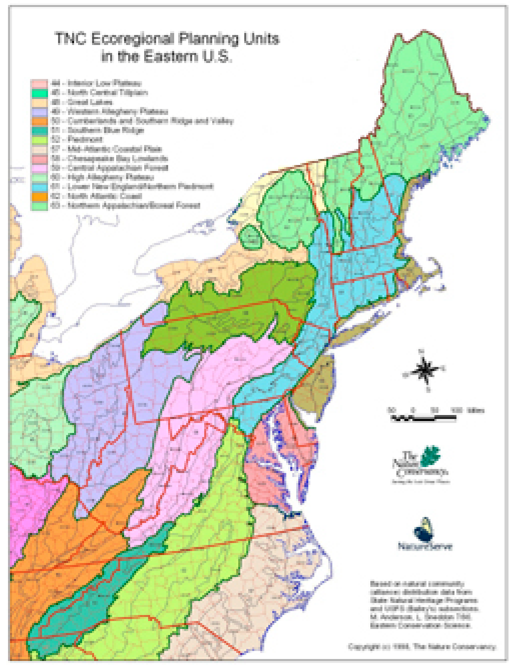
ECOREGIONAL CONSERVATION:

A Comprehensive Approach to Conserving Biodiversity

The Nature Conservancy, Northeast & Caribbean Division*

Biodiversity conservation has evolved in recent decades, fueled by the activities of practitioners supported by new research in ecology and conservation biology. Scientists have increasingly recognized shortcomings in the single species approach to conservation, and are accordingly emphasizing the conservation of ecological communities and ecosystems. Coupled with this emphasis has been an increased appreciation for natural processes and landscape-level factors that sustain these communities and ecosystems.

These developments have led The Nature Conservancy to evolve new principles for conservation planning. The mission of the Nature Conservancy is the long-term conservation of all biodiversity present in all ecoregions. This broad objective encompasses every living thing from rare salamanders or large carnivores to whole ecosystems such as montane spruce-fir forest with all its associated species diversity, along with structural components and ecosystem functions. In broadening the scope of its work, the Conservancy has shifted towards protecting landscapes on an ecoregional scale.

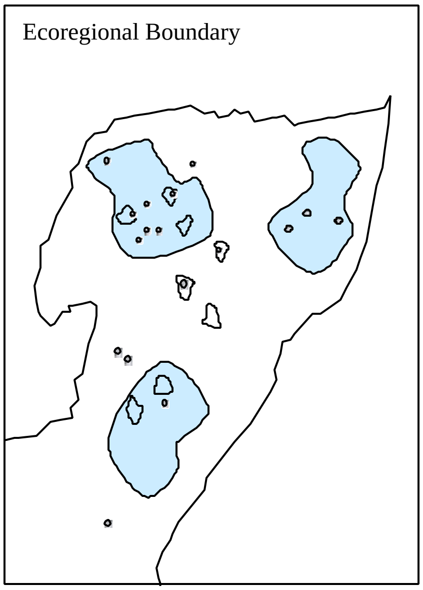


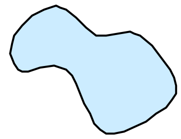
Planning by ecoregions, or areas that are unified in climate, topography, geology, and vegetation, is more sensible ecologically than planning within political boundaries such as states or provinces. **Ecoregional conservation**, or selecting conservation areas within ecological regions (see map), expands the traditional approach of protecting rare species and terrestrial communities by including common ecosystems that are representative of each ecoregion. Protection of viable examples of these representative ecosystems can serve as a "coarse filter," protecting a broad diversity of both common and rare species. **Landscape-scale conservation,** a finer-scale strategy, determines what actions need to take place in each of these areas. The intent of these efforts is to develop a scientific context and a flexible strategy for successful conservation in each ecoregion.

A Multiple-Scale Model For Conservation Areas

The overall goal of ecoregional conservation is to assemble a portfolio of public and private conservation areas that collectively conserve the full biological diversity of an ecoregion. Each portfolio is meant to encompass multiple examples of all native species and ecological communities in sufficient number, distribution, and quality to insure their long-term persistence within the ecoregion. In the Northeast and Mid-Atlantic the portfolios have focused first on terrestrial ecosystems, defined using a standard classification system. Freshwater aquatic systems have been integrated into the portfolios as scientists develop new analytic techniques and richer data sets.) The terrestrial ecosystems occur at three basic size scales: *Matrix-forming*, *Large patch* and *Small patch*.

* Based on a paper of the same name by Mark G. Anderson, 2001. Updated and edited to include material adapted from Groves et al, 2002. This document may be cited as follows:
Anderson, M.G. 2003. Ecoregional conservation: A comprehensive approach to conserving biodiversity. The Nature Conservancy, Northeast & Caribbean Division, Boston, MA.





Matrix-forming ecosystems in the Northeast are dominant forest communities delineated by large intact areas of forest on the scale of thousands to millions of acres. Conservation areas must be big enough to absorb and recover from infrequent but catastrophic regional-scale disturbances such as hurricanes, tornadoes, fire and insect outbreaks. They must also be large enough to insure that multiple breeding populations of forest interior species have the habitat they need to survive. Conservation of the matrix forest is particularly important to the biological integrity of the ecoregion.

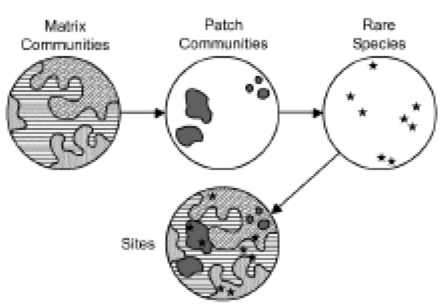
Large patch-forming ecosystems are associated with environmental conditions that are more specific than those of matrix forests. Examples include red maple swamps, peatlands, riparian river systems, fire-dependent pine barrens and isolated mountaintops. Conservation areas may be an order of magnitude smaller than the matrix-forming ecosystems but they must still be large enough to contain the many species that associate with them (fifty to five thousand acres).

 **Small patch-forming ecosystems** form small, discrete patches of cover, and often contain a disproportionately large percentage of species that associate with very specific ecological conditions. Examples include wetlands with calcium rich groundwaters (calcareous fens), outcrops of serpentine bedrock (serpentine communities), and rivershore grasslands.

The protection of many **rare species**, such as the best remaining populations of a rare dragonfly and its supporting habitat, may be accomplished by protecting patch-forming ecosystems. Other **focal species** that we believe cannot be adequately conserved by protection of ecosystems alone but require explicit conservation attention, whether because they are globally rare, in decline, native to the ecoregion, or designated as threatened or endangered by state or federal agencies, are designated “fine-filter” conservation targets.

The Ideal Conservation Area

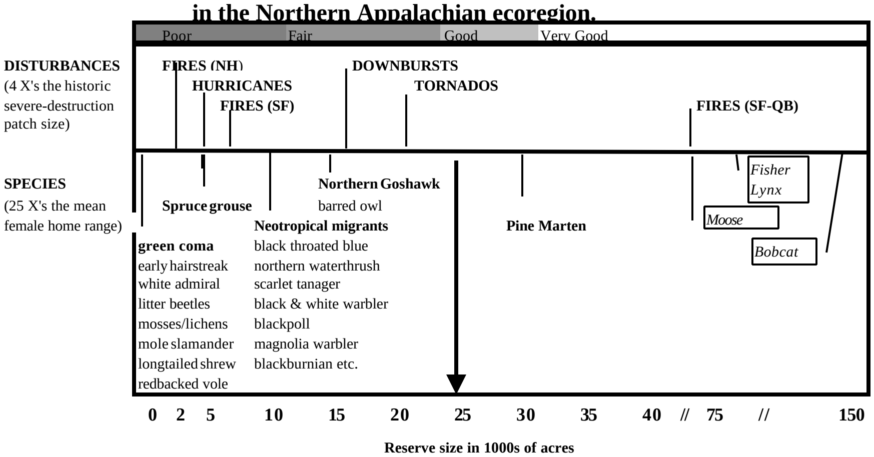
When examining a landscape, it becomes immediately clear that patch-forming ecosystems nest within matrix-forming ecosystems. By definition, this way of grouping systems recognizes a spatial hierarchy. For example, a large area dominated by lowland conifer forest (a matrix-forming system) may, on close examination, reveal a network of bogs, fens, marshes and rolling hills (large patch systems). These may contain even smaller settings of cliffs, outcrops and shores (small patch systems). Accordingly, the highest priority action will be given to those places where matrix, large and small conservation targets are co-located at the same site. Nesting and clustering targets together increases their individual and joint viability and is cost effective. Thus an ideal reserve consists of a mosaic of *viable* matrix, large and small patch communities, and rare species populations.



What Is A Viable Example Of A Matrix Or Patch Ecosystem?

A viable example of a ecosystem is one that has the integrity in structure, composition, internal processes and external processes needed to persist for over one hundred years without serious degradation. As this is difficult to evaluate directly, we measure three indirect factors, the *size*, *current condition* and *landscape context* of each example, and use the information to make judgements about viability.

Scaling factors and Reserve size for Matrix forests in the Northern Appalachian ecoregion.



Factors to the left of the arrow should be encompassed by a 25,000 acre reserve
NH = N. hardwoods SF = Spruce-fir
[The estimate for spruce-fir is based on mean fire size in Maine (low estimate) and Quebec (high estimate)
Neotropical estimates based on Robbins et al. 1989, see text for full explanation]

For patch communities, **landscape context** is of primary importance as these communities typically depend on landscape level processes, such as intact hydrology or fire cycles, that operate beyond the actual acreage.

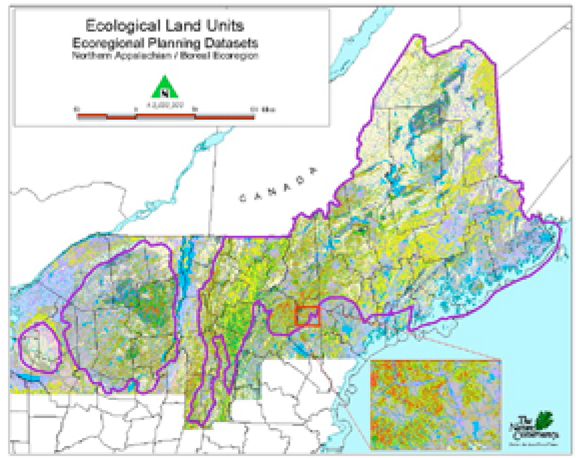
Size is particularly important for matrix-forming ecosystems. In the accompanying figure, the upper half of the table illustrates the size a forest would need to be to absorb and recover from a variety of regional-scale disturbances. For example, based on historical records, hurricanes tend to create a mosaic of disturbance with patches of total destruction ranging up to about 1000 contiguous acres. From this we estimate a reserve would need to be at least four times that size (4000 acres) to remain viable with respect to hurricanes. The lower half indicates how large the area should be to expect multiple (in this case, 25) breeding populations of some of the more space demanding, interior forest dwelling species.

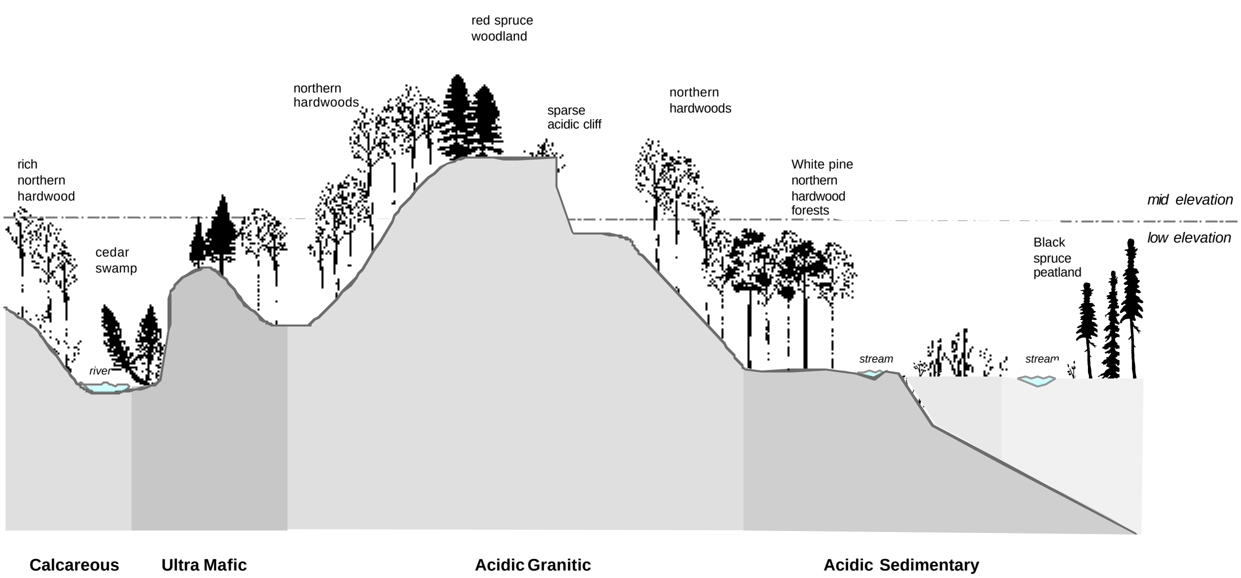
A variety of observable features affect the **condition** of an ecosystem. Primary among these features are fragmentation by roads, trails or land conversion, invasion by exotics, and human manipulation, such as cutting, grazing, mowing, altered soils, and altered natural processes, usually reflected in changes in vegetation structure and composition. Positive features such as signs of historical continuity or the development of biological legacies—critical features that take generations to develop (e.g. fallen logs and rotting wood in old-growth forests)—are evidence of good condition.

To allow for change and guard against unexpected attrition, viability also implies conserving replicate examples. Exactly how many examples of each type of ecosystem we need to conserve is not known with any precision. However, based on evidence from minimal viable population studies, we have generally set an initial minimum of 20 examples for small patch communities. For a widespread community type, examples can be spread throughout its native range, and protection can occur in several ecoregions. Conversely, if the community is completely restricted to a single ecoregion, then all 20 examples must come from that ecoregion.

Placement Of Conservation Areas

How do we select these conservation target examples to insure that the full ecological variability of the communities and of the ecoregion is represented? To answer this question we turn to the geography and ecology of the ecoregion itself. Using maps and digital information we ask questions such as: Where are the steep slopes, summits, ridgetops, valleys, floodplains and wetlands? Which of these are underlain by resistant granite and which are constructed on sandstone? Where are the areas underlain by calcium-bearing rocks which often indicate richer soils supporting unusual species assemblages? Where are the deep deposits of coarse glacial outwash that are often associated with fire driven communities? Where is the elevation change rapid and where is it slow? We summarize this information in a set of **Ecological Land Units** (ELUs), which are unique combinations of elevation, bedrock and topographic features. The figure below illustrates how selected community types relate to the ELUs. For example, rich northern hardwood forests typically occur at low elevations on coves and toeslopes over calcareous bedrock. Inspection of an ELU map of the northern Appalachians reveals much of the underlying structure of the ecoregion, critical in influencing current and future biodiversity patterns.





Using the ELUs as a measure, we may subdivide the ecoregion into more homogeneous subregions. On this geographic framework we overlay all the viable examples of communities and species that have been located and evaluated by the State **Natural Heritage Network**, our long-term partners in biodiversity conservation. The Natural Heritage programs maintain an ongoing inventory of each state's flora, fauna and communities. We then select replicate examples of each target from each of the different subregions to insure that we conserve examples in a variety of ecological settings. At this stage we also identify gaps in our knowledge. This information is channeled back to our Heritage partners as recommendations on which areas and which targets need more inventory attention.

Selection of matrix-forming ecosystems and stream networks involves additional data analysis. With respect to the former, in recent years, a variety of methods have been developed to assess the location and condition of large unfragmented pieces of forest. The method we have used to delineate matrix forest examples in all Northeast plans is based on roads, land cover, and expert interviews using geographic tools and data. Using road-bounded blocks to delineate matrix examples has practical advantages. The core idea behind the road-bounded block, however, was not practicality but that roads have altered the landscape so dramatically that their presence provides a useful way of assessing the size and ecological importance of remaining contiguous areas of forest.

By combining potential forest blocks with ELUs in an ecoregion, we identify forest-landscape combinations (for example, *Conifer spruce-fir forests on high-elevation, resistant granite mountains*). Experts review the forest-landscape groupings to ensure that they indeed capture the range of diversity within the ecoregion, and then, within each grouping, prioritize the matrix-forming areas based on their relative biodiversity values, the feasibility of protection and the urgency of action. A similar approach is used for delineating critical watersheds. We evaluate watershed condition by examining additional features, such as dams, toxic release points, road-stream crossings, and proportion of agriculture or developed land.

Landscape-Scale Conservation Planning

After viable examples have been identified and selected, conservation areas must be designed to insure their long-term viability. Like the ecoregional assessment, landscape-scale designs revolve around a series of questions.

- How is the landscape constructed and what is the condition of the forest?
- Where are the identified ecoregional targets, and where are other potential ecoregional targets?
- What do we want these ecosystems and focal species populations to look like over the long term?
- What attributes of the landscape maintain these targets over the long term?
- What are the current and potential activities on the landscape that might interfere with the maintenance of those attributes? What can we do about those activities to prevent or mitigate them?
- Where, on the ground, do we need to act and what kind of actions are necessary to accomplish our goals? Can we do enough to succeed in our goals?

A Seven-Step Conservation Planning Framework

Step 1: Identify conservation targets
Communities and ecosystems: matrix-forming, large patch, small patch
Abiotic (physically or environmentally derived targets) as well as biological
Species: imperiled or endangered, endemic, focal, keystone

Step 2: Collect information and identify information gaps
Use a variety of sources, including Natural Heritage Network inventories
Rapid ecological assessments, rapid assessment programs
Expert workshops

Step 3: Establish conservation goals
Two components of goal: representation and quality
Distribute targets across environmental gradients
Set a range of realistic goals

Step 4: Assess existing conservation areas
Gap analysis: the degree to which existing managed areas adequately protect biodiversity

Step 5: Evaluate ability of conservation targets to persist
Use viability criteria of size, condition, and landscape context

Step 6: Assemble a portfolio of conservation areas
Use selection methods and algorithms
Design networks of conservation areas employing biogeographic principles

Step 7: Identify priority conservation areas
Use the criteria of existing protection, conservation value, threat, feasibility, and leverage

Adapted from Groves et al. (2002)

Careful attention to these questions forms the basis for a site conservation plan. This plan is the foundation of our future stewardship and protection activities.

Partnerships And Implementation

We are convinced that ecoregional conservation represents the most efficient and effective strategy towards our mission of biodiversity conservation. In the Northeast we have completed eight ecoregion plans. One drafted plan is expanding to include its Canadian portion, a significant step in capturing the ecoregion’s biodiversity. Funding for portions of the plans has come from federal agencies and private foundations. A sample ecoregional assessment identified 38 matrix forest areas (averaging 75,000 acres each), 247 patch ecosystems and species examples, and knowledge gaps for about one-third of the targets. With an agenda this ambitious we expect both challenges and opportunities. Clearly the scope of work is beyond that which any one organization can accomplish. Thus a crucial question of the implementation phase is: Who are the partners with which we will need to work to insure success? In some cases an area of interest will already be protected (e.g. part of a National Forest). In these instances our role may be minimal except to applaud and support the efforts of others. In other cases the role of The Nature Conservancy will likely involve major land purchases, easements and partnerships with a variety of players, working together to best protect and manage the biotic resources of the area.

Further Reading

Anderson. M.G. 1999. Viability and spatial assessment of ecological communities in the Northern Appalachian ecoregion. Ph.D. dissertation, University of New Hampshire, Durham. 224p.

Anderson, M.G., F. Biasi and S. Buttrick. 1998. Conservation site selection: Ecoregional planning for biodiversity. The Nature Conservancy, Eastern Regional Office, Boston, MA

Forman, R.T.T. and L.E. Alexander. 1998. Roads and their major ecological effects. Annu. Rev. Ecol. Syst. 29:207-231.

Groves, C.R., D.B. Jensen, L.L. Valutis, K.H. Redford, M.L. Shaffer, J.M. Scott, J.V. Baumgartner, J.V. Higgins, M.W. Beck, and M.G. Anderson. 2002. Planning for biodiversity conservation: Putting conservation science into practice. BioScience. 52(6): 499-512.

Maybury, Kathleen P., editor. 1999. Seeing the Forest *and* the Trees: Ecological Classification for Conservation. The Nature Conservancy, Arlington, VA

Poiani, K.A., B.D. Richter, M.G. Anderson and H.Richter. 2000. Biodiversity conservation at multiple scales: Functional sites, landscapes, and networks. BioScience 50:133-146.