderate pH's and higher ANC's. Potentially more productive and species-rich biota. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types, and they likely have a range of substrates, including silty, sandy, and rocky substrates. These lakes are likely to be stratified in summer (dimictic). Lakeshore emergent marshes with higher species richness. Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser

abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna.

Characterizing and Mapping Lake:
To apply the lake classification system, and thus map and assess lakes and ponds throughout the ecoregion, we characterized every waterbody by its size class, elevation class, estimated acid or neutral water pH, and local connectivity. Although depth is also a key structuring variable, this was not available for all lakes in the region. However, lake depth was available in Maine and New Hampshire and in these states it was incorporated into the mapping effort (Olivero and Bechtel 2005, Olivero and Vaux 2005). Patterns highlighted for the ecoregion are presented below.

Lake Macrohabitats:
Certain variables useful in classifying lakes were developed for each lake in U.S. NAP. These include size class, elevation class, estimated acid or neutral water pH, and local connectivity. Further work will be necessary to link these data to the above 7 major biological lacustrine community types, however initial trends in the data are reported below.

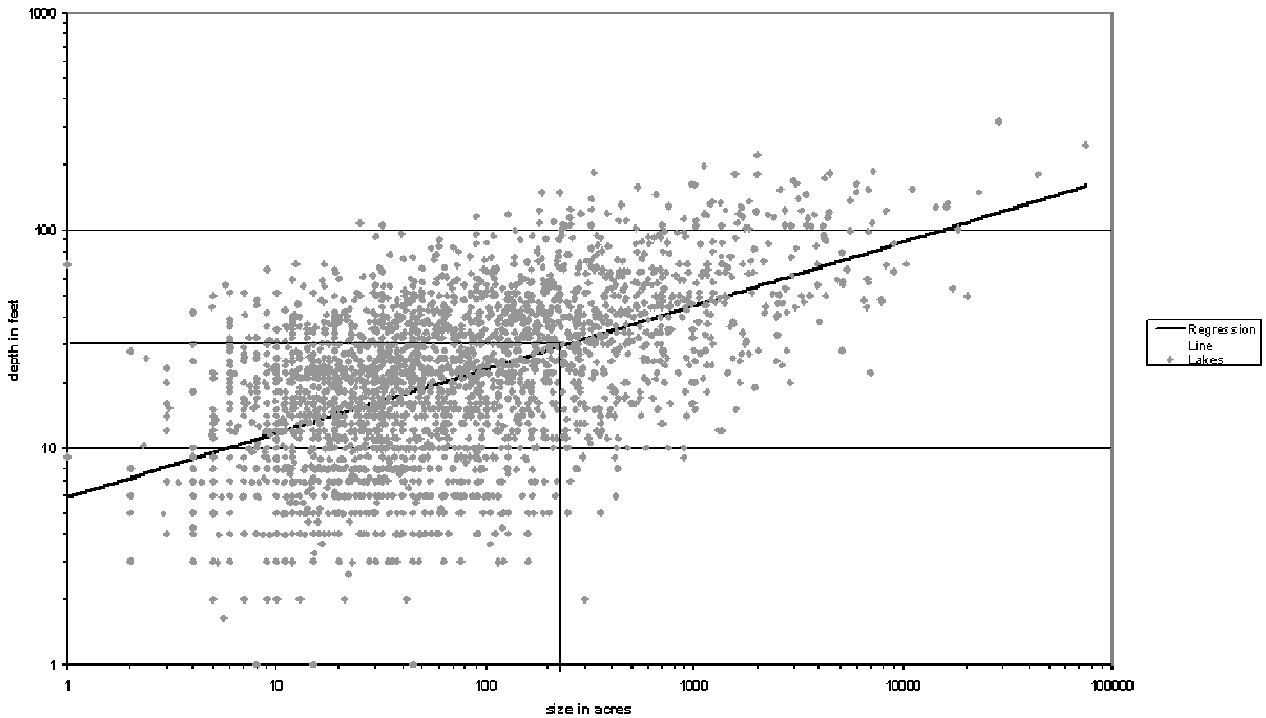
Lake Area and Depth

Lake area has been used consistently in the literature as the best predictor of lake species richness (Minns 1989, Tonn & Magnuson 1982, Matuszek & Beggs 1988). However other morphological variables also exert a strong influence over key attributes that shape lacustrine biological community types. For example in addition to lake area, depth and to a lesser degree shoreline complexity and maximum length or fetch interact to determine the likelihood and extent of light penetration and thermal stratification (Silk and Ciruna, 2004).

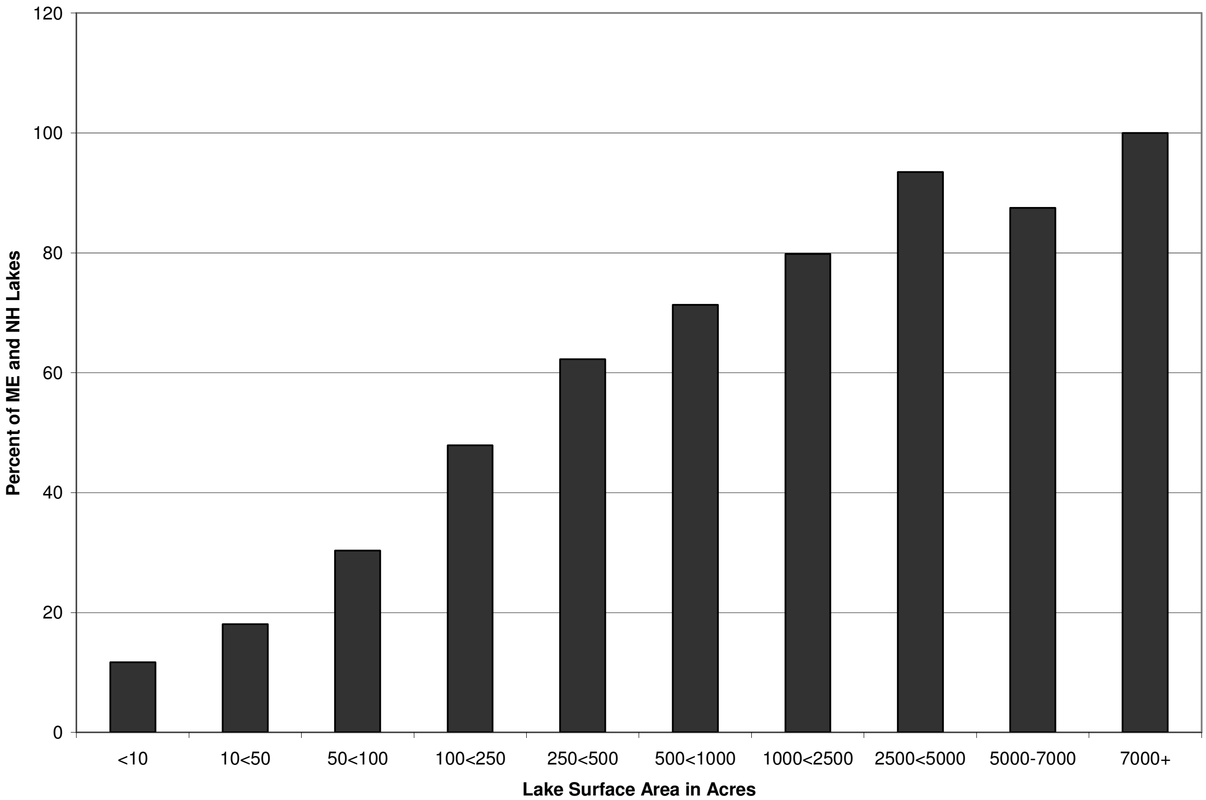
Light penetration is particularly critical in shaping lacustrine aquatic macrophyte and phytoplankton communities due to its influence on the extent of the littoral zone (where sunlight fully penetrates to the bottom and enables emergent and submergent aquatic plants), the euphotic pelagic zone of open water (where light levels allows photosynthesizing phytoplankton), the profuncal pelagic zone (where light levels are too low for photosynthesizing phytoplankton) and the benthic zone (lake bottom and its accumulated sediment and detritus). Although the exact extent or proportion of these habitats in individual lakes is hard to measure, shallow lakes with high shoreline complexity have much more extensive littoral zones and euphotic pelagic zones than deeper lakes of similar surface area for example.

Lakes also exhibit different biological communities based on thermal stratification. During the summer, lakes may exhibit the following major temperature zones 1) the epilimnion where warm water is well mixed, 2) the metalimnion of placid water where temperature drops quickly, and the 3) hypolimnion of cool/cold water at the bottom of the lake. Lakes shallower than 10 meters (~30ft) generally do not develop a stable thermal stratification during the summer due to heat transfer/water volume and as their wave action can stir water to such a depth that the thermal boundary never forms for long. At the other extreme, deeper lakes have a permanent summer thermocline and hypolimnion giving species access to permanent cold-water habitat (Silk and Ciruna 2004). Certain species requiring permanent cold-water habitat, such as lake trout, brook trout, rainbow smelt, burbot, and landlocked Atlantic salmon, will only be found in these deeper summer stratified lakes.

Although area was easily available for all lakes in the U.S. National Hydrography Lake Polygon dataset, depth was not available for all lakes. However, using data on lake size and depth from 2,698 lakes in Maine and New Hampshire, the following relationship could be described $Y = 1.78031219635747 + x(0.293142912147106)$, where x is the log(area in acres) and y is the log(depth in feet). This regression yielded an R squared of .30 and a multiple R of .55.



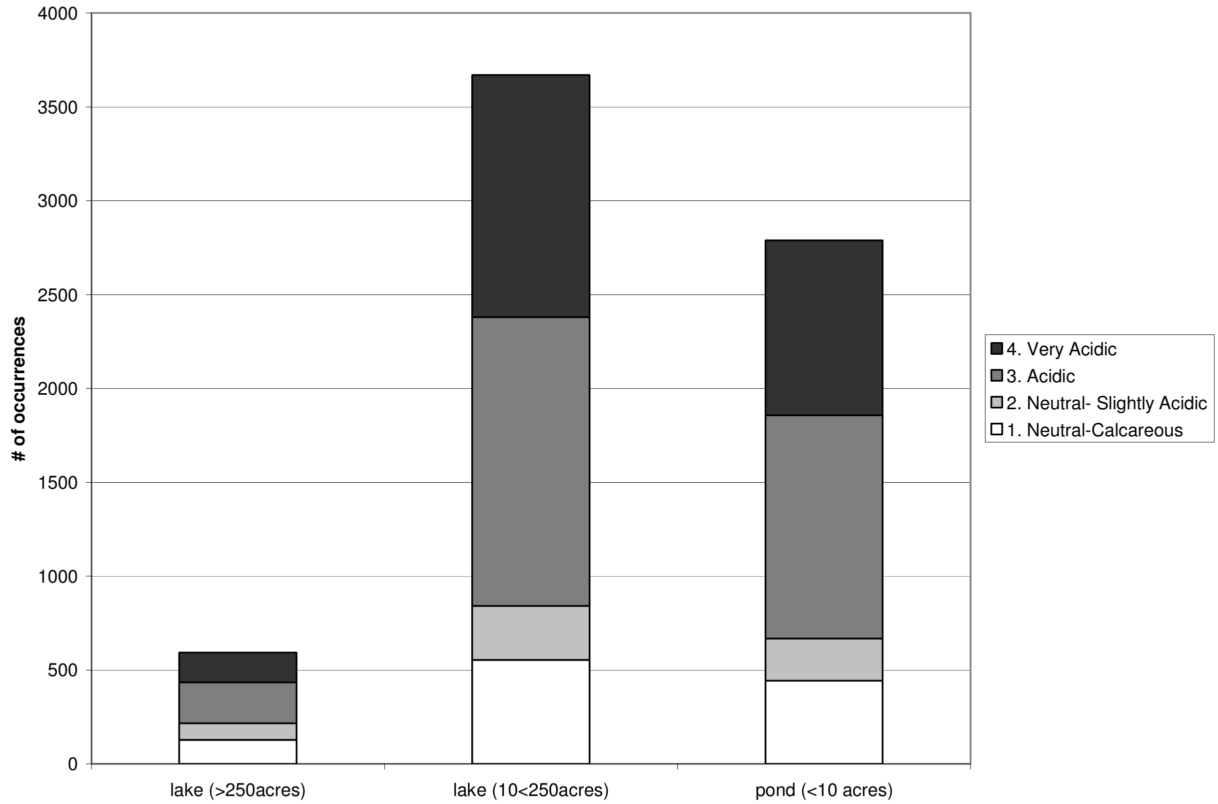
Because thermal stratification is a key variable structuring lacustrine communities, we were specifically interested in predicting the depth of lakes > or < 30ft deep, as lakes > 30ft are likely to develop a stable thermal stratification during the summer and provide enough deep cold water habitat to support cold water lacustrine communities. Looking specifically at the 30ft intercept, revealed a lake area of ~250 acres where we would predict the depth of lakes to be >30ft. Although there is scatter in the relationship and the equation has a multiple R squared of .55, reviewing our original dataset showed that indeed over half (62%) of lakes > 250 acres are >= 30ft deep lakes. The percentage of deep lakes occurring also increases in the population with area until after 7000 acres all lakes are >= 30ft deep. Although further research is necessary to determine if there are additional ecologically significant thresholds in lake size where we begin to see significant changes in lacustrine community composition, we suggest at least using this 250 acre threshold as a proxy in further analysis of lacustrine communities until additional lake depth data becomes available.



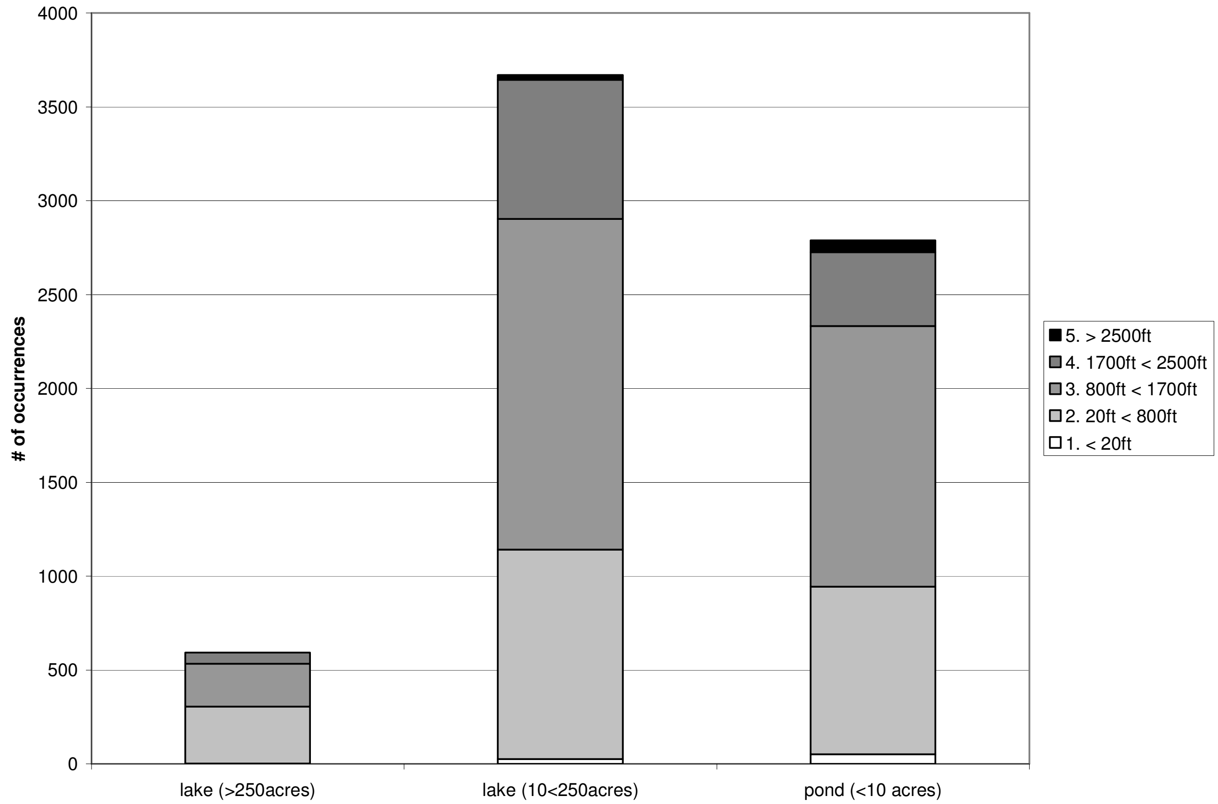
Lakes by Size Class and Water pH. The acidic or alkaline nature of lake water has been noted as another particularly key structuring variable for lacustrine communities. The water of most lakes has a natural range of variation between 6 a 9. pH below 4 or above 10 is toxic and very few aquatic organisms and even tolerate pH values below 5 or above 9 (Silk and Ciruna 2004). Although the pH of the water in lakes can be influenced by land cover (acidic coniferous needle inputs) and local agricultural practices (liming of fields), lake water pH is dominated by the influence of the buffing capacity of the local bedrock (Norton 1980). For example although rain and snowmelt are usually acidic, lakes with substantial groundwater inputs can buffer this acidic input if the bedrock material in the watershed contains minerals with buffering capacity (Norton 1980). Limestone and other forms of carbonate rock are noted as bedrock types containing molecules that dissolves in the groundwater and have the ability to bind with and reduce the concentration of hydrogen ions. Granite however does not contain much if any buffering material, so lakes in granite settings tend to be more acidic because of both acidic groundwater inputs and acidic surface runoff inputs.

The ph of lakes in NAP was initially estimated by sampling the buffering capacity of the local geology within 500m buffer of the lake (Norton 1980). Lakes in local setting of >= 90% acidic granitic are expected to be very acidic and lakes with <90% acidic granitic and no calcareous or moderately calcareous bedrock in their local settings are expected to be acidic. Lakes with local settings containing some moderately calcareous bedrock are expected to have some buffering capacity and be neutral to slightly acidic, while lakes with some calcareous bedrock in their local setting are expected to have substantial buffering capacity and be neutral to calcareous.

Results of this initial analysis show that 76% of ponds and lakes in NAP are expected to be acidic to very acidic. Neutral-calcareous ponds and lakes are much rarer types, representing only about 16% of examples.



Lakes by Size Class and Elevation Class. Elevation can influence the thermal regime and hydrologic regime (snowmelt vs. winter rain pattern) of lakes. For example, although exact effects of elevation on lacustrine communities are in general hard to measure, we know that small ponds and lakes at elevations > 2500 ft have distinct communities composed of species that can tolerate the colder climate influences at these elevations. We also expect lakes at elevations > 1700ft to experience more coniferous needle acidic inputs as a larger smaller percentage of surrounding forests are deciduous or mixed at these elevations. Review of the NAP lake dataset reveals that while the small ponds and lakes are distributed across all elevation zones, lakes > 250 acres are found mainly in elevations < 1700ft. Small ponds and lakes in the <20ft elevation zone are also noted as likely having some brackish communities and salt water intrusion given they are within the tidal elevation range. Given the distribution of surficial sediments, lakes and ponds in the 20ft-800ft are also more likely to have hydrologies influenced by deep coarse sediment sand deposit and/or fine marine clay surficial deposits.

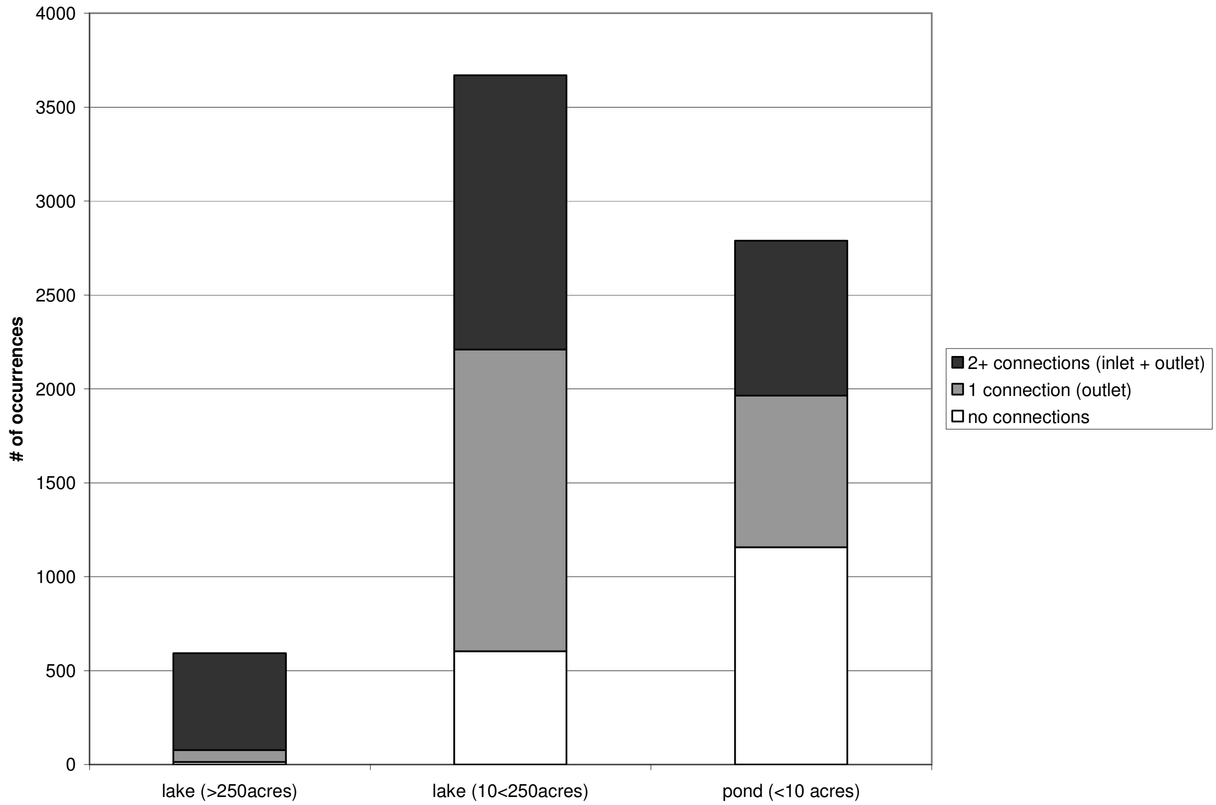


Lakes by Number of Connections.

The hydrologic connectivity of a lake within its larger drainage basin also plays a role in defining the lake's chemistry, hydrologic regime, and colonization/dispersal of lacustrine species. The hydrologic position of lakes is correlated with variation in a number of water chemistry attributes such increasing conductivity, Ca^{2+}, Mg^{2+}, alkalinity, and dissolved inorganic carbon with increasing downstream lake chain number. These patterns are partly explained by the fact that lakes high in the watershed receive a greater proportion of input waters from precipitation than lakes lower in the landscape. For example, seepage lakes (no inlets/outlets) and lakes positioned at the headwaters of a river drainage with only an outflow have been shown to be more sensitive to acid rain and snowmelt events (Quinlan et al. 2003). The relationship with inorganic carbon was also partly explained by the systematic processing of materials in lakes and in the stream segments between lakes (Webster and Sorrano 2000, Quinlan et al 2003, Kling et al. 2000). Lakes with larger river inputs and outflows are also likely to experience higher flushing rates than lakes of similar surface area/depth ratio located higher in the river network. These lakes will often be less thermally stratified and have lacustrine communities with a higher percentage of species typical of more riverine environments (Hunt 2003).

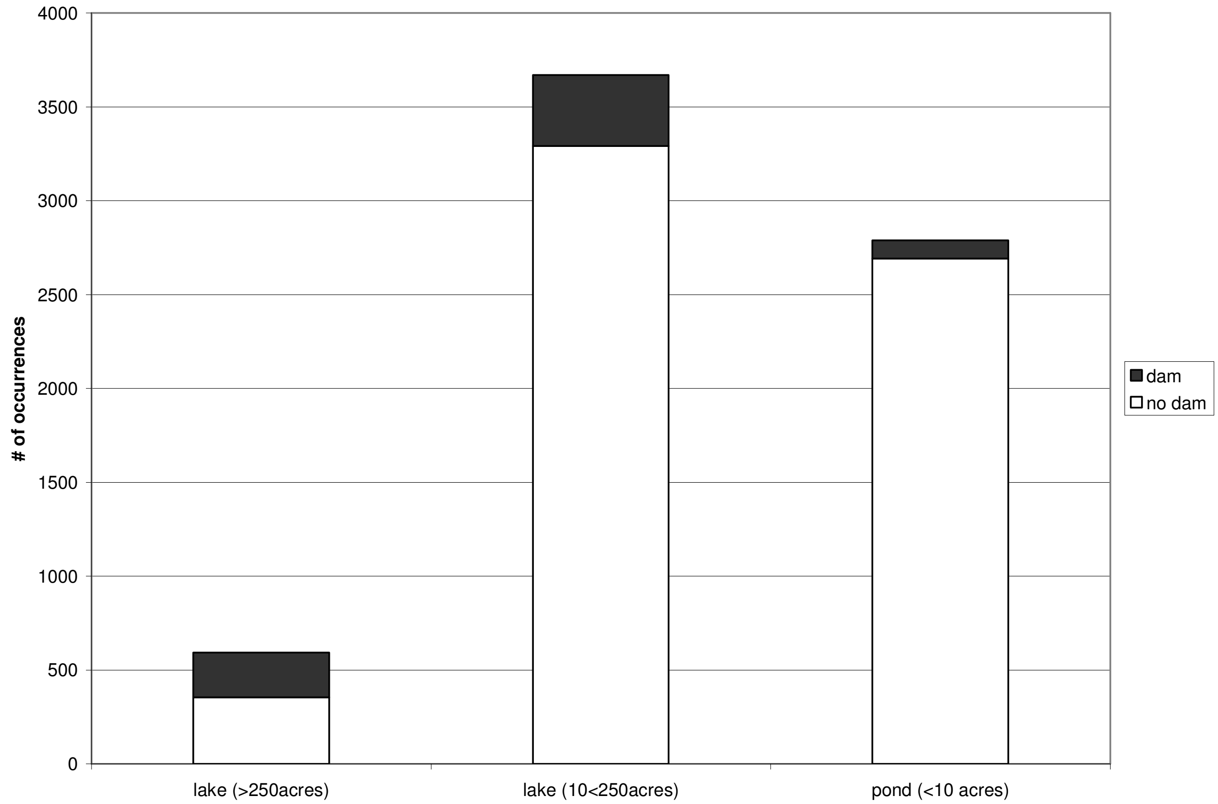
Connectivity also plays an important role in colonization and dispersal. For example, lakes that were formed in isolation and were never part of a larger water system tend to be less faunally species rich and/or fishless. Headwater lakes also tend to have a more limited fauna and flora than expected by size and depth. Connectivity is suggested as influencing this pattern due to limitations imposed by the downstream floating dispersal of many lacustrine species seeds/spores and the presence of dams and other barriers further down in the watershed that prevent upstream movement/access into headwater lakes for many fish, mollusks, and other invertebrates. These patterns have been documented for algal communities, macrophyte communities, macroinvertebrate assemblages, snails, and fish (Quinlan et al. 2003, Lewis and Magnuson 2000, Kratz et al. 1997).

Considering NAP lake/pond connectivity to stream networks at the 1:100,000k scale, 60% of lakes and ponds <250 acres are either unconnected (zero connections) or headwater lakes (one outlet connection). As lakes get larger, a higher percentage of the population are part of more complex drainage systems. Although 25% of lakes in NAP U.S. appear unconnected at the 1:100,000k hydrography scale, some of these may actually be connected to very small streams that were not mapped at the 100,000k scale. However, within this unconnected group we would expect to find a subset which are true seepage systems (no stream connections) that likely to contain unique fishless lacustrine communities.



Lakes by Size Class and Presence of Dam Dam alter lake ecosystems by creating non-natural lakes out of riverine systems and by artificially increasing the surface area and depth of natural lakes. Dams also create barriers to colonization/dispersal of lacustrine species and can alter the thermal stratification and hydrology of lakes depending on the method and timing of water releases from the reservoir.

Lakes in NAP were queried to determine which lake were likely influenced by damming. Lakes were coded as dam influenced if the lake was a NHD reservoir or < 300m from National Inventory of Dams, GNIS dams, GNIS reservoir point. Although only 11% of NAP U.S. lakes appear dammed, a larger percentage of large lakes are dammed. For example, stratified by lake size we find that 10% of lakes 10-250 acres in size are dammed, 32% of lakes 250-1,000 acres in size are dammed, 56% of lakes 1,000-10,000 acres in size appear dammed, and 64% of lakes > 10,000 acres in size appear dammed.

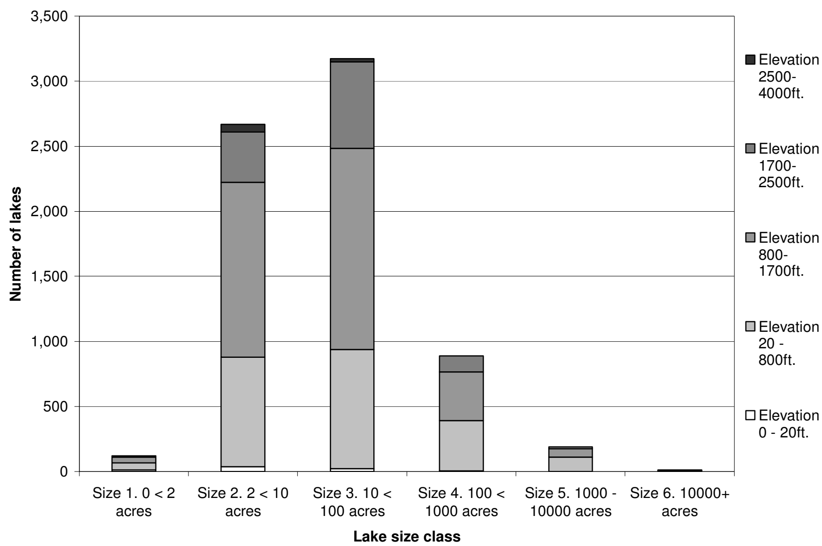


5. Condition Assessment

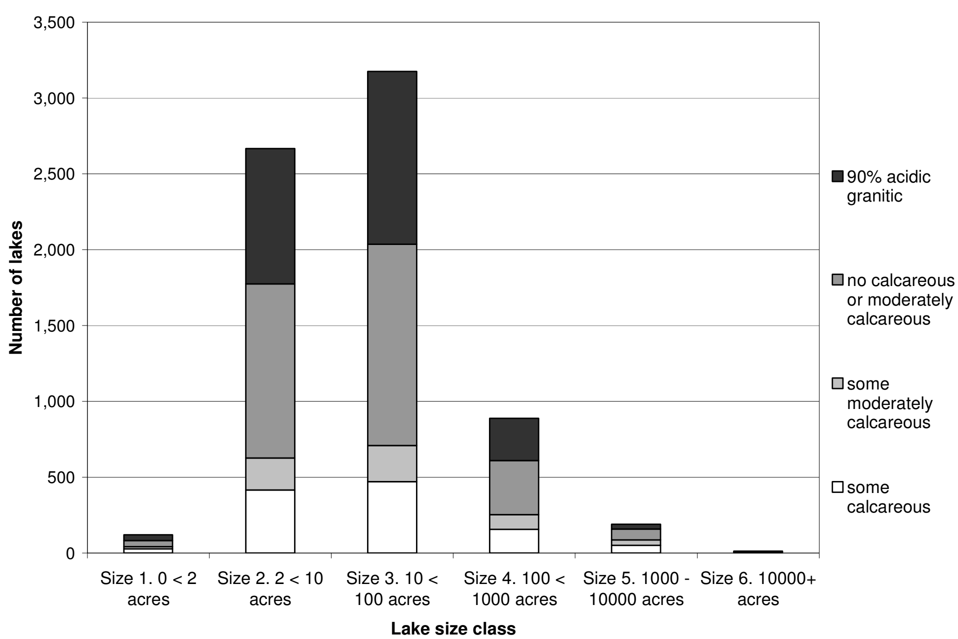
Assessing the viability and condition stream system targets presented a unique challenge. Although some water quality and biomonitoring data existed in various states, this information was not readily available or in a standardized comparable format across states. Consensus among scientists regarding viability thresholds for variables related to the biological functioning of aquatic ecosystems have also not been developed for northeastern streams, with the exception of impervious surface thresholds. 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. Second, this preliminary assessment was refined and expanded during a series of expert interviews conducted with scientists and resource managers across the planning region.

Please see the detailed methods documented in the standard Eastern Region Ecoregional Planning for Aquatic Systems Methods section (Anderson and Olivero, 2002) for more information on the exact GIS variables included in the GIS Screening and a description of how the variables were combined to yield a 1) Land cover and Road Impact Rank to represent changes in permeable surfaces and other threats from roads, urbanization, or agriculture; a 2) Dam and Drinking Water Supply Impact Rank to represent changes in hydrologic regime and migration barriers from dams; and 3) a Point Source Impact Rank to represent potential point source chemical alteration threats. Data tables of the GIS variables and ranks for NAP streams are provided in Appendix 5. Results of the expert interviews conducted in Maine, the Adirondacks, and Androscoggin drainages of New Hampshire during are provided in Appendix 6. Expert interviews were previously obtained in the other New Hampshire and Vermont sections of NAP during the Lower New England Ecoregional Plan and are found on the Lower New England Ecoregional Planning 1st Iteration CD.

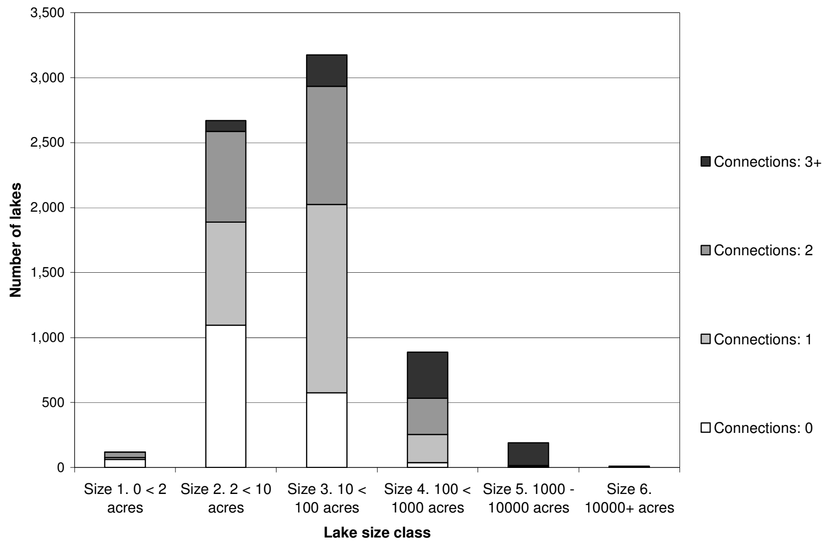
<u>Lakes by Size Class and Elevation Class.</u> The majority of NAP lakes are < 100 acres with only 16% of lakes >100 acres. While the small lakes are distributed across all elevation zones, lakes > 100 acres are found mainly in elevations < 1700ft. Small lakes at elevations > 2500 ft are expected to have distinct communities composed of species that can tolerate the colder climate influences at these elevations.



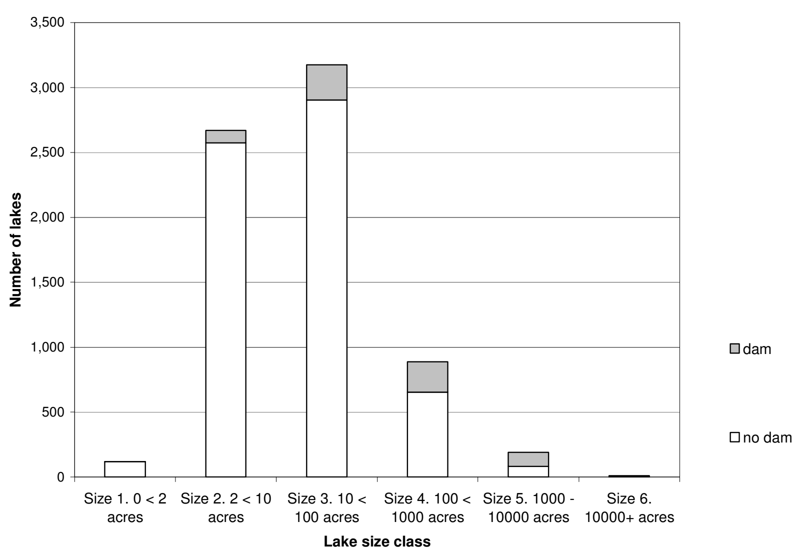
<u>Lakes by Size Class and Underlying Bedrock Geology Chemistry within 500m buffer.</u> Most lakes in NAP are acidic, with 76% of lakes in acidic or very acidic local settings. Lakes in local setting of 90% acidic granitic are expected to be very acidic, lakes with no calcareous or moderately calcareous bedrock are expected to be acidic, lakes with some moderately calcareous bedrock are expected to be neutral-slightly acidic, and lakes with some calcareous bedrock are expected to be neutral-calcareous.



Lakes by Number of Connections. Most lakes in NAP are connected to stream networks. A larger percentage of the lakes < 100 acres are unconnected (zero connections) or headwater lakes (one outlet connection). As lakes get larger, a higher percentage are drainage lakes with simple (2 connections, inlet and outlet) or complex (3+ connection) drainage patterns. Although 25% of lakes in NAP U.S. appear unconnected at the 1:100,000k hydrography scale, some of these may actually be connected to very small streams that were not mapped at the 100,000k scale. However, within this unconnected group we would expect to find a subset which are true seepage systems (no stream connections) that likely to contain fishless communities.



Lakes by Size Class and Presence of Dam (dams include lakes coded as NHD reservoir or < 300m from National Inventory of Dams, GNIS dams, GNIS reservoirs).
Although only 11% of NAP U.S. lakes appear dammed, a larger percentage of large lakes are dammed. For example, stratified by lake size class we find that 26% of lakes 100-1,000 acres in size are dammed, 56% of lakes 1,000-10,000 acres in size appear dammed, and 64% of lakes > 10,000 acres in size appear dammed.



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1. Very acidic ponds. Size < 10 acres with very low pH and low ANC. Associated with acidic bedrock types and more common at higher elevations. Characteristics such as tannic, brown water, very low biological productivity (dystrophic), shallow depths, and where tannic, low light penetration. Range of substrates, but most likely mucky peat with organic material. Characterized by low species richness; fish species may be absent in the most acidic examples. Where fish do occur, they likely are similar to the brown bullhead-golden shiner assemblage with only brown bullhead in the most acidic ponds. Acid tolerant plants and macroinvertebrate fauna.

2. Acidic ponds. . Size < 10 acres and acidic, but not as likely to have pH's low enough to exclude fish as Type #1. They are most common in middle elevations and are predominantly associated with acidic bedrock types. They share other characteristics with Type #1, such as low biological productivity (oligotrophic) and relatively shallow depths. They have low pH and low ANC, with a range of substrates, including sandy and rocky substrates, as well as mucky peat. Characterized by relatively low species richness. Fish assemblages are likely similar to the "Brown bullhead-golden shiner assemblage", with brown bullhead in the most acidic ponds, and golden shiner, rainbow smelt, burbot and possibly stocked trout (brook, brown, rainbow) in others. Acid tolerant plants and macroinvertebrate fauna.

3. Neutral ponds. Size < 10 acres with primarily neutral pH's and higher ANC's. Most prevalent on calcareous bedrock types, but also often found in association with marine clays. They are potentially more productive and species-rich, with occasional alkaline, highly nutrient rich ponds. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types. They likely have a range of substrates, including silty, sandy, and rocky substrates. Ponds may have pondshore emergent marshes with higher species richness. Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna present.

4. Acidic shallow lakes. Size > 10 acres, maximum depth < 30ft, and predominantly associated with acidic bedrock types. They are found both high and in the middle of their watersheds and relatively few are non-connected to a river system. They are primarily acidic, but not likely to have pH's low enough to exclude fish. They share other characteristics with Types #1 and #2, such as low biological productivity (oligotrophic). They likely have relatively low pH and low ANC, with a range of substrates, including sandy and rocky substrates, as well as mucky peat. These lakes are unlikely to be permanently stratified in summer (dimictic). Characterized by moderate species richness. Fish assemblages are likely similar to be dominated by chain pickerel, golden shiner, pumpkinseed, largemouth bass, with brown bullhead, yellow perch, white sucker as well. Acid tolerant plants and macroinvertebrate fauna present and acid intolerant plant and macroinvertebrates absent.

5. Neutral shallow lakes. Size > 10 acres, maximum depth < 30ft, with primarily neutral pH's and higher ANC's. Potentially more productive and species-rich biota, with occasional alkaline,

nutrient rich examples. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types, and they likely have a range of substrates, including silty, sandy, and rocky substrates. These lakes are unlikely to be permanently stratified in summer (dimictic). Shallow lakes may have lakeshore emergent marshes with higher species richness. Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna.

6. Acidic deep lakes: Size > 10 acres and depth > 30ft maximum depth, predominantly associated with acidic bedrock types. They are primarily acidic, but not likely to have pH's low enough to exclude fish. They share other characteristics with Types #1 and #2, such as low biological productivity (oligotrophic). Relatively low pH and low ANC, with a range of substrates, including sandy and rocky substrates, as well as mucky peat. These lakes are stratified in summer (dimictic). With extensive deeper water columns, they provide an abundance of habitat for cold water fisheries. This type is characterized by high-moderate fish species richness. Fish assemblages are likely similar to be dominated by chain pickerel, golden shiner, pumpkinseed, largemouth bass, with brown bullhead, yellow perch, white sucker as well. Cold water habitat support lake trout, rainbow smelt, burbot, landlocked Atlantic salmon, and brook trout. Acid tolerant plants and macroinvertebrate fauna.

7. Neutral deep lake. Size > 10 acres, maximum depth > 30ft., primarily neutral, with moderate pH's and higher ANC's. Potentially more productive and species-rich biota. They will exhibit relatively higher biological productivity (meso- and eutrophic) than other types, and they likely have a range of substrates, including silty, sandy, and rocky substrates. These lakes are likely to be stratified in summer (dimictic). Lakeshore emergent marshes with higher species richness. Depending on stocking, fish assemblages are likely to include both warmer and cold species, such as chain pickerel, golden shiner, pumpkinseed, large- and small-mouth bass, with lesser abundances of white sucker, longnose sucker, brown bullhead, yellow perch, fallfish, walleye, northern pike. Acid intolerant plants and macroinvertebrate fauna.

UnUSED TEXT

1. Natural Cover

Natural Cover in Medium Sized River Watersheds: NAP size 2 river watersheds are very intact with landcover on average 90% natural. Portfolio Priority 1 or Priority 2 Watersheds have a slightly higher percent natural cover (93%) than non-selected watersheds (85%) or Priority: Connectivity Only (9c) watersheds (87%).

Table x.

LAND COVER in Size 2 Rivers and Watersheds	Ecoregion Average	Not Selected	Priority 1	Priority 9c: Necessary for Connectivity Only
Watershed	90.91	85.82	93.47	87.40
Stream Buffer	>90.00	??	??	??

2. Percent Impervious Surfaces from Land Cover
Intactness of freshwater ecosystems, particularly small to medium sized freshwater systems, is often measured as a function of watershed impervious surfaces (CWP, 2003). Watersheds with >5% impervious surfaces begin to show signs of impairment while watersheds with >10% show clear signs of degradation. Watersheds > 25% impervious surfaces are considered "nonsupporting" for aquatic biota (CWP, 2003). Impervious surfaces in the near shore riparian area are also particularly noted as having detrimental effects to riverine systems due increased likelihood of point sources and contaminant inputs, disruption of nutrient and sediment filtering processes, impeding natural stream channel meandering/morphology, and reducing streamside vegetation shading and allochthonous carbon inputs. (HOW WAS THIS CALCULATED? IS IT A LINEAR RELATIONSHIP WITH LANDCOVER – IF SO, IT IS REDUNDANT)

Impervious Surfaces from Land Cover in Medium Sized River Watershed:
NAP size 2 watersheds are again very intact as measured by impervious surfaces, with an overall ecoregional average size 2 watershed imperviousness from land cover measured at 0.58. The overall impervious level in portfolio watersheds is lower than the imperviousness in non-portfolio watersheds.

% IMPERVIOUS SURFACES relative to Size 2 rivers	Ecoregional Average	Not Selected	Priority 1	Priority 9C: Necessary for Connectivity Only
WaterSheds	0.58	1.08	0.44	0.70
Stream Buffers	2%	??	??	??

3. Agriculture

Percent Agriculture in Medium Sized River Watersheds: NAP U.S. Size 2 Watersheds have low agricultural impacts with watershed averages, ranging from 5% in the North Atlantic drainages to nearly 14% in the Ontario drainages with an overall ecoregional average of 6.7%. Portfolio size 2 watersheds have less percent total agriculture than their non-portfolio counterparts.

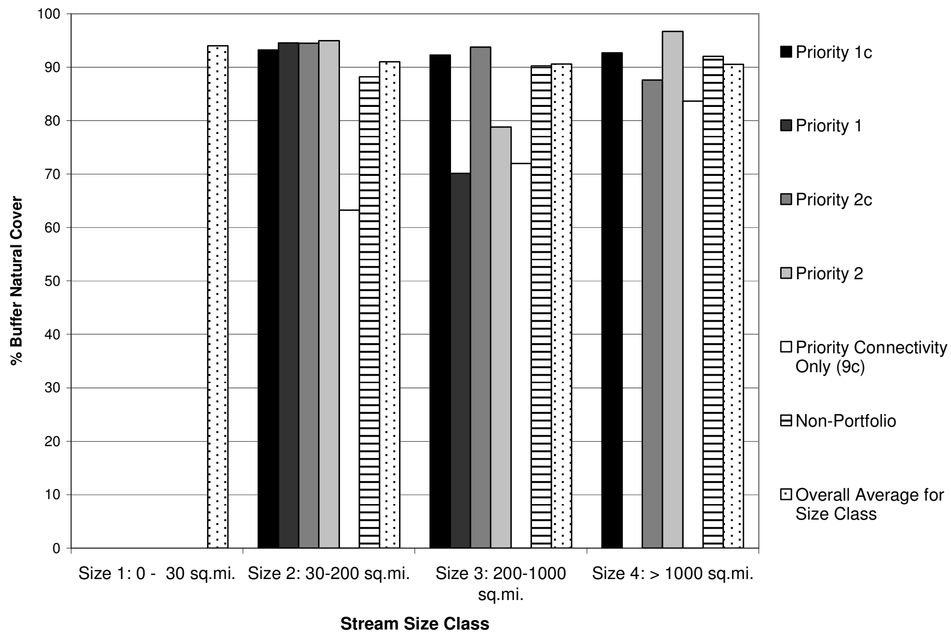
% AGRICULTURE for size 2 streams	Ecoregional Average	Not Selected	Priority 1	Priority 9c: Necessary for Connectivity Only
Watershed	6.70	11.54	3.61	10.83
Stream Buffer				

1. Natural Cover

Natural Cover in Medium Sized River Watersheds: NAP size 2 river watersheds are very intact with landcover on average 90% natural. Portfolio Priority 1 or Priority 2 Watersheds have a slightly higher percent natural cover (93%) than non-selected watersheds (85%) or Priority: Connectivity Only (9c) watersheds (87%).

Portfolio Status	Ecoregional Average	Not Selected	Priority 1 and Connectivity Network (1c)	Priority 1, without connectivity (1)	Priority 2 and Connectivity Network (2c)	Priority 2, without connectivity (2)	Priority: Necessary for Connectivity Only (9c)
% Natural Land Cover	90.91	85.82	93.48	93.45	93.73	93.24	87.40

Natural Cover in 100m stream buffer: The 100m riparian area around rivers in NAP is very intact with all size classes of rivers having > 90% natural stream buffers. The intactness of the riparian buffer decreases slightly with increasing size of river, for example size 1 rivers have the most intact buffers at 94% , while the size 4 rivers have the least intact at 90.55%. Our highest priority portfolio rivers, 1c, have more intact buffers than the non-selected rivers. The 9c priority rivers have on average the worst riparian buffer conditions, ranging from 63-83% natural cover on average. These 9c rivers were known to be in poor condition and only selected as targets for connectivity/passage of fish and water volume.



4. Percent Impervious Surfaces from Land Cover

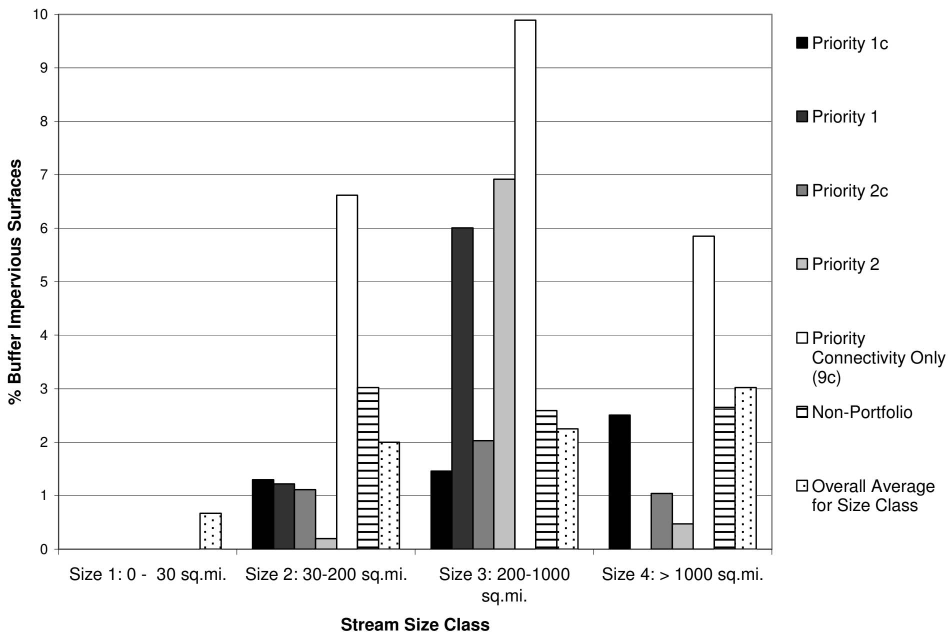
Intactness of freshwater ecosystems, particularly small to medium sized freshwater systems, is often measured as a function of watershed impervious surfaces (CWP, 2003). Watersheds with >5% impervious surfaces begin to show signs of impairment while watersheds with >10% show clear signs of degradation. Watersheds > 25% impervious surfaces are considered "nonsupporting" for aquatic biota (CWP, 2003). Impervious surfaces in the near shore riparian area are also particularly noted as having detrimental effects to riverine systems due increased likelihood of point sources and contaminant inputs, disruption of nutrient and sediment filtering processes, impeding natural stream channel meandering/morphology, and reducing streamside vegetation shading and allochthonous carbon inputs.

Impervious Surfaces from Land Cover in Medium Sized River Watershed:
NAP size 2 watersheds are again very intact as measured by impervious surfaces, with an overall ecoregional average size 2 watershed imperviousness from land cover measured at 0.58. The overall impervious level in portfolio watersheds is lower than the imperviousness in non-portfolio watersheds.

Portfolio Status	Ecoregional Average	Not Selected	Priority 1 and Connectivity Network (1c)	Priority 1, without connectivity (1)	Priority 2 and Connectivity Network (2c)	Priority 2, without connectivity (2)	Priority: Necessary for Connectivity Only (9c)
% Impervious Surfaces	0.58	1.08	0.32	0.56	0.37	0.06	0.70

Impervious Surfaces from Land Cover in 100m Stream Buffer: The 100m riparian area around rivers in NAP is very intact with all river size classes on average <3% impervious. A trend is seen that as rivers get larger they have more impervious cover with a average of 0.67% for size 1 rivers, 2% for size 2 rivers, 2.25% for size 3 rivers, and 3.02% for size 4 rivers.

Although higher than the watershed imperviousness for size 2 rivers (.58), the value of 2% in the riparian area of size 2 rivers is still extremely low. A trend is seen that our highest priority portfolio rivers, 1c, have lower riparian area impervious surfaces than their non-portfolio counterparts for all size classes of rivers. Portfolio rivers of priority class other than 1c are sometimes above the overall average for their size class of river, indicating that other factors likely drove these sites to be selected such as intact connectivity or presence of exemplary rare biota. No rivers of any portfolio class have > 10% of their riparian area in impervious surface.

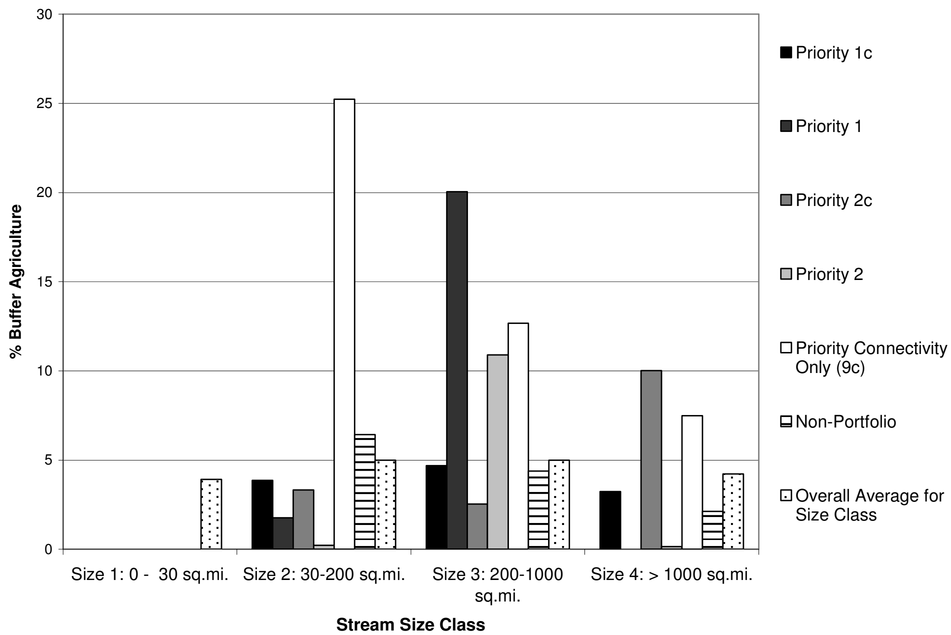


5. Agriculture

Percent Agriculture in Medium Sized River Watersheds: NAP U.S. Size 2 Watersheds have low agricultural impacts with watershed averages, ranging from 5% in the North Atlantic drainages to nearly 14% in the Ontario drainages with an overall ecoregional average of 6.7%. Portfolio size 2 watersheds have less percent total agriculture than their non-portfolio counterparts.

Portfolio Status	Ecoregional Average	Not Selected	Priority 1 and Connectivity Network (1c)	Priority 1, without connectivity (1)	Priority 2 and Connectivity Network (2c)	Priority 2, without connectivity (2)	Priority: Necessary for Connectivity Only (9c)
% Agriculture	6.70	11.54	4.64	2.58	4.16	0.90	10.83

Percent Agriculture in 100m Stream Buffer: The 100m riparian area around rivers in NAP has on average 4% agricultural land use. For size 2 rivers, the highest priority 1c portfolio rivers have roughly half the agricultural levels of non-selected streams. For size 3 and size 4 rivers, our highest priority, 1c, river have similar or slightly less agriculture in the buffer than non-selected streams Many of our Priority 1, 2, 2c, and 9c portfolio rivers appear to have similar or slithgly more agriculture in their riparian area than the non-selected examples. This likely indicates that factors other than riparian agricultural use were weighted more heavily in determining portfolio status for these rivers, particularly as rivers got larger.

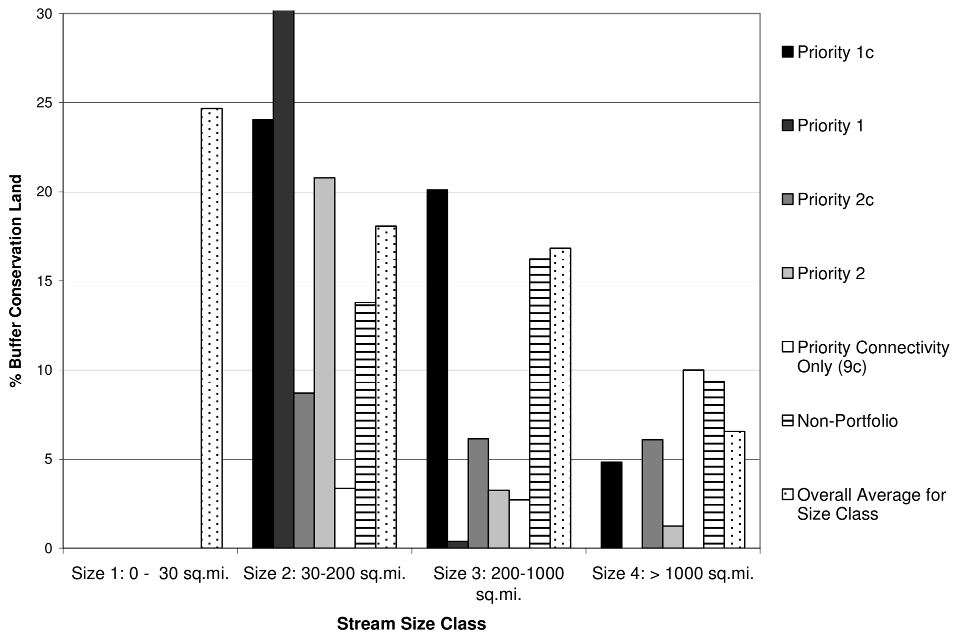


4. Conservation Status

Percent Conservation Land in Medium Sized River Watersheds: Across the ecoregion, on average 10% of a portfolio size 2 watershed is in GAP Status 1. On average 24% of a size 2 watershed is in GAP Status 1, 2, or 3. Portfolio Priority 1 watersheds have a higher percentage of GAP Status 1, 2, or 3 land than non-portfolio watersheds.

Portfolio Status	Ecoregional Average	Not Selected	Priority 1 and Connectivity Network (1c)	Priority 1, without connectivity (1)	Priority 2 and Connectivity Network (2c)	Priority 2, without connectivity (2)	Priority: Necessary for Connectivity Only (9c)
%GAP 12	10.72	9.32	14.39	11.35	5.67	6.08	2.96
% GAP123	24.34	16.85	33.63	31.34	13.21	29.07	12.90

Percent Conservation Land in Portfolio River Buffers: Roughly 23% of the riparian 100m buffer streams within the ecoregion was in some form of conservation status. This included nearly 25% of size 1 rivers riparian area, 18% of size 2 riparian areas, 17% of size 3 river riparian areas, and 7% of size 4 river riparian areas. For size 1-3 rivers, our highest priority rivers, 1c, have more conservation land in their riparian reas than non-portfolio examples.


% Buffer Conservation Land
30
25
20
15
10
5
0
Size 1: 0 - 30 sq.mi.
Size 2: 30-200 sq.mi.
Size 3: 200-1000 sq.mi.
Size 4: > 1000 sq.mi.
Stream Size Class
Priority 1c
Priority 1
Priority 2c
Priority 2
Priority Connectivity Only (9c)
Non-Portfolio
Overall Average for Size Class

Levels of generalization for the NAP Ecoregion NOTE: due to different stratification criteria, sub-units are not fully equivalent	Definition and delineation criteria for ecological units and approximate map scale	National Ecological Framework Canada (Wiken et al)	USFS National Hierarchical Framework (Bailey et al; Keys et al)	USEPA Ecoregions of the Conterminous (Omernik et al)	Le cadre écologique de référence du Québec (Li & Ducruc)	New Brunswick Ecological Land Classification	Nova Scotia Ecological Land Classification
Upper level units (continental)	Broad continental climatic zones		Domain <1:30m	Level I			
NAP ecoregion	Sub-continental (macro) climate and latitudinal gradients as expressed by dominant natural cover 1:75m-1:5m	Ecozone	Division 1:30m-1:7.5m	Level II	Province Naturelle >1.5m		
NAP ecoregion subdivisions	Subdivsions characterized by dominant assemblages of structural and surficial features and related macro climatic-elevational-vegetation-soil zonation, as expressed in dominant vegetation types 1:1m	Ecoprovince	Province: 1:15m-1:5m	Level III			
Lower level units (sub-regional)	Subdivisions characterized by regional (meso) climate, elevation, broad scale aspect, geomorphology, soil types and moderating influence of major waterbodies, as expressed by dominant ecosystem types 1:5m-1:500,000	Ecoregion	Section: 1:7.5m-1:3.5m		Région Naturelle 1:5m-1:1m	Ecoregion	Ecoregion
					Ensemble Physiographique 1:500,000-1:200,000		
	Subdivisions characterized by large order microclimate, major assemblages of relief, geology, landform and soils, as expressed by dominant plant assemblages (alliances) 1:250,000-1:50,000	Ecodistrict	Sub-section 1:3.5m-1:250,000	Level IV?	District Écologique 1:250,000-1:100,000	Ecodistrict	Ecodistrict
	Subdivsions characterized by repeating patterns of landform, topography and glacial deposit type, as expressed by dominant plant associations 1:100,000-1:10,000	Ecosection	Landtype Association 1:250,000-1:60,000		Ensemble Topgraphique 1:100,000-1-50,000	Ecosection	Ecosection
	Subdivsions characterized by a uniformity of topoclimate, soil parent material, hydrology, topography (elevation, aspect, exposure, slope gradient and position), as expressed by plant species composition 1:50,000-1:5,000	Ecosite	Landtype 1:60:000-1-25,000		Entité Topographique 1:50,000-1:20,000	Ecosite	Ecosite
	Subdivision features characterized by a uniformity of microclimate and relief, soil moisture and nutrient regime <1:5,000	Ecoelement	Landtype phase >1:24,000		Elément Topographique 1:20,000-1:5,000	Ecoelement	
					Faciés Topographique <1:5,000		

NAP Ecoregions
Subdivisions
Subsections

Gaspe Penninsula:
A04 Québec Région Naturelles Péninsule de la Gaspésie

Temiscouata Hills/St. John Uplands - Central:
A03 Québec Région Naturelles Appalachien du bas Saint-Laurent
NBELC 1 NB Highlands
1-1 Kejwik Ecodistrict
NBELC 3 Central Uplands Ecoregion
3-1 Madawaska Ecodistrict

Estrie-Beauce Plateaus & Hills/St. John Uplands:
A01 Québec Région Naturelles Appalachien de l'Estrie
A02 Québec Région Naturelles Appalachien de la Beauce
M212 USFS Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province?
M212Aa-b White Mountains Subsections

Green & White Mountains:
M212 USFS Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province
M212Ac-g White Mountains Subsections
M212B Vermont-New Hampshire Uplands Subsection
M212C Green, Taconic and Berkshire Mountains Subsection

Adirondacks & Tug Hill:
M212 USFS Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province
M212D Adirondacks Mountains Subsection
M212F Tug Hill Subsection

Acadian Highlands:
NBELC 1 NB Highlands Ecoregion
1-2 Ganong Ecodistrict

NBELC 2 Northern Uplands Ecoregion
2-1 Upsalquitch Ecodistrict
2-2 Tetagouche Ecodistrict
2-3 Tjigog Ecodistrict
2-4 Tomogonops Ecodistrict
2-5 Nicolas Denys Ecodistrict

NBELC 3 Central Uplands Ecoregion
3-2 Sisson Ecodistrict
3-3 Serpentine Ecodistrict
3-4 Brighton Ecodistrict
3-5 Beadle Ecodistrict
3-6 Caledonia Ecodistrict

NSELC 100 Cape Breton Taiga Ecoregion

NSELC 200 Cape Breton Highlands Ecoregion
210 Cape Breton Highlands Ecodistrict
220 Victoria Lowlands Ecodistrict

Acadian Uplands:
212 USFS Laurentian Mixed Forest Province
212Aa Aroostook Hills and Lowlands Subsection
212Ab Aroostook Lowlands Subsection
212Ba Central Maine Foothills Subsection
212Bb Maine/New Brunswick Lowlands Subsection
212Ca Maine Eastern Interior Subsection
212Da Central Maine Embayment Subsection

NBELC 7 Grand Lake Lowlands Ecoregion
7-1 Aukpaque Ecodistrict
7-2 Grand Lake Ecodistrict

NBELC 5 Valley Lowlands Ecoregion
5-1 Wapske Ecodistrict
5-2 Blue Bell Ecodistrict
5-3 Meductic Ecodistrict
5-4 Buttermilk Ecodistrict
5-5 Cardigan Ecodistrict
5-6 Nackawic Ecodistrict
5-7 Cranberry Ecodistrict
5-8 Magaguadavic Ecodistrict
5-9 Yoho Ecodistrict
5-10 Mount Pleasant Ecodistrict
5-11 Kingston Ecodistrict
5-12 Anagance Ecodistrict

NSELC 300 Nova Scotia Uplands Ecoregion
310 Cape Breton Hills Ecodistrict
320 Inverness Lowlands Ecodistrict
330 Pictou Antigonish Highlands Ecodistrict
340 Cobequid Hills Ecodistrict
350 Cobequid Slopes Ecodistrict
360 Mulgrave Plateau Ecodistrict

370 St. Mary's River Ecodistrict
380 Central Uplands Ecodistrict

Northumberland/Bras D'Or Lowlands

- NBELC 6 Eastern Lowlands Ecoregion
  - 6-1 Tabusintac Ecodistrict
  - 6-2 Caraquet Ecodistrict
  - 6-3 Red Bank Ecodistrict
  - 6-4 Castaway Ecodistrict
  - 6-5 Bantalor Ecodistrict
  - 6-6 Kouchibouguac Ecodistrict
  - 6-7 Petitcodiac Ecodistrict

- Atlantic Maritime Ecozone
  - 130 Prince Edward Island Ecoregion
  - 131 Îles-De-La-Madeline Ecoregion

- NSELC 500 Northumberland-Bras D'Or Ecoregion
  - 510 Bras d'Or Lowlands Ecodistrict
  - 520 St. George's Bay Ecodistrict
  - 530 Northumberland Lowlands Ecodistrict
  - 540 Cumberland Hills Ecodistrict
  - 550 Tantramar Marshes Ecodistrict
  - 560 Chignecto Ridges Ecodistrict

Gulf of Maine/Bay of Fundy/Minas Basin:

- 212 USFS Laurentian Mixed Forest Province
  - 212Dc Casco Bay
  - 212Cb Maine Eastern Coastal

- NBELC 4 Fundy Coastal Ecoregion
  - 4-1 Fundy Coastal Ecodistrict

- NSELC Ecoregion 900 Fundy Shore
  - 910 Parrsboro Shore Ecodistrict
  - 920 North Mountain Ecodistrict

Nova Scotia Hills & Drumlins:

- NSELC 400 Eastern Ecoregion
  - 410 Rawdon/Wittenburg Hills Ecodistrict
  - 420 Eastern Drumlins Ecodistrict
  - 430 Eastern Granite Uplands Ecodistrict
  - 440 Eastern Interior Ecodistrict
  - 450 Governor Lake Ecodistrict

- NSELC 600 Valley & Central Lowlands Ecoregion
  - 610 Annapolis Valley Ecodistrict
  - 620 Minas Lowlands Ecodistrict
  - 630 Central Lowlands Ecodistrict

- NSELC 700 Western Ecoregion
  - 710 Valley Slope Ecodistrict
  - 720 South Mountain Ecodistrict
  - 730 Clare Ecodistrict
  - 740 LaHave Drumlins Ecodistrict
  - 750 Rossignol Ecodistrict
  - 760 Sable Ecodistrict
  - 770 Flint Ecodistrict

Atlantic Coast

- NSELC 800 Atlantic Coastal Ecoregion

NAP Ecoregions
 # Subdivisions
 # Subsections

US
1 M212 Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province
1 M212A White Mountains Subsection
1 M212B Vermont-New Hampshire Uplands Subsection
1 M212C Green, Taconic and Berkshire Mountains Subsection
1 M212D Adirondacks Mountains Subsection
1 M212F Tug Hill Subsection

1 212 Laurentian Mixed Forest Province
1 212Aa Aroostook Hills and Lowlands Subsection
1 212Ab Aroostook Lowlands Subsection
1 212Ba Central Maine Foothills Subsection
1 212Bb Maine/New Brunswick Lowlands Subsection
1 212Ca Maine Eastern Interior Subsection
1 212Cb Maine Eastern Coastal
1 212Da Central Maine Embayment Subsection
1 212Dc Casco Bay

Québec
1 A01 Québec Région Naturelles Appalachien de l'Estrie
1 A02 Québec Région Naturelles Appalachien de la Beauce
1 A03 Québec Région Naturelles Appalachien du bas Saint-Laurent
1 A04 Québec Région Naturelles Péninsule de la Gaspésie

PEI & Îles-De-La-Madeline
1 Atlantic Maritime Ecozone
1 130 Prince Edward Island Ecoregion
1 131 Îles-De-La-Madeline Ecoregion

NB
1 NBELC 1 NB Highlands
1 1-1 Kejwik Ecodistrict
1 1-2 Ganong Ecodistrict

1 NBELC 2 Northern Uplands Ecoregion
1 2-1 Upsalquitch Ecodistrict
1 2-2 Tetagouche Ecodistrict
1 2-3 Tjigog Ecodistrict
1 2-4 Tomogonops Ecodistrict
1 2-5 Nicolas Denys Ecodistrict

1 NBELC 3 Central Uplands Ecoregion
1 3-1 Madawaska Ecodistrict
1 3-2 Sisson Ecodistrict
1 3-3 Serpentine Ecodistrict
1 3-4 Brighton Ecodistrict
1 3-5 Beadle Ecodistrict
1 3-6 Caledonia Ecodistrict

1 NBELC 4 Fundy Coastal Ecoregion
- 1 4-1 Fundy Coastal Ecodistrict

1 NBELC 5 Valley Lowlands Ecoregion
- 1 5-1 Wapske Ecodistrict
- 1 5-2 Blue Bell Ecodistrict
- 1 5-3 Meductic Ecodistrict
- 1 5-4 Buttermilk Ecodistrict
- 1 5-5 Cardigan Ecodistrict
- 1 5-6 Nackawic Ecodistrict
- 1 5-7 Cranberry Ecodistrict
- 1 5-8 Magaguadavic Ecodistrict
- 1 5-9 Yoho Ecodistrict
- 1 5-10 Mount Pleasant Ecodistrict
- 1 5-11 Kingston Ecodistrict
- 1 5-12 Anagance Ecodistrict

1 NBELC 6 Eastern Lowlands Ecoregion
- 1 6-1 Tabusintac Ecodistrict
- 1 6-2 Caraquet Ecodistrict
- 1 6-3 Red Bank Ecodistrict
- 1 6-4 Castaway Ecodistrict
- 1 6-5 Bantalor Ecodistrict
- 1 6-6 Kouchibouguac Ecodistrict
- 1 6-7 Petitcodiac Ecodistrict

1 NBELC 7 Grand Lake Lowlands Ecoregion
- 1 7-1 Aukpaque Ecodistrict
- 1 7-2 Grand Lake Ecodistrict

NS

1 NSELC 100 Cape Breton Taiga Ecoregion

1 NSELC 200 Cape Breton Highlands Ecoregion
- 1 210 Cape Breton Highlands Ecodistrict
- 1 220 Victoria Lowlands Ecodistrict

1 NSELC 300 Nova Scotia Uplands Ecoregion
- 1 310 Cape Breton Hills Ecodistrict
- 1 320 Inverness Lowlands Ecodistrict
- 1 330 Pictou Antigonish Highlands Ecodistrict
- 1 340 Cobequid Hills Ecodistrict
- 1 350 Cobequid Slopes Ecodistrict
- 1 360 Mulgrave Plateau Ecodistrict
- 1 370 St. Mary's River Ecodistrict
- 1 380 Central Uplands Ecodistrict

1 NSELC 400 Eastern Ecoregion
- 1 410 Rawdon/Wittenburg Hills Ecodistrict
- 1 420 Eastern Drumlins Ecodistrict
- 1 430 Eastern Granite Uplands Ecodistrict
- 1 440 Eastern Interior Ecodistrict

	1	450 Governor Lake Ecodistrict
1		NSELC 500 Northumberland-Bras D'Or Ecoregion
	1	510 Bras d'Or Lowlands Ecodistrict
	1	520 St. George's Bay Ecodistrict
	1	530 Northumberland Lowlands Ecodistrict
	1	540 Cumberland Hills Ecodistrict
	1	550 Tantramar Marshes Ecodistrict
	1	560 Chignecto Ridges Ecodistrict
1		NSELC 600 Valley & Central Lowlands Ecoregion
	1	610 Annapolis Valley Ecodistrict
	1	620 Minas Lowlands Ecodistrict
	1	630 Central Lowlands Ecodistrict
1		NSELC 700 Western Ecoregion
	1	710 Valley Slope Ecodistrict
	1	720 South Mountain Ecodistrict
	1	730 Clare Ecodistrict
	1	740 LaHave Drumlins Ecodistrict
	1	750 Rossignol Ecodistrict
	1	760 Sable Ecodistrict
	1	770 Flint Ecodistrict
1		NSELC 800 Atlantic Coastal Ecoregion
1		NSELC Ecoregion 900 Fundy Shore
	1	910 Parrsboro Shore Ecodistrict
	1	920 North Mountain Ecodistrict
23	**83**	

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