HIGH ALLEGHENY PLATEAU ECOREGIONAL PLAN: FIRST ITERATION

Conservation Science Support—Northeast and Caribbean

The High Allegheny Plan is a first iteration, a scientific assessment of the ecoregion. As part of the planning process, other aspects of the plan will be developed in future iterations, along with updates to the ecological assessment itself. These include fuller evaluations of threats to the ecoregion, constraints on conservation activities, and implementation strategies.

CSS is now developing a standard template for ecoregional plans, which we have applied to the HAL first iteration draft report, distributed in 2002. Some of the HAL results have been edited or updated for this version.

Click on the navigation pane to browse the report sections.

What is the purpose of the report template?
The purpose of creating a standard template for ecoregional plans in the Northeast is twofold:

— to compile concise descriptions of methodologies developed and used for ecoregional assessment in the Northeast. These descriptions are meant to meet the needs of planning team members who need authoritative text to include in future plan documents, of science staff who need to respond to questions of methodology, and of program and state directors looking for material for general audience publications.
— to create a modular resource whose pieces can be selected, incorporated in various formats, linked to in other documents, and updated easily.

How does the template work?
Methods are separated from results in this format, and the bulk of our work has gone into the standard methods sections. We have tried to make each methods section stand alone. Every section includes its own citation on the first page. All documents are in PDF format.

Some sections of the template have no counterpart in the HAL first iteration. For the most part we have left these empty, although we have added some material. We have modified HAL results sections only to streamline the remaining text and to reflect any divergence from or elaboration of the standard methods.

This CD Guide takes advantage of the template's features. Throughout, you will find links to modules of the standard template in different contexts.

EXECUTIVE SUMMARY[*]

Brief description of the ecoregion

The High Allegheny Plateau Ecoregion is located along the southern tier of New York and the northern tier of Pennsylvania. It includes a small portion of New Jersey. Well known features in HAL include the Catskills, The Shawangunks, The Kittatinny Ridge, The Poconos, Allegany State Park, Allegheny National Forest, and a large mass of Pennsylvania state-owned land.

The ecoregion is defined by high elevation features at the northern end of the Appalachian Plateau. Most of the ecoregion is above 1200 feet. The general land form of the area is mid-elevation hills separated by numerous narrow stream-cut valleys.

One of the main features of the ecoregion is an abundance of rivers and streams. The Delaware, Susquehanna, and Allegheny Rivers and their many tributaries cover the entire ecoregion. The Delaware River drains into Delaware Bay; the Susquehanna flows into the Chesapeake Bay; the Allegheny flows into the Ohio and eventually into the Mississippi. These three different drainages contribute to the high overall aquatic diversity in the ecoregion.

The northern and eastern portions of the ecoregion were glaciated; the southwest portion was not. Many northern species and communities reach their southern limit in HAL, while many southern species extend into the ecoregion but not beyond. Species and communities associated with glaciated landforms occur in the north and east; biodiversity associated with older substrate and deeper erosional soils occurs in the southwest.

One of the main features of the ecoregion is its currently low population density, although major population centers are nearby. There are 1.7 million people living in the 16.9 million acres of HAL. The largest city is Binghamton, New York at 47,000. Only 250,000 people in HAL live in cities over 10,000. The overall population trend in HAL indicates that people are moving out of the ecoregion with the notable exception of the areas within reach of New York City by major highways.

There are large and significant managed areas in HAL, including three large intact forested areas: the Catskills, the Allegheny National Forest/Allegany State Park complex, and the Pennsylvania state land in central PA.

The planning process

The standard ecoregional planning methods developed and used in other Northeastern ecoregional plans have been applied to HAL. A Core Team made up of the four TNC operating units was assembled to guide the process and report interim results to each office. Five additional teams were assembled to develop targets or minimum standards and to select sites for matrix forests, aquatics, natural communities, animals, and plants. Information to select sites for matrix forests and aquatics was developed with guidance from outside experts. GIS assessment of the entire ecoregion for both matrix forests and aquatics was undertaken at the ECS GIS lab. Data for natural communities, animals, and plants were obtained from the three state Natural Heritage Programs. Only data currently included in these databases were used in this assessment. An assessment of viability was applied in review of these data. Numerous occurrences were not

[*] Zaremba, R.E., M.G. Anderson et al. 2003. High Allegheny Plateau Ecoregional Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, Boston, MA.

ultimately selected for conservation action. A lengthy list of future field survey needs was developed from old and incomplete Heritage occurrence information.

The portfolio

26 Preferred (Tier 1) Forest Matrix Blocks; 27 Alternate (Tier 2) Blocks
93 Priority 1 Aquatics System units; 72 Priority 2 units
253 Natural Community occurrences
74 Animals occurrences
88 Plant occurrences
238 "sites" based on Heritage site names and an overlay of matrix block units

- NJ — 15
- PA — 140
- NY — 83
- ENY — 27
- CWNY — 56

118/462 = 26% of selected Heritage occurrences are found within matrix blocks
75/93 = 81% of selected Priority 1 aquatics system units are associated (in some way) with matrix blocks.

Natural communities

A vegetation classification based on the National Vegetation Classification (NVC) maintained by NatureServe was prepared for HAL and reviewed during the assessment of the combined Heritage occurrences database for the ecoregion. A total of 109 vegetation types were identified in HAL. The combined databases included 509 occurrences. Goals for communities were based on the global distribution of the NVC type in relation to the ecoregion, distribution within HAL, and patch size. The ecoregion was stratified into glaciated and non glaciated subsections, as well as other subsection groupings to make sure that occurrences captured the full range of the NVC type. A total of 253 community occurrences (50%) were assessed as distinct and viable and included in the portfolio.

Fifty three matrix forest blocks in nine different physical settings defined by Ecological Land Units (ELUs) were chosen for the portfolio. Twenty-six of these are Preferred or Tier 1 Blocks, identified as the best opportunities to undertake matrix forest conservation in the physical setting of the block. Goals for matrix forest in HAL were to identify at least one block in each of the nine ELU groupings and at least one block per subsection. Additional blocks were included if they were characterized by distinctive ELUs or if they were in outstanding condition as a matrix forest unit. The remaining 27 forest blocks are included in the portfolio as alternatives to the Tier 1 blocks. Each of these blocks will need to undergo significant assessment.

Aquatics

Ninety three aquatic system units were selected as Priority 1 sites in four Ecological Drainage Units (EDUs) in HAL. These rivers and streams, totaling a length of 3263 miles, were selected as conservation targets because of expert information and GIS data indicating good landscape condition for the system. Goals for aquatics in HAL were to identify one example of each major river in each EDU; one example of each Size 3, major tributary type; two examples of each Size 2 or minor tributary, and three examples of each Size 1 or headwater stream type. Seventy-two Priority 2 aquatic system units were selected as possible occurrences, pending further assessment. Many of these Priority 2 sites were not known to experts or TNC staff or were located in poorer landscape settings. Major field surveys will be needed to inform portfolio selection and site conservation planning.

Animals

Vertebrate and invertebrate targets were determined by an animal team made up of Heritage zoologists from each of the states. Eleven vertebrate targets and 22 invertebrate targets, ranked G1-G3G4 were chosen for HAL. A total of 215 occurrences of these species were include in the HAL assessment. A total of 74 occurrences (34%) were chosen for the portfolio. For 13 species, multiple viable occurrences were combined into metapopulations. Twenty one of these occurrences (18%) appear to define new conservation sites in which no other biodiversity features are currently identified for the portfolio. The animal working group identified 49 secondary animal targets in need of further assessment.

An assessment of bird conservation issues in HAL has been initiated. Working with a Partners in Flight (PIF) report for the Allegheny Plateau, a geographic area very similar to HAL, a list of potential bird species targets was developed. The PIF report includes specific areas where these birds or groups of birds are found in HAL. Data were also assembled from National Audubon's Important Bird Areas Project, available for New York and Pennsylvania, but not for New Jersey. In addition, breeding bird atlas information is available for each of the three states. No specific bird conservation areas were selected for HAL.

Plants

Plant targets were determined by a plant team made up of Heritage botanists from each of the states. Twenty-two vascular plant and 2 non-vascular plant species were chosen as targets for HAL. Nineteen of these species are ranked G1-G3G4; seven are ranked G4 or G5 and reflect declining populations or significant disjunct populations. A total of 121 Heritage occurrences of these 24 species were included in the analysis. Eighty-eight occurrences (73%) were chosen for the HAL portfolio. Twenty eight of these occurrences (30%) appear to define new conservation sites in which no other biodiversity features are currently identified in the portfolio. The plant working group identified 15 potential plant targets that warrant further assessment to determine whether they should be full targets for planning.

General overview of the portfolio

The overall portfolio consists of 581 occurrences (680 counting Tier 2 matrix blocks and Priority 2 aquatic system units) scattered over all parts of the ecoregion. The concentration of occurrences partly reflects conservation importance and partly reflects inventory effort. The Pennsylvania Heritage (PNDI) has developed much of its database through county inventories. Several of the counties in HAL have been inventoried; most have not. Several counties have very few Heritage occurrences. Large portions of the agricultural section of HAL in NY have not been inventoried at all. Heritage occurrences are concentrated in the Poconos, the Catskills, the Shawangunks, Allegany State Park, in New Jersey, and in the calcareous section of New York in the north-central part of the ecoregion.

Unquestionably, large parts of the ecoregion would benefit from additional Heritage survey work for species and natural communities. These include most matrix forest blocks and the counties along the border of NY and PA. Additional survey work for aquatic targets associated with field assessment of aquatic portfolio sites is likely to result in numerous new occurrences for the Heritage databases and for the HAL portfolio. Natural community inventory work would be most productive within matrix forest blocks since examples of all common upland forest communities are needed to reach goals, and are likely present in the range of matrix forest blocks. Small patch communities will require more detailed survey work.

Action plan

All features in the portfolio were sorted into strategic implementation groups: 1) partner lead, 2) TNC lead - no immediate action, and 3) TNC lead - 5 year action. Sites for all types of biodiversity were selected, scattered at locations throughout HAL. Forty-seven % of the matrix forest blocks were included; 65% of Natural Community Occurrences; 39% of Animal Occurrences; and 34% of Plant Occurrences. A total of 2478 stream miles were selected, including 70 stream system units of the 148 identified as Priority 1 and Priority 2 aquatic units. In several cases, notably the Catskills, the Delaware River, Allegany State Park and the mass of Pennsylvania state land, matrix forest blocks were grouped into larger conservation planing areas that included aquatic features and embedded Heritage occurrences selected for the portfolio.

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ACKNOWLEDGMENTS*

Edited Version and Plan Template

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

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

Methodologies

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

HAL Planning Team and Working Groups

The HAL ecoregional plan was the work of many people, both within the Eastern Conservation Science Office in Boston and in TNC Offices. Numerous outside experts also provided important inputs. The project was coordinated by staff in the ECS Office. Dan Morse conducted all GIS analyses and developed both working group maps as well as final products. His patience and creativity are much appreciated. Arlene Olivero conducted the aquatics GIS assessment and provided detailed maps on aquatic systems and watershed condition to the aquatics working group and did all data management. Her long and hard work has developed new methods for aquatic assessment that will be further refined and used in all Northeastern ecoregions. Shyama Khanna obtained and maintained all Heritage data sets throughout this process, sustaining an optimistic outlook despite frequent small scale changes. Mark Anderson mentored the entire process, developing key concepts to initiate new approaches to ecoregional planning as well as enforcing that standards in use for other plans are maintained.

The Aquatics Working Group was let by George Schuler who provided expert leadership and key ideas to the development of the aquatics assessment process. George wrote the aquatics section. The Plant Working Group was led by Troy Weldy with patience and clear thought in

* Zaremba, R.E., M.G. Anderson et al. 2003. High Allegheny Plateau Ecoregional Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, Boston, MA.

defining targets and assessing potential occurrences. The Animal Working Group was led by Tony Davis, who brought together a vast amount of variable-quality data into a sensible conservation agenda and endured a nearly endless series of telephone calls with small questions. Julie Lundgren coordinated the development of the HAL community classification.

Others who provided key assistance include:

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INTRODUCTION TO THE ECOREGION*

The General Setting

The High Allegheny Plateau Ecoregion is defined primarily by a broad series of high elevation hills that form a plateau rising to 1700-2100 feet extending in the north from the Great Lakes Plains of Lake Ontario to the Ridge and Valley region of the Central Appalachians to the south and from the Lake Erie Plain in the west to the southeastern Pennsylvania lowlands and the Hudson River Valley. The High Allegheny Plateau (HAL) consists of nine Forest Service Subsections. The six subsections forming the central and western portion of HAL are moderately uniform in land form. Along the eastern portion of HAL, the two Catskills subsections and the Shawangunk/Kittatinny Ridge subsection are somewhat different in character in that they were formed by a different set of geological processes and have high elevation landforms, which extend to over 3000 feet and include numerous cliffs and talus slopes, absent from most of the rest of the ecoregion. Because the forest types of these three subsections are most similar to the other six subsections in HAL, these three subsections are combined into the High Allegheny Plateau rather than being combining into a disjunct part of the Northern Appalachian Ecoregion or a dissimilar part of Lower New England/Northern Piedmont Ecoregion.

The ecoregion is 51.6% in New York; 47.8% is in Pennsylvania; the remaining 0.6% is in the northwest corner of New Jersey. The High Allegheny Plateau includes nearly one quarter of both New York and Pennsylvania, but only 6% of New Jersey.

The ecoregion extends over 16.9 million acres and has the highest percentage of natural cover (81%) of any Northeastern ecoregion besides the Northern Appalachian Ecoregion. Deciduous forest covers 52% of HAL; 21% is covered by Mixed forests: coniferous forests cover 6%; and only 0.7% of the ecoregion is covered by wetlands. Agricultural uses account for 18% of HAL. Dairy farms are the principle agricultural use with row crops fields limited to floodplains. Only 1% of the ecoregion is covered by residential and urban development, industry, and transportation corridors.

Significant Natural and Cultural Features

The ecoregion is primarily made up of a series of hills cut from a huge plateau by hundreds of small streams coalescing into larger rivers. The hills have rounded, usually forested summits with gradually sloping sides and are separated by narrow valleys with well drained, rich soils favored by agriculture. The landscape is suitable to timber production on the hills and small farm agriculture, usually dairy farming, in the lowlands.

In the eastern part of HAL, significant features include the Catskills and the Poconos, as well as the Shawangunk Ridge which continues into New Jersey as the Kittatinny Ridge. In the west, HAL includes a mass of state-owned forested land in north-central Pennsylvania totaling nearly 2,000,000 acres, the Allegheny National Forest at over 370,000 acres, and Allegany State Park, the largest state park in New York at 65,000 acres.

All of HAL is influenced by major rivers. The upper drainages of three major northern US rivers extend across HAL. The Delaware River originates within HAL and drains the west and south

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slopes of the Catskill Mountains. The Susquehanna and its West Branch drain central New York and the hills of north-central Pennsylvania; The Allegheny River drains west-central New York and the western slopes of the HAL Pennsylvania hills. The Delaware and Susquehanna flow into the Atlantic; The Allegheny River flows west into the Ohio River and eventually the Mississippi. One small section of the northwestern part of HAL includes the upper drainage of the Genessee River which flows north into Lake Ontario. There are also sections of the upper watersheds of the streams flowing into Lake Erie in HAL. Aquatic features with affinities to both the East Coast and Midwest are significant characteristics of HAL. The high percentage of natural vegetation cover and the diverse confluence of different drainages makes HAL an ecoregion with significant aquatic biodiversity.

HAL includes both glaciated and non-glaciated features. The south-central and western parts of HAL were not glaciated and are made up of older eroded features and remnant bedrock exposes. The rest of HAL includes a full range of glaciated features including end moraine, eskers, drumlins, kame terraces, kettleholes, and other features associated with the terminus of the ice sheet advance and deposits associated with glacial meltwater flow. The northern and eastern parts of HAL have numerous lakes, ponds, and shallow wetlands associated with glaciation. The south-central and western parts have few natural lakes and ponds. The only non-glaciated part of New York is around the Allegany State Park in western HAL. Because HAL is moderately high elevation and extends east-west, there are many communities and species that reach either their northern or southern range limits within HAL. HAL is the southern limit for many bog species, including *Vaccinium macrocarpon*. The extension of Midwestern watersheds into HAL also means that there are several species, mainly aquatics, that reach their eastern range limit in HAL.

The climate of the ecoregion is characteristic of high elevation areas in the mid-Atlantic region with hot, humid summers and cold winters with moderate snowfall. Lake-effect snow off Lake Erie occasionally extends into the extreme western part of the ecoregion. There is usually a continuous cover of snow throughout the winter. Characteristic of the East, there are periodic droughts that occur principally in the summer and can have profound impacts on vegetation and aquatic systems. The hills do create some rain shadow effect with higher levels of rainfall in the western hills and the west slopes of the Catskills. The Pocono Plateau also received slightly higher rainfall than other areas. The growing season is shorter than in surrounding areas because of the general elevation effect on temperature. The growing season in one Potter County PA site is as short as 100 days. A shorter growing season also influences species distributions.

Significant natural processes include tornadoes which occur occasionally throughout the ecoregion, but are more frequent in the west. Ice storms occur with some regularity opening the forest canopy. Hurricanes impact mostly the eastern part of HAL, although occasionally infrequent storms can cause significant wind damage and severe flooding such as occurred during Hurricane Agnes in 1972. Fires have occurred throughout HAL but are more common in the eastern sections on dry ridgetops. Several areas currently dominated by pitch pine have burned regularly. Large fires are known, but infrequent, in the more mesic forests of western Pennsylvania.

Natural vegetation

The dominant vegetation type of HAL is Beech-maple forest in lower elevation mesic sites and Appalachian oak on drier sites. Oak-hickory occupies many south-facing, dry slopes. In the eastern part of the ecoregion, pine barrens occur on rocky ridgetops and on the Pocono Plateau.

Richer forests occur in the southwest part of the ecoregion with *Liriodendron* and *Magnolia* in more mesic sites. Spruce fir occurs at high elevation sites in the Catskills.

Timber management has modified forest composition significantly. Hemlocks were targeted by the tannery industry many years ago and have returned only sporadically throughout the ecoregion. There are small scattered old growth hemlock forest remnants in Allegany State Park and along the steep slopes of the West Branch of the Susquehanna River. Most of the western Pennsylvania forests are managed for cherry.

Forest pathogens have also dramatically modified the forest of HAL. American chestnut was found throughout the ecoregion and has been nearly eliminated. American beech is dominant in many forested areas and significantly impacted by Beech bark disease. Gypsy moths reduce oak vigor and during severe prolonged outbreaks may kill oaks. Sugar maples are also in decline.

High deer populations have also impacted forests in HAL. The deer herds in New York and Pennsylvania have been managed for many years at high population levels resulting in overbrowse of understory species. Over large parts of HAL, particularly in the west, there is no canopy species recruitment and few shrubs and herbaceous plants. Many forests have a clear understory with a very simplified species composition. State land managers have acknowledged the problem of deer overbrowse and there are efforts underway to address the issue.

The pre-colonial forest was vast and nearly continuous across the ecoregion with woodlands on dry ridgetops in the east and some open communities along major rivers with floods and ice scour. The low mountains in the west were all nearly consistently covered with a dense canopy.

Rare animals in HAL

Most of the rare and significant animals that characterize HAL are associated with the major rivers. A high diversity of mussels, fish and dragonflies occur in HAL related to different drainages, including mid Atlantic coast and the Mississippi and to large remnant forest. Woodrats are scattered through steep rocky sections of the east with large talus slopes. Timber rattlesnakes are also common in these areas. Bog turtles are found at several locations in the southeast part of the ecoregion in remnant wetland complexes. Significant birds include Bicknell’s thrush in the Catskills, Cerulean warbler and Swainson’s thrush in floodplain corridors and grassland nesting birds in old fields and at sites owned by public agencies such as airports. Bear and bobcat are common over most of the ecoregion. Deer are abundant throughout. Elk have been reintroduced to western Pennsylvania and are expanding in number. Five federally listed animal species occur in HAL: Peregrine falcon, Bald eagle, Dwarf wedgemussel, Bog turtle, and Indiana bat.

Rare plants in HAL

The flora of HAL is typical of the Northeast and not very distinctive with a few notable exceptions. Most species are characteristic of the generic mixed coniferous/deciduous forests of the Northeast. Among the unusual species are *Aconitum noveboracense* in the Catskills, which occurs along headwater streams, *Trollius laxus* spp *laxus* which occurs in fens. Both species are locally abundant and globally rare. Also distinctive within HAL are *Scirpus ancistrochaetus* in Pennsylvania *and Carex polymorpha* in the Poconos. There are three federally-listed species in the ecoregion: *Scirpus ancistrochaetus, Aconitum noveboracense* and *Isotria medeoloides*.

Rare HAL natural communities

The only globally rare natural communities in HAL are the dwarf pine ridges in the Shawangunks and the variants of pine barrens in the Poconos. Unusual, but not globally rare communities include fens, ridgetop woodlands and talus slopes. Northern bogs and black spruce wetlands reach their southern range limit in HAL and there are several Atlantic white cedar swamps which are unusual at sites away from the seacoast.

Many natural communities previously characteristic of HAL are now absent or much reduced in extant. Floodplain forest were once common along the major river corridors. These have been largely converted to agriculture, villages, or transportation corridors. Many rivers have been regulated and no longer flood dramatically.

Hemlocks and white pines are much reduced in extent and no longer a major component of their historical communities. The loss of chestnut, healthy beech and American elm have all altered forest composition and structure.

People in HAL

In the highly populated Northeast, HAL has a noticeable lack of big cites and associated suburbs. From Landsat imagery at 65,000 feet at night, the ecoregion is defined as being the dark area surrounded by intense development. The largest city is Binghamton, New York with 47,000 people. Other cities include Elmira, Corning, and Johnson City, NY, and Bradford and Warren, Pennsylvania. A total of 1,773,000 people live in HAL, a density of 61 people per sq. mile on average, second only to NAP in the Northeast in low population density.

There are very few suburban areas within the ecoregion. Only 215,000 live in cities with populations over 10,000. Only along Rte 17 near Binghamton are there suburban landscapes. The Poconos area is, however, increasingly becoming more suburban in character with second homes on large lots and commuter neighborhoods.

Population trends indicate that the overall population for much of HAL is likely to decline significantly over the next 50 years with the greatest losses in the northern and western parts of the ecoregion. Significant increases are projected in the southeast around the Poconos. Between 1990 and 2000, the population of HAL increased by only 67,000 people or 3.3%. Significant population increases occurred in Monroe and Pike Counties in Pennsylvania around the Poconos. Decreases were evident throughout the remainder of the ecoregion. The population of the whole ecoregion is projected to increase by 38% over the next 50 years with most growth occurring in the southeast and eastern parts of the ecoregion and minor decreases occurring elsewhere.

While there are no large cities within HAL, the borders of the ecoregion are not far from major population centers. Scranton, located within the Reading Prong of the Central Appalachian Plateau Ecoregion is centered only 8 miles from HAL. Interestingly, there are, however, few suburban areas outside the Scranton/Wilkes-Barre Valley that extend into the nearby, higher elevation parts of HAL. Albany, NY is 12 miles from the HAL border; Syracuse is 25 miles, Rochester is 40 miles; New York City is only 70 miles to the east. Currently, HAL with its higher elevation landforms is just beyond the suburban reach of these population centers.

Land use in HAL

There were few permanent Indian settlements in HAL, except along major rivers in the eastern part of the ecoregion. The entire area was hunted seasonally and rich in wildlife. Beaver were a major target in the early colonial period.

European settlement in HAL began in the eastern part of the Catskills nearest the Hudson River in the early 1700s and spread slowly into nearby areas over the next 50 years. After the Revolutionary War and the reduction in hostilities from Indian, settlement expanded up the major river corridors beginning with the Delaware and extending south from the Mohawk. Initially, small farms were established in the narrow fertile valleys with expansion up hillsides. Eventually land was cleared and small farms covered the landscape in the eastern portion of the ecoregion. Settlement in the Catskills was limited to low elevation areas.

The principal industry for most of the 19^{th} century was logging to feed the expansion needs of major East Coast cities. Canals were constructed along river corridors to facilitate transport of raw materials. Later railroads were built linking the timber resources of the West to Eastern markets. Most of central and western part of the ecoregion in NY and the north-central part of Pennsylvania were eventually cleared and used for farming. The areas with poorest soils were soon abandoned. Most forests in these areas are now second or third growth.

Settlement of the western part of the ecoregion in Pennsylvania was much later and never as widespread, limited only to the narrow river valleys. In these areas, the forest was cleared, but quickly grew back.

In the 1850s, oil was discovered along Oil Creek in the far western portion of HAL, beginning extensive exploitation of oil and gas deposits in the western sections of PA and NY. Many of these wells remain in operation today and have shaped the development of roads and pollution impacts on streams. Extensive sections of Western PA are recovering strip mines. Coal was also dug from many of the areas in Western PA, although the major coal fields lie just outside of HAL.

Managed Areas in the High Allegheny

Extensive tracts of managed areas are scattered in all parts of HAL. A map of HAL managed areas is included with this report (see 05-man_area.pdf). This map is based on several different GIS datalayers and includes comprehensive data for federal and state properties, but less complete data for county, town, and privately-owned conservation land. For these latter categories all calculations are low.

Nearly 20% of the total acreage of the ecoregion is held by public agencies and private organizations with a conservation mission. A review of managed areas by state appears in Table M1.

Table M1. Review of Managed Areas within HAL by State

State	Managed Area type	Acreage	% of State within HAL
NJ	Federal	32,000	
	State	33,000	
	Private	approx.2,000	
	Total	65,000	64.4
NY	Federal	260	
	State	821,000	
	Municipal	34,000	
	Private	16,000	
	Total	837,000	9.6
PA	Federal	543,000	
	State	1,803,000	
	County	5,000	
	Private	30,000	
	Total	2,381,000	29.4
All managed areas		**3,319,000**	
Acreage of Entire Ecoregion		**16,894,000**	
Percentage of Ecoregion in Managed Area = 19.6%			

The small section of NJ included within HAL is 64% managed area. Most of this land is within the Delaware Water Gap. There are also large state properties and several TNC preserves.

In Pennsylvania, 29% of the ecoregion is included within managed areas. Large state lands held primarily as state forests and state gamelands form a nearly continuous mass of forested land in the south-central part of the ecoregion. Allegheny National Forest, just west of the state land, extends this mass of forested land for another fifty miles. Most of these public lands are separated only by state roads and minor agricultural development along low-lying river corridors. There are also large tracts of state land in the eastern part of HAL in Pennsylvania around the Poconos and in Pike County. These tracts are more severely fragmented by roads and other development. Most of the Pennsylvania part of HAL immediately adjacent to the New York border has few areas with public ownership. This part of HAL is at lower elevation and highly dissected by small farms and wood lots.

Nearly 10% of New York in HAL is held in managed areas. The Catskills is by far the largest managed area included within HAL in New York. Most of the state-designated areas included within the Catskill “Blueline” is within HAL. Only a small portion of the eastern side of the Catskills is located within LNE. There are extensive private lands with the “Blueline,” but over 280,000 acres is owned by New York State. Allegany State Park at nearly 60,000 acres is the largest state park in New York. There are also numerous small state holdings in the north-central part of the ecoregion.

The ten largest managed areas in HAL appear in Table M2. Allegheny National Forest is the largest managed area in the ecoregion at 372,000 acres. Six of the ten largest managed areas are Pennsylvania state forests. Overall, there are 31 managed areas in HAL over 10,000 acres; 26 are state owned, 4 are federal and one is owned by New York City as a part of its Upstate New York water supply system.

Table M2. Ten largest managed areas in HAL.

Managed Area Name	Ownership type	State(s)	Acreage
Allegheny National Forest	Federal	PA	372,000
The Catskills	NY State	NY	284,000
Sproul State Forest	PA State	PA	153,000
Tioga State Forest	PA State	PA	138,000
Susquehannock State Forest	PA State	PA	136,000
Tiadaghton State Forest	PA State	PA	113,000
Allegany State Park	NY State	NY	60,000
Delaware Water Gap	Federal	PA/NJ	56,000
Wyoming State Forest	PA State	PA	53,000
Delaware State Forest	PA State	PA	52,000

These extensive managed areas in HAL present significant conservation opportunities. Many of the highest quality matrix forests and good condition aquatic features are associated with these areas.

PRIORITIES*

All features in the portfolio were sorted into strategic implementation groups: 1) partner lead, 2) TNC lead – no immediate action, and 3) TNC lead – 5 year action. During separate meetings for each of the TNC operating units, each occurrence or cluster of occurrences of Heritage elements, plants, animals, and natural communities, matrix forest units, and aquatic system units was evaluated for several characteristics. A brief review of these features follows:

1. **Biodiversity importance** was evaluated on a scale of 1-3: high, medium, and low. *High* = Having a broad range of conservation targets, high number of individual occurrences, large scale features, or globally rare elements.
   Medium = Moderate range of biodiversity features, multiple occurrences, or moderate importance in terms of globally rare elements.
   Low = Having only one or two target occurrences, often species or natural communities in small or large patches without significant landscape context.
2. **Threats/urgency.** Evaluated as High, Medium or Low. What are the major threats facing this site? Will action be needed at this site in the next few years?
3. **Feasibility.** What is the potential for effective conservation action? Who currently owns the site? Is there program capacity to undertake this type of work?
4. Who should take the **lead in conservation action** at this site?
5. Is this a **high priority for action** in the next 5-10 years? Yes or No.

Notes were taken during each of these meetings and returned to the operating units for quality control.

At a meeting of the entire group, selections were made for the ecoregion based on these initial discussions and an overview of the ecoregion as a whole. Overall, Action sites selected within HAL represent a significant portion of the biodiversity characterized in this plan (see Table A-1) and capture examples of all the types of biodiversity that will, over time, need attention in the ecoregion.

Table A-1. Review of Action Site Biodiversity by State.

	NJ	ENY	CWNY	PA	Total	% of total
Plant Occurrences	3	21	7	10	41	34
Animal Occurrences	4	9	6	42	61	39
Natural Community Occurrences	11	62	30	62	165	65
Matrix Forest Blocks	1	8	7	9	25	47
Aquatic Stream Miles	81	311	489	1597	2478	11*

* Percent of total stream miles in the ecoregion

Matrix forest blocks

A total of 25 matrix forests blocks were selected as Action sites. Twenty one of these are Tier 1 matrix forest blocks, 84% of the total of Tier 1 blocks. Four were Tier 2 blocks, 14% of all Tier 2 blocks. Seven of the nine Ecological Land Unit (ELU) groupings of matrix forests are represented in these selections. The two groupings that were not included, both in the agricultural part of New York, require significant restoration. Matrix blocks chosen in Action sites are

* Zaremba, R.E., M.G. Anderson et al. 2003. High Allegheny Plateau Ecoregional Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, Boston, MA.

located in all parts of HAL, with the greatest concentrations in the Catskills, the Allegany State Park region, and the central portion of the mass of Pennsylvania state-owned lands around Emporium. In four areas, matrix forest blocks were combined to facilitate conservation planning.

Natural communities

A total of 165 of the 253 natural community occurrences selected for the HAL portfolio (65%) were included in Action sites. Most natural community occurrences selected for Action sites are associated with matrix forest blocks with the exception of a series of large and small patch communities in the Poconos and in Madison County, Pennsylvania, where TNC has been active for many years. Much of the representation of communities in both the HAL database and in these Action sites reflects the bias of selective inventories within HAL.

Aquatic system units

Of the 148 aquatic system units identified in the four Ecological Drainage Units (EDUs) assessed within HAL, 70 or 47% were chosen as Action sites. Aquatic action sites were selected in all parts of HAL including each of the EDUs and in areas associated with each of the four major river segments in the ecoregion. Major portions of the Allegheny and Delaware Rivers are included. Only limited sections of the Susquehanna and West Branch of the Susquehanna were identified as Action sites. A total of 2478 stream miles are included in these selections: 800 miles in New York, 81 in New Jersey and 1597 in Pennsylvania

Animals

A total of 61 occurrences of the 158 animal occurrences identified in HAL (39%) were selected in Action sites. Many of these selections are associated with aquatic systems. The ecoregion has a high diversity of mussels, fish, and dragonflies, which help define many of its important aquatic features.

Plants

A total of 41 occurrences of the 121 plant occurrences identified in HAL (34%) were selected in Action sites. Fewer plant occurrences than communities or animals occurrences are included in Action sites because many of the plants documented within the database are known from historical records and often found at isolated, small patch sites. Plants included within Action sites are generally associated with matrix blocks, particularly the Catskills, Shawangunks in NY, the Kittatinny Ridge in NJ, and the Poconos.

PLANNING METHODS FOR ECOREGIONAL TARGETS: SPECIES[*]

Coarse-filter and fine-filter targets

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

Primary species targets

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

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

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

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

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

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

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

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

Secondary species targets

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

Developing the target list

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

Table SPP1. Criteria for selecting species targets

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

Species of special concern:	Ranked G3-G5 by Natural Heritage Programs/Conservation Data Centers, but match one or more of the following criteria:
Declining species	Exhibit significant, long-term declines in habitat and/or numbers, are subject to a high degree of threat, or may have unique habitat or behavioral requirements that expose them to great risk.
Endemic species	Restricted to the ecoregion (or a small geographic area within an ecoregion), depending entirely on the ecoregion for survival, and may be more vulnerable than species with a broader distribution.
Disjunct species	Have populations that are geographically isolated from other populations.
Peripheral species	Are more widely distributed in other ecoregions but have populations in this ecoregion at the edge of their geographical range.
Vulnerable species	Are usually abundant and may or may not be declining, but some aspect of their life history makes them especially vulnerable (e.g., migratory concentration or rare/endemic habitat).
Focal species	Have spatial, compositional, and functional requirements that may encompass those of other species in the region and may help address the functionality of ecological systems. Focal species can include: *Keystone species*: those whose impact on a community or ecological system is disproportionately large for their abundance. They contribute to ecosystem function in a unique and significant manner through their activities. Their removal initiates changes in ecosystem structure and often a loss of diversity. *Wide-ranging species*: regional-scale species that depend on vast areas. These species often include top-level predators (e.g., wolves, grizzly bear, pike minnow, killer whale), wide-ranging herbivores (e.g., elk), and wide-ranging omnivores (e.g., black bear) but also migratory mammals, anadromous fish, birds, bats and some insects.

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

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

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

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

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

Setting Minimum Conservation Goals for Species Targets

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

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

Quantitative global minimums

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

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

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

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

Distribution and Stratification goals

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

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

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

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

Assessing the Viability of Local Populations

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

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

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

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

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

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

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

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

RESULTS FOR SPECIES*

Modification to Standard Method

All G1-G3G4 and T1-T3 species known in the ecoregion were considered as potential targets. Other G4 and G5 species were nominated for discussion by each of the state programs. Several of these species were rejected as targets by the group based on questions about the taxonomic status of the species. Several species were removed as targets because they were considered to be more common throughout their range than reflected in the current global rank. The global rank for these species needs to be updated. One species was considered to be misidentified; several were not tracked in all three states and distribution information was considered to be inadequate. Several of these species were retained on a potential target list for future consideration.

Target Selection Results

The HAL plant target list includes 22 vascular plants and 2 non vascular plants (Table P+AT1).

Table P+AT1. Primary Plant Target Species List with Rangewide Distribution Categories

PRIMARY VASCULAR PLANT TARGET SPECIES (22)				
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**ELCODE**	**GRANK**	**DISTRIBUTION**
ACONITUM NOVEBORACENSE	NORTHERN WILD MONKSHOOD	PDRAN01070	G3	Limited
ADOXA MOSCHATELLINA	MUSK-ROOT	PDADO01010	G5	Peripheral
CALAMAGROSTIS PERPLEXA	WOOD REED GRASS	PMPOA17180	G1Q	Restricted
CAREX LUPULIFORMIS	FALSE HOP SEDGE	PMCYP037T0	G4	Widespread
CAREX POLYMORPHA	VARIABLE SEDGE	PMCYP03AW0	G3	Limited
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	PMCYP03C60	G3	Widespread
CAREX WIEGANDII	WIEGAND'S SEDGE	PMCYP03ES0	G3	Widespread
CHENOPODIUM FOGGII	FOGG'S GOOSEFOOT	PDCHE090J0	G3Q	Widespread
CLAYTONIA VIRGINICA VAR HAMMONDIAE	HAMMOND'S YELLOW SPRING BEAUTY	PDPOR030Q3	G5T1	Restricted
COREMA CONRADII	BROOM CROWBERRY	PDEMP02010	G4	Peripheral
DRYOPTERIS FRAGRANS	FRAGRANT CLIFF WOOD-FERN	PPDRY0A0C0	G5	Peripheral
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	PMORC1F010	G2	Widespread
JUNCUS ENSIFOLIUS	THREE-STAMENED RUSH	PMJUN01130	G5	Peripheral
MONTIA CHAMISSOI	CHAMISSO'S MINER'S-LETTUCE	PDPOR05020	G5	Peripheral
PLATANTHERA HOOKERI	HOOKER ORCHIS	PMORC1Y0A0	G5	Widespread
POA LANGUIDA	DROOPING BLUEGRASS	PMPOA4Z1C0	G3G4Q	Widespread
POA PALUDIGENA	BOG BLUEGRASS	PMPOA4Z1W0	G3	Widespread
POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	PDPLM0E0L0	G3	Limited
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	PMCYP0Q030	G3	Widespread
SEDUM ROSEA	ROSEROOT STONECROP	PDCRA0A170	G5	Peripheral
TRIPHORA TRIANTHOPHORA	NODDING POGONIA	PMORC2F050	G3G4	Widespread
TROLLIUS LAXUS SSP LAXUS	SPREADING GLOBEFLOWER	PDRAN0P022	G4T3	Widespread

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for species. Based on Zaremba, R.E. 2002. High Allegheny Plateau Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast and Caribbean Division, Boston, MA.

PRIMARY NON VASCULAR PLANT TARGET SPECIES (2)				
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**ELCODE**	**GRANK**	**DISTRIBUTION**
SPHAGNUM ANDERSONIANUM		NBMUS6Z1Q0	G3?	Limited
SPHAGNUM ANGERMANICUM		NBMUS6Z010	G3G4	Limited

Sixteen of the plant species targets are globally rare and ranked G1-G3G4 (or T1-T3); eight are secure globally and ranked G4 or G5. Three plant target species are federally listed: *Aconitum noveboracense*, *Scirpus ancistrochaetus*, and *Isotria medeoloides.* Two targets: *Calamagrostis perplexa* and *Claytonia virginica* var. *hammondiae* are identified as restricted to HAL. Both are known from only one population. Five species (three vascular and two non vascular) are designated as Limited in distribution with HAL one of the important locations for these species. All other species are widespread in distribution or peripheral within HAL.

The HAL animals target list includes 11 vertebrate species and 22 invertebrate species (Table P+AT2).

Table P+AT2. Primary Animal Target Species List with Rangewide Distribution Categories

PRIMARY VERTEBRATE TARGET SPECIES (11)				
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**ELCODE**	**GRANK**	**DISTRIBUTION**
CLEMMYS MUHLENBERGII	BOG TURTLE	ARAAD02040	G3	Widespread
ETHEOSTOMA MACULATUM	SPOTTED DARTER	AFCQC02420	G2	Limited
ETHEOSTOMA TIPPECANOE	TIPPECANOE DARTER	AFCQC02800	G3	Limited
ICHTHYOMYZON BDELLIUM	OHIO LAMPREY	AFBAA01010	G3G4	Peripheral
ICHTHYOMYZON GREELEYI	MOUNTAIN BROOK LAMPREY	AFBAA01050	G3G4	Peripheral
MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS	AMACC01130	G3	Widespread
MYOTIS SODALIS	INDIANA BAT	AMACC01100	G2	Widespread
NEOTOMA MAGISTER	ALLEGHENY WOODRAT	AMAFF08100	G3G4	Peripheral
NOTURUS STIGMOSUS	NORTHERN MADTOM	AFCKA02220	G3	Widespread
PERCINA MACROCEPHALA	LONGHEAD DARTER	AFCQC04120	G3	Widespread
SISTRURUS CATENATUS CATENATUS	EASTERN MASSASAUGA	ARADE03011	G3G4T3	Peripheral
PRIMARY INVERTEBRATE TARGET SPECIES (22)				
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**ELCODE**	**GRANK**	**DISTRIBUTION**
ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	IMBIV02030	G1G2	Widespread
ALASMIDONTA VARICOSA	BROOK FLOATER	IMBIV02100	G3	Widespread
CHAETAGLAEA CERATA	A NOCTUID MOTH	IILEYFM010	G3G4	Widespread
CHEUMATOPSYCHE HELMA	HELMA'S NET-SPINNING CADDISFLY	IITRI22040	G1G3	Peripheral
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	IICOL02070	G3	Widespread
CICINDELA MARGINIPENNIS	COBBLESTONE TIGER BEETLE	IICOL02060	G2G3	Widespread
ENALLAGMA LATERALE	NEW ENGLAND BLUET	IIODO71020	G3	Peripheral
EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	IMBIV16184	G2T2	Limited

ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	IILEP37171	G5T2T3	Widespread
FUSCONAIA SUBROTUNDA	LONGSOLID	IMBIV17120	G3	Widespread
GOMPHUS QUADRICOLOR	RAPIDS CLUBTAIL	IIODO08380	G3G4	Widespread
GOMPHUS SEPTIMA	SEPTIMA'S CLUBTAIL	IIODO08190	G2	Restricted
GOMPHUS VIRIDIFRONS	GREEN-FACED CLUBTAIL	IIODO08460	G3	Widespread
ITAME SP 1	BARRENS ITAME (c.f. I. INEXTRICATA)	IILEU09X10	G3	Widespread
LASMIGONA SUBVIRIDIS	GREEN FLOATER	IMBIV22060	G3	Widespread
OPHIOGOMPHUS ANOMALUS	EXTRA-STRIPED SNAKETAIL	IIODO12020	G3	Widespread
OPHIOGOMPHUS HOWEI	PYGMY SNAKEFAIL	IIODO12090	G3	Widespread
PAPAIPEMA SP 1	FLYPOISON BORER MOTH	IILEYC0X10	G2G3	Limited
PLEUROBEMA CLAVA	CLUBSHELL	IMBIV35060	G4	Peripheral
PSECTRAGLAEA CARNOSA	PINK SALLOW	IILEYFN010	G3	Widespread
PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	IILEP38090	G2	Limited
VILLOSA FABALIS	RAYED BEAN	IMBIV47050	G1G2	Widespread

All animal targets are ranked as globally rare, G1-G3G4 (or T1-T3). Three targets are Federally listed: *Clemmys muhlenbergii*, *Myotis leibii*, and *Alasmidonta heterodon*. Only one animal species is identified as "Restricted" to HAL: *Gomphus septima*. Four species (*Epioblasma torulosa rangiana*, *Papaipema* sp. 1, *Etheostoma maculatum*, and *Etheostoma tippecanoe*,) are designated as having "Limited" distributions including HAL. All other species are "Widespread" or "Peripheral" in HAL. Two species (*Epioblasma triquetra* and *Quadrula cylindrica*) are globally rare and found in HAL, but were not included in this assessment because their occurrences are associated with French Creek which is primarily in Western Allegheny Plateau (WAP) Ecoregion and in the far western part of the ecoregion. These species and their HAL occurrences have been included in the WAP ecoregional plan.

A list of potential additional targets was developed during the assessment process for both plants and animals. These lists are made up of a broad range of species types including species needing more taxonomic work, species not well inventoried in the ecoregion, species of unknown global rarity, species tracked in one state but not in others, species which may be undergoing decline, and species which may be misidentified. The discussion concerning these taxa was recorded to assist in future assessments of HAL targets. The potential target list for plants in HAL includes 15 species and appears in Table P+AT3.

Table P+AT3. Potential Plant Target Species (Listed alphabetically by Global Name)

GNAME (GLOBAL NAME)	GCOMNAME (Global Common Name)	ELCODE	GRANK
AMELANCHIER BARTRAMIANA	BARTRAM SHADBUSH	PDROS05030	G5
CAREX COLLINSII	COLIN'S SEDGE	PMCYP032W0	G4
CHAMAECYPARIS THYOIDES	ATLANTIC WHITE CEDAR	PGCUP03030	G4
CHAMAELIRIUM LUTEUM	DEVIL'S-BIT	PMLIL0F010	G5
CRATAEGUS PENNSYLVANICA	A HAWTHORN	PDROS0H3V0	G3?Q
CRYPTOGRAMMA STELLERI	FRAGILE ROCKBRAKE	PPADI0B020	G5
FRASERA CAROLINIENSIS	CAROLINA GENTIAN	PDGEN05030	G5
GLYCERIA OBTUSA	BLUNT MANNA-GRASS	PMPOA2Y0C0	G5
HASTEOLA SUAVEOLENS	SWEET-SCENTED INDIAN-PLANTAIN	PDASTDX010	G3

HUPERZIA POROPHILA	ROCK CLUBMOSS	PPLYC02080	G4
JUNCUS MILITARIS	BAYONET RUSH	PMJUN011Y0	G4
POLYSTICHUM BRAUNII	BRAUN'S HOLLY-FERN	PPDRY0R040	G5
POTAMOGETON CONFERVOIDES	ALGAE-LIKE PONDWEED	PMPOT03050	G3G4
RIBES LACUSTRE	BRISTLY BLACK CURRANT	PDGRO020T0	G5
TRICHOMANES INTRICATUM	A FILMY-FERN	PPHYM020V0	G3G4

The potential targets list for animals includes 49 species (13 vertebrates and 36 invertebrates) and appears in Table P+AT4.

Table P+AT4. Potential Animal Target Species (Listed alphabetically by Global Name)

VERTEBRATE SPECIES (13)			
ELCODE	**GNAME (Global Name)**	**GCOMNAME (Global Common Name)**	**GRANK**
ABNKC12060	ACCIPITER GENTILIS	NORTHERN GOSHAWK	G5
AFCKA06030	AMEIURUS MELAS	BLACK BULLHEAD	G5
ARADE02040	CROTALUS HORRIDUS	TIMBER RATTLESNAKE	G4
AMABA04010	CRYPTOTIS PARVA	LEAST SHREW	G5
ABPBX03230	DENDROICA STRIATA	BLACKPOLL WARBLER	G5
ABPAE33010	EMPIDONAX FLAVIVENTRIS	YELLOW-BELLIED FLYCATCHER	G5
AFCQB10030	ENNEACANTHUS OBESUS	BANDED SUNFISH	G5
AFCQB11080	LEPOMIS MEGALOTIS	LONGEAR SUNFISH	G5
AFCJB28310	NOTROPIS CHALYBAEUS	IRONCOLOR SHINER	G4
AFCJB31020	PHOXINUS EOS	NORTHERN REDBELLY DACE	G5
ABNME05020	RALLUS ELEGANS	KING RAIL	G4G5
ABNME05030	RALLUS LIMICOLA	VIRGINIA RAIL	G5
AMAEB01090	SYLVILAGUS OBSCURUS	APPALACHIAN COTTONTAIL	G4
INVERTEBRATE SPECIES (36)			
ELCODE	**GNAME (Global Name)**	**GCOMNAME (Global Common Name)**	**GRANK**
IILEYAQ180	ACRONICTA ALBARUFA	BARRENS DAGGER MOTH	G3G4
IIODO14110	AESHNA MUTATA	SPATTERDOCK DARNER	G3G4
IIODO15030	ANAX LONGIPES	COMET DARNER	G5
IMBIV04080	ANODONTA IMPLICATA	ALEWIFE FLOATER	G5
IILEYLP110	ANOMOGYNA ELIMATA	SOUTHERN VARIABLE DART MOTH	G5
IILEYBB010	APAMEA BURGESSI	A NOCTUID MOTH	G4
IILEYB9070	APAMEA CRISTATA	A NOCTUID MOTH	G4
IILEYGR010	APHARETRA DENTATA	A NOCTUID MOTH	G4
IILEYM1010	APLECTOIDES CONDITA	A NOCTUID MOTH	G4
IIODO68010	ARGIA BIPUNCTULATA	SEEPAGE DANCER	G4
IIODO68020	ARGIA TIBIALIS	BLUE-TIPPED DANCER	G5
IILEPJ9150	CHLOSYNE HARRISII	HARRIS'S CHECKERSPOT	G4
IIODO70010	COENAGRION RESOLUTUM	TAIGA BLUET	G5
IILEPA8140	COLIAS INTERIOR	PINK-EDGED SULPHUR	G5
IILEY02100	DATANA RANAECEPS	A HAND-MAID MOTH	G3G4
IILEYLC020	DIARSIA RUBIFERA	RUBIFERA DART	G5
IILEP77030	EUPHYES DION	DION SKIPPER	G4
IILEU0S060	GLENA COGNATARIA	BLUEBERRY GRAY	G4
IIODO08410	GOMPHUS ABBREVIATUS	SPINE-CROWNED CLUBTAIL	G3G4

IILEW0M040	HEMILEUCA MAIA	THE BUCKMOTH	G5
IMBIV21050	LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	G3G4
IILEYFE440	LITHOPHANE THAXTERI	THAXTER'S PINION MOTH	G4
IILEU1S030	LYCIA RACHELAE	TWILIGHT MOTH	G4
IMBIV27030	MARGARITIFERA MARGARITIFERA	EASTERN PEARLSHELL	G4
IILEYFK030	METAXAGLAEA SEMITARIA	FOOTPATH SALLOW MOTH	G5
IIODO50010	NANNOTHEMIS BELLA	ELFIN SKIMMER	G4
IILEYAH070	PANTHEA SP 1	A MOTH	G4
IILEYHL040	SIDERIDIS MARYX	A MOTH	G4
IIODO32080	SOMATOCHLORA FORCIPATA	FORCIPATE EMERALD	G5
IIODO32130	SOMATOCHLORA INCURVATA	INCURVATE EMERALD	G4
IILEX0B170	SPHINX GORDIUS	GORDIAN SPHINX	G4
IILEY8T030	SYNGRAPHA EPIGAEA	A NOCTUID MOTH	G5
IILEY7P260	ZALE CUREMA	A NOCTUID MOTH	G3G4
IILEY7PX10	ZALE SP 1	PINE BARRENS ZALE	G3Q
IILEY7P190	ZALE SUBMEDIANA	A NOCTUID MOTH	G4
IILEY43110	ZANCLOGNATHA MARTHA	PINE BARRENS ZANCLOGNATHA	G4

Portfolio Status for Plant Species in HAL

The Plant Working Group assessed a total of 121 (See Table P+AT7) occurrences for the 24 target plant species in HAL. Eighty-eight occurrences (73%) were selected for the HAL portfolio. Goals and portfolio status for plant targets in HAL are presented in Table P+AT7**.**

Table P+AT7 Primary Plant Target Species: Goals, Portfolio Status, And Goals Met

PRIMARY VASCULAR PLANT TARGET SPECIES (22)						
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**Rangewide Distribution**	**# of EORs in HAL**	**Minimum Needed for Goals**	**# of EORs Accepted**	**Goal Met**
ACONITUM NOVEBORACENSE	NORTHERN WILD MONKSHOOD	Limited	8	10	8	N
ADOXA MOSCHATELLINA	MUSK-ROOT	Peripheral	5	5	3	N
CALAMAGROSTIS PERPLEXA	WOOD REED GRASS	Restricted	1	20	1	N
CAREX LUPULIFORMIS	FALSE HOP SEDGE	Widespread	2	5	1	N
CAREX POLYMORPHA	VARIABLE SEDGE	Limited	6	10	6	N
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	Widespread	6	5	4	N
CAREX WIEGANDII	WIEGAND'S SEDGE	Widespread	2	5	2	N
CHENOPODIUM FOGGII	FOGG'S GOOSEFOOT	Widespread	1	5	0	N
CLAYTONIA VIRGINICA VAR HAMMONDIAE	HAMMOND'S YELLOW SPRING BEAUTY	Restricted	1	20	1	N
COREMA CONRADII	BROOM CROWBERRY	Peripheral	2	5	2	N
DRYOPTERIS FRAGRANS	FRAGRANT CLIFF WOOD-FERN	Peripheral	3	5	3	N
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	Widespread	2	5	2	N
JUNCUS ENSIFOLIUS	THREE-STAMENED RUSH	Peripheral	2	5	1	N
MONTIA CHAMISSOI	CHAMISSO'S MINER'S-LETTUCE	Peripheral	3	5	2	N
PLATANTHERA HOOKERI	HOOKER ORCHIS	Widespread	3	5	0	N
POA LANGUIDA	DROOPING BLUEGRASS	Widespread	1	5	0	N
POA PALUDIGENA	BOG BLUEGRASS	Widespread	6	5	5	Y
POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	Limited	25	10	13	Y

SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	Widespread	1	5	4	N
SEDUM ROSEA	ROSEROOT STONECROP	Peripheral	4	5	3	N
TRIPHORA TRIANTHOPHORA	NODDING POGONIA	Widespread	6	5	6	Y
TROLLIUS LAXUS SSP LAXUS	SPREADING GLOBEFLOWER	Widespread	24	5	14	Y
SUBTOTAL			**114**	**155**	**81**	--
PRIMARY NON VASCULAR PLANT TARGET SPECIES (2)						
GNAME (Global Name)	**GCOMNAME (Global Common Name)**	**Rangewide Distribution**	**# of EORs in HAL**	**Minimum Needed for Goals**	**# of EORs Accepted**	**Goal Met**
SPHAGNUM ANDERSONIANUM		Limited	4	10	4	N
SPHAGNUM ANGERMANICUM		Limited	3	10	3	N
SUBTOTAL			**7**	**20**	**7**	**--**
GRAND TOTAL			**121**	**175**	**88**	--

Only four species met their goal: *Poa paludigena*, *Polemonium vanbruntiae*, *Triphora trianthophora*, and *Trollius laxus* spp *laxus.* New York is the center of distribution for *Trollius laxus* spp *laxus*. Of the 22 occurrences assessed as viable in HAL, only 14 were selected for the portfolio. Eight occurrences located in marginal habitat were not selected. Likewise, New York is the center of distribution for *Polemonium vanbruntiae*. Two viable occurrences for *Polemonium* in marginal habitat were not selected for the portfolio. For all other species, all viable occurrences were selected for the HAL portfolio.

The overall goal for plants in HAL was to locate and identify 175 populations (see Table P+AT7). Half of the goal (88 of 175 or 50%) for plant targets was met in this first iteration of the HAL plan.

Comments on the HAL plant portfolio

The plant data used in the development of the HAL portfolio were in overall good condition and easy to evaluate. The HAL botanists knew the species tracked well and had a good sense of what remains left to document their states.

Goals for the two species “Restricted” to HAL are currently unattainable. Both species (*Calamagrostis perplexa* and *Claytonia virginica* var. *hammondiae*) appear to be good taxa, but are only known from one population. The goal for these species in HAL is 20 populations. It is expected that no other populations will be found. Thus these targets are unlikely to persist over centuries without restoration work.

It is the opinion of the HAL botanists that several species designated as targets will be found at new sites with continued inventories. These species include: *Scirpus ancistrochaetus*, *Triphora trianthophora*, *Chenopodium foggii*, and *Juncus ensifolius*. Many of the other species are well known and have been the subject of detailed searches.

Plant occurrences for targets are concentrated in the calcareous region in New York, the Catskills, along the Kittatinny ridge and vicinity, and in the Poconos. There are large sections of western Pennsylvania and the New York/Pennsylvania border counties where there have been few surveys. These areas should receive additional attention.

Portfolio Status for Animals in HAL

The HAL Animal Working Group assessed 158 occurrences including metapopulations for the 33 targets species. Seventy-four occurrences for 27 species were selected for the portfolio. Goals for animals targets in HAL are presented in Table P+AT8**.**

Table P+AT8. HAL Primary Animal Target Species: Goals and Goals Met

PRIMARY VERTEBRATE TARGET SPECIES (11)

GNAME (Global Name)	GCOMNAME (Global Common Name)	ELCODE	RANGEWIDE	GRANK	GOAL minimum	# OF EORs	# OF EORs (converted to include	Explanation of Conversion	# of EORs ACCEPTED	COMMENTS for EORs ACCEPTED	NUMERICAL GOAL MET?	DISTRIBUTION GOAL
CLEMMYS MUHLENBERGII	BOG TURTLE	ARAAD02040	W	G3	5	38	24	22 eors + 2 metapops of 6 and 10 eors	2	Both Metapops incl.	N	N
ETHEOSTOMA MACULATUM	SPOTTED DARTER	AFCQC02420	L	G2	10	2	1	1 metapopulation of 2 eors	1	Metapop. included	N	Y
ETHEOSTOMA TIPPECANOE	TIPPECANOE DARTER	AFCQC02800	L	G3	10	5	1	1 metapopulation of 5 eors	1	Metapop. included	N	Y
ICHTHYOMYZON BDELLIUM	OHIO LAMPREY	AFBAA01010	P	G3G4	5	15	14	13 eor + 1 metapop of 2 eors	8	Metapop. included	Y	Y
ICHTHYOMYZON GREELEYI	MOUNTAIN BROOK LAMPREY	AFBAA01050	P	G3G4	5	5	5	---	0	---	N	N
MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS	AMACC01130	W	G3	5	4	4	---	1	---	N	N
MYOTIS SODALIS	INDIANA BAT	AMACC01100	W	G2	5	1	1	---	0	---	N	N
NEOTOMA MAGISTER	ALLEGHENY WOODRAT	AMAFF08100	P	G3G4	5	17	17	---	5	---	Y	N
NOTURUS STIGMOSUS	NORTHERN MADTOM	AFCKA02220	W	G3	5	1	1	---	1	---	N	Y
PERCINA MACROCEPHALA	LONGHEAD DARTER	AFCQC04120	W	G3	5	10	5	4 eors + 1 metapop. of 4 eors	5	Metapop. included	Y	Y
SISTRURUS CATENATUS CATENATUS	EASTERN MASSASAUGA	ARADE03011	P	G3G4T3	5	6	6	---	0	---	N	N
SUBOTAL					65	104	79	---	24			

PRIMARY INVERTEBRATE TARGET SPECIES (22)

GNAME (Global Name)	GCOMNAME (Global Common Name)	ELCODE	RANGEWIDE DISTRIBUTI	GRANK	GOAL minimum	# OF EORs	# OF EORs (converted to include	Explanation of Conversion	# of EORs ACCEPTED	COMMENTS for EORs ACCEPTED	NUMERICAL GOAL MET?	DISTRIBUTION GOAL
ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	IMBIV02030	W	G1G2	5	8	2	1 + 1 metapopulation of 7 eors	2	Metapop. included	N	Y
ALASMIDONTA VARICOSA	BROOK FLOATER	IMBIV02100	W	G3	5	8	8	---	7	---	Y	N
CHAETAGLAEA CERATA	A NOCTUID MOTH	IILEYFM010	W	G3G4	5	3	3	---	3	---	N	Y
CHEUMATOPSYCHE HELMA	HELMA'S NET-SPINNING CADDISFLY	IITRI22040	P	G1G3	5	1	1	---	1	---	N	Y
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	IICOL02070	W	G3	5	3	3	---	3	---	N	Y
CICINDELA MARGINIPENNIS	COBBLESTONE TIGER BEETLE	IICOL02060	W	G2G3	5	3	3	---	3	---	N	Y
ENALLAGMA LATERALE	NEW ENGLAND BLUET	IIODO71020	P	G3	5	3	2	1 + 1 metapopulation of 2 eors	1	Metapop. included	N	N
EPIOBLASMA TORULOSA RANGIANA	NORTHERN RIFFLESHELL	IMBIV16184	L	G2T2	10	3	1	1 metapopulation of 3 eors	1	Metapop. included	N	Y
ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	IILEP37171	W	G5T2T3	5	2	2	---	1		N	N
FUSCONAIA SUBROTUNDA	LONGSOLID	IMBIV17120	W	G3	5	2	2	---	0		N	N
GOMPHUS QUADRICOLOR	RAPIDS CLUBTAIL	IIODO08380	W	G3G4	5	7	2	1st metapop. 2 eors, 2nd metapop. of 5 eors	2	Both metapops. included	N	Y

GOMPHUS SEPTIMA	SEPTIMA'S CLUBTAIL	IIODO08190	R	G2	20	0	0	---	0		N	N
GOMPHUS VIRIDIFRONS	GREEN-FACED CLUBTAIL	IIODO08460	W	G3	5	11	6	5 eors + 1 metapop. of 6 eors	6	Metapop. included	Y	Y
ITAME SP 1	BARRENS ITAME (c.f. I. INEXTRICATA)	IILEU09X10	W	G3	5	4	4	---	2		N	N
LASMIGONA SUBVIRIDIS	GREEN FLOATER	IMBIV22060	W	G3	5	27	27	---	7		Y	Y
OPHIOGOMPHUS ANOMALUS	EXTRA-STRIPED SNAKETAIL	IIODO12020	W	G3	5	3	3	---	3		N	Y
OPHIOGOMPHUS HOWEI	PYGMY SNAKEFAIL	IIODO12090	W	G3	5	1	1	---	1		N	Y
PAPAIPEMA SP 1	FLYPOISON BORER MOTH	IILEYC0X10	L	G2G3	10	6	5	4 eors + 1 metapop. of 2 eors	3	Metapop. included	N	N
PLEUROBEMA CLAVA	CLUBSHELL	IMBIV35060	P	G4	5	3	1	1 metapop. of 3 eors	1	Metapop. included	N	Y
PSECTRAGLAEA CARNOSA	PINK SALLOW	IILEYFN010	W	G3	5	4	2	2 eors + 1 metapop. of 2 eors	2	Metapop. included	N	N
PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	IILEP38090	L	G2	10	0	0	---	0		N	Y
VILLOSA FABALIS	RAYED BEAN	IMBIV47050	W	G1G2	5	1	1	---	1		N	Y
SUBTOTAL					140	103	79	---	50			
GRAND TOTAL					205	207	158		74			

* Rangewide Distribution Symbols: L Limited; P Peripheral, R Restricted, W Widespread

Six species known to have occurred in HAL within the last 30 years did not have any occurrences selected (*Ichthyomyzon greeleyi, Myotis sodalis, Sistrurus catenatus catenatus, Fusconaia subrotunda, Gomphus septima, and Pyrgus wyandot*). Four species (*Ichthyomyzon bdellium, Percina macrocephala, Gomphus viridifrons*, and *Lasmigona subviridis*) met both numerical and distributional goals for the ecoregion. Two other species (*Neotoma magister* and *Alasmidonta varicosa*) met numerical goals, but failed to meet the distributional goal. Fifteen species met the distributional goal, but failed to meet the numerical goal.

The overall goal for animals in HAL was 205 occurrences. The HAL first iteration portfolio identifies 33% of the viable animal populations to meet the plan goals, 68 of 205 occurrences. Six occurrences were included in the portfolio that were beyond the goals set for four species.

Comments on the HAL animal portfolio

The data used in the development of the HAL portfolio were variable in detail and difficult to evaluate. Data were collected by a wide variety of surveyors. Some occurrence information was old; some was very sketchy. It was often hard to evaluate an occurrence beyond that a collection had been made at a specific site. Much of these type of data were set aside and occurrences were not included in the portfolio. Comments were collected that reflect needed additional information for future assessment.

For 13 of the species identified as targets, some individual occurrences were grouped into metapopulation concepts. For example, 16 bog turtle occurrences from the New Jersey and Pennsylvania databases were grouped into two populations. Species whose viable occurrences were in some way grouped into metapopulations during this assessment include:

Clemmys muhlenbergii
Etheostoma maculatum
Etheostoma tippecanoe
Ichthyomyzon bdellium
Percina marcrocephala
Alasmidonta heterodon
Enallagma laterale
Epioblasma torulosa rangiana
Gomphus quadricolor
Gomphus viridifrons

Papaipema sp. 1
Pleurobema clava
Psectraglaea carnosa

For six species, no occurrences appear in the portfolio at all. For *Pyrgus wyandot* there are no currently known populations. Data for *Gomphus septima* have been collected, but have not yet been processed by New York Heritage and have not been included in this plan. Four other species: *Ichthyomyzon greeleyi*, *Myotis leibeii*, *Fusconaia subrotunda*, and *Sistrurus catenatus* are believed to still be extant in HAL, but additional field work is needed to confirm locations and population viability, before portfolio sites can be chosen.

The animal occurrences in the HAL portfolio are concentrated along the major rivers: the Delaware, the Susquehanna, and the Allegheny, along the Clarion River in Western Pennsylvania, and Olean Creek in New York, and in the eastern parts of the ecoregion.

Additional field work for most species is needed to confirm the continued existence of many species and individual populations and to improve an understanding of viability for these occurrences. There are likely more occurrences for many of these species, particularly those associated with aquatic systems.

Assessing and integrating the appropriate bird target species is not complete. A list of PIF priority species for HAL is shown in Table BT1.

TABLE BT-1. Draft Bird Target List Based on Allegheny Plateau PIF Report

High Continental Priority- High Regional Responsibility
Henslow's sparrow
Bicknell's thrush
Wood thrush
Canada warbler
American woodcock
Black-billed cuckoo
Black-throated blue warbler
Field sparrow
Louisiana waterthrush
Scarlet tanager
High Continental Priority- Low Regional Responsibility
Golden-winged warbler
Cerulean warbler
Worm-eating warbler
High Regional Concern
Eastern wood-pewee
American kestrel
Eastern towhee
Least flycatcher
Sharp-shinned hawk
High Regional Responsibility
Blue-winged warbler
Bobolink
Rose-breasted grosbeak
High Regional Threats
American black duck
Red-headed woodpecker
Sedge wren
Yellow-bellied flycatcher
Upland sandpiper
Northern harrier
Short-eared owl

Arranged by habitat with priority set by PIF plan (species differ some from the first part of this list-only species with high PIF scores are included)
Agricultural grasslands
Henslow's sparrow
Upland sandpiper
American kestrel
Bobolink
Shrub-early succession
Golden-winged warbler
American woodcock
Field sparrow
Boreal mountaintop and bog
Bicknell's thrush
Yellow-bellied flycatcher
Riparian-deciduous forest
Cerulean warbler
Worm-eating warbler
Wood thrush
Louisiana waterthrush
Canada warbler
Black-throated blue warbler
Freshwater wetlands
American black duck
King rail
American bittern
Black tern

Next Steps for HAL Species Assessment

1. Data collected during this assessment were returned to the Heritage Programs. Element occurrences should be updated to reflect any new information obtained during development of this plan about viability and occurrences grouped into metapopulations.
2. Species targets lists should be assembled for all Northeastern ecoregions and evaluated to make sure that the globally-rare species are addressed in all ecoregions and that globally-secure species are appropriately included. Comments concerning taxonomic and identification problems, inadequate inventories, and aging surveys should be collected and addressed.
3. Numerical and distributional goals for species should be reevaluated and coordinated across ecoregional boundaries. For most species, goals should be tailored to known extant and suspected populations, as well as available habitat. Information should be collected to address minimum viable populations size. For some species which may be highly sensitive to global warming, sites should be selected to allow movement of populations over time.
4. For select species, particularly those that are globally rare, restoration should be considered. At a minimum, for Federally-listed species, introductions and reintroduction sites should be identified. All goals should be adjusted to reflect any detailed information included in Federal recovery plans, as they are developed.
5. Viability assessments should be reevaluated as more information becomes available. The basis of the viability assessment for species in this plan was the judgment of the Heritage ecologists. While this was the best information currently available, many occurrences were documented with very sketchy data and the ecologists were not personally familiar with specific populations, During the Site conservation planning process, population viability should be reassessed and new information added to the Heritage databases.

6. Field work should continue for all species to update current occurrence data and locate new populations. Particular attention should be focused on aquatic species, animals targets that have not been seen in many years, and species which occupy large areas for which only presence/absence information is currently available.
7. Those sections of the ecoregion that have not been subject to detailed surveys should be assessed. These areas include all rivers and streams, the large forested areas in central and western Pennsylvania, and the counties along the New York/Pennsylvania border.

PLANNING METHODS FOR ECOREGIONAL TARGETS: TERRESTRIAL ECOSYSTEMS AND COMMUNITIES*

Coarse-filter and fine-filter targets

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

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

Ecosystem and community targets: Introduction

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

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

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

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

Ecosystems and communities

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

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

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

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

Ecosystems and scale

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

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

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

Ecosystems and physical setting

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

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

Developing the target list

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

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

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

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

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

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

Auxiliary information on each ecosystem

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

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

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

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

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

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

Methods for developing auxiliary information

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

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

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

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

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

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

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

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

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

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

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

Table COMM2. Ecological Land Unit variables

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

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

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

[4] Incomplete as of July 2003, but see Ferree 2003.

Setting Minimum Conservation Goals for Ecosystem Targets

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

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

Quantitative global minimums

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

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

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

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

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

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

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

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

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

Distribution goals

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

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

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

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

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

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

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

Assessing the Viability of Individual Ecosystem Examples

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

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

Locating examples of patch-forming communities

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

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

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

Viability screening criteria

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Combining the viability criteria

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

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

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

Addressing Gaps in the Data

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

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

Quercus rubra / Polypodium virginianum Woodland (CEGL006320 ECS) — G3G5
LNP SUGGESTED NAME: Quercus rubra – Betula alleghaniensis / Polypodium virginianum Woodland

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

LNP Scale: Small to large patch **Distribution**: Limited
TNC Ecoregions: 61:C, 62:C, 63:C
References:

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

Quercus rubra / Vaccinium spp. / Deschampsia flexuosa Woodland (CEGL006134 ECS) — G3G5
LNP SUGGESTED NAME: Quercus rubra – Quercus prinus / Vaccinium spp. / Deschampsia flexuosa Woodland

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

LNP Scale: Small patch or large patch? **Distribution:** Widespread
TNC Ecoregions: 59:C, 61:?, 62:C, 63:C
References: Thompson and Sorenson 2000

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

RESULTS FOR TERRESTRIAL COMMUNITIES AND SYSTEMS*

All natural terrestrial vegetation community types are identified as conservation targets in the ecoregion. Aquatic communities are analyzed separately. A description of the aquatics selection process and results appear in the aquatics systems and species chapter.

Modification to Standard Method

The methodology used to develop an ecoregional vegetation classification in other Northeastern ecoregions (NAP, NAC, LNE, CBY, and CAP) was applied to the HAL Ecoregion to define the full complement of associations that occur in the ecoregion. Of the 140 associations initially described for HAL in the NVC, 34 were evaluated as not occurring in HAL. Three associations not previously identified as within HAL were added, and several associations were described for consideration for inclusion in a revised NVC. Every association within HAL was also categorized into a coarser scale vegetation system or **group**, of which 14 were initially identified. A total of 109 associations known or thought to occur in the HAL ecoregion were described through these efforts. By comparison, 126 associations were described for CAP and 153 for LNE. These results were assembled into a single document for HAL natural communities and reviewed by the participating ecologists (Sneddon et al., 2000).

Three (possibly four) associations within HAL were described as matrix forming (see matrix forest chapter). Fourteen NVC types were described as large patch (or which may occur as large patch), 65 were described as small patch, and 8 were described as linear. For 36 associations, the patch size was either uncertain or believed to be intermediate between patch types; hence the number of associations tallied by patch size exceeds the total number of associations with the ecoregion. For 21of the types, the patch type was assigned based on best available knowledge, but with less certainty than for the majority of the types (see discussion in Assessing Viability section below). For a small number of types the patch size was completely unknown at the time of this assessment, but these cases were too few to affect the overall results presented here.

Data were assembled for the three states within the ecoregion. A total of 509 occurrences were in this dataset: 20 for NJ, 282 for PA, and 206 for NY. Each of these occurrences was initially identified within their respective state classifications, and thus needed to be linked ("crosswalked" or "tagged") to the NVC classification developed for HAL. Each association was also categorized as one of the 14 vegetation systems or groups. Some occurrences were easily connected to a specific association; others were a mosaic of identifiable associations and could be considered to be occurrences of multiple associations; for some it was not possible to crosswalk them to the HAL classification given available data. In the cases where it was not possible to connect an occurrence to a specific association, but it was clear that the occurrence was high quality and able to be matched to a coarser scale level of classification, occurrences were tied to the appropriate vegetation **group**.

Unlike many community occurrences in other ecoregions, most community occurrences documented by the Natural Heritage Programs in HAL were very detailed and scaled similarly to associations within the NVC, so that occurrences could be effectively crosswalked to specific

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* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for terrestrial communities and systems. Based on Zaremba, R.E. 2002. High Allegheny Plateau Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast and Caribbean Division, Boston, MA.

associations. For 38 of the occurrences (7%), however, it was necessary to limit analysis to the coarser-scale Group level (Appendix nc1).

Assessing Viability

Viability assessment followed the standard method for terrestrial communities and systems. Combining the viability criteria of size, condition, and landscape context for HAL resulted in Table NC-1, which guided the assessment.

Table NC-1. Natural community (small, large, and linear patch) viability ranking grid.

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

Note that linear patch communities were variously evaluated on small or large patch size criteria depending on an understanding of the growth and habitat characteristics of the vegetation type. Also, where there was uncertainty about the classification of a community to patch type (e.g., large vs. small), generally the more conservative criteria were applied.

Stratification

As in other ecoregions, HAL was divided into groups of subsections to reflect the range of physiographic variability throughout the ecoregion. For the purposes of stratification, HAL subsections were grouped to reflect similar ecological settings. Table NC-2 shows the levels that were defined. Level 1 refers to anywhere within the ecoregion. The first and most fundamental ecological separation in HAL is between subsections that are within the glaciated portion of the ecoregion and those that were never subject to glaciation. For the most common widespread communities at a minimum, occurrences should be distributed in both of these units (Level 2), if in fact, the association occurs in both units. Level 3 divides the ecoregion into four groups, reflecting glaciation, elevation, and bedrock differences. Level 4, reserved for Restricted associations, further divides the lower elevation subsections reflecting differences between the rugged terrain in the vicinity of the Poconos and the Middle Delaware River and the more gently sloping, rolling hills of the northern subsections of HAL.

Table NC-2. Sectional and subsectional classification (USFS categories) and geographic extent in HAL ecoregion.

<table>
<tr><td colspan="5">High Allegheny Plateau</td><td>Level 1</td></tr>
<tr><td>Non-glaciated</td><td colspan="4">Glaciated</td><td>Level 2</td></tr>
<tr><td>Western PA Highlands-Ga/Gb</td><td>Catskills-Ea</td><td>Kittatinny-Bd</td><td colspan="2">Allegheny Lowlands</td><td>Level 3</td></tr>
<tr><td>Western PA Highlands-Ga/Gb</td><td>Catskills-Ea</td><td>Kittatinny-Bd</td><td>NY Lowlands and Catskill Hills Eb/Fb/Fa</td><td>Poconos/ Neversink Fc/Fd</td><td>Level 4</td></tr>
</table>

Conservation goals

Conservation goals for terrestrial communities in HAL were set to reflect that Restricted and Limited associations in HAL should be distributed in the ecoregion more broadly than Peripheral and Widespread communities, because a high percentage of the global range of these communities occurs in the ecoregion. For those communities whose distribution is thought to be Restricted to HAL, occurrences should be located as broadly as possible, in all five sections shown in Level 4 of Table NC-2.

For those communities categorized as Limited to HAL (found in HAL and one other ecoregion), the goal was set at Level 3, with four subsection groups. For the more widely distributed Widespread and Peripheral communities, the stratification level was Level 2, occurrences distributed in both glaciated and non-glaciated subsections. Level 1 with occurrences anywhere in the ecoregion is limited to those widespread or peripheral communities that only occur in either the glaciated or non-glaciated parts of HAL. Within these stratification units, the number of occurrences was set at four per unit for large patch and linear communities and five per unit for small patch communities (Table NC-3).

Table NC-3. Minimum conservation goals for HAL natural communities as a function of patch size and rangewide distribution of the type.

		Patch Size	
Rangewide Distribution	**Minimum Stratification (Level)**	**Large or Linear (4)**	**Small (5)**
Restricted	4 (5 groups of subsections)	20	25
Limited	3 (4 groups of subsections)	16	20
Widespread	2 (2 groups of subsections)	4*	5*
Peripheral	2 (2 groups of subsections)	4*	5*

* For Widespread and Peripheral associations the total ecoregional goal is 4 for Large Patch and 5 for Small Patch associations. If the association occurs in both glaciated and non glaciated parts of HAL, then these occurrences must be distributed in both units.

The combination of stratification levels across the ecoregion and minimum number of occurrences per section produces a set of numerical conservation goals for natural community targets in HAL that ranges from four to 25 (Table NC-3).

Results: Summary of HAL Natural Community Portfolio by Group

Of the total of 509 Heritage natural community occurrences in the HAL database, 253, or 50%, were assessed as viable and included in the HAL portfolio. These Heritage element occurrence records represent 264 occurrences of NVC types. The number of occurrences of NVC types in HAL does not equal the number of element occurrences identified as viable and included in the portfolio because some documented Heritage occurrences consisted of multiple viable NVC associations. This was particularly true of black spruce bogs and dwarf shrub gobs, which are most often documented as complexes of NVC types. In those cases where data provided in the element occurrences record were detailed or where the staff ecologist personally knew the occurrence, all NVC types included at the site were included in the portfolio and counted toward community goals.

Fifty-nine NVC associations of the total of 109 are included in the portfolio. Ten NVC types had examples within the HAL database, but none of these occurrences were considered to be viable. Forty NVC types were not represented by any occurrences in the database. Eight Heritage community occurrences were included in the portfolio that could not be connected to a specific NVC association but were connected to a vegetation group.

Communities best represented in the portfolio include those that have been considered globally rare and the focus of Heritage surveys. These communities include bogs, fens, black spruce wetlands, ridgetops and rocky summits, and cliffs. Recent Heritage work has increased the numbers of some of the more common forest associations, particularly for deciduous forests which are dominant in HAL.

There are many groups that are very poorly represented in the portfolio that will require extensive additional field work to meet ecoregional goals. There are no occurrences of marshes and wet meadows or springs and seeps and very few occurrences of talus slope woodlands, floodplain forests, or the broad range of communities in HAL related to streams, rivers, lakes, and ponds.

Summary of results by NVC group

A summary of the success of capturing natural communities in the HAL portfolio by group is presented in Table NC-4 and below, with observations on inventory needs, likelihood of additional occurrences at other portfolio sites, and restoration potential.

Table NC-4. Assessment of HAL Portfolio for Natural Communities in relation to Goals by Group.

Group #	Group Name	# NVC types in HAL	#NVC types with EORs	Total # of Occurrences	Total # viable	Goal for Group	% of Goal Met
1	Bogs and Acid Fens	6	4	99	51	60	85
2	Calcareous Fens	8	5	30	10	110	5
3	Cliffs (not wooded)	2	1	9	5	10	50
4	Deciduous or Mixed Woodlands	3	2	10	7	65	11
5	Floodplain Forests and Rivershores	15	8	36	16	155	10
6	Marshes and Wet Meadows	5	4	7	0	24	0
7	Palustrine Forests and Woodlands	23	16	86	50	339	15
8	Ponds and Lakes	4	2	15	3	20	15
9	Ridgetops and Rocky Summits	13	11	46	34	169	20
10	Rivers and Streams	4	1	1	1	20	5
11	Seeps and Springs	1	0	0	0	5	0
12	Terrestrial Coniferous Forests	5	2	16	12	65	18
13	Terrestrial Deciduous Forests	12	6	33	27	114	54
14	Terrestrial Mixed Forests	8	6	18	13	65	20
	All NVC Types	109	68	416	264	1221	22

Group 1: Bogs and Acid Fens. 6 NVC Types. Goal: 60. Total in portfolio: 51 Progress: Good. Bogs and acid fens have been the target of many of the inventory projects in the glaciated portion of HAL. This is the southern limit of these communities and also the southern limit of several of the major species found in these Heritage communities. Most of the work to date has focused on the dwarf shrub bog aspect (NVC type 6225) of this assemblage. Most occurrences in the database are probably mosaics of several communities in this group and may also include examples of Group 7 Palustrine Forests and Woodlands, as well. There are undoubtedly many more examples of these communities within HAL. All of them will be in the glaciated part of the ecoregion, mainly in the Catskills and in eastern Pennsylvania. Some may remain in good condition even in very small patches. Surveys within matrix forest blocks should lead to additional occurrences for the portfolio. There is an excess of one dwarf shrub bog NVC association in the portfolio (Goal=5; Viable in the portfolio=27).

Group 2: Calcareous Fens. 8 NVC Types. Goal: 110. Total in portfolio: 10. Progress: Good- (the goals are highly inflated). The number of fens in HAL is limited by the low percentage of calcareous bedrock areas within the ecoregion. Within those areas in New York and New Jerseys where fens are found significant attention has been focused on the documentation and management of fens and fen-related communities. Viability has been a major concern for most fen occurrences. Because fens occur in alkaline environments, upland soils near fens are generally well suited for agriculture, row crops in areas with good soil development, and pastures in areas with thinner, rocky soil. Many fens are found in a generally agricultural landscape. Some have cornfields at the upland edge. Cows are often grazing in wetlands on alkaline soil in plant communities that might be good fens with fewer disturbances. Despite considerable nearby impacts, many of these fens have persisted for years without serious loss of native species diversity or invasion by weeds. There are likely very few additional fens to document with increased field work. Restoration may be possible in some areas. It may be difficult to reach the current goals set for these associations**.** The goals for this group are dramatically inflated by the limited and restricted distribution of some of these NVC types. While restoration may be possible at some sites to increase numbers of occurrences in the portfolio, the very limited extent of available habitat will restrict the possible number of occurrences. Additional work is also needed to connect currently documented occurrences to NVC types.

Group 3: Cliffs (not wooded). 2 NVC types. Goal: 10. Total in portfolio: 5. Progress: Good. With the exception of the Shawangunks, cliffs have received little attention in HAL. There are significant areas with cliffs in the Catskills, along the Shawangunk/Kittatinny Ridge, along the major rivers where shale deposits have been eroded, and along the steep cut valleys of the West Branch of the Susquehanna River. Elsewhere in HAL, despite moderate elevation hills, most slopes are gradually tapered without rock exposures. The diversity of cliffs within HAL has not been assessed well, mainly because these are sparsely vegetated areas and most inventory work has focused on forest and woodland communities in HAL. There are likely other NVC cliff types in HAL. Many more examples of good quality cliff communities will likely be found within the many matrix forest blocks with steeply sloped mountains, particularly in the Catskill and in north-central Pennsylvania.

Group 4: Deciduous or Mixed Woodlands. 3 NVC types. Goal: 65. Total in portfolio: 7. Progress: Poor. Most dry woodland communities are found on thin soils along upper slopes and on rocky summits. These NVC types are grouped together in Group 9: Ridgetops and Rocky Summits. This group in HAL is limited to talus slope woodlands and low elevation areas with poor, rocky soil. These community types are believed to exist throughout the ecoregion. These communities are not well understood in HAL in terms of vegetation types or distribution. Areas with woodrats or rattlesnakes probably support these types of communities. Many examples will be small patch in HAL and likely in good condition. Many matrix forest blocks likely support good examples of Deciduous or Mixed Woodlands.

Group 5: Floodplain Forests and Rivershores. 15 NVC types. Goal: 155. Total in Portfolio: 16. Progress: Poor. This is a broadly defined and poorly understood group in HAL. Floodplain Forests and Rivershore could easily be subdivided, since most of the rivershore communities are dry upland grass- and shrub-dominated open canopy communities that are associated with rivershore processes, particularly ice scour in the winter, and only slightly related to floodplain forest communities. Detailed work by the Heritage Programs in LNE and CAP has characterized most of the community types represented in this group. The distribution and composition of these associations in HAL are not well understood. To create goals for these types, a conservative estimate of distribution was used when there were incomplete data. It was assumed that the NVC types were at rarest "Limited" to HAL because these types were first described in other ecoregions. Many are probably Widespread. Floodplain forest work is planned in both NY and PA that will lead to a refinement of the NVC types in HAL, better distribution information, and new occurrences for the databases. It is likely that many of the NVC types described for Hal to date will be combined and rewritten leading to fewer overall types in the ecoregion. Because there are extensive networks of rivers and streams throughout HAL, there are also numerous floodplain forests. Most of the sites have, however, been altered dramatically because original floodplain forest sites provide ideal locations for agriculture or residential or commercial development. Virtually all of these areas in HAL have been cleared over times. Only a few have been allowed to revert to natural forest. Most of these occurrences are small. Floodplain forest types that were formerly large patch are probably extant only as small patches. Restoration will be needed to establish floodplain forest community examples at historical scales. However, little is known of biodiversity in these formerly extensive forests in HAL.

Group 6: Marshes and Wet Meadows. 5 NVC types. Goal: 24. Total in portfolio: 0. Progress: No progress. Marshes and wet meadows have not been the focus of any Heritage field work in HAL. Most of the marshes and wet meadows in HAL are successional and associated with floodplains, beaver activity, or human disturbance. These communities have received little conservation attention. The five NVC types are broadly defined. Additional field work on marshes and wet meadows associated with continued aquatic assessment will likely define new NVC types already known from other ecoregions.

Group 7: Palustrine Forests and Woodlands. 23 NVC types. Goal: 339. Total in portfolio: 50. Progress: Fair (considering goals are inflated) Palustrine forests and woodlands have not been well studied in HAL. Survey projects in LNE and CAP have identified numerous NVC types that may be present in HAL. After surveys within the ecoregion, it is probable that many NVC types in this group will be combined and rewritten. Goals for this group are highly inflated due to the high number of NVC types currently described in HAL and insufficient data to make an accurate assessment of distribution. Notable among these associations in HAL are Atlantic white cedar dominated communities that extend into the eastern portion of HAL and Northern white cedar communities that reach their southern limit in the calcareous part of the ecoregion. Many of the palustrine forest and woodlands in HAL have been filled or drained. Most occurrences are now present as small patch communities, which were previously larger. Many of the remnant examples are associated with the numerous rivers within the ecoregion. Surveys within matrix forest blocks should identify many of the best examples of these communities remaining in the ecoregion.

Group 8: Ponds and Lakes. 4 NVC types. Goal: 20. Total in portfolio: 3. Progress: Poor. Very little inventory work has been conducted in the ponds and lakes of HAL. Only two NVC types associated with these features have been identified. There are certainly many more associations within the ecoregion related to ponds and lakes. It is probable that none of these are unique to HAL, and that all are widespread and small patch. Little information has been compiled about important species associated with lakes and ponds in the ecoregion.

The southern limit of glaciation runs through HAL. The northern and eastern parts of the ecoregion were glaciated and have numerous ponds and lakes related to glacial landforms. Most large lakes, particularly in the Catskills, have been modified with dams and are either reservoirs or flood control features. The unglaciated portion of HAL in the southwest have very few natural ponds and lakes.

Group 9: Ridgetops and Rocky Summits. 13 NVC types. Goal: 169. Total in portfolio: 34. Progress: Good (goals are inflated). The eastern sections of HAL support numerous hills and ridges with open canopy communities. Many of these summits are in good condition and support unusual species and communities. Several ridgetop communities that have been identified as globally rare have been well surveyed. A general rocky summit inventory effort was undertaken in New York that added numerous occurrences in the eastern part of HAL to the database. There are fewer open canopy rocky summit community occurrences in the non glaciated southwestern part of the ecoregion. Better distribution information about these communities is likely to indicate limitation to the range of these association in HAL and will reduce general goals for this group. It is also likely that for some of these associations, all occurrences have been documented and that goals for these community types will need to be adjusted to reflect natural distribution and abundance. Restoration is not like to play a major role in the establishment of new occurrences although fire management is needed in several types that have been fire-suppressed for many years.

Group 10: Rivers and Streams. 4 NVC types. Goal: 20. Total in portfolio: 1. Progress: No progress. This group refers to vegetated areas within rivers and streams and the palustrine graminoid/herbaceous borders of rivers and streams. The numerous rivers and streams in HAL have not been inventoried at all for natural communities, except for the more upland types of communities associated with flooding and ice scour. These communities appear in Group 5: Floodplain forest and rivershores. There are many occurrences of emergent vegetation in shallow, slow moving sections of streams and rivers, and many instream aquatic community occurrences dominated by plants. These need additional assessment in terms of the NVC and documentation of occurrences. Most of these occurrences will be small patch, but there may be some large patch occurrences associated with slow moving, shallow sections of the major rivers.

Group 11: Seeps and Springs. 1 NVC type. Goal: 5. Total in portfolio: 0. Progress: No progress. Seeps and springs occur as small patch communities throughout HAL. No inventories have been conducted in these communities to date. The related communities associated with waterfalls have also not been documented, although Pennsylvania carried occurrences of waterfalls as a physical feature in the database and has begun an NVC assessment of these small patch communities. Good examples should be found in the matrix forest blocks identified in HAL.

Group 12: Terrestrial Coniferous Forests. 5 NVC types. Goal: 65. Number in portfolio: 12. Progress: Fair. Terrestrial conifer-dominated forests occur mainly at high elevations and in the eastern part of HAL. There have been detailed surveys of the spruce-fir forest of the Catskills, but fewer surveys of the pine and hemlock forests scattered along ravines throughout the Catskills and in other steep terrain in the eastern parts of HAL and on the steep slopes along the West Branch of the Susquehanna River. Past logging has significantly altered many of these forests. More recently, effects of the wooly adelgid have decimated some hemlock stands. The wooly adelgid currently occurs in the southeast and eastern sections of the ecoregion, but has not yet advanced into central Pennsylvania and western New York, where hemlocks are more scattered. Additional inventory work in matrix forest blocks will result in many new occurrences for the portfolio. The Pine-hemlock forest (6328) is probably no longer present as a large patch community over much of its range in HAL.

Group 13: Terrestrial Deciduous Forests. 12 NVC types. Goal: 114. Number in portfolio: 20. Progress: Fair. Terrestrial deciduous forests dominate much of the remaining natural areas of HAL. All the current matrix forest types are in this group. Because the initial focus of Heritage Programs was on globally rare natural communities, few terrestrial deciduous forests have been inventoried until recently. These forest have also been significantly altered by excessive logging, management for particular species, notably cherry and oak, forest pathogens, and severe deer browse. Chestnuts were once dominant in several of these community types and are now nearly absent. Beech has declined severely as a result of beach bark disease. Gypsy moths have reduced oak dominance locally and even killed trees over some large areas. Many forest occurrences in HAL have a continuous canopy, but lack much of the diversity of the former forest communities. Restoration of many of these associations may be necessary to reestablish some forest processes. Occurrences of most of these associations will be abundant within matrix forest blocks. Additional NVC types may be identified for this group. Some types may be combined and altered significantly with additional field work. In the statistics for this group, it is assumed that examples of all matrix forming associations will be found in selected matrix forest blocks.

Group 14: Terrestrial Mixed Forests. 8 NVC types. Goal: 65. Number in portfolio: 13. Progress: Fair. Terrestrial mixed forests, like Deciduous forests, are widespread and common in HAL. Because none of these associations are globally rare, only limited field work has been conducted to document these communities. These associations have also been severely altered from their condition prior to European settlement by selective logging, clearing for agriculture, forest pathogens, and excessive deer browse. Many occurrences of these associations will be found in matrix forest blocks. Many of these occurrences may be large, although significantly altered from their original compositions, structure and conditions.

Heritage occurrences not selected for the portfolio

From the combined Heritage state databases, 256 natural community occurrences were not included in the HAL portfolio.

There were a broad range of reasons why natural communities were not selected for the portfolio. Chief among these was that occurrences did not represent recognizable NVC associations. Occurrences of waterfalls and plunge pools and high gradient streams did not include any vegetation data. Nor in most cases did these occurrences include detailed condition information. Vernal pools were also not included, because within the NVC, vernal pools are generally very small and considered to be a part of the larger, usually forested, association in which they are located.

Many occurrences were eliminated because the data were very old. All occurrences with a LASTOBS (last observation) date before 1988 were questioned. If the ecologist in the state knew that the occurrence remained in good condition, the occurrences was included. If no additional data were available, the occurrences were not included, but annotated that the element occurrence record needs to be updated. These occurrences, particularly those with a high occurrence rank, should be the first investigated to add community occurrences to the HAL portfolio.

Some Heritage occurrences lacked sufficient detail to be able to distinguish the NVC association or in a few cases even whether the occurrence was a forest, woodland , or open canopy community. These were annotated and not included in the assessment.

Several occurrences were not included because their size was too small to meet the minimum standards of the NVC association. The concept of patch size for specific NVC associations is only recently developed and has not been included in some Heritage documentation. There are numerous occurrence of natural communities that, while highly recognizable as a vegetation unit, are no longer able to persist over time, because they are irreparable fragmented or otherwise compromised and lack necessary ongoing processes. Several occurrences of matrix forest communities were very small, some under 100 acres, and not capable of maintaining the diversity and processes necessary to capture the full range of biodiversity expected in a matrix forest example. Similarly, several very small large patch community examples were discarded from the portfolio. In many cases, particularly for floodplain forests and the upland forests that occur at sites suitable for agriculture or residential/commercial development, remnant examples are very small and lack sufficient extent to allow all necessary processes to occur to maintain the natural community long term. In many of these cases, it will be necessary to identify restoration sites, if these natural communities are to be included in the portfolio. Remnant occurrences may play an important role as a nucleus for these restoration efforts, but to date these occurrences have not been include in this portfolio without further assessment of their potential.

Many occurrences were eliminated from the portfolio because of poor landscape context. Landscape context has for many years been a major component of assessing the rank of a Heritage community occurrence. In general, low quality context diminishes a rank, but often has not eliminated the documentation of a recognizable occurrence. Following an initial assessment by each state ecologist, the community database was returned to the ecologist with the GIS landscape assessment of the 1000 acres surrounding each occurrences. The ecologists were asked to look again at those occurrences with a landscape context of "3," highly developed or "4," intensely developed. Many of these occurrences, particularly for large patch communities, were not included in the portfolio. Those occurrences with a low landscape context value that were included in the portfolio were generally small patch communities which are believed to be capable of persisting in very small areas because the processes needed to maintain the community are very local and not highly impacted by surrounding conditions.

Comments were recorded for all community occurrences that were not included in the portfolio and returned to the Heritage Programs. Of the 256 natural community occurrences in HAL that were not selected, 71 of these are labeled with a "?" in a column describing viability. All of these occurrences would benefit from additional assessment, usually including a field visit. This group of occurrences is one of the best sources of additional occurrences for the HAL portfolio to meet community goals.

Geographically, Heritage occurrences not included in the portfolio are found throughout the ecoregion with highest concentrations in central and western Pennsylvania, in the calcareous section of central New York, and at scattered small sites in the agricultural areas of central and western New York and Pennsylvania.

General observations about the HAL natural community assessment

Goals: Stratification and numerical goals for communities in HAL are based on having good information on global distribution and patch size for each NVC association. The HAL ecoregion occurs in parts of each of the three participating states that are not known well to the ecologists. Most of the data included on distribution and patch size are estimates. The link between state classifications and the NVC require new ways of looking at plant communities for many ecologists. Furthermore, most state ecologists are not familiar with the full range of associations outside their state. A conservative approach was used in calculating numerical goals from estimated patch size and distribution. Many of the associations in HAL are probably more widespread than noted. Additional refinement of the distribution of NVC associations is likely to reduce numerical goals for many groups.

The goals set for several NVC types are unrealistically high and should be modified downward to reflect the potential distribution of biodiversity in the ecoregion. For example, there are several small patch communities that are believed to be restricted to HAL. These are particularly rare communities and it is important that the HAL portfolio recognize their relative importance within the ecoregion. In many cases, there is, however, very limited available habitat of these communities. For example, the dwarf pine community in the Shawangunks (NVC- 6079) is found only at this one site. It is described as a small patch restricted community with a goal of 25 occurrences in the ecoregion. There is only one occurrence in the portfolio and no other occurrences are reasonably expected to be found anywhere. There are other similar examples within the classification, particularly for the globally rare communities that have been well studied throughout their ranges. Numerical goals should be adjusted for these communities to reflect current occurrences and any potential occurrences that might benefit from restoration.

Additional field work is needed to meet goals for most communities in HAL. There is a significant opportunity to document many of these communities that are represented in the portfolio at levels below their goals by conducting field surveys associated with matrix forest blocks and aquatic systems conservation action. Most viable occurrences of communities in HAL will be associated with these areas and will benefit from conservation associated with other ecoregional targets.

The HAL NVC needs additional work that will further clarify goals. Many of the associations currently ascribed to HAL will be modified as the ecoregion becomes better known. Palustrine forests and woodlands and floodplain forests are poorly understood in the ecoregion. All HAL NVC types in these groups were first described from other ecoregions and believed to extend into HAL. More detailed work on these groups in HAL should define fewer NVC types and clarify what appears to be a proliferation of wetland types resulting from a series of projects in neighboring ecoregions. It is likely that the 38 NVC types in these two groups can be combined into far fewer associations and descriptions effectively broadened to create a more even approach to these communities. Many of the occurrences of these communities are highly altered by filling, changes in hydrology, or past land use. Restoration is likely to be an important tool in capturing the biodiversity in these communities at their former scale.

Other communities poorly understood in the HAL classification include cliffs, talus slope woodlands, and the full range of non-forested communities associated with the many rivers and streams in HAL.

Next Steps for Natural Communities in HAL

1. Continue to refine the HAL NVC.
2. Continue inventory work on HAL associations, particularly focusing on poorly understood groups.
3. Continue to make connections between NVC associations and the physical features associated with ELUs.
4. Create more usable versions of the HAL NVC that can become a part of standard Heritage documentation and TNC conservation action.
5. Create more efficient crosswalks between state classifications and the NVC, leading to the connection of all documented Heritage natural communities to NVC associations.
6. Encourage and enable the Heritage programs to update their natural community databases with information collected during this ecoregional planning process. Maintain the connections between field assessment of HAL portfolio sites and Heritage documentation.

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:

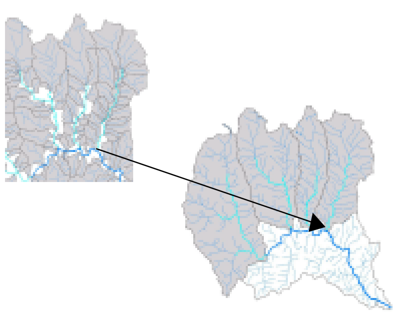
Table 1: Generalized Stream Size and Community Relationships

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.

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[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.

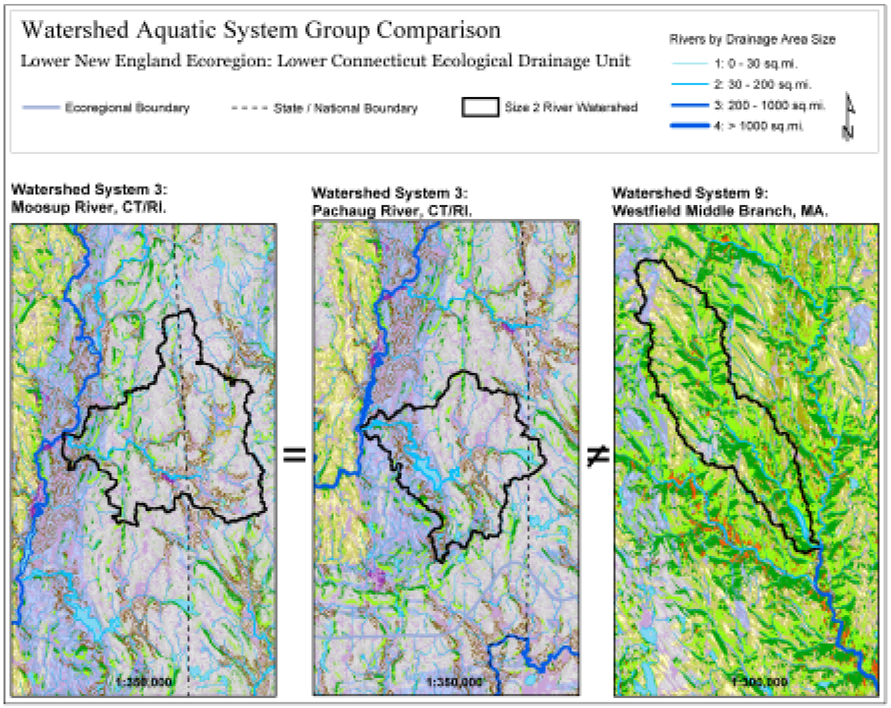

Figure 2: Watershed Aquatic System Group Comparison

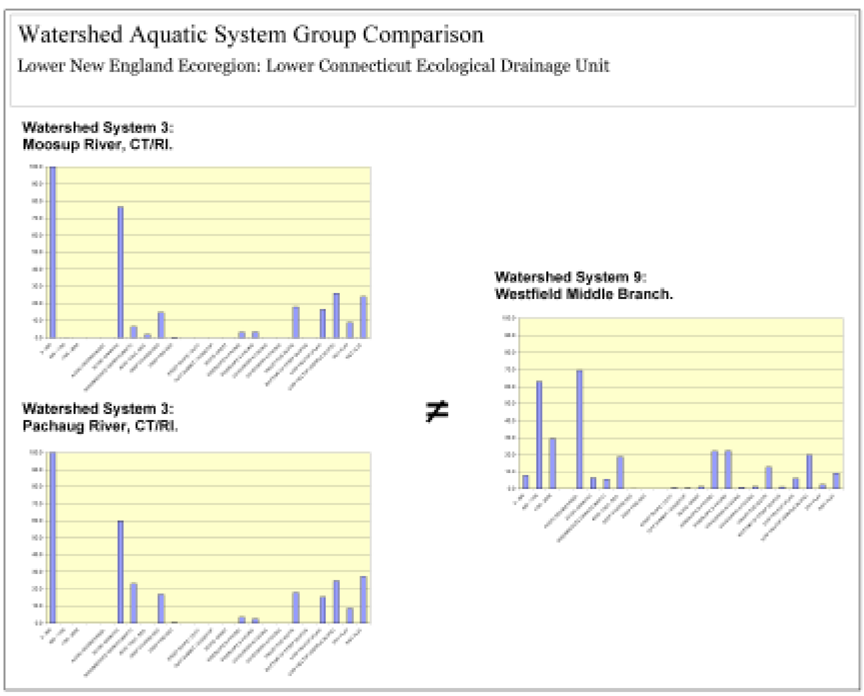

Figure 3: Watershed Aquatic System Component Summary

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

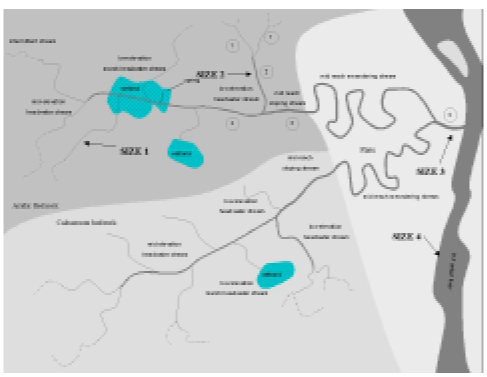

Figure 4: Anatomy of a Stream Network Macrohabitat Model

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

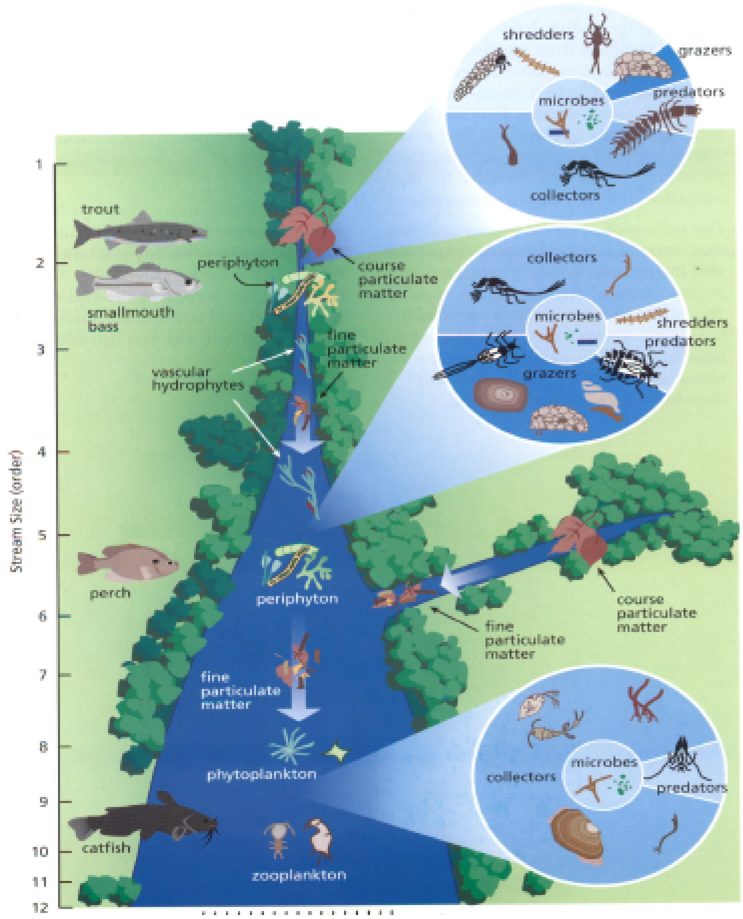

Figure 1: River Continuum in Size

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:

RESULTS FOR AQUATIC SYSTEMS AND SPECIES[*]

The HAL aquatics analysis did not deviate from the standard methodology documented in Olivero et al (2003)[1]. In fact, the hard work of the HAL aquatics assessment team significantly contributed to the formulation of this standard methodology for aquatic ecoregional assessments in the Northeast.

Major Rivers Within HAL

Allegheny River – The Allegheny River drains much of the region west of the Appalachians then flows westward to join the Mississippi. The river flows 325 miles and drains 11,778 square miles, flowing north from its source near Coudersport, PA, through Olean, NY, before turning south and entering the huge Allegheny Reservoir on the Pennsylvania/New York border. Below the reservoir, the river flows another 200 miles before it joins the Monongahela River in Pittsburgh to form the Ohio River, which empties into the Mississippi and eventually flows into the Gulf of Mexico below New Orleans, Louisiana.

Nearly 72 percent of the Allegheny River watershed is covered in forest. Along its course the river and its tributaries cross through both glaciated and unglaciated landforms. This journey gives the river much of its unique physical and biological characteristics. The Allegheny River also passes through 22 counties, 2 states, the Allegheny National Forest, Allegany State Forest (NY), thousands of acres of state game lands, and 85-miles of Allegheny National Wild and Scenic River corridor.

*Delaware Rive*r – The Delaware is the longest undammed river east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, New York to the mouth of the Delaware Bay. Along its course, 216 tributaries feed the river, the largest being the Schuylkill and Lehigh Rivers in southeastern Pennsylvania. In all, the basin contains 13, 539 square miles, draining parts of Pennsylvania (6, 422 square miles or 50.3%); New York (2,3,62 square miles, 18.5%); New Jersey (2,969 square miles, or 23.3%) and Delaware (1,002 square miles, 7.9%).

Over 17 million people rely on the waters of the Delaware River Basin for drinking and industrial use and the Delaware Bay is but a day's drive away for about 40 percent of the people living in the United States. Yet the basin drains only four-tenths of one percent of the total land area of the continental United States. Three reaches of the Delaware have been included in the National Wild and Scenic Rivers System resulting in nearly three-quarters of the non-tidal Delaware River being included in the NWSRS (73 miles from Hancock, NY to Milrift, PA; 40 miles from Port Jervis, NY to Stroudsburg, PA and 65 miles from Delaware Water Gap, PA to Washington, Crossing, PA).

Susquehanna River – The Susquehanna River drains 27, 510 miles, covering half the land area of Pennsylvania and portions of New York and Maryland. The river flows 444 miles from its headwaters at Otsego Lake near Cooperstown, New York to Havre de Grace, Maryland, where

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[*] Schuler, G. (author) and Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for aquatic systems and species. Based on Zaremba, R.E. 2002. High Allegheny Plateau Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast and Caribbean Division, Boston, MA.

[1] See the chapter on standard methods for aquatics: 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 river meets the Chesapeake Bay. The Susquehanna represents the longest commercially non-navigable river in North America. It is also the largest river lying entirely in the United States that drains into the Atlantic Ocean (the river is nearly one mile wide at Harrisburg, PA).

Despite the fact that nearly 60% of the Susquehanna River Basin is forested the basin is one of the most flood-prone watersheds in the entire nation. Since the early 1800s, the main stem of the Susquehanna has flooded every 20 years, on average. Even the Native Americans who once lived in the area told of frequent floods.

The Susquehanna River comprises 43% of the Chesapeake Bay's drainage area and represents the largest tributary of the Chesapeake Bay, providing 90 percent of the freshwater flows to the upper half of the bay and 50 percent overall.

Selecting Ecoregional Targets

Developing Ecological Drainage Units (EDU)

Ecological Drainage Units (EDUs) are groups of watersheds (8-digit catalog units as defined by USGS) that share a common zoogeographic history and physiographic and climatic characteristics. It is expected that each EDU will contain sets of aquatic system types with similar patterns of drainage density, gradient, hydrologic characteristics, and connectivity. In the United States, ecoregional planning teams have defined EDUs based on two main sources of information: zoogeography from Hocutt and Wiley, World Wildlife Fund's aquatic ecoregions, and the US Forest Service; and ecoregional section and subsection attributes defined by the US Forest Service. Identifying and describing EDUs allows us to stratify ecoregions into smaller units so ecoregional planning teams can better evaluate patterns of aquatic community diversity. Furthermore, EDUs provide a means to stratify the ecoregion to set conservation goals.[2]

Within HAL, four Ecological Drainage Units (EDUs) were identified from east to west as follows: Upper Delaware, Upper Susquehanna, Western Susquehanna, and Upper Allegheny. Portions of 3 other EDUs cross into HAL but the HAL ecoregional planning team anticipates that these EDUs, which are mostly contained within neighboring ecoregions, will be included in the planning efforts for the appropriate ecoregion.

Species targets

The aquatic species targets for HAL were selected according to criteria established by the appropriate ecoregional planning sub-team. These criteria prioritized imperiled, endemic and declining species - those that warrant urgent attention. Species location information was obtained primarily from the Natural Heritage Program databases with additional information about fish coming from state fisheries databases and NatureServe's *Summary of National Fish Distribution by 8-digit Watershed.* The identification of regional- and intermediate-scale fish species targets (see Tables 1 and 2) is hoped to compliment data on imperiled, endemic and declining species and assure that common species are also captured in the ecoregional portfolio.

Table 1. Regional-Scale Fish Species Found In HAL

Regional Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Upper Allegheny EDU*	*Western Susquehanna EDU*

[2] Bryer and Smith, 2001.

Alewife	✔	✔		
American eel	✔	✔	✔	✔
American shad	✔	✔		
Sea lamprey	✔	✔		
Striped bass	✔			

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*

Table 2. Intermediate-Scale Fish Species Found In HAL

Intermediate Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Western Susquehanna EDU*	*Upper Allegheny EDU*
Brook Trout	✔	✔	✔	✔
Creek chubsucker	✔	✔	✔	
Gizzard shad	✔			
White sucker	✔	✔	✔	✔
River redhorse				✔
Paddlefish				✔

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*
Note: incomplete/DRAFT list requires review.

Coarse filter targets

Developing Aquatic Ecological Systems (AES) – Within HAL no freshwater community or ecosystem classification existed before The Nature Conservancy's ecoregional planning effort. The Nature Conservancy's Eastern Resources Office, with assistance from TNC's Freshwater Initiative and members of the HAL aquatic planning team, developed coarse-filter ecological system targets using a classification framework derived from ERO's Ecological Land Unit (ELU) analysis and the Freshwater Initiative's hierarchical approach. This multi-scale, landscape-based classification framework for freshwater ecosystems is based upon hierarchy theory, and several key principles of and empirical studies in freshwater ecology.[3] This GIS based platform, allowed the partitioning and mapping of environmental patterns from the stream reach to regional basins that strongly influence the distribution of freshwater biodiversity.

Aquatic Ecological Systems serve as a more general classification and stratification level for ecoregional planning purposes than The Nature Conservancy's stream reach macrohabitat classification. Aquatic Ecological Systems (AES) are defined as dynamic spatial assemblages of aquatic ecological communities that occur together in an aquatic landscape with similar geomorphological patterns, are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains) or environmental gradients (e.g., temperature, chemical and habitat volume), and form a robust, cohesive and distinguishable unit on a hydrography map. The Nature Conservancy's Eastern Resource Office, with assistance from other Conservancy staff and partners, identified AES within each Ecological Drainage Unit by developing a coarse-scale classification of riverine and lacustrine environments based on biophysical GIS data. This classification unit is intended to represent different aquatic environmental settings and serves to provide stratification across an Ecological Drainage Unit. Different aquatic communities are expected to currently occur or develop over evolutionary time within each system given the

[3] See Methods chapter and Bryer and Smith, 2001.

different environmental setting of each AES. AES thus serve as coarse filters for representation and conservation of all current and potential aquatic species and communities in the ecoregion.

In each HAL Ecological Drainage Unit, the Eastern Resource Office developed AES for size 1, 2, and 3 streams and rivers. Stream sizes are based on size classes developed for ERO's macrohabitat classification that provided the lowest level of detailed reach specific classification.

Setting Conservation Goals

The Nature Conservancy's assumption is that the conservation of multiple examples of each aquatic species target stratified across its geographic range is necessary to capture the variability of the target and its environment and to provide replication to insure persistence in the face of environmental stochasticity and the likely effects of climate change. The HAL aquatic planning team placed most of its efforts towards developing goals for the ecoregion's AES. Goals for species and natural communities, mostly based on data from the Association for Biodiversity Information and the PA and NY Natural Heritage Programs, were developed by the appropriate HAL plant, animal or natural community teams.

Goals for ecoregional planning can be divided into two categories – numeric goals and design goals. Numeric goals address issues of abundance and distribution of biological diversity. Design goals address issues of portfolio design.

> *Distribution Goals Objective:* Capture multiple occurrences of each aquatic ecological system within each Ecological Drainage Unit to ensure representative conservation of biodiversity.
>
> *Abundance Goals Objective:* Capture "sufficient" redundancy of ecological system types within each EDU. Redundancy of the EDUs at the scale of the ecoregion is irrelevant since each EDU considered independent and non-replicable.
>
> *Design Goals Objective:* Create a functional network of hydrologically connected aquatic ecological systems and other elements of biodiversity to ensure representative and functional conservation areas within *and across* terrestrial-based ecoregions.

Distribution goals

Aquatic ecological systems should capture "adequate representation" of macrohabitat types across major environmental gradients at the Ecological Drainage Unit level. The HAL aquatics planning team agreed upon the recommendation that the portfolio should contain macrohabitat types representing 100% of the following major environmental gradients at the EDU level: (1) elevation, (2) landform and (3) geology.

Abundance goals

Abundance goals for HAL aquatics are intended to capture multiple examples of each aquatic ecological system type within each EDU. The number of examples is determined by the relative increase in probability of environmental or stochastic events reducing the ecological integrity of these system types. As system size decreases, the number of replicates needed increases. Since no data or guidelines exist to inform the number of replicates needed, a conservative approach was taken – increasing by a single unit per level. See Table 3 for abundance (numeric) goals for HAL aquatic ecological systems.

Table 3. Abundance Goals for HAL Aquatic Ecological Systems.

Aquatic Ecological System Type	*Goal per EDU*
Headwater streams (size 1 system types)	Minimum of 3 examples per system type per EDU
Medium-sized tributaries (size 2 system types)	Minimum of 2 examples per system type per EDU
Small rivers (size 3 system types)	Minimum of 1 example per system type per EDU
Large rivers (size 4 system types)	1 per EDU

Design goals

The primary criteria driving the design goal for the HAL aquatic portfolio is to provide the best examples of connectivity for regional-scale fish species (Table 4) known to occur in each EDU. The goal will be to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU where each of the regional-scale fish species has current or historic distribution.

Table 4. Regional Scale Fish Species Found in HAL

Regional Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Upper Allegheny EDU*	*Western Susquehanna EDU*
Alewife	✔	✔		
American eel	✔	✔	✔	✔
American shad	✔	✔		
Sea lamprey	✔	✔		
Striped bass	✔			

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*

A secondary criterion driving the design goal for the HAL aquatic portfolio is to provide the best pattern of connectivity for intermediate-scale fish species which occur in systems size 2, 3 and 1 systems. The goal will be to provide at least one connected suite of aquatic ecological systems within each EDU. See Table 5 for HAL intermediate scale species

Table 5. Intermediate Scale Fish Species Found in HAL

Intermediate Scale Fish Species	*Upper Delaware EDU*	*Upper Susquehanna EDU*	*Western Susquehanna EDU*	*Upper Allegheny EDU*
Brook Trout	✔	✔	✔	✔
Creek chubsucker	✔	✔	✔	
Gizzard shad	✔			
White sucker	✔	✔	✔	✔
River redhorse				✔
Paddlefish				✔

**Source: Summary of National Fish Distribution by 8-digit Watershed. Larry Masters, ABI.*
Note: *incomplete/DRAFT list requires review.*

Assessing Viability

Conservation targets are elements of biological diversity that are considered important for conservation. Conservation targets can occur at multiple levels of biological organization – including species, natural communities, and ecological systems. One of the most significant challenges to planning teams posed by aquatic conservation targets is the need for a more standardized language and methodology for describing non species-level aquatic conservation targets and their status. In particular, it has been especially challenging to develop an effective and credible method for estimating their viability (i.e., the probability of persistence over the long term).

Previously, assessing the viability of aquatic species (or the ecological integrity of communities and/or ecological systems), has presented unique challenges to ecoregional planning teams. Teams have often learned that their attempts to assess viability or integrity are little more than a screening process which they hope correlates with viability and/or integrity. Others have found, much more work is necessary to truly assess viability for a range of species, and there is little actual guidance on assessing the "viability" of communities and ecological systems. For now, The Conservancy is working on the assumption that through the use of informed estimates, our attempts characterize the status of biodiversity will correlate closely with more comprehensive viability assessments when the necessary information and resources become available. However, conservation efforts must move forward with a methodology that will at least make progress in the direction of more credible status assessments that will be used in an effective manner to inform our planning process.

Expert derived data

Use of external experts was a critical and necessary component of all HAL aquatic conservation assessments. To engage experts in a meaningful and effective manner, planning teams provided adequate direction and guidance to insure consistency and integrity in data collection. This was particularly critical in a) *defining* what is meant by the "status" of an occurrence, and b) *describing* the status of an occurrence so that the information can be used to "screen" conservation targets in order to set priorities.

Although initially developed by The Conservancy for terrestrial viability assessment, three useful descriptive categories have been used to describe and assess the status of conservation target occurrences at all scales: 1) size, 2) condition, and 3) landscape context. To do this effectively, descriptions of the varying status levels are required to set standards to minimize variability in interpretation among TNC and non-TNC staff and experts. The HAL aquatics planning team adopted a status assessment divided into four descriptive categories: "Very Good," "Good," "Fair," or "Poor." The team also developed general descriptions for each status rating to bring further consistency to the expert review process.

The Nature Conservancy publication titled "*The 5-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning*"[4] provided the HAL aquatic planning team with a good starting point for defining the status of conservation targets. The following definitions are based on this work, and have been modified slightly for an aquatic focus.

Size – a measure of the area or abundance of the conservation target's occurrence.

- *For animal and plant species* size is the area of occupancy and/or the number of individuals in a population.
- *For ecological systems and natural communities* size is the patch size or geographic coverage. Assessments of size for natural communities and ecological systems should consider the area necessary to maintain the functionality of dominant ecological

[4] The 3rd edition of this publication can be found in http://www.conserveonline.org/2000/11/b/en/5-SVOL1.pdf.

processes considered in "Landscape Context," the area required to maintain area-sensitive species identified as key factors under "Condition," as well as the Minimum Dynamic Area of the target. The *Minimum Dynamic Area* is the size of the area needed for a conservation target to recover from natural disturbances, such as a hurricane, fire, or flood.

Size (roughly analogous to stream length) is the component with the weakest applicability in aquatic systems. It is useful to think of size in aquatic systems or communities in terms of the species-specific life history needs known to occur in these areas. For example, consider if headwater streams of a given system are large enough to conserve ample spawning habitat for trout, or are side channel wetlands large and numerous enough to support adequate annual recruitment of sturgeon nursery stock.

Condition – a measure of the biological composition, structure, and biotic interactions that characterize the target. This includes factors such as:

- Reproduction, dispersal, and age structure of specific populations of concern.
- Biological composition (e.g., presence of native versus exotic species, presence of various habitat/abiotic community types within a system).
- Structure (e.g., habitat composition – pool-riffle-run, substrate diversity, sediment load, bank erosion, riparian canopy, groundcover, etc.)
- Biotic interactions (e.g., competition, herbivory, predation, and disease).

Condition information from experts can be broken into two general categories: information on map-based assessment and information not accessible through map-based assessment. For example, a watershed condition analysis is provided to planning teams. This remotely-assessed, map-based approach requires substantial ground-truthing to be useful and effective. As is the case with most assessments of this nature, it is expected that such an assessment will work well for some systems and not for others. Expert input is needed to validate, and correct, this initial draft condition assessment.

In addition, it is known that some factors can dramatically alter condition assessments such as the degree of invasive species contamination, current condition or management of dams, extent of harvesting impacts from fisheries management, and the extent of pollution from non-point sources. Information on these topics is important to collect during expert review.

Landscape context – an integrated measure of two factors:

- *Dominant ecological processes and environmental regimes* that establish and maintain the target occurrence (e.g., hydrologic and water chemistry regimes, geomorphic processes, climatic regimes, fire regimes all within their natural ranges of variation and distribution)
- *Connectivity* that includes such factors as species having access to habitats/ resources needed for life cycle completion, fragmentation of ecological communities and systems, and the ability of any target to respond to environmental change through dispersal, migration, or re-colonization.

Of particular importance is consideration of the natural flow regime and its role in assessing the viability of many larger, impacted river systems. Even if formal analysis have not been performed (e.g., Index of Hydrologic Assessment (IHA) analyses), teams should consider how the hydrologic regime of aquatic systems has changed over time.

In addition, the influence of connectivity on the mobility of aquatic species is a topic that merits special consideration in any status assessment of aquatic systems. Barriers to movement (e.g., dams, inadequate water flow conditions), or impediments to habitat occupancy or passage (e.g., poor water quality or unsuitable physical habitat) should be taken into consideration when evaluating aquatic regions for viability. This is further complicated by the fact that many species have differing habitat or passage requirements depending on varying life history stages.

Furthermore, the HAL aquatics planning team also considered the following guidelines while working with TNC and non-TNC staff to evaluate the status of conservation targets:

- degree of habitat fragmentation of a community or system;
- degree of exotic or invasive species;
- extent of habitat conversion or long-term human disturbance;
- whether natural disturbance regimes are intact – especially seasonal or annual flooding and drought;
- proximity of other conservation sites or managed areas to a potential conservation site for a community or system;
- connectivity of community to other areas of natural habitat;
- watershed land use patterns that may effect the stream reach.

GIS aquatic condition analysis

The HAL assessment of viability also included a GIS condition analysis performed by the Eastern Resource Office. Such condition analysis for watersheds and stream reaches is a subject of considerable ongoing research. ERO developed a set of attributes for watersheds that facilitated a rapid assessment of watersheds in terms of their general potential aquatic condition. This condition analysis used 22 variables related to land cover, roads, dams, and point sources to calculate the overall condition for each size 1, size2, and size 3 watershed.
The variables are listed as follows:

Watershed % Natural (forested, shrubland, wetland)	Watershed % Total Agriculture
Watershed % Hay/Pasture	Watershed % Row Crops
Watershed % Developed	Watershed % Impervious Surface (derived from land cover, see data sources)
100m Stream Buffer: % Natural	100m Stream Buffer: Impervious
Watershed: % Managed Land	# Road/stream Crossings/stream mile
Miles of Roads/ watershed square miles	100m Stream Buffer: Miles of Roads/Miles of Streams
Total # Dams	# of Dams > 20ft or stores > 1000 acre/feet
Maximum Dam Height	Maximum Dam Storage in acre/feet
# Dams/Miles of Stream	Dam Storage in Acre/Feet / Stream Miles
# Drinking Water Supplies (DWS)	Total Population Served by DWS
# DWS / Stream Miles	DWS Population Served/Stream Miles

Total Point Sources (CERCLIS, IFD, PCS, TRI, MINES) # CERCLIS (Superfund)/Stream Mile # Mines / Stream Mile # TRI / Stream Mile	Total BASINS Point Sources/Stream Mile # Industrial Facilities Discharge/Stream Mile # PCS / Stream Mile

This condition analysis highlighted general areas of potential high condition for aquatic systems for use by the HAL planning team and non-TNC experts.

Portfolio Assembly

For the HAL aquatic assembly process, the *connectivity* of an aquatic ecological system occurrence was based on the presence of physical barriers to migration for both regional and intermediate-scale fish species. Each occurrence selected through the assembly process was categorized as either Priority 1 or Priority 2.

Priority 1**:** Priority 1 occurrences are in the portfolio. They are expert recommended systems that fall within the optimal condition analysis (% natural cover, road density, dams). Priority 1 occurrences count towards meeting ecoregional goals and can include “extra” occurrences which exceed goals).

Priority 2: Priority 2 occurrences are only *conditionally* in the portfolio. Priority 2 occurrences require more evaluation before being included in the portfolio as a Priority 1 occurrence. Priority 2 occurrences do not count towards meeting ecoregional goals.

The HAL aquatic assembly process was designed to provide connected networks of AES within each EDU. Connectivity was included at several scales for both the regional-scale and intermediate-scale fish species found within each EDU and across HAL. Since only one example of size 4 systems existed in each EDU each of these occurrences was automatically included in the portfolio, at least as a Priority 2 occurrence within its respective EDU.

The HAL aquatic planning team has highest confidence in the Priority 1 occurrences since they were established using a combination of best available expert information; available biological data sets, NHP information and GIS condition analysis. The HAL aquatic planning team strongly urges TNC Operating Units, partner organization and agencies to further gather and evaluate expert information and empirical and remote sensing data for Priority 2 occurrences. Further evaluation, in some cases, may result in a change in status for these occurrences, elevating them to Priority 1, or eliminating them from the portfolio altogether. It is the recommendation of the HAL aquatic planning team that there must be further rigorous evaluation of all Priority 2 occurrences before any decisions regarding conservation action or ecoregional goals are made.

Portfolio Results

Fine-filter targets: Species

Table 6. Fish Species Targets (Natural Heritage Program Data)

Scientific Name	Common Name	Distri-bution	Global Rank	HAL Goal	# Of EORs	# Viable EORs in HAL	Numeric Goal Met?
Etheostoma maculatum	Spotted Darter	L	G2	10	2	2	N
Etheostoma Tippecanoe	Tippecanoe Darter	L	G3	10	5	5	N
Ichthyomyzon bdellium	Ohio Lamprey	P	G3G4	5	15	9	Y
Ichthyomyzon greeleyi	Mountain Brook Lamprey	P	G3G4	5	5	0	N
Noturus stigmosus	Northern Madtom	W	G3	5	1	1	N
Percina macrocephala	Longhead Darter	W	G3	5	10	10	Y
Total					**38**	**27**	

Table 7. Invertebrate Species Targets (Natural Heritage Program Data)

Scientific Name	Common Name	Distri-bution	Global Rank	HAL Goal	# OF EO Records	# Viable EORs	Numeric Goal Met?
Alasmidonta heterodon	Dwarf wedgemussel	W	G1G2	5	8	8	Y
Alasmidonta varicosa	Brook floater	W	G3	5	8	7	Y
Cheumatopsyche helma	Helma's Net-Spinning Caddisfly	P	G1G3	5	1	1	N
Cicindela ancocisconensis	A Tiger Beetle	W	G3	5	3	3	N
Cicindela marginipennis	Cobblestone Tiger Beetle	W	G2G3	5	3	3	N
Enallagma laterale	New England Bluet	P	G3	5	3	2	N
Epioblasma torulosa rangiana	Nothern Riffleshell	L	G2T2	10	3	3	N
Gomphus quadricolor	Rapids Clubtail	W	G3G4	5	2	2	N
Gomphus septima	Septima's Clubtail	R	G2	20	0	0	N
Gomphus viridifrons	Green-faced Clubtail	W	G3	5	11	11	Y
Lasmigona subviridis	Green Floater	W	G3	5	27	7	Y
Ophiogomphus	Extra-Striped	W	G3	5	3	3	N

anomalus	Snaketail						
Ophiogomphus howei	Pygmy Snaketail	W	G3	5	1	1	N
Pleurobema clava	Clubshell	P	G4	5	3	3	N
Villosa fabalis	Rayed Bean	W	G1G2	5	1	1	N
Total					**77**	**55**	

Coarse-filter targets: Aquatic ecological systems

Abundance Goals: There are a total of 22, 098 miles of streams represented in size 1, 2, 3 and 4 systems in the four High Allegheny Plateau Ecological Drainage Units included in this plan. Table 8 shows the number of selected occurrences for each size system and the corresponding number of stream miles.

Table 8. Summary of Occurrences Selected for the four major EDUs by System Type.

Size and type	# Priority 1 Occurrences Selected	Miles	# Priority 2 Occurrences Selected	Miles	Total # of Priority 1 and 2 Occurrences	Total miles
All size 1	36	1834	19	721	55	2555
All size 2	39	520	40	435	79	913
All size 3	15	441	10	162	25	603
All size 4	3	468	0	0	3	468
TOTAL	**93**	**3263**	**69**	**1318**	**162**	**4581**

The High Allegheny Plateau selection process identified 3,263 out of 22, 098 total miles of stream as Priority 1 aquatic system occurrences across the four major EDUs within the ecoregion (Tables 8 and 9).

Distribution Goals: One note, while an analysis has been done for each EDU with regards to the abundance and design goals none has yet been done for the distribution goal. Further analysis should be completed for Priority 1 and 2 occurrences to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) at the Ecological Drainage Unit level are captured by selected occurrences. The distribution goal for HAL is to capture macrohabitat types representing 100% of the major environmental gradients.

Design Goals: At least one connected suite of aquatic ecological systems (system sizes 4 through 1) was developed in each of the four ecological drainage units analyzed for the High Allegheny Plateau, to provide connectivity to each of the best examples of each system type for the appropriate regional-scale and intermediate fish species with current or historic distribution in that EDU.

The size 4 system in the Western Susquehanna EDU was not included in the portfolio by the HAL team working to assemble the portfolio in that drainage. This however appears to be an oversight. All size 4 systems should be included in the portfolio at least as Priority 2 occurrences. It is recommended that the appropriate TNC OUs should evaluate the size 4 system occurrence of the Western Susquehanna as Priority 2 until more information is gathered regarding the system's viability/integrity and its eventual inclusion in the portfolio as a Priority 1 occurrence or complete elimination from the portfolio.

Table 9. Percentage of Total System Miles of Priority 1 Aquatic System Occurrences.

EDU Name	Size Class	Total Miles	Total Miles Selected As Priority 1 Systems	% Of total selected
Upper Allegheny	1	4132	449	11
Upper Susquehanna	1	9179	831	9
Upper Delaware	1	3091	170	5
Western Susquehanna	1	2578	384	15
Upper Allegheny	2	341	116	34
Upper Susquehanna	2	933	200	21
Upper Delaware	2	315	108	34
Western Susquehanna	2	192	96	50
Upper Allegheny	3	197	113	57
Upper Susquehanna	3	326	118	36
Upper Delaware	3	150	79	53
Western Susquehanna	3	146	131	90
Upper Allegheny	4	81	82	100
Upper Susquehanna	4	268	268	100
Upper Delaware	4	118	118	100
Western Susquehanna	4	53	0	0
TOTAL		**22098**	**3263**	

Upper Allegheny EDU

Abundance Goals: In the Allegheny River EDU numerical goals were met for only 7 of the 14 aquatic ecological system types found in the EDU. Table 10 illustrates how these goals were met, or not met, for each of the aquatic system types. Goals for most of the size 1 system types were not met. No Priority 1 occurrences were identified for two of the EDU's system types, system 2-13 and system 3-12.

Table 10. Aquatic System Priority 1 Occurrences for the Upper Allegheny EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	13	2	56	3	-1
1	14	1	174	3	-2
1	15	3	87	3	met
1	16	1	17	3	-2
1	17	1	115	3	-2
	Size 1 System Total		**449**		
2	16	2	46	2	met
2	17	2	29	2	met
2	18	2	8	2	met
2	19	4	33	2	+2
2	20	0	0	2	-2
	Size 2 System Total		**116**		

3	11	1	35	1	met
3	12	0	0	1	-1
3	13	1	78	1	met
	Size 3 System Total		**113**		
4		1	82	1	met
	Size 4 System Total		**82**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences in all but a few cases. Goals for all of size 2 and 3 systems can be met with the addition of Priority 2 occurrences (Table 11). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals. Even with the inclusion of all currently identified Priority 2 occurrences only one of the size 1 system types reaches its numeric goal. The shortage of viable occurrences of size 1 systems within the Allegheny River EDU represents a priority information gap and certainly requires further investigation and analysis to fill.

Table 11. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Allegheny EDU.

System Size	System Type	# Priority 2 Occurrences	Total Priority Occurrences (1 and 2)	HAL Goal	Status of Goal WITH Priority 2 Occurrences Included
1	13	0	2	3	-1
1	14	0	1	3	-2
1	15	0	3	3	met
1	16	1	2	3	-1
1	17	0	1	3	-2
	Size 1 System Total		**9**		
2	16	1	3	2	+1
2	17	2	4	2	+2
2	18	1	3	2	+1
2	19	0	4	2	+2
2	20	5	5	2	+3
	Size 2 System Total		**19**		
3	11	0	1	1	met
3	12	2	2	1	+1
3	13	0	1	1	met
	Size 3 System Total		**4**		
4			1	1	met
	Size 4 System Total		**1**		

Distribution Goals: The distribution goal analysis for AES in the Upper Allegheny EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Note: the distribution goal for HAL is to capture macrohabitat types representing 100% of the major environmental gradients within an EDU.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Allegheny EDU two 4-3-2-1 connected suites were constructed from Priority 1 streams which achieved design goals for the portfolio.

The connected networks include the:

- Allegheny River → Tionesta Cr./Coon Cr./Salmon Cr. drainage
- Upper Allegheny River → Potato Cr./Oswayo Cr./Johnson Cr. drainage

Unlike the Potato Creek sub-drainage, the Johnson and Oswayo Creek sub basins, however, did not have any size 1 systems selected either as Priority 1 or Priority 2 occurrences.

Table 12. Connected Suites w/in Upper Allegheny EDU which meet HAL design goals (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Allegheny	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Allegheny River → Tionesta Cr./Coon Cr./Salmon Cr.
		4-3-2-1	Yes	Upper Allegheny River → Potato Cr./Oswayo Cr./Johnson Cr.
Total	2			

A 4-3-2 connected suite was created from Priority 2 occurrences for the Oil Creek/Caldwell Creek sub drainage and the Brokenstraw Creek sub drainage. No size 1 systems were identified for either of these drainages. Pithole Creek, Little Valley Creek, Sandy Creek and East Sandy Creek all create 4-2 connected drainages in the lower portion of the Upper Allegheny River.

Table 13. Smaller connected suites and unconnected systems w/in Upper Allegheny EDU which meet HAL design goals (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Allegheny	(1) 4-3-2-1 suite/EDU	4-3-2	No	Allegheny River → Oil Creek/Caldwell Cr.
		4-3-2	No	Allegheny River → Brokenstraw Creek
		2-1	No	Bear Creek → Bear Cr. headwaters
		2	No	Tunungwant Creek
		2	No	Allegheny Portage Creek

The Bear Creek drainage represents a 2-1 connected suite of Priority 2 streams not connected to a size 3 or 4 system. Likewise, Tunungwant Creek and Allegheny Portage Creek represent Priority 2 size 2 systems not connected to any other aquatic systems.

Table 14. Priority 1 Occurrence Names in the Upper Allegheny EDU

Allegheny R	Hand Brook	Pithole Creek
Allender Run	Havens Run	Porky Run
Beaver Run	Hemlock Creek	Potato Creek
Beehunter Creek	Henderson Run	Prather Run
Blacksmith Run	Indian Run	Queen Creek
Bova Creek	Irish Brook	Red House Brook
Boyer Brook	Jacks Run	Red Mill Brook
Brewer Run	Jaybuck Run	Rice Brook
Caldwell Creek	Johnson Creek	Robbins Brook
Camp Run	Lick Run	Salmon Creek
Campbell Creek	Lyman Run	Schoolhouse Run
Carrollton Run	Marvin Creek	South Branch Cole Creek
Cherry Run	Marvin Creek	South Branch Tionesta Creek
Coalbed Run	Middle Branch West Branch Cald	Taylor Field Branch
Cole Creek	Middle Hickory Creek	Three Bridge Run
Colegrove Brook	Mud Lick Run	Tionesta Creek
Coon Creek	North Branch Cole Creek	Tyler Brook
Daly Brook	North Branch Colegrove Brook	Walcott Brook
Dunderdale Creek	Olean Creek	West Branch Caldwell Creek
Dunham Run	Oswayo Creek	West Branch Potato Creek
East Hickory Creek	Penoke Run	West Pithole Creek
Golby Run	Pierce Brook	Wolf Run
Guiton Run	Pine Creek	Woodcock Run
Hamlin Run	Piney Run	

Table 15. Priority 2 Occurrence Names in the Upper Allegheny EDU

Allegheny Portage Creek	Maple Run
Bear Creek	Oil Creek
Bennett Brook	Pigeon Run
Bloody Run	Pine Creek
Brokenstraw Creek	Pine Run
Caldwell Creek	Pithole Creek
Crooked Run	Pole Road Run
Davidson Run	Red Lick Run
E Sandy Creek	Sandy Creek
Little Bear Creek	Shanty Run
Little Brokenstraw Creek	Spring Creek
Little Otter Creek	Tunungwant Creek
Little Valley Creek	West Branch Tunungwant Creek

Upper Delaware EDU

Abundance Goals: In the Upper Delaware ecological drainage unit numerical goals were met or exceeded for only 6 of the 12 aquatic ecological system types found in the EDU. Table 16 illustrates how these goals were met, exceeded or not met, for each of the aquatic system types in the EDU. For most of the size 1 system types goals were not met. No Priority 1 occurrences were identified for three of the EDU’s system types, 1-3, 2-2, and 3-2.

Table 16. Aquatic System Priority 1 Occurrences for the Upper Delaware EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	1	2	86	3	-1
1	2	2	9	3	-1
1	3	0	0	3	-3
1	4	3	75	3	met
	Size 1 System Total		**170**		
2	1	2	27	2	met
2	2	0	0	2	-2
2	3	1	36	2	-1
2	4	3	45	2	+1
	Size 2 System Total		**108**		
3	1	3	56	1	+2
3	2	0	0	1	-1
3	3	2	23	1	+1
	Size 3 System Total		**79**		
4		1	118	1	met
	Size 4 System Total		**118**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences in all but one instance. All of system size 1, 3 and 4 goals are met with the inclusion of Priority 2 occurrences (Table 17). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals. Even with the inclusion of all currently identified Priority 2 occurrences, system type 2-2 (system size 2, type 2) does not reach its numeric goal.

Table 17. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Delaware EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal WITH Priority 2 Occurrences Included
1	1	4	150	3	+1
1	2	4	66	3	+1
1	3	3	69	3	met
1	4	5	106	3	+2
	Size 1 System Total		**391**		
2	1	4	57	2	+2
2	2	1	9	2	-1
2	3	5	72	2	+3
2	4	6	72	2	+4
	Size 2 System Total		**210**		

3	1	3	56	1	+2
3	2	1	20	1	met
3	3	2	23	1	+1
	Size 3 System Total		**99**		
4		1	118	1	met
	Size 4 System Total		**118**		

Distribution Goals: The distribution goal analysis for AES in the Upper Delaware EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Delaware EDU two 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences which exceeds design goals for the portfolio (Table 18).

The connected networks included the:

- Delaware River → Neversink River → Bashakill Creek drainage
- Delaware River → E. Branch Delaware R. → Beaverkill River/Little Beaverkill drainage.

Table 18. Connected Suites w/in Upper Delaware EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Delaware	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Delaware River → Neversink River → Neversink R./Bashakill Cr.
		4-3-2-1	Yes	Delaware River → E. Branch Delaware R. → Beaverkill River/Little Beaverkill R.
		4-2-1	No	Delaware R. → Bushkill Cr. → headwaters
		4-2-1	No	Delaware R. → Flat Brook Cr. → headwaters
		4-3	No	Delaware R. → McMichael Cr.
Total	2			

The Broadhead Creek portion of the 4-3-2 Delaware River → Broadhead Creek connected suite listed in Table 19 is a Priority 2 occurrence. The size 3 system which connects Broadhead Creek to the Delaware River to create a potential 4-3-2-1 connected suite is a Priority 1 occurrence (McMichael Creek). The aquatic ecological systems within the Delaware River → Broadhead Creek drainage require more evaluation before including them in the portfolio as a connected suite.

Table 19. Connected suites and unconnected systems w/in Upper Delaware EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Delaware	(1) 4-3-2-1 suite/EDU	4-3-2	No	Delaware R. → Lackawaxan R. → Middle Cr.
		4-2-1	No	Delaware R. → Calicoon Cr.
		4-2-1	No	Delaware R. → Equinunk Cr.
		4-2	No	Delaware R. → Shohola Cr.
		4-2-1	No	Delaware R. → Pocono Cr.
		4-3-2*	No	Delaware R. → Broadhead Cr.
		2	No	Oquaga Cr.
		2-1	No	Little Delaware R.
		2-1	No	E. Branch Delaware R. → Dry Brook

Table 20. Priority 1 Occurrence Names in the Upper Delaware EDU

Alder Creek	High Falls Brook
BASHER KILL	LITTLE BEAVER KILL
BEAVER KILL	Little Flat Brook
Beerskill	MCMICHAEL CR
Biscuit Brook	NEVERSINK R
BUSH KILL	Parker Brook
Cattail Brook	Pigeon Brook
Criss Brook	Shandelee Brook
DELAWARE R	Stony Brook
Fall Brook	Tarkill Creek
FLAT BROOK	Willowemoc Creek
Forked Brook	Willsey Brook
Gumaer Brook	

Table 21. Priority 2 Occurrence Names in the Upper Delaware EDU

Alder Marsh Brook	Kinneyville Creek
BRODHEAD CR	LACKAWAXEN R
Brush Brook	LITTLE DELAWARE R
Buck Brook	Little Equinunk Creek
Bulgers Run	MCMICHAEL CR
Butz Run	MIDDLE CR
Calkins Creek	OQUAGA CR
CALLICOON CR	Paradise Creek
Cherry Creek	Pocono Creek
Coulter Brook	Riley Creek
Cranberry Creek	Rose Pond Branch
Crooked Creek	Salt River Brook
DELAWARE R	Sand Spring Run
DRY BK	Scot Run
Dry Sawmill Run	SHOHOLA CR

East Branch Dyberry Creek	Transue Run
EQUINUNK CR	Tyler Brook
Factory Creek	WALLENPAUPAUK CR
Gulf	Wolf Swamp Run

Upper Susquehanna EDU

Abundance Goals: For the Upper Susquehanna ecological drainage unit numerical goals were met or exceeded for 14 of the 19 aquatic ecological system types found in the EDU. Table 22 illustrates how these goals were met, exceeded or not met, for each aquatic system type. Numeric goals for only one of the size 3 system types was not met or exceeded and for system type 3-8, no Priority 1 occurrences were identified in the portfolio. No Priority 1 occurrence was identified for system type 2-12 either.

Table 22. Aquatic System Priority 1 Occurrences for the Upper Susquehanna EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	5	4	125	3	+1
1	6	2	27	3	-1
1	7	4	105	3	+1
1	8	2	401	3	-1
1	9	2	173	3	-1
	Size 1 System Total		**831**		
2	5	2	48	2	Met
2	6	2	28	2	Met
2	7	2	28	2	Met
2	8	1	46	2	-1
2	9	2	34	2	Met
2	10	1	9	2	-1
2	11	1	7	2	-1
2	12	0	0	2	-2
	Size 2 System Total		**200**		
3	4	1	64	1	Met
3	5	1	32	1	Met
3	6	1	15	1	Met
3	7	0	0	1	-1
3	8	1	7	1	Met
	Size 3 System Total		**118**		
4		1	268	1	Met
	Size 4 System Total		**268**		

Priority 2 occurrences, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences and would help to reach numeric goals in all but one instance (system type 1-9) (Table 23). Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals.

Table 23. Total Aquatic System Occurrences (Priority 1 and 2) for the Upper Susquehanna EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal
1	5	9	154	3	+6
1	6	2	27	3	-1
1	7	6	237	3	+3
1	8	3	418	3	met
1	9	2	173	3	-1
	Size 1 System Total		**1009**		
2	5	5	81	2	+3
2	6	4	41	2	+2
2	7	2	28	2	met
2	8	2	46	2	met
2	9	3	44	2	met
2	10	3	31	2	+1
2	11	5	75	2	+3
2	12	3	44	2	+1
	Size 2 System Total		**390**		
3	4	3	102	1	+2
3	5	1	32	1	met
3	6	2	22	1	+1
3	7	2	27	1	+1
3	8	2	46	1	+1
	Size 3 System Total		**229**		
4		1	268	1	met
	Size 4 System Total		**268**		

Distribution Goals: The distribution goal analysis for AES in the Upper Susquehanna EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Upper Susquehanna EDU four 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences exceeding the design goals for the ecoregion.

Table 24. Connected Suites w/in Upper Susquehanna EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	Susquehanna R. → Tunkhannock Cr. → Martins Cr.
		4-3-2-1	Yes	Susquehanna R.→ Towanda Cr. → Schrader Cr.
		4-3-2-1	Yes	Susquehanna R. → Chenango R. → Genaganslet R. → Sangerfield R.
		4-3-2-1	Yes	Susquehanna R. → Unadilla R. → Butternut Cr./Beaver Cr.
		4-2-1	No	Susquehanna R. → Mehoopny Cr.
		2-1	No	E. BranchTioughnioga R.
		2-1	No	Catatonk Cr.
Total	4			

Table 25. Connected suites and unconnected systems w/in Upper Susquehanna EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Upper Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	No	Susquehanna R. → Owego Cr.
		4-3-2	No	Susquehanna R.→ Cohocton R. → Mud Cr./Five Mile Cr./Upper Cohocton R.
		4-3-2	No	Susquehanna R. → Canesteo R. → Bennettes Cr.
		4-2	No	Susquehanna R. → Nanticoke Cr.
		4-2	No	Susquehanna R. → Wysox Cr.
		2-1	No	Susquehanna R. → Wyalusing Cr.
		4-2-1	No	Otselic Cr. → Brakel Cr. Susquehanna R. → Wappasening Cr.
		3*	No	Tioghnioga R.

The Priority 2 occurrence of the Size 3 Tioghnioga River listed in Table 25 is unconnected as a Priority 2 occurrence, however, it provides connectivity for the P1 occurrence of the East Branch Tioghnioga River thereby creating a 4-3-2-1 connected to the Susquehanna River. These Priority 2 occurrences require more evaluation before including them in the portfolio and assembling them as a connected suite.

Table 26. Priority 1 Occurrence Names in the Upper Susquehanna EDU

Ackerly Creek	Five Streams	Millstone Creek	Sulphur Springs Creek
Albright Creek	GENEGANTSLET CR	Monroe Creek	SUSQUEHANNA R
BEAVER CR	Haights Creek	Nates Run	Thomas Run
Becker Brook	Handsome Brook	Nine Partners Creek	Tinker Creek
Bell Creek	Horton Creek	Number Six Brook	TIOUGHNIOGA CR
Bellas Brook	Hunt Creek	Oxbow Creek	TIOUGHNIOGA R
Billings Mill Brook	Idlewild Creek	Partners Creek	TOWANDA CR
Bliven Creek	Jones Creek	Pine Swamp Run	Tower Branch
Bull Run	Kasson Brook	Pond Brook	Tunkhannock Creek
Butler Creek	Kennedy Creek	Red Brook	UNADILLA R
BUTTERNUT CR	Kenney Brook	Rhiney Creek	Utley Brook
Carbon Run	LABRADOR CR	Rock Creek	White Brook
CATATONK CR	Leslie Creek	Rollinson Run	Willow Brook
Catlin Brook	Little Butler Creek	SANGERFIELD R	Wolf Run
CHEMUNG R	Little Creek	Schrader Creek	
CHENANGO R	Little Rhiney Creek	Sciota Brook	
CHENINGO CR	Little Schrader Creek	Shackham Brook	
Chilson Run	Lye Run	Silver Creek	
Coal Run	Martins Creek	Smith Cabin Run	
Dry Creek	McCraney Run	Snake Creek	
Dundaff Creek	MEHOOPANY CR	Somer Brook	
East Branch Field Brook	MICHIGAN CR	South Brook	
Fall Brook	Mill Creek	Sterling Brook	
Falls Creek	Millard Creek	Stony Brook	
Field Brook	Miller Brook	Sugar Run	

Table 27. Priority 2 Occurrence Names in Upper Susquehanna EDU

Babcock Run	NEILS CR
BENNETTES CR	OAKS CR
BRAKEL CR	OTSELIC R
Canisteo	OWEGO CR
CATATONK CR	Pendleton Creek
Chaffee Run	Prince Hollow Run
COHOCTON R	Russell Run
Corbin Creek	TIOGA R
FIVEMILE CR	TIOUGHNIOGA R
Little Falls Creek	TOWANDA CR
MESHOPPEN CR	Wappasening Creek
MUD CR	WYALUSING CR
NANTICOKE CR	WYSOX CR

Western Susquehanna EDU

Abundance Goals: For the Western Susquehanna ecological drainage unit numerical goals were met or exceeded for 3 of the 7 aquatic ecological system types identified. Table 28 illustrates how these goals were met, exceeded or not met, for each aquatic system. Numeric goals for the size 4 system type was not met, no Priority 1 or Priority 2 occurrences were identified.

Due to the assembly rules that were developed by the aquatic planning team for this ecoregion, this appears to be an oversight. All size 4 systems should be included in the portfolio at least as Priority 2 occurrences. It is recommended that the appropriate TNC OUs should evaluate the size 4 system of the Western Susquehanna as Priority 2 occurrences until more information is gathered regarding the system's viability/integrity and its eventual inclusion in the portfolio as a Priority 1 occurrence or complete elimination from the portfolio.

Table 28. Aquatic System Priority 1 Occurrences for the Western Susquehanna EDU.

System Size	System Type	# Priority 1 Occurrences	Miles	HAL Goal	Status of Goal
1	11	1	7	3	-2
1	12	6	377	3	+3
	Size 1 System Total		**384**		
2	13	11	93	2	+9
2	14	1	3	2	-1
	Size 2 System Total		**96**		
3	9	0	0	1	-1
3	10	4	131	1	+3
	Size 3 System Total		**131**		
4		0	0	1	-1
	Size 4 System Total		**0**		

The Priority 2 occurrences selected for the Western Susquehanna EDU, which currently do not count towards HAL goals, increase the number of total aquatic system occurrences and would help to reach numeric goals in two instances; systems type 2-14 and 3-9 (Table 29). Again, no Priority 2 occurrences were identified for the size 4 system in this EDU. Further evaluation with regard to the viability of these occurrences may warrant a change of status so that they count towards reaching ecoregional goals.

Table 29. Total Aquatic System Occurrences (Priority 1 and 2) for the Western Susquehanna EDU.

System Size	System Type	Total Priority Occurrences (1 and 2)	Total miles	HAL Goal	Status of Goal
1	11	1	7	3	-2
1	12	7	652	3	+4
	Size 1 System Total		**659**		
2	13	15	145	2	+13
2	14	2	10	2	Met
	Size 2 System Total		**155**		
3	9	1	4	1	Met
3	10	4	131	1	+3

Size 3 System Total		**135**		
4	0	0	1	-1
Size 4 System Total		**0**		

Distribution Goals: The distribution goal analysis for AES in the Western Susquehanna EDU has not been completed. Further analysis should be completed for both Priority 1 and 2 occurrences within the EDU to evaluate what percentage of macrohabitat types across major environmental gradients (elevation, landform and geology) are captured by selected occurrences.

Design Goals: The design goal for HAL was to provide at least one connected suite of aquatic ecological systems (system sizes 4 through 1) within each EDU. For the Western Susquehanna EDU two 4-3-2-1 connected suites of aquatic systems were constructed from Priority 1 occurrences which exceeds the design goals for the portfolio.

Table 30. Connected Suites w/in Western Susquehanna EDU (Priority 1 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Western Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2-1	Yes	W. Susquehanna R. → Pine Cr. → Slate Run/Cedar Run
		4-3-2-1	Yes	W. Susquehanna R.→ Kettle Cr. → Cross Fk./ Hammersley Fk.
		4-3-2*	No	W. Susquehanna R. → Sinnemahoning R. → Driftwood Cr.
		2	No	Left Br. Young Womans Cr.
		2	No	Bakers Run
Total	2			

The 4-3-2 connected suite of the W. Susquehanna R. → Sinnemahoning R. → Driftwood Creek becomes a complete 4-3-2-1 connected suite with the addition of the size 1 system occurrences contained in an adjacent matrix forest block. This would bring the total of connected suites which meet the ecoregion's design goals to three. However, none of the occurrences of these size 1 systems were selected during the aquatics assembly process and require significant further evaluation by TNC OUs and partners before inclusion into the aquatics portion of the portfolio.

Table 31. Connected suites and unconnected systems w/in Western Susquehanna EDU (Priority 2 occurrences).

EDU	Design Goal	Connected Systems	Meets goal	Description *(mainstem to headwaters)*
Western Susquehanna	(1) 4-3-2-1 suite/EDU	4-3-2	No	W. Susquehanna R. → Mosquito Cr./Black Moshannon Cr./Trout Run
		2-1*	No	Little Pine Cr. → Block House Run
		2-1*	No	Babbs Cr.
		2*	No	Upper Pine Cr.

The 2-1 connected suites of Little Pine Cr./Block House Run and Babbs Creek and the size 2 system of Upper Pine Creek listed in Table 31 all become part of a potential 4-3-2-1 connected suite when assembled with the Priority 1 occurrence of the size 3 system, Pine Creek. These Priority 2 occurrences require more evaluation before including them in the portfolio and assembling them as a connected suite.

Table 32. Priority 1 Occurrence Names in Western Susquehanna EDU

Baker Run	East Mine Hole Run	Left Fork Green Branch	Short Run
Bear Run	Elk Lick Run	Little Daugherty Run	SINNEMAHONING CR
Beaverdam Run	Elm Camp Run	Little Fourmile Run	SINNEMAHONING PORTAGE CR
Bell Branch	English Run	Little Indian Run	Slate Run
BENNETTE BR	Fahnestock Run	Little Kettle Creek	Sliders Branch
Big Spring Brook	First Big Fork	Little Lyman Run	Solomon Run
Billings Branch	FIRST FK	Little Slate Run	Spicewood Run
Boedler Branch	Fourmile Run	Lloyd Run	Straight Run
Bohen Run	Francis Branch	Lock Branch	Sulphur Run
Bolich Run	FREEMAN RUN	Long Run	SUSQUEHANNA R
Browns Run	Frying Pan Run	Lower Pine Bottom Run	Trout Run
Bruner Branch	Gamble Run	McClure Run	Upper Pine Bottom Run
Buck Run	Germania Branch	McCoy Run	Veley Fork
Bunnell Run	Gravel Lick Run	Miller Run	Walters Run
Cedar Run	Greene Branch	Mine Hole Run	WEST CR
Cherry Run	Hammersley Fork	Naval Run	Windfall Run
Cow Run	Hevner Run	Nelson Branch	Wingerter Run
CROSS FK	Hogstock Run	Page Run	Wykoff Branch
Cushman Branch	Hopper Run	PINE CR	Yochum Run
Daugherty Branch	Indian Camp Run	Red Rock Run	Young Womans Creek
Daugherty Run	Indian Run	Red Run	
DRIFTWOOD BR	KETTLE CR	Rexford Branch	
Driftwood Branch Sinnemahoning	Left Branch Fourmile Run	Right Branch Fourmile Run	
Dyke Run	Left Branch Young Womans Creek	Sawmill Run	
East Branch Cedar Run	Left Fork Beaverdam Run	Shanty Run	

Table 33. Priority 2 Occurrence Names in the Western Susquehanna EDU

BABB CR	English Run	Opossum Run
Bark Cabin Run	Flicks Run	Otter Run
Bear Run	Fourmile Run	PINE CR
Bennys Run	Hackett Fork	Pine Run
Big Run	Harrison Run	Ramsey Run
Black Moshannon Creek	Jacobs Run	Right Fork Mill Run
Blacks Creek	Lick Creek	Rock Run
BLOCK HOUSE CR	LICK RUN	Rogers Run
Blockhouse Creek	Lick Run	Sand Run
Bonnell Run	Little Fall Creek	Sebring Branch
Bonnell Run	LITTLE PINE CR	Shingle Mill Branch
Boone Run	Love Run	Silver Branch
Buckeye Run	McKees Run	South Creek
Bull Run	Mill Run	Steam Valley Run

Callahan Run	MOSHANNON CR	SUSQUEHANNA R
Carsons Run	Mosquito Creek	TEXAS CR
Custard Run	Muddy Run	Three Springs Run
Dam Run	Naval Run	Tombs Run
Dixie Run	Nickel Run	Trout Run
Dyke Creek	North Fork Tombs Run	Truman Run
		Wolf Run

How to interpret these results

All of the occurrences of Priority 1 and Priority 2 aquatic ecological systems identified in this plan as part of the ecoregional portfolio signify The Nature Conservancy's attempt to identify the best examples of aquatic biodiversity across the ecoregion. These occurrences should serve as a first iteration starting point for conserving the best examples of representative biodiversity throughout the High Allegheny Plateau. The aquatics portion of the HAL ecoregion plan presents a framework for thinking about conservation of aquatic systems, particularly in an ecoregion with heavily fragmented and disconnected aquatic systems.

Next Steps

Most, if not all, of the occurrences of aquatic ecological systems noted in this section of the HAL plan require a significant amount of additional assessment and evaluation with regards to the biodiversity represented by these coarse filter targets.

The following are some recommended next steps for filling data gaps and further analysis:

- Compile additional ecological data sources (macroinvertebrate, herptile atlases, fishery data sets, etc.) to develop a more complete list of species and community targets as well as improve understanding of AES
- Complete analysis of distribution goals for each EDU
- Better define/describe the biological, physical, and process components of HAL AES to better assess their significance in representing aquatic biodiversity at the EDU and ecoregional scales.
- Develop more ecologically based viability criteria and goals for HAL AES

Moreover, it is recommended that TNC and actively involved partners hold additional meetings and workshops with experts/partners to:

- Further evaluate the validity of and refine HAL AES and coarse-filter goals
- Refine GIS condition analysis and coordinate its use as a planning tool and as an adaptive tool to measure success at conservation areas and across the ecoregion for TNC and partners
- Review portfolio occurrence selection,
- Gather additional expert opinion data on aquatic systems throughout the ecoregion
- Refine and further implement use of HAL aquatic information database

The current condition and landscape context for each of the AES occurrences should be further documented and evaluated. Much of this work could be completed by additional expert workshops and interviews that could add information about stresses, sources of stress, conservation work currently underway, partners and potential partners within each EDU and across the ecoregion.

Additional planning needs include:

- Continue to assemble uniform data sets for use in ecoregional and conservation area planning which can be distributed to TNC OUs and partners working throughout the ecoregion *and* routinely updated with new information
- Detailed, multi-scale stresses and sources analysis
- Ecoregion, EDU and state-wide multi-scale strategies
- Develop a uniform criteria based process for prioritization of all ecoregional portfolio priorities (information gaps, conservation strategies, etc.)
- Identify, and include in future revisions of the HAL ecoregional plan, conservation work currently underway on aquatic targets (species, communities and ecological systems)
- Develop methodology and protocol for adding new information to the ecoregional data sets and rerunning analysis, and portfolio selection,
- Develop a series of impact (impact of specific conservation actions on the target occurrences) and process “measures of success” for the ecoregion
- Develop a timeline for next evaluation of at least the aquatics portion of the HAL ecoregional plan and portfolio.

The HAL aquatic planning team urges consideration of two broad recommendations for the next iteration of the aquatic portion of the HAL ecoregional plan: (1) more partner involvement to achieve significant buy-in to The Conservancy’s process and product(s) and (2) a standardized process for ecoregional aquatics planning across HAL so that data and decisions are comparable across EDU, ecoregion and state boundaries.

The ecoregional planning process is inherently iterative and dynamic in nature; as new data become available and ecological conditions change in the ecoregion, the portfolio must change to reflect these and ensure conservation happens with the best available knowledge.

PLANNING METHODS FOR ECOREGIONAL TARGETS: MATRIX-FORMING ECOSYSTEMS*

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

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

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

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

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

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

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

[2] Patch-forming ecosystems are discussed in the chapter on Terrestrial Ecosystems and Communities.

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

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

Assessing viability criteria for matrix-forming forest ecosystems

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

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

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

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

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

Size

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

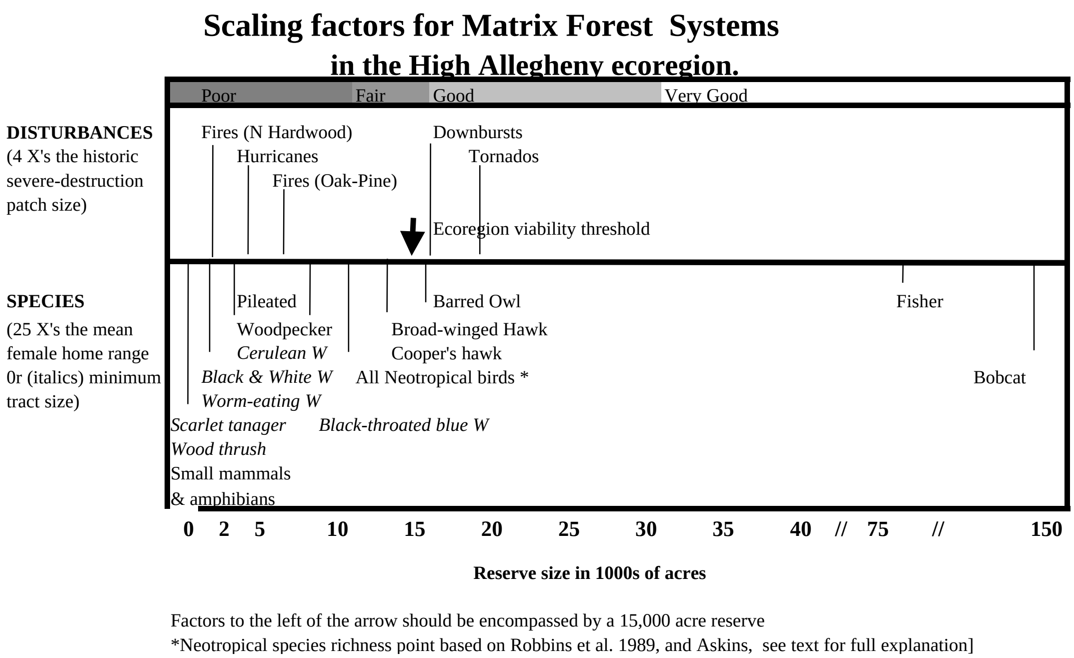

Figure MAT1. Scaling factors for matrix forest systems in the High Allegheny Ecoregion. Note: Fisher and bobcat are included in the figure for context; they were not considered to be interior-forest-requiring species.

Current condition

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Landscape context

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

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

Viability factors summarized

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

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

Locating examples of matrix-forming forests

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

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

Matrix blocks

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

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

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

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

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

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

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

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

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

Collecting expert information on the matrix blocks

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

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

[36] Forman and Alexander 1998.

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

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

Representing forest blocks across all landscape types

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

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

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

[37] Incomplete as of July 2003.

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

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

Table MAT4. Ecological Land Unit variables

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

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

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

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

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

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

Prioritizing and selecting matrix forest areas for the portfolio

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

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

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

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

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

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

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

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

Numeric goals and total acreage

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

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

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

Assumptions and future needs

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

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

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

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

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

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

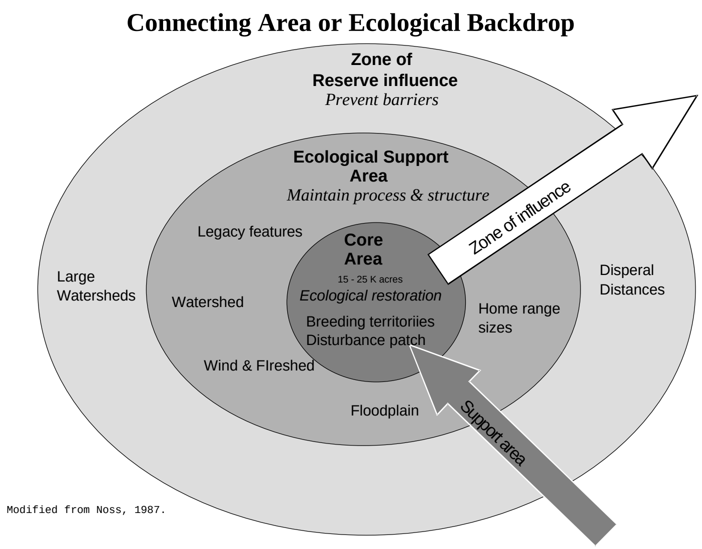

Figure MAT3. Model of protection zones, based on Noss (1987).

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

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

MATRIX SITE: 26
NAME: Merry Meeting Lakes
STATE/S: NH

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

COMMENTS:
collected during potential matrix site meetings, Summer 1999

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

Sample Block Report

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

SIZE:

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

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

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

INTERNAL LAND BLOCKS OVER 5k: 42 %

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

Internal Land Block Size Distribution:

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

MANAGED AREAS: 7 %

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

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

15 Largest managed area parcels within site

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

LANDCOVER SUMMARY:

Natural Cover: 96 %

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

Non-Natural Cover: 4 %

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

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

ROADS, ETC.:
Miles / 1k acres: 2

Internal Transportation Linework

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

Boundary Linework

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

RESULTS FOR MATRIX-FORMING ECOSYSTEMS*

Matrix forest systems in the High Allegheny Plateau ecoregion are comprised of a handful of dominant forest community types, including Northern hardwoods, Maple-birch- Beech forest, Oak Hickory forest and Allegheny oak forests. Included in the definition of matrix forest systems are also all the early and mid-successional stages of these forest types. Descriptions and technical names of all matrix forest types as well as the (approximately) 100 other forested and non forested community types are available in the High Allegheny Plateau community classification booklet (Lundgren et al. 2001) developed by the Heritage Ecologists in the participating states and region.

Modification to Standard Method

Matrix forest blocks by ELU composition in HAL

Standard methods were used to set the minimum block size (15,000 acres), identify potential matrix forest blocks, determine the composition and quantities of each Ecological Land Unit (ELU) present in each block, and determine which blocks were ecologically interchangeable and which blocks represented very different sets of ecological land features. For the High Allegheny Plateau ecoregion the ELU map was based on a 90 meter digital elevation model using the categories shown in Table MAT-1.

Table MAT-1. Ecological Land Units for the High Allegheny Plateau

Ecological Land Units (ELUs)- High Allegheny Plateau		
Elevation class in feet	**Geology**	**Topographic**
1000 1 - 1000	100 Acidic sed/metased	**10's steep slopes/**
2000 1000 - 2000	200 Acidic shale	10 Cliff
3000 2000 - 2500	300 Calcareous sed/meta	11 Steep slope
4000 2500 - 3250	400 Mod calc sed/metased	12 Slope crest
5000 > 3250	500 Acidic granitic	13 Upper slope
	600 Mafic/intermediate gr	14 Flat summit
	800 Deep sediment	**20's Side Slopes**
		20 Side slope- N/E
		21 Cove- N/E
		22 Sideslope S/SW
		23 Cove - S/SW
		30's Flats
Example:		30 Dry Flat Till
2000 (1000-2000 feet) + 500 (Acidic granitic) + 11 (steep slope) =		31 Dry Flat Fine Grained Sediment
ELU2511 Mid elevation, acidic, granitic steep slope		32 Wet/Moist Flat
		33 Slope Bottom
		34 Dry Flat Coarse Grained Sediment
		35 Dry Flat Residuum, Colluvium, Alluvium
		36 Dry Flat Patchy Sediment
		37 Dry Flat Exposed Bedrock
		40's Aquatic
		40 Stream
		41 Wide River
		42 Lake

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for matrix-forming ecosystems. Based on Zaremba, R.E. 2002. High Allegheny Plateau Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast and Caribbean Division, Boston, MA.

The analysis initially partitioned the blocks into three groups. Group A is made up of blocks occurring on fine-grained shale bedrock. These blocks are all at low to mid elevations within the ecoregion and are found in Western New York extending only slightly into Pennsylvania. The Group B blocks are all primarily on coarse-grained sandstone bedrock with a broad range of elevations. These blocks occur in Pennsylvania, New Jersey, and in the extreme eastern part of New York. Group C consists of a small subset of blocks located in the localized portion of HAL with calcareous bedrock. Descriptions of each of these block groups follow.

Group A blocks

Group A1a consists of three low elevation blocks, each currently with moderate forest cover (81-85% cover). These blocks include scattered NY State Forest land and private forested land, which are actively being logged. There are numerous pine plantations. No Heritage inventory work has taken place in these blocks. Low elevation sites are generally used by small dairy farms. Only one of these blocks is large (Jersey Hill); all are moderately dissected by roads and would require significant restoration to support functional matrix forest characteristics.

Group A1b consists of five blocks at mid elevations for the ecoregion with good forest cover (87-92%). The dominant forest type is Allegheny oaks with oak hickory on south facing and drier sites. There are some remnant silver-maple ask swamps along some stream corridors. Both Trollius and Carex schweinitzii occur within this area reflecting local influence of alkaline substrate. All blocks under consideration are large, but moderately dissected by roads. The blocks near the Allegheny River are mainly privately owned and managed for timber production with few farms. These forests produce high quality cherry. The Bristol Hills block is a mosaic of public and private land with dairy farms at low elevation.

Group A2a blocks occur in glaciated areas and have shallow soils on dry flats. Because the area was glaciated there are scattered wetland and glacially derived upland features. These blocks have not been inventoried by Heritage. The dominant forest types are believed to be Allegheny oak with oak hickory on drier sites. There are three blocks included in the assessment of this group; two of these are small (Connecticut Hills and Red House Run). All three have relatively low public ownership compared to many other blocks in HAL. All are moderately dissected by roads. Red House Run has low forest cover.

Group A2b is made up of six blocks, all within the non glaciated part of HAL. These blocks have few wetlands and deeper soils at low elevation. Dominant forest types include Beech maple forest and Hemlock northern hardwoods. On drier sites Allegheny oaks are found; richer sites with deeper soils support Rich mesophytic forests. These blocks are locally dominated by cherry and have been managed for high quality hardwoods. There are a few areas of old growth. Cerulean warblers are found in good concentration along the Allegheny River. Swainson's thrush is also found within these blocks. Four of these blocks are large; one is small (Kinzua East-10K acres), but in great condition (99% natural cover and high percentage of managed area-99.8%). Allegheny State Park is primarily owned by NY State, has high natural cover and has not been logged for many years. There is currently no logging going on in the park. There are numerous interior roads which dissect the forest into smaller units. The two Kinzua blocks are both within the Allegheny National Forest designation boundary. Kinzua West is in good forest cover, but has a low percentage of land in managed area.

Group B blocks

Group B2 consists of six block in the Catskills that have the greatest abundance of mid elevation features in HAL and the only high elevation feature in the ecoregion. All of the B2 block are in great condition with a high percentage of managed area. The NY State has designated that all state owned land in the Catskills will be held as Forever Wild with no cutting of trees. This assemblage of six blocks constitutes that largest mass of natural area within HAL.

Group B1a is made up of low elevation blocks that have been glaciated. These blocks have the highest concentration of glacial features and associated wetlands in HAL. This group is by far the most heterogenous of all block groups in HAL. Tobyhanna in the Poconos supports only 13 ELU types, the second lowest in all of HAL, Kittatinny supports 82 ELU types, second highest in all of HAL. Vegetation types include shale cliff communities and talus slopes, ridgetop woodlands, Northern Appalachian shale barrens, a range of pine barrens, and chestnut oak forests. There are numerous wetlands, including black spruce bogs, Northern conifer swamps, kettlehole bogs, and Inland Atlantic white cedar swamps. Size and public ownership percentages also vary widely.

Blocks within **Group B1b2** are all located within the non glaciated part of HAL. These blocks have greater development of eroded features (residuum) at low and mid elevations than the blocks in B1b1 (orange). Many of the blocks in B1b2 have deeply cut narrow valleys established by the West Branch of the Susquehanna River. Dominant forest types include Hemlock northern hardwoods, Northern hardwoods and Appalachian oaks. There are scattered pockets of old growth. There are several woodrat sites. Introduced elk are in some blocks. Many sites are owned by Pennsylvania state forestry. Like the six Catskills, the forest blocks around Emporium constitute a significant forest matrix fragmented only by scattered state roads. There are, however, numerous smaller interior roads and scattered roads supporting gas wellfields. Group B1b2 includes some of the largest Pennsylvania state forest units and Tionesta and Hickory Creek within the Allegheny National Forest. In sum these block present great opportunities for forest matrix conservation.

The blocks within **B1b1** are quite varied with elevation features and low abundance of deep soils on dry flats. Dominant vegetation varied considerably from site to site, but includes hemlock northern hardwoods, chestnut oak forest, ridgetop pine barrens, spruce rocky summits, and oak hickory forest. Locally there are steep cliffs and talus slopes. Woodrats were found throughout the areas with talus slopes. There are numerous wetlands including bogs. These blocks are as varied as the Northern Gunks block in NY which supports a pine barrens on thin high elevation sites to Blooming Grove in Pike County PA. These blocks currently support a varied group of forest types. One of the largest Pennsylvania State Forest units- Sproul is within this group.

Group C blocks

Group C consisted initially of four blocks that are located in the only significantly calcareous part of HAL. These blocks are clustered in the north-central part of the ecoregion and are a low to mid elevation extension of a band of calcareous bedrock exposures that runs along the northern border of HAL, primarily in the Great Lakes Ecoregion. These blocks are all low and mid elevation and are currently covered with second and third growth forests on upper slopes and summits. Most of these blocks were at one time completely cleared and used for agriculture, including row crops on low elevation areas with good soils and pastures at higher elevation Dominant forest types include oak-hickory and sugar maple-dominated hardwoods with high diversity spring ephemerals. There are large patches of hemlock northern hardwoods and Allegheny oak forest. These blocks have numerous wetlands including some of the only fens and other alkaline communities in HAL. Some of these wetlands have affinities to more northern communities, including spruce-fir swamps and black spruce tamarack swamps. The lower elevation parts of these block are primarily covered with small-scale dairy farms, many of which are abandoned. Some the state-owned tracts in these blocks are planted to pines which are known for their use by crossbills. All candidate blocks in this grouping would need significant restoration to become functional matrix forest blocks. Only one block was chosen for consideration in the portfolio.

Matrix Forest Block Selection Results

Each of the 57 candidate forest matrix blocks was evaluated during a meeting of the HAL Core Team. Members from each state in each block group evaluated blocks based on size, condition, ELU composition, biodiversity, and conservation opportunity.

Fifty-three matrix forest blocks were selected for the HAL portfolio. Twenty six of these were identified as Tier 1, defined as preferred blocks in an ELU block group; twenty seven were selected as Tier 2 blocks, defined as alternatives to Tier 1 blocks. Four proposed blocks, all within the calcareous part of the ecoregion (Group C) were rejected entirely for the portfolio as unsuitable for matrix forest conservation.

Five matrix block ELU Groups met the goal of two Tier 1 blocks for the portfolio; selections exceeded goals for three of these groups (Table MAT-2).

TABLE MAT-2. Goals and Status of Portfolio for Matrix Forest Block Groups in HAL

Block Group Code	Goal	# Tier 1	# Tier 2	# Needed for Portfolio
A1a	2	1	2	1*
A1b	2	2	1	1
A2a	2	1	2	1*
A2b	2	2	2	Goal met
B2	2	6	0	Goal exceeded
B1a	2	2	3	Goal met
B1b2	2	4	8	Goal exceeded
B1b1	2	6	6	Goal exceeded
C	2	1	0	1*

* All matrix blocks in these groups need extensive restoration

The Catskills (B2- 6 Tier 1 selections) and the blocks located in the mass of Pennsylvania state-owned land (B1b2 and B1b1- 10 Tier 1 selections) present unusual opportunities for matrix forest conservation in the Northeast. Several other blocks were added to Tier 1 for their groups because they included an assemblage of ELUs that were considered important to capture in the ecoregion. These blocks include Kittatinny, Northern Gunks, and Blooming Grove. Several Tier 2 blocks, which were marginal in terms of size, fragmentation, or forest quality, were also added to the portfolio because they included unusual ELU composition or significant conservation potential. These blocks include Tobyhanna, Mongaup, and Buckham Mountain.

All blocks selected for the portfolio, both Tier 1 and Tier 2, will require restoration to create minimum standards for disturbance regimes, area-sensitive species, and legacy features. Several blocks included in this portfolio will require extensive restoration to establish a functional matrix forest. These include all of the blocks in the northern part of New York, in Groups A1a, A2a, and C. These block groups include unique ELU groups and fragments of recovering forest with a mosaic of public ownership in a landscape with abandoned farms. There is potential with focused conservation effort within these areas for the reestablishment of functional forests.

A second goal in HAL for matrix forest conservation was that one block be selected within each subsection, reflecting the differences in physical settings captured by the Forest Service subsection divisions. Table iii. reviews the distribution of selected matrix blocks by subsection. For those blocks that occur in two subsections, the block is assigned to the subsection in which most of the block occurs. At least one block was chosen in each subsection. The greatest number of blocks was selected in the three westernmost subsections, primarily in the areas with large Pennsylvania state land holdings and in the vicinity of Allegany State Park. Nearly all of the Catskills high elevation subsection is included in matrix block units. All the matrix blocks selected in the northern Allegheny Plateau subsection (212Fb), which is primarily a mosaic of farms and small forest tracts, will require extensive restoration.

General statistics of the 53 matrix forest blocks in the HAL portfolio appear in Table MAT-3. The total acreage for Tier 1 blocks is 1.4 million acres, or 8 % of the entire ecoregion. Combined Tier 1 and Tier 2 blocks total 2.5 million acres or 15 %. Block size ranges from 10,000 acres at Kinzua East to 176,000 at Chittenango Highlands. The meaning of the acreage of these matrix blocks should be cautiously interpreted. Kinzua East is below the 15,000 acres standard for HAL matrix blocks, but is included because of high forest cover, nearly complete public ownership, and interest on the part of the Allegheny National Forest in matrix forest conservation. Conversely, Chittenango Highlands at 176,000 is highly fragmented with roads, has low public ownership (23%), and moderate forest cover (78%). The large size of this matrix block reflects an area in which matrix forest conservation will be considered in a site conservation plan. There is no implied intention that all 176,000 acres will be subject to restoration. All other HAL blocks fall between these two extremes.

Table MAT-3. Basic Statistics for Matrix Forest Blocks in HAL

Tier 1 Matrix Forest Block												
Matrix Block Name	**Acres**	**ELU Group**	**Subsection**	**State 1**	**State 2**	**% Managed Area**	**% Forested**	**% Wetland**	**% Natural Cover**	**% Agriculture**	**% Developed**	**Miles of Interior Roads**
Kittatinny	28051.1	B1a	221Bd	NJ		41.3	84.9	1.5	88.5	10.1	11.5	126.4
Allegheny State Park	88760.6	A2b	212Ga	NY	PA	78.1	97.6	0.0	97.8	1.8	2.2	170.7
Bone Run	30271.9	A2b	212Ga	NY	PA	21.6	95.9	0.0	96.1	3.6	3.9	92.8
Bear Pen Vly	48807.6	B2	M212Eb	NY		19.9	94.7	0.0	94.7	5.1	5.3	115.1
Beaverkill	136172.8	B2	M212Ea	NY		53.0	97.5	0.2	98.0	2.0	2.0	241.6
Bristol Hills	24880.2	A1b	212Fb	NY		2.7	88.6	2.5	91.1	8.8	8.9	98.9
Bucktooth State Forest	29897.9	A1b	212Ga	NY		7.8	90.9	0.0	91.0	8.8	9.0	90.1
Cannonsville	18762.2	B1b1	M212Eb	NY		3.8	97.7	0.1	98.0	1.7	2.0	50.9
Catskill Escarpment	40547.6	B2	M212Ea	NY		55.0	97.2	0.2	97.9	1.6	2.1	102.0
Chenango Highlands	176380.0	C	212Fb	NY		22.9	77.6	0.5	79.5	20.1	20.5	589.3
Connecticut Hill	19998.7	A2a	212Fb	NY		55.6	89.5	0.9	90.5	9.1	9.5	68.2
Neversink Unique Area	30364.0	B1a	212Fc	NY		17.3	97.0	1.4	98.8	0.3	1.2	80.3
Nine Mile Creek	35758.4	A1b	212Ga	NY		11.6	91.9	0.0	91.9	8.0	8.1	104.9
Northern Gunks	32263.1	B1b1	221Bd	NY		59.7	97.5	0.3	98.5	0.9	1.5	108.4

Panther Mountain	122116.2	B2	M212Ea	NY		61.1	98.5	0.1	98.7	1.1	1.3	195.2
Rattlesnake Hill	20631.0	A1a	212Fa	NY		36.5	80.3	0.1	80.6	19.2	19.4	63.6
Sugarloaf	58613.8	B2	M212Ea	NY		50.3	98.6	0.2	98.9	0.5	1.1	125.4
West Kill Wilderness	51359.2	B2	M212Ea	NY		60.1	97.5	0.0	97.6	1.6	2.4	74.5
Blooming Grove	44492.1	B1b1	212Fc	PA		38.7	89.2	7.8	99.4	0.3	0.6	84.0
Emporium	98527.9	B1b2	212Gb	PA		78.3	97.8	0.0	98.3	1.4	1.7	209.3
Hammersley	112744.5	B1b2	212Gb	PA		91.5	98.3	0.1	98.8	1.1	1.2	191.8
Hickory Creek	28093.0	B1b2	212Ga	PA		99.9	98.7	0.5	99.6	0.4	0.4	61.6
Mountain Springs	89513.5	B1b1	212Fa	PA		57.7	96.9	0.8	98.5	1.5	1.5	151.7
Pine Creek	17522.3	B1b1	212Fa	PA		66.2	93.5	0.2	94.4	5.4	5.6	55.6
Tionesta	39167.3	B1b2	212Ga	PA		100.0	96.4	0.0	97.3	2.5	2.7	116.9
Wolf Run/Cedar Run	16075.3	B1b1	212Gb	PA		81.5	98.4	0.0	99.0	1.0	1.0	21.9
Tier 2 Matrix Forest Block												
Alma Hill	56094.5	A1b	212Fa	NY	PA	0.0	89.0	0.4	89.6	10.2	10.4	272.4
Chipmunk Run	30582.7	A2b	212Ga	NY	PA	0.0	92.6	0.4	92.9	5.7	7.1	162.3
Jersey Hill	79013.4	A1a	212Fa	NY		25.5	81.3	0.4	82.0	17.7	18.0	270.8
McCarty Hill	21249.8	A1b	212Ga	NY		27.8	86.8	0.0	86.7	12.2	13.3	86.3
Mongaup	19256.1	B1a	212Fc	NY		30.0	93.4	2.7	98.7	0.9	1.3	58.7
Schuyler County State Land	48050.2	A2a	212Fb	NY		39.8	88.6	0.0	88.8	10.8	11.2	157.2
Turnpike State Forest	19378.7	A1a	212Fa	NY		39.9	84.8	0.0	85.2	14.0	14.8	76.0
East of Chipmunk Run	33453.3	A2b	212Ga	PA	NY	0.0	95.5	0.6	96.2	3.3	3.8	210.8
Kinzua East	10455.4	A2b	212Ga	PA	NY	99.6	98.4	0.0	99.4	0.6	0.6	18.9
Kinzua West	25960.1	A2b	212Ga	PA	NY	35.2	95.2	0.0	96.7	3.1	3.3	77.2
Red House Run	17125.3	A2a	212Fa	PA	NY	0.0	71.0	0.0	71.1	28.6	28.9	54.6
Big Run	19319.1	B1b2	212Gb	PA		2.9	94.3	0.0	94.4	0.5	5.6	70.2
Bogg's Run	31234.8	B1b1	212Gb	PA		78.2	99.0	0.0	99.5	0.5	0.5	61.5
Buckham Mountain	32789.7	B1a	212Fc	PA		39.2	96.7	1.5	98.4	0.7	1.6	78.9
Butternut Hollow	35056.2	B1b2	212Gb	PA		93.3	98.2	0.0	98.3	1.7	1.7	93.5
Catherine Swamp	28701.1	B1b2	212Ga	PA		0.8	93.8	0.7	95.1	3.3	4.9	53.3
Cranberry Swamp	13403.2	B1b1	212Gb	PA		74.7	98.8	0.1	99.6	0.4	0.4	29.8
Dutchman Swamp	28894.1	B1b1	212Fa	PA		63.9	94.3	0.7	96.8	1.9	3.2	50.8
East Branch Dam	78639.4	B1b2	212Ga	PA		21.8	98.3	0.0	98.9	1.1	1.1	181.7
Gray's Run/McIntyre	46815.6	B1b1	212Fa	PA		52.0	95.7	0.1	96.5	2.9	3.5	124.2
Larry's Creek	20380.0	B1b1	212Gb	PA		13.7	95.0	0.0	95.1	4.3	4.9	48.2
Marshburg	37696.0	B1b2	212Ga	PA		72.7	98.7	0.0	99.2	0.7	0.8	92.3
Parker Run	48170.4	B1b2	212Gb	PA		39.7	97.6	0.0	97.8	1.6	2.2	83.2
Quehanna	98671.4	B1b2	212Gb	PA		47.4	99.5	0.0	99.6	0.3	0.4	166.9
Tobyhanna	16203.5	B1a	212Fd	PA		91.7	76.4	21.9	99.5	0.4	0.5	33.5
Trout Run	69475.8	B1b2	212Gb	PA		47.1	97.1	0.0	97.6	1.6	2.4	137.6
West Branch-Sproul	64962.9	B1b1	212Gb	PA		68.9	95.9	0.0	98.4	0.9	1.6	160.2

Most of the forest matrix blocks are currently in very good condition. Seventy five percent (40 blocks) support forest cover greater than 90%; only 6% (3 blocks) have forest cover under 80%. Only nine blocks that were selected have a percentage of land in agriculture greater than 10%. Seventy percent (37 blocks) have less than 5% acreage in agriculture. Only six selected blocks have residential and commercial development over 1%. Many HAL blocks are currently in great condition and have high potential for successful conservation work.

The ELU composition of Tier 1 and Tier 2 matrix forest blocks appears in each of the block reports.[1] The 53 matrix blocks represent a good cross section of the ELUs within HAL. Of the 353 ELUs in the ecoregion, all but 20 are included within selected matrix blocks. These 20 ELUs are all in either the calcareous region in north-central New York or in the non-glaciated sections of western Pennsylvania where residuum has accumulated along major river corridors. All of these ELUs are suitable for agriculture or developed into villages or transportation corridors. An analysis of elevation for the matrix blocks relative to the ecoregion as a whole revealed that the selected blocks represent all the highest elevation sites: 79% of the areas 2500-3250 feet and 15% of areas 2000-2500. Only the lowest two elevation units (under 1000 feet and 1000-2000 feet) are represented in percentages less than for the whole ecoregion. These are the most developed parts of the ecoregion.

Statistics for managed areas in HAL matrix blocks appear on each block report. The total area of the 53 HAL matrix blocks is 2,466,185 acres. Forty-six percent of this acreage is publicly owned. Twenty-three percent (12 blocks) have greater than 70% public ownership; 9% (5 blocks) are greater than 90% in public ownership. Thirty three (18 blocks) have less than 30% public land; 17% (9 blocks) have less than 10%; 8% (4 blocks) have no public land at all.

This assessment includes matrix forest blocks selected for HAL during the development of this ecoregional plan. There are other matrix forest blocks selected in adjacent ecoregions that extend into HAL. Swartswood in NJ is adjacent to the Kittatinny block and straddles the HAL/LNE boundary. Four blocks were selected during the WAP planning process that extend into the western part of HAL.

General comments on HAL matrix blocks

The 53 matrix forest blocks in HAL reflect the diversity of ELU types present in HAL and are well distributed throughout the ecoregion. Site conservation planning will be an essential step to identify where within these draft matrix blocks effective forest matrix conservation can be undertaken. Emphasis will be needed on both current good conditions and ELU composition, which will often not correlate. Site conservation planning will need to identify areas that are large enough to sustain important forest processes, configured to maximize area sensitive species needs and capture the broadest possible assortment of ELUs.

This selection of Tier 1 and Tier 2 matrix forest blocks represents a first effort to identify sizable units within HAL where matrix forest conservation might take place. Greater familiarization with these sites and an increased knowledge of the goals of matrix forest conservation in the East, including size, shape, and condition within the conservation unit, will better inform the selection of sites.

This assessment did not directly address issues of wide-ranging species, connectivity, or global climate change. All of these landscape issues should be addressed at a time when these first iteration HAL matrix blocks are combined with blocks selected for adjacent ecoregions. Through this process it has been recognized that within HAL there are greater opportunities for matrix forest conservation than in all adjacent ecoregions (WAP, CAP, LNE, and Great Lakes). The

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

value of masses of matrix forest blocks has been recognized in the selection of the Catskills, Western PA, and the area around Allegany State Park as Action sites.

Next Steps for Matrix Forest Blocks in HAL

1. Connect ELUs to communities and assess distribution and groupings in the ecoregion. Do these matrix block selections act as coarse filters and in fact represent the full range of community diversity within HAL?
2. Determine which ELU types are not represented in the portfolio and assess potential for restoration. There are 20 ELUs not represented in any selected matrix forest block. There are also many lower elevation, flatter ELUs that are under represented relative to their abundance in the ecoregion. These ELUs should be identified and located. An assessment should be undertaken to determine the feasibility of creating new blocks or expanding existing bocks to include these features in the portfolio.
3. Recirculate matrix forest selections to the experts for review. Experts were involved in the first phase of identifying potential matrix forest blocks, but have not reviewed the final selections. There will be likely adjustments in block selections and boundaries based on new expert opinion.
4. Become familiar with matrix forest blocks and develop conservation plans. The first step in developing site conservation plans for matrix forests will be to assess current condition, composition, threats, and potential for each block. Rapid ecological assessments should be undertaken for each block to evaluate where more detailed inventories are needed.
5. Continue evaluation of matrix block characteristics. The selection of matrix forest blocks is driven by the characteristics of what are understood to be the important features that need to be conserved in these areas. Disturbance regimes, which define and maintain matrix forests, are poorly known in HAL. More work needs to be done to compile disturbance histories and ecological effects within the ecoregion. There may be geographic differences between far western Pennsylvania and the Catskills that need to be understood to refine the minimum dynamic areas of matrix forests in HAL. The needs of areas sensitive species also are considered in scaling matrix forest. More information is needed on what these species are in HAL. And what do they need within matrix forests? What minimum standards are needed to assure that these selected matrix forests are functioning as source areas of other conservation areas and the general ecoregion?
6. Conduct multi-ecoregional cooperative plans for matrix forests, focused on similar matrix forest types or settings, include assessment of threats, goals, and strategies. There are clear similarities among many of the matrix forest blocks in HAL and in adjacent ecoregions. Field assessments, research on matrix forest characteristics, and development of conservation strategies will benefit from assessments of multiple sites. Similar matrix blocks should be grouped and analyzed base on ELU characteristics, ownership, threats, and restoration needs.
7. Conduct assessment of matrix blocks for wide ranging species and global climate change.

HAL THREATS*

1. Forest fragmentation- from a range of causes.
2. Forest simplification- Reduced species dominance. Loss of chestnut, beech undergoing reduction, loss of hemlocks, elms, poor oak regeneration, shift to sugar maple and red maple and cherry in some managed forests.
3. Global warming.
4. Acid precipitation.
5. Second home development: Catskills, Poconos, Western PA hills. Pike and Wayne county are considered to be “good real estate” markets.
6. Deer overpopulation—not as bad in the Catskills as in other areas. Bad in NJ and Western PA, and Allegany State Park.
7. Invasive species issues.
8. Forest pathogens: Hemlock wooley adelgid; gypsy moth; beech bark disease, etc.
9. Highway expansion- Rte 17 becoming Rte 86.
10. New types of development: Casinos, warehouses, racetracks.
11. Oil and Gas leasing,expansion and maintenance
12. Residential development—NYC sprawl, other areas with suburban expansion

Other threats:

13. Gas transmission lines
14. Fire suppression
15. Road management- think ASP and wider roads
16. Wise use
17. Increased logging
18. Woodrat disease
19. Turtle poaching
20. Oak regeneration- related to deer overbrowse
21. Excessive or inappropriate game species management

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* Zaremba, R.E., M.G. Anderson et al. 2003. High Allegheny Plateau Ecoregional Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, Boston, MA.

OPPORTUNITIES, LESSONS, AND NEXT STEPS*

Conservation Opportunities in HAL

1. Depopulation over most of the ecoregion—notable exceptions (Poconos).
2. Location of ecoregion—edge of most things—center is far from population centers.
3. Public land acquisition money—NJ and NY; not much in PA right now.
4. New York City Water Supply money, plan is to acquire several 100,000 more acres.
5. A lot of land is in public ownership already— Catskills, PA state forests and gamelands, ANF, Delaware Water Gap.
6. Many new land trusts.
7. Many new conservation coalitions are in place or developing—watershed groups, Gunks, Delaware River, Catskills, Friends of the … Advocacy groups are in place in a few areas, recreation groups, old growth forest groups, limited logging groups, hiking groups.
8. New ecosystem thinking in State and Federal land management. Fishing, logging, oil and gas well development and maintenance. NPS, NFS, PA State Forestry, Catskills. There is a new PA state agency hire who is beginning the hard work of addressing the need to reduce the deer herd.
9. Dam removals and relicensing: Neversink story.
10. Restoration techniques—developing. Limited now, but interest is high and commitment strong.
11. Fire management thinking developing—NY has a fire manager. Planning has taken place in NY and PA at other sites. Some planning initiated in Poconos and Gunks.
12. New control measures for invasives being investigated. Adelgid control; Loosestrife biocontrol, Phragmites research underway, invasives groups forming.
13. Bog turtle plan out—work ongoing in NY and PA and some in NJ. Need to work together with a coalition focused on the plan and with USFWS support.
14. Catskills and ANF designations.
15. GIS info developing and sharing—TNC ECS has worked on ELUs and data layers for this plan. Will be available for use in planning and will hopefully be further developed over time.
16. Deer management need acknowledged within NY and PA. Uncertain about where this is going.
17. Changes in logging practices.
18. Gas and oil well line development continues, but with some regulation.
19. Species introductions— Uncertain; may play a role with Fed and State listed species: Bog turtle, dwarf wedge mussel.

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* Zaremba, R.E., M.G. Anderson et al. 2003. High Allegheny Plateau Ecoregional Plan; First Iteration, Edited. The Nature Conservancy, Northeast and Caribbean Division, Boston, MA.

20. Still few roads—Fewer major roads than in other areas, although there is a dense network of road in many PA state lands.) There is not many interstates and major state roads through the ecoregion. (81, 86, 88, ??).

HAL Cross-Boundary Possibilities

1. Assessment of aquatic portfolio sites.
2. Forest matrix block conservation in similar types of settings. NY, NJ, and PA.
3. Invasive species work- assessment, raising public awareness, developing control or avoidance methodology.
4. Delaware River- water shed related to aquatics, series of Matrix forest blocks, species interests. NY, PA and NJ. Work partly underway within TNC and numerous partners already focused on area and organized into various types of coalitions.
5. Shawangunk Ridge/Kittatinny Ridge- NY and NJ.
6. Bog turtle conservation. NJ and PA. (and NY in other ecoregions)
7. Wood rat conservation. NY and PA.
8. Dragonflies- assessment and development of conservation strategies.
9. Discussion of aquatic restoration concepts. Goals and feasibility. Methods. NY, PA, and NJ.
10. Mussel conservation—*Alasmidonta heterodon*. (Subset of aquatic conservation but federally listed species needs detailed work.)
11. Deer management.
12. Beaver management.
13. Response to loss of hemlock.
14. Floodplain forest restoration.
15. Fire management.
16. Inventories
17. Cooperative work with the Forest Service
18. Work with timber management operations.

Lessons Learned During the Planning Process

In no particular order:

1. Develop an identity for the ecoregion early in the process. The boundaries and character of the ecoregion are not necessarily well known to all participants.
2. Become very familiar with the ecoregion. The team leader may be the only person who is thinking about the multi-state ecoregion as a unit.
3. In each state and in each Heritage Program, establish a point person who will be responsive to requests. It may be appropriate to identify a point person in some other offices of TNC or in a partner organization.

4. Include partners early in the process. Keep them informed and share final products.
5. Maintain good data management. Set up files early and maintain good documentation of the process.
6. Be ready to deal with staff turn over. During this process, several key participants left and were replaced by new staff. There is a critical need to train new staff quickly in the process.
7. Provide funds to the Heritage Program for their participation. Arrange time and money in annual planning process. Make sure the demands made of participants are reasonable.
8. See that new information generated during the ecoregional planning process is added to the Heritage databases. Capture collective thinking. Currently there is no money to do this. Find out what money is needed to update EORs and EO specification and find and commit the money.
9. Develop comprehensive bird information with goals and sites selected for the portfolio. All three states have detailed bird information that needs to be pulled together and assessed. There are numerous people, mostly in state government and other NGOs, that will be willing to help.
10. Develop connectivity issues between portfolio sites. Address wide ranging species issues and global warming.
11. Assemble better managed area data for GIS analysis. Current data layers lack county and town conservation land and many NGO properties.
12. Develop better goals for species. The goals are currently intended to be generic, as place holders for individual recovery plans with rangewide assessments. The goals are very general and even misleading at this point.
13. Develop comprehensive assessments/inventories for aquatic features and matrix forests. Test assumptions in ecoregional assessment methods.
14. Connect ELUs better with natural communities to assess whether ELUs actually represent differences in biodiversity.
15. Seek feedback from experts on aquatic features and matrix forest block selections.
16. Obtain clerical assistance for the ecoregional plan leader to set up and run meetings and manage data sets and files.
17. Set up meetings far in advance and secure attendance by key participants. Remind them frequently that the meetings are still on the calendar.
18. Keep the maps simple. Create maps with multiple layer for analysis, but for most uses in meetings reduce map detail to the most significant information. May of the maps are very information rich and too difficult to present to working groups that are not actively engaged. Maps with too much detail become presentation tools and not working maps.
19. Maintain good communications. Experiment with conference call or a regular e-mail update to keep Core Team members informed and engaged.
20. Work with good models for other ecoregions. Talk regularly with leaders of other ecoregional planning efforts.

21. Visit state offices and develop a presentation that can be used broadly to share developing information about the ecoregion.
22. Allow plenty of time for requests for input. Send reminders near the due date with additional time to get the work done.
23. Maintain a shared timeline and update regularly. Make sure that the sequencing is correct.

Next Steps for the HAL Portfolio Assessment

Next steps are presented at the end of each section for plants and animals, natural communities, matrix forests, and freshwater aquatics. For convenience, these are compiled and re-presented in Table N, below. The following list reviews the major needs to meet conservation goals and improve the conservation agenda for the ecoregion.

1. Assemble a team from all HAL states to assess the HAL first draft plans and develop a strategy for making revisions.
2. Assemble a working group to develop bird targets and a strategy to address bird conservation issues in HAL.
3. Assess wide-ranging species issues.
4. Roll together matrix blocks for HAL and adjacent ecoregions and develop concepts for connectivity among blocks. Select sites.
5. Evaluate the importance of the three masses of matrix forest blocks in HAL: The Catskills, the area around Allegany State Park, and the mass of state-owned land in Pennsylvania.
6. Review the current aquatics portfolio with experts.
7. Build out the aquatics assessment to the entire ecoregion.
8. Roll up species targets for all Northeastern ecoregions and reevaluate HAL targets.
9. Combine portfolio data for HAL with all abutting ecoregions and make sure that no features are omitted because they occur at the edge of the ecoregion.
10. Continue evaluation of matrix forest blocks. Do these meet minimum standards for matrix forests? What restoration is needed?
11. Assess all species targets using more information on rangewide distributions.
12. Improve species goals by developing rangewide assessments. Coordinate goals among ecoregions and develop conservation needs for species throughout their range.
13. Further refine the National Vegetation Classification for HAL.
14. Consider restoration for species and communities that do not meet conservation goals.
15. Assess the Site Conservation Planning needs of portfolio sites throughout the ecoregion and in adjacent ecoregions. Develop strategy to address similar sites.

Table N. Compilation of Next Steps for Each Target Class

Next Steps for Species Assessment

1. Data collected during this assessment were returned to the Heritage Programs. Element occurrences should be updated to reflect any new information obtained during development of this plan about viability and occurrences grouped into metapopulations.
2. Species targets lists should be assembled for all Northeastern ecoregions and evaluated to make sure that the globally-rare species are addressed in all ecoregions and that globally-secure species are appropriately included. Comments concerning taxonomic and identification problems, inadequate inventories, and aging surveys should be collected and addressed.
3. Numerical and distributional goals for species should be reevaluated and coordinated across ecoregional boundaries. For most species, goals should be tailored to known extant and suspected populations, as well as available habitat. Information should be collected to address minimum viable populations size. For some species which may be highly sensitive to global warming, sites should be selected to allow movement of populations over time.
4. For select species, particularly those that are globally rare, restoration should be considered. At a minimum, for Federally-listed species, introductions and reintroduction sites should be identified. All goals should be adjusted to reflect any detailed information included in Federal recovery plans, as they are developed.
5. Viability assessments should be reevaluated as more information becomes available. The basis of the viability assessment for species in this plan was the judgment of the Heritage ecologists. While this was the best information currently available, many occurrences were documented with very sketchy data and the ecologists were not personally familiar with specific populations, During the Site conservation planning process, population viability should be reassessed and new information added to the Heritage databases.
6. Field work should continue for all species to update current occurrence data and locate new populations. Particular attention should be focused on aquatic species, animals targets that have not been seen in many years, and species which occupy large areas for which only presence/absence information is currently available.

Those sections of the ecoregion that have not been subject to detailed surveys should be assessed. These areas include all rivers and streams, the large forested areas in central and western Pennsylvania, and the counties along the New York/Pennsylvania border.

Next Steps for Natural Communities

1. Continue to refine the HAL NVC.
2. Continue inventory work on HAL associations, particularly focusing on poorly understood groups.
3. Continue to make connections between NVC associations and the physical features associated with ELUs.
4. Create more usable versions of the HAL NVC that can become a part of standard Heritage documentation and TNC conservation action.
5. Create more efficient crosswalks between state classifications and the NVC, leading to the connection of all documented Heritage natural communities to NVC associations.

Encourage and enable the Heritage programs to update their natural community databases with information collected during this ecoregional planning process. Maintain the connections between field assessment of HAL portfolio sites and Heritage documentation.

Next Steps for Matrix Forest Blocks

1. Connect ELUs to communities and assess distribution and groupings in the ecoregion. Do these matrix block selections act as coarse filters and in fact represent the full range of community diversity within HAL?
2. Determine which ELU types are not represented in the portfolio and assess potential for restoration. There are 20 ELUs not represented in any selected matrix forest block. There are also many lower elevation, flatter ELUs that are under represented relative to their abundance in the ecoregion. These ELUs should be identified and located. An assessment should be undertaken to determine the feasibility of creating new blocks or expanding existing bocks to include these features in the portfolio.
3. Recirculate matrix forest selections to the experts for review. Experts were involved in the first phase of identifying potential matrix forest blocks, but have not reviewed the final selections. There will be likely adjustments in block selections and boundaries based on new expert opinion.
4. Become familiar with matrix forest blocks and develop conservation plans. The first step in developing site conservation plans for matrix forests will be to assess current condition, composition, threats, and potential for each block. Rapid ecological assessments should be undertaken for each block to evaluate where more detailed inventories are needed.
5. Continue evaluation of matrix block characteristics. The selection of matrix forest blocks is driven by the characteristics of what are understood to be the important features that need to be conserved in these areas. Disturbance regimes, which define and maintain matrix forests, are poorly known in HAL. More work needs to be done to compile disturbance histories and ecological

effects within the ecoregion. There may be geographic differences between far western Pennsylvania and the Catskills that need to be understood to refine the minimum dynamic areas of matrix forests in HAL. The needs of areas sensitive species also are considered in scaling matrix forest. More information is needed on what these species are in HAL. And what do they need within matrix forests? What minimum standards are needed to assure that these selected matrix forests are functioning as source areas of other conservation areas and the general ecoregion?

6. Conduct multi-ecoregional cooperative plans for matrix forests, focused on similar matrix forest types or settings, include assessment of threats, goals, and strategies. There are clear similarities among many of the matrix forest blocks in HAL and in adjacent ecoregions. Field assessments, research on matrix forest characteristics, and development of conservation strategies will benefit from assessments of multiple sites. Similar matrix blocks should be grouped and analyzed base on ELU characteristics, ownership, threats, and restoration needs.

7. Conduct assessment of matrix blocks for wide ranging species and global climate change.

Next Steps for Aquatic Ecological Systems

Most, if not all, of the occurrences of aquatic ecological systems noted in this section of the HAL plan require a significant amount of additional assessment and evaluation with regards to the biodiversity represented by these coarse filter targets.

The following are some recommended next steps for filling data gaps and further analysis:

- Compile additional ecological data sources (macroinvertebrate, herptile atlases, fishery data sets, etc.) to develop a more complete list of species and community targets as well as improve understanding of AES
- Complete analysis of distribution goals for each EDU
- Better define/describe the biological, physical, and process components of HAL AES to better assess their significance in representing aquatic biodiversity at the EDU and ecoregional scales.
- Develop more ecologically based viability criteria and goals for HAL AES

Moreover, it is recommended that TNC and actively involved partners hold additional meetings and workshops with experts/partners to:

- Further evaluate the validity of and refine HAL AES and coarse-filter goals
- Refine GIS condition analysis and coordinate its use as a planning tool and as an adaptive tool to measure success at conservation areas and across the ecoregion for TNC and partners
- Review portfolio occurrence selection,
- Gather additional expert opinion data on aquatic systems throughout the ecoregion
- Refine and further implement use of HAL aquatic information database

The current condition and landscape context for each of the AES occurrences should be further documented and evaluated. Much of this work could be completed by additional expert workshops and interviews that could add information about stresses, sources of stress, conservation work currently underway, partners and potential partners within each EDU and across the ecoregion.

Additional planning needs include:

- Continue to assemble uniform data sets for use in ecoregional and conservation area planning which can be distributed to TNC OUs and partners working throughout the ecoregion *and* routinely updated with new information
- Detailed, multi-scale stresses and sources analysis
- Ecoregion, EDU and state-wide multi-scale strategies
- Develop a uniform criteria based process for prioritization of all ecoregional portfolio priorities (information gaps, conservation strategies, etc.)
- Identify, and include in future revisions of the HAL ecoregional plan, conservation work currently underway on aquatic targets (species, communities and ecological systems)
- Develop methodology and protocol for adding new information to the ecoregional data sets and rerunning analysis, and portfolio selection,
- Develop a series of impact (impact of specific conservation actions on the target occurrences) and process “measures of success” for the ecoregion
- Develop a timeline for next evaluation of at least the aquatics portion of the HAL ecoregional plan and portfolio.

The HAL aquatic planning team urges consideration of two broad recommendations for the next iteration of the aquatic portion of the HAL ecoregional plan: (1) more partner involvement to achieve significant buy-in to The Conservancy’s process and product(s) and (2) a standardized process for ecoregional aquatics planning across HAL so that data and decisions are comparable across EDU, ecoregion and state boundaries.

Glossary

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Conservation Target: see Target.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Goal: see Conservation Goal.

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

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

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

Herptile: A term encompassing reptiles and amphibians.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Mosaic : An interconnected patchwork of distinct vegetation types.

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

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

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

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

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

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

Portfolio Occurrence: see Occurrence.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Review of current portfolio for HAL communities- status in relation to goals- 61902-REZ- halncgoals61902.xls- update 6/19/02

A= accepting into the portfolio

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C= currently believed to be in subsection

P= believed to probably be in the subsection

NO= believe not to be in subsection

M= Matrix community

LP= Large Patch

SP= Small Patch

LI= Linear

W= Widespread

P= Peripheral

L=Limited to HAL and one other ecoregion

R= Restricted to HAL

1*= numerical goals met, but stratification goals not met. Need additional occurrence in specific part of ecoregion.

				Non Glaciated		Glaciated								Goals		Status			
NVC #	NVC Name	Patch size	Global distrib.	Ga	Gb	Ea	Bd	Eb	Fb	Fa	Fc	Fd		Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
Group 1- Bogs and Acid Fens																			
3908	Cephalanthus occidentalis Semipermanently Flooded Shrubland	SP	W	C	C	C	C	C	C	C	C	C		2	5	0	0	no	5
6008	Chamaedaphne calyculata- (Gaylussacia dumosa) - Decodon verticillatus/ Woodwardia virginica Dwarf shrubland	SP	L	NO	NO	P	2A	P	1A 2R	1A	5A 8R	1A 1R		3	20	10	11	no	10
6164	Alnus (serrulata, incana)/ Osmunda cinnamomea - Sphagnum spp. Shrubland	SP	W	C	C	P	P	C	C	C	C	C		2	5	0	0	no	5
6190	Vaccinium coymbosum / Sphagnum spp. Shrubland	SP	W	P	P	C	2A	C	2A 1R	2A 2R	1A 1R	5A 4R		2	5	12	8	no	1*
6225	Kalmia angustifolia - Chamaedaphne calyculata - (Picea mariana) / Cladina spp. Dwarf-shrubland	SP	W	C	NO	C	1A	1R	1A 4R	3A 5R	5A 11R	17A 7R		2	5	27	28	no	1*
6302	Chamaedaphne calyculata/Carex lasiocarpa- Utricularia spp. Shrub Herbaceous Vegetation	SP	L	NO	P	NO	1A	NO	P	P	1A 1R	C		3	20	2	1	no	18
	Untagged, but in group															0	0		
Group 2- Calcareous Fens																			
6068	Myrica gale - Pentaphylloides floribunda /Carex lasiocarpa - Cladium mariscoides Shrub Herbaceous Vegetation	SP	P	NO	NO	NO	NO	NO	1A 1R	NO	NO	NO		1	5	1	1	yes	4
6101	Deschampsia cespitosa - Symplocarpus foetidus Herbaceous Vegetation	SP	R	NO	NO	NO	1A	NO	NO	NO	NO	NO		4	25	1	0	no	24
6103	Myrica pensylvanica - Pentaphylloides / Carex sterilis - Carex flava Shrub Herbaceous Vegetation	SP	P	NO	NO	NO	1A	NO	NO	NO	NO	NO		1	5	1	0	yes	4
6123	Cornus racemosa / Carex (sterilis, hystericina, flava) Shrub Herbaceous Vegetation	SP	L	NO	NO	NO	P	NO	1A 8R	1A 2R	NO	NO		3	20	2	10	no	18
6142	Tofieldia glutinosa - Carex garberi Herbaceous vegetation	SP	P	NO	NO	NO	P	NO	NO	NO	NO	NO		1	5	0	0	no	5
6326	Pentaphylloides floribunda / Carex (sterlis, hystericina, flava) Shrub Herbaceous Vegetation	SP	L	NO	NO	NO	NO	NO	1A	NO	NO	NO		3	20	1	0	no	19
6357	Juniperus virginiana / Pentaphylloides floribunda / Carex flava - Carex tetanica Shrub Herb Vegtetation	SP	R	NO	NO	NO	1A 1R	NO	NO	NO	C	NO		4	25	1	1	no	24
6360	Betula pumila - Toxicodendron vernix - Pentaphylloides floribunda Shrubland	SP	P	NO	NO	NO	P	NO	NO	NO	NO	NO		1	5	0	0	no	5
	untagged, but in group						2A		2A 5R	3R						4	8		

An Excel version of this table is included, as well. To open it immediately, click here.

Review of current portfolio for HAL communities- status in relation to goals- 61902-REZ- halncgoals61902.xls- update 6/19/02

A= accepting into the portfolio	M= Matrix community	W= Widespread
R= rejected-not in portfolio	LP= Large Patch	P= Peripheral
C= currently believed to be in subsection	SP= Small Patch	L=Limited to HAL and one other ecoregion
P= believed to probably be in the subsection	LI= Linear	R= Restricted to HAL
NO= believe not to be in subsection		

1*= numerical goals met, but stratification goals not met. Need additional occurrence in specific part of ecoregion.

				Non Glaciated		Glaciated							Goals		Status			
NVC #	NVC Name	Patch size	Global distrib.	Ga	Gb	Ea	Bd	Eb	Fb	Fa	Fc	Fd	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
Group 3 - Cliffs (not wooded)																		
2045	Sandstone Dry Cliff Sparse Vegetation (acidic)	SP/LP	W?	?	?	?	2A	?	1A 1R	?	?	1R	2	5	3	2	no	2
4476	Asplenium ruta-muraria - Pellaea atropurpurea Sparse Vegetation- circumneutral	SP	P	NO	NO	?	P	P	?	?	?	?	1	5	0	0	no	5
	Untagged but in group					1A			1A		1R	1R			2	2		
Group 4- Deciduous or Mixed Woodlands																		
6037	Juniperus virginiana - Fraxinus americana - Carya glabra / Carex pensylvanica - Cheilanthes lanosa Woodland	SP	R?	?	?	?	4A	?	2R	?	NO	NO	4	25	4	2	no	21
5058	Tilia americana - Franxinus americana - (Acer saccharus) / Geranium robertianum Woodland	SP/LP	L	C	NO	C	C	C	C	C	P	NO	3	20	0	0	no	20
6320	Quercus rubra / Polypodium virginianum Woodland	SP	L	P	P	P	3A 1R	P	P	P	P	P	3	20	3	1	no	17
	Untagged, but in group														0	0		
Group 5- Floodplain Forests and Rivershores																		
6947	Acer saccharinum - Platanus occidentalis - (Betula nigra) Shrubland	SP/ L	?	NO	P	?	C	?	1A	?	C	P	2	5	1	0	no	4
6001	Acer saccharinum - Ulmus americana / Onoclea sensibilis Forest	SP	?	P	NO	NO	P	P	P	P	P	?	2	5	0	0	no	5
6036	Platanus occidentalis - Franxinus pennsylvanica Forest	SP	W	?	NO	?	C	?	P	1A	C	?	2	5	1	0	no	4
6042	Acer saccharinum - Ulmus americana / Physocarpus opulifolius Forest	SP	?	?	?	?	?	?	?	P	?	?	2	5	0	0	no	5
6147	Acer saccharinum - (Populus deltoides) / Matteuccia struthiopteris	SP	L/W	1A	?	?	?		1A 1R	C	1A 4R	NO	2	5	3	5	no	2
6176	Acer saccharinum / Onoclea sensibilis - Boehmeria cylindrica Forest	SP	?	P	NO	NO	NO	NO	P	P	N	NO	2	5	0	0	no	5
6184	Betula nigra - Platanus occidentalis / Impatiens pallida Forest	SP- histor. LP	L/W	P	P	NO	1A	C	P	C	1A 5R	C	3	20	2	5	no	18
6185	Quercus palustris - Acer rubrum / Carex grayi - Geum canadense Forest	SP	?	NO	NO	?	?	?	?	?	?	NO	2	5	0	0	no	5
6114	Acer sccharum - Fraxinus spp. Tilia americana / Matteuccia struthiopteris - Ageratina altissima Forest	SP	L/W	NO	NO	NO	P	NO	P	P	1R	NO	3	20	0	1	no	20
new	Solidago rugosa - Carex torta - Equisetum spp. Herbaceous Vegetation- proposed	SP?	L?	?	?	?	P	?	P	P	C	?	3	20	0	0	no	20
3896	Betula nigra - Salix exigua Shrubland	SP/L	R/L	NO	P	NO	C	NO	C	?	1R	P	4	25	0	1	no	25
3901	Salix nigra Temporarily Flooded Shrubland	SP/L	W	P	P	NO	P	P	P	1R	1A	P	2	5	1	1	no	4
6251	Alnus serrulata - Physocarpus opulifolius Shrubland	SP	P	?	?	?	2A	?	?	1A	?	?	2	5	3	0	no	2
6283	Andropogon gerardii - Panicum virgatum - Baptisia australis Herbaceous Vegetation	SP	L/W	P	P	NO	C	NO	5A 1R	?	1R	NO	3	20	5	2	no	15

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6284	Andropogon gerardii - Campanula rotundifolia - Solidago simplex Herbaceous Vegetation	SP	P	?	?		?		P		?	?	?		C	?		2	5	0	0	no	5
	Untagged, but in group											1R			4R					0	5		
Group 6- Marshes and Wet Meadows																							
5174	Calamagrostis canadensis - Phalaris arundinacea Herbaceous Vegetation	SP	W	C	C		C		C		C	1R	1R		C	C		2	5	0	2	no	5
6153	Typha (angustifolia, latifolia) - (Scirpus spp.) Eastern Herbaceous Vegetation	LP	W	C	C		C		C		C	C	1R		C	C		2	4	0	1	no	4
6275	Scirpus (tabernaemontani, acutus) Eastern Herbaceous Vegetation	SP	W	C	C		P		P		P	C	C		C	C		2	5	0	0	no	5
6349	Scirpus cyperinus Seasonally Flooded Herbaceous Vegetation	SP	W	P	P		C		1R		C	C	1R		C	P		2	5	0	2	no	5
4121	Carex stricta Seasonally Flooded Herbaceous Vegetation (placeholder)	SP	W	C	C		1R		C		C	1R	C		C	C		2	5	0	2	no	5
	Untagged, but in group																			0	0		
Group 7- Palustrine Forests and Woodlands																							
6189	Chamaecyparis thyoides / Ilex verticllata Forest	SP	P	NO	NO		NO		C		NO	NO	NO		1A	NO		1	5	1	0	yes	4
6355	Chamaecyparis thyoides / Rhododendron maximum Forest	SP	P	NO	NO		NO		1A		NO	NO	NO		NO	NO		1	5	1	0	yes	4
6007	Thuja occidentalis / Hylocomium splendens Forest	SP	P	NO	NO		NO		P		3A	C	P		NO	P		1	5	3	0	yes	2
6098	Picea mariana / (Vaccinium corybosum, Gaylussacia baccata) / Sphagnum sp. Woodland	SP	L	NO	C		C		2A		C	1A	2A 1R		10A 4R	2A 2R		3	20	17	7	no	3
6168	Picea mariana / Kalmia angustifolia / Sphagnum spp. Forest	SP/LP	W	NO	C		C		1A		NO	P	C		2A 2R	3A		2	5	6	2	no	1*
6194	Pinus rigida / Chamaedaphne calyculata / Sphagnum spp. Woodland	SP	L	NO	1R		?		1A		?	C	NO		C	C		3	20	1	0	no	19
6226	Tsuga canadensis - Betula alleghaniensis / Ilex verticillata / Sphagnum spp. Forest	LP	W	P	P		P		P		?	1A 3R	1A		2A 2R	P		2	4	4	5	no	1*
6277	Picea rubens - (Tsuga canadensis) / Rhododendron maximum Saturated Forest	SP	L?	NO	NO		C		P		NO	C	NO		1R	1A 1R		3	20	1	2	no	19
6279	Tsuga canadensis / Rhododendron maximum / Sphagnum spp. Forest	SP	L?	P	P		NO		C		NO	P	NO		2R	1R		3	20	0	3	no	20
6311	Picea rubens - Abies balsamea / Sphagnum magellanicum Forest	SP	L	?	NO		C		?		P	1R	2R		1R	1A 1R		3	20	1	5	no	19
6312	Picea rubens - Abies balsamea / Gaultheria hispidula / Sphagnum spp. Forest	SP	L/W	P	1A		P		NO		P	1R	P		1A	1A 1R		3	20	3	2	no	17

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				Non Glaciated		Glaciated												Goals		Status			
NVC #	NVC Name	Patch size	Global distrib.	Ga	Gb		Ea		Bd		Eb	Fb	Fa		Fc	Fd		Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6009	Fraxinus nigra - Acer rubrum - (Larix larcina) / Sphagnum spp. Forest	SP	W	NO	?		C		C		C	C	C		C	?		2	5	0	0	no	5
6014	Acer rubrum - Nyssa sylvatica - Betula alleghaniensis / Sphagnum spp. Forest	SP	L	C	C		NO		1A		P	1R	C		2A	1A		3	20	4	1	no	16
6118	Acer rubrum - Larix larcina / Rhamnus alnifolia Woodland	SP	L	NO	P		C		C		C	1A	1R			1A		3	20	2	1	no	18
6119	Acer rubrum / Carex stricta - Onoclea sensibilis Woodland	SP?	W	C	C		C		C		C	C	C		C	C		2	5	0	0	no	5
6156	Acer rubrum - Nyssa sylvatica / Rhododendron viscosum - Clethra alnifolia Forest	SP	P	?	?		?		1A		p	?	?		1R	?		2	5	1	1	no	4
6198	Picea rubens - Acer rubrum / Nemopanthus mucronatus Forest	SP/LP	L	P	P		C		P		C	C	2A		2R	3A		3	20	5	2	no	15
6220	Acer rubrum - Fraxinus nigra / Nemopanthus mucronatus - Vaccinium corymbosum Forest.	SP	P	?	?		?		?		?	?	?		?	?		2	5	0	0	no	5
6240	Quercus palustris - Acer rubrum / Osmunda cinnamomea Forest	SP	L?	P	?		?		?		?	?	?		?	?		3	20	0	0	no	20
6241	Quercus bicolor / Vaccinium corymbosum / Carex stipata Forest	SP	R	?	?		?		?		?	1R	P		?	?		4	25	0	1	no	25
6406	Acer rubrum - Fraxinus (pennsylvanica, americana) / Lindera benzoin / Symplocarpus boetidus Forest	SP	L/W?	?	?		?		?		?	P	P		P	P		3	20	0	0	no	25
7441	Fraxinus nigra - Acer rubrum / Carex leptalea Saturated Forest	SP	R	?	?		?		?		?	1R	?		?	P		4	25	0	1	no	25
6199	Thuja occidentalis / Acer rubrum / Cornus stolonifera Forest	SP	R	NO	NO		?		?		?	?	?		?	NO		4	25	0	0	no	25
	Untagged, but in group											2R			2R					0	4		
Group 8- Ponds and Lakes																							
2386	Nuphar lutea ssp. Advena - Nymphaea odorata Herbaceous Vegetation	SP	W	P	P		P		P		P	P	P		1A	1A		2	5	2	0	no*	3
4291	Pontederia cordata - Peltandra virginica Semipermanently Flooded Herbaceous Vegetation (Placeholder)	SP	W	P	?		P		P		?	C	C		C	C		2	5	0	0	no	5
6349		SP	W	?	1R		?		?		?	?	?		?	?		2	5	0	1	no	5
5174		SP	W	?	?		?		?		?	?	?		?	1R		2	5	0	1	no	5
	untagged, but in group				1R				1A 1R						6R	2R				1	10		
Group 9- Ridgetops and Rocky Summits																							
3883	Quercus ilicifolia shrubland (provisional)	LP	W	P	C		P		2R		P	C	P		3R	3A		2	4	3	5	no	1
6079	Pinus rigida - Gaylussacia baccata Shrubland	SP	R	NO	NO		NO		1A		NO	NO	NO		NO	NO		4(1)	25	1	0	yes	24

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				Non Glaciated			Glaciated											Goals		Status			
NVC #	NVC Name	Patch size	Global distrib.	Ga	Gb		Ea		Bd		Eb	Fb	Fa		Fc	Fd		Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6116	Pinus rigida /Aronia melanocarpa / Deschampsia flexuosa - Schizachyrium scoparium Woodland	SP/LP	W	C	C		C		6A		P	C	C		C	1A		2	5	7	0	no	1*
6157	Pinus rigida - Quercus ilicifolia - Rhodoendron canadense Woodland	SP/LP	R	NO	NO		NO		C		NO	NO	NO		NO	3A		4(2)	25	3	0	no	22
6166	Pinus rigida - Quercus (coccinea, velutina) / Schizachyrium scoparium Woodland	SP/LP	L?	C	C		p		C		1A	C	C		2A 1R	2A		3	20	5	1	no	15
6323	Pinus rigida / Quercus ilicifolia / Aronia melanocarpa Woodland	SP/LP	W	C	1A		C		1A		P	C	C		C	3A		2	5	5	0	yes	Goal met
6053	Picea rubens / Vaccinium angustifolium - Sibbaldiopsis tridentata Woodland	SP	P	NO	NO		C		NO		NO	NO	1A		NO	NO		2	5	1	0	yes	4
6002	Juniperus virginiana - Fraxinus americana / Danthonia spicata - Poa compressa Woodland	SP/L	R	?	?		?		1A		?	1A 2R	?		P	?		4	25	2	2	no	23
6134	Quercus rubra / Vaccinium spp. /Deschampsia flexuosa Woodland	SP	W	P	P		1A		C		P	P	P		3A	C		2	5	4	0	no	1
3958	Vaccinium (angustifolium, myrtilloides, pallidum) High Allegheny Plateau / Central Appalachian Dwarf Shrubland	SP/LP/	L	P	P		P		NO		P	P	C		1R	C		3	20	0	1	no	20
5094	Vaccinium angustifolium - Sorbus americana Dwarf-shrubland	SP	L	P	NO		C		P		P	C	C			C		3	20	0	0	no	20
6268	Picea mariana / Ledum groenlandicum - Empetrum nigrum / cladina spp. Dwarf-shrubland	SP	P	NO	NO		1A		1A 1R		NO	NO	NO		NO	NO		1	5	8	1	yes	2
6267		SP	W	?	?		1A		?		?	?	?		?	?		2	5	1	0	no	4
	Untagged, but in group								1R						1R					0	0		

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				Non Glaciated		Glaciated							Goals		Status			
NVC #	NVC Name	Patch size	Global distrib.	Ga	Gb	Ea	Bd	Eb	Fb	Fa	Fc	Fd	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
	Group 10- Rivers and Streams																	
4103	Carex torta Herbaceous Vegetation	SP/L	W	P	P	P	P	P	P	P	P	P	2	5	0	0	no	5
4286	Justica americana Verbaceous Vegetation	SP/L	W	P	P	NO	NO	NO	1A	P	NO	NO	2	5	1	0	no	4
4331	Podostemum ceratophyllum Herbaceous Vegetation	SP/L	?	P	P	NO	C	NO	NO	P	C	P	2	5	0	0	no	5
6196	Vallisneria americana - Potamogeton perfoliatus Herbaceous Vegetation	SP/L	W	P	NO	NO	P	NO	P	P	P	NO	2	5	0	0	no	5
	Untagged, but in group														0	0		
	Group 11- Seeps and Springs																	
6193	Chrysosplenium americanum Herbaceous Vegetation	SP	W	C	C	C	C	C	C	C	C	C	2	5	0	0	no	5
	Untagged, but in group														0	0		
	Group 12 - Terrestrial Conifer Forests																	
new	proposed Tsuga canadensis - Quercus muehlenbergii type	SP	?	?	?	?	C	?	?	?	?	?	3	20	0	0	no	20
6128	Picea rubens - Abies balsamea - Sorbus americana Forest	LP	P	NO	NO	10A	NO	1A	NO	NO	NO	NO	1	4	11	0	yes	Goal met
6253	Pinus strobus - Pinus resinosa / Cornus canadensis Forest	SP	P	NO	NO	P	NO	N	NO	NO	NO	NO	1	5	0	0	no	5
6324	Pinus strobus - Tsuga canadensis - Picea rubens Forest	SP/LP	L	NO	NO	C	C	C	?	?	1A 2R	1R	3	20	1	3	no	19
6328	Pinus strobus - Tsuga canadensis Lower New England Northern Piedmont Forest	LP	L	C	C	C	P	C	C	C	C	C	3	16	0	0	no	16
	Untagged, but in group				1R										0	0		
	Group 13- Terrestrial Deciduous Forests																	
6125	Quercus rubra - Acer saccharum - Lirodendron tulipifera Forest	M	W	2A	P	P	1R	P	C	C	P	C	2	4	2	1	no	2
6252	Acer saccharum - Betula alleghaniensis - Fagus granifolia / Viburnum lantanoides Forest	M	W	C	C	C	C	C	C	C	C	C	2	4	0	0	no	4
6236	Carya (glabra, ovata) - Fraxinus americana - Querucs spp. Central Appalachian forest	LP/M	W	C	C	P	C	C	2A	C	2R	C	2	4	2	2	no	2
6173	Quercus rubra - Acer saacharum / Viburnum acerifolium - Corylus cornuta Forest	LP/M	L	?	?	?	?	?	P	C	?	?	3	16	0	0	no	16
5008	Acer saccharum - Fraxinus spp. - Tilia americana / Osmorhiza claytonii - Caulophyllum talictroides Forest	LP	W	6A	C	C	C	C	C	C	C	C	2	4	6	0	no	goal met
6017	Acer saccharum - Quercus muehlenbergii / Cercis canadensis Forest	SP	P	P	P	NO	NO	NO	P	NO	NO	NO	2	5	0	0	no	5
6018	Quercus (velutina, alba) / Vaccinium pallidum High Allegheny Plateau Forest	SP/LP	L	8A	?	?	?	?	1A	?	?	?	3	20	9	0	no	11
6020	Acer saccharus - Fraxinus americana - Juglans cinerea / Staphalea trifolia Forest	SP/LP	P	?	?	?	?	?	?	?	?	?	2	5	0	0	no	5
6045	Acer saccharum - Betula alleghaniensis - Prunus serotina Forest	M	L	2A	P	2A	1A	P	C	C	P	1R	3	16	5	1	no	11
6282	Quercus prinus - Quercus (rubra, velutina) / Gaylussacia baccata Forest	LP	W	C	C	C	1A	1A	C	NO	2R	C	2	4	2	2	no	2
6301	Quercus rubra -Carya (glabra, ovata) - Ostrya virginiana / Carex pensylvanica Forest	LP	L?	P	P	NO	P	C	C	P	NO	NO	3	16	0	0	no	16
6336	Quercus (alba, velutina) / Cornus florida / Viburnum acerifolium Forest	LP?	L/W	?	?	?	C	?	?	?	C	?	3	16	0	0	no	16

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	Untagged, but in group				1A															1	0		
	Group 14- Terrestrial Mixed Forests																						
6293	Pinus strobus - Quercus (rubra, velutina) - Fagus grandifolia Forest	LP (was M)	W	NO	NO		C		3A		1A	1A	P		C	C		1	4	5	0	no	1*
5005	Acer saccharum - Pinus strobus / Acer pensylvanicum Forest	SP	P or L	P	NO		P		NO		NO	P	P		P	P		3	20	0	0	no	20
6109	Tsuga canadensis - Betula alleghaniensis Lower New England / Northern Piedmont Forest	LP	W	C	C		C		P		C	2R	C		1A	C		2	4	1	2	no	3
6129	Tsuga canadensis - Betula alleghaniensis - Picea rubens / Cornus canadensis Forest	LP	P	NO	NO		C		NO		1A	NO	NO		NO	NO		1	4	1	0	no	3
6206	Tsuga canadensis - Betula alleghaniensis - Prunus serotina / Rhododendron maximum Forest	LP	L	1A	C		NO		C		P	1A	C		1R	NO		3	16	2	1	no	14
6267	Picea rubens - Betula alleghaniensis / Clintonia borealis Forest	LP	P	NO	NO		4A		NO		NO	NO	NO		NO	NO		1	4	4	0	no	1*
6273	Picea rubens - Abies balsamea - Betula papyrifera Forest	SP	P	NO	NO		NO		NO		?	NO	NO		NO	NO		2	5	0	0	no	5
6290	Pinus rigida - Quercus (velutina, prinus) Lower New England, Northern Piedmont Forest	LP	W	NO	NO		NO		C		NO	C	NO		1R	C		1	4	0	1	no	4
	Untagged, but in group										1R									0	1		

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