Central Appalachian Forest Ecoregional Plan

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The Nature Conservancy

EXECUTIVE SUMMARY
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The Nature Conservancy

The Nature Conservancy's Central Appalachian Forest ecoregion encompasses the Blue Ridge Mountains, the Great Valley, the Ridge and Valley, and the Allegheny Mountains of Virginia, West Virginia, Maryland, and Pennsylvania. Valleys are mostly settled with farms and, more recently, urban and suburban development, but the vast majority of the hills and mountains of this ecoregion are forested. Lying so close to the major East Coast metropolitan areas of Philadelphia, Baltimore, and Washington, DC, the region represents a tremendous natural resource for both the local people and these urbanites. The high mountains, the lack of past glacial coverage, and the environmental diversity of this ecoregion have combined to make this area one of the most ecologically diverse regions of the eastern United States.

This ecoregional plan has identified plants, animals, natural communities, and ecological systems that represent the most urgent conservation priorities for The Nature Conservancy and its partners. Using an exceptional Natural Heritage database and sound science, this plan recommends protection of 467 sites. Within this set of sites, The Nature Conservancy has selected 122 sites for immediate conservation action. The approximate area covered by the portfolio is 3,011,000 acres. Of this area, 2,530,000 acres occurs within large, roadless forest areas. Therefore, smaller sites cover an additional 481,000 acres. The Federal government manages approximately 46% of roadless forest area acreage and various state governments an additional 18%. The majority of the remaining area of roadless forest areas is privately owned. For smaller sites the ownership and management status pattern is almost exactly reversed. Two-thirds of smaller sites are in private ownership and one-third is publicly owned.

We set numerical goals for the number of examples needed to ensure long term survival for each species or natural community. We met our goals for 37 plant species out of 73, 73 invertebrate species out of 103, and 13 vertebrate species out of 20. For terrestrial plant communities, we met our goals for 45 out of 143 communities. Of the 23 species listed under the US Endangered Species Act, 18 species were adequately conserved by this portfolio.

With the cooperation of its conservation partners, The Nature Conservancy will use this portfolio to direct conservation action within the Central Appalachian Forest ecoregion over the next ten years.

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The overarching goal of conservation in the Central Appalachian Forest ecoregion is to ensure the long-term viability of all native species, natural communities, and ecological systems, and to sustain the landscape configurations and ecological processes critical to ensuring their long-term survival.

CONSERVATION GOALS

1. Ensure the continued existence of the eight matrix forest communities and restore natural processes to promote development of all-aged stands.
2. Conserve multiple viable occurrences of all aquatic community types and restore hydrologic processes to promote healthy, functioning aquatic ecosystems.
3. Protect multiple viable occurrences of all terrestrial communities. The multiple occurrences should represent the range of variability found within each of the community types in the ecoregion.
4. Protect viable occurrences of all rare species, and significantly disjunct, vulnerable, and declining common species, with the goal of protecting multiple occurrences of such species in the variety of habitats in which they naturally occur. Explicitly emphasize the conservation of potential metapopulations where they are believed to occur.

1.0 INTRODUCTION TO THE ECOREGION

1.1 THE SETTING

The Central Appalachian Forest ecoregion includes the Blue Ridge Mountains from Virginia to southern Pennsylvania, the historic Great Valley, and the dramatic ridges and valleys and mountains that stretch south to north through the whole ecoregion as the Allegheny Mountains. The Monongehela National Forest in West Virginia and the Jefferson and George Washington National Forests in Virginia and West Virginia cover vast areas of the Blue Ridge and Allegheny Mountains of those states. Virginia is also home to Shenandoah National Park, a national treasure that encompasses a great acreage of protected forest. The MD Department of Natural Resources manages extensive forests and the PA Department of Conservation and Natural Resources and the PA Game Commission also have substantial forest holdings.

Because much of the forested areas are within a few hours' drive of growing metropolitan areas such as Washington, Baltimore, Pittsburgh, and Philadelphia, they are being increasingly fragmented by first and second home development. While the mountainous areas of the ecoregion are lightly settled now, the valleys, especially the limestone valleys, have been long settled for agriculture, and, more recently, urban development (see Map 1—Central Appalachian Ecoregion Land Cover). Coal mining, limestone quarrying, and timber-harvesting represent three other major land use activities that impact the Central Appalachian Forest.

Map 1: Central Appalachian Ecoregion Land Cover

In a larger perspective, the Central Appalachian Forest ecoregion provides unique and significant contributions to the biological diversity of eastern North America. It is a center of endemism for certain groups, including twelve vascular plants of shale barren communities (the communities are also unique to the ecoregion), dozens of species endemic to subterranean habitats of the ecoregion (including at least one vertebrate), and a number of plants, invertebrates, salamanders, and small mammals restricted to subalpine habitats of this ecoregion, or this ecoregion and the Southern Blue Ridge ecoregion. The ecoregion encompasses part of the Ohio River drainage, which, along with the Tennessee River drainage, are global centers of diversity for freshwater mussels and several groups of freshwater fish. The Central Appalachian Forest ecoregion also includes clusters of significantly disjunct species, including western species in the Ridge and Valley subsections and boreal species in the High Allegheny subsections.

The total species diversity of the Central Appalachian Forest ecoregion is high for eastern North America for two reasons. First, the ecoregion was completely unglaciated, so species were not recently lost to the influences of ice cover and extreme cold. The second reason is that the ecoregion contains some of the highest environmental diversity in eastern North America. Annual precipitation varies from some of the driest to some of the wettest in the East: 30 to 85 inches, with annual snowfall ranging from under 50 to over 190 inches. Elevations range from 200 feet to 4861 feet. The ecoregion, which includes the highest summits between the High Peaks region of the Adirondacks and the Southern Blue Ridge, has the greatest amount of land higher than 2600 feet in the East, outside of the Southern Blue Ridge. There is substantial geologic variation, including sedimentary shales, limestones, and sandstones, and igneous basalts. Also, the ecoregion is traversed by the largest drainage divide in the East, between rivers of the Atlantic Slope and Mississippi Valley.

Seven subsections within the ecoregion have been well characterized (Bailey 1995) and were used in the planning process to set geographic distribution goals where appropriate. They are: Northern Allegheny Mountains, Southern/Central Allegheny Mountains, Western Low Mountains, Eastern Low Mountains, Northern Ridge and Valley, Southern Ridge and Valley, and Northern Blue Ridge. See Map 2 (Central Appalachian Ecoregion Topography) for the locations of these subsections and their topographic influences.

1.2 LAND OWNERSHIP

The Central Appalachian Forest ecoregion covers aproximately 23,880,000 acres. Of this area, there are 2,634,745 acres in Federal ownership (11% of the total acreage), 1,984,242 acres in State ownership (8% of the total acreage), and the remainder is almost entirely private land (See Map 3: Central Appalachian Ecoregion Managed Land). Therefore, about 20% of the ecoregion is managed by public entities.

Map 2: CENTRAL APPALACHIAN ECOREGION TOPOGRAPHY

MAP 3 CENTRAL APPALACHIAN ECOREGION MANAGED LAND

2.0 INTRODUCTION TO THE PLANNING PROCESS

The ecoregional planning process for the Central Appalachian Forest involved three steps:

1. Data Development and Analysis. The development of data on potential conservation targets and viable occurrences of those targets occupied the planning teams for most of the process. After developing preliminary target lists, experts verified the targets and added other targets needed for the portfolio. Based on rangewide distributions of elements and assumptions made about the number of occurrences needed for long term element survival, we developed conservation goals for each target. These goals specified the number of occurrences that need to be protected in the Central Appalachian Forest ecoregion to ensure the long-term survival of each element. Using a database of element occurrences (that is, occurrences of species and natural communities), we then selected viable occurrences to meet our conservation goals.

2. Portfolio Development and Assessment. Element occurrences selected for inclusion were then aggregated into sites and sites were prioritized based on threat, irreplaceability, conservation status, and feasibility. We divided the portfolio into two classes of sites; sites for action over the next 10 years by The Nature Conservancy, and other sites in the portfolio where we hope that conservation partners will take action. The other sites in the portfolio may need action by The Nature Conservancy within the 10-year time frame. However, these were not designated for action over the next 10 years by The Nature Conservancy because partners were achieving conservation action, threats were currently low, and/or resources were limited. The Nature Conservancy should monitor these other portfolio sites and take action if necessary.

3. Strategy Development and Implementation. The Core Team opted not to embark on a detailed threat assessment for sites at the time the portfolio was assembled. Conservation staff and others will use the Measures of Success spreadsheet to develop threat assessments for high priority action sites shortly after publication of the plan. The Core Team developed a schedule for plan implementation, including regular Core Team meetings to discuss threats (particularly threats shared by many sites) and implementation progress.

3.0 DATA DEVELOPMENT AND ANALYSIS

3.1 DATA ASSEMBLY AND MANAGEMENT

Most of the data used for assembling the portfolio for the Central Appalachian Forest derived from the participating Natural Heritage programs. These were the Virginia Division of Natural Heritage, the West Virginia Natural Heritage Program, the Maryland Wildlife and Heritage Division of the Maryland Department of Natural Resources and the Pennsylvania Science Office of The Nature Conservancy (a.k.a. Pennsylvania Natural Diversity Inventory-East). The

Pennsylvania Natural Diversity Inventory-West Office, operated by the Western Pennsylvania Conservancy, initially contributed data to this planning process, but withdrew that data prior to the assembly of the portfolio. Because of the late date of data withdrawal, no attempt was made to try to assemble an alternative database using local experts. For this reason there are few portfolio sites in western Pennsylvania.

The Heritage information in this ecoregion reflects years of searching scientific literature and interviewing local taxonomic experts to populate databases, especially for occurrences of species. As a result, the Core Team felt that conducting independent expert reviews of potential species locations would not yield significant new information. For this reason, Heritage data were used almost exclusively to identify prospective portfolio sites.

The Eastern Resource Office (ERO) of The Nature Conservancy in Boston, MA compiled data on all G1-G3[1] species, other important species, and natural communities for the four states and clipped data falling within the ecoregional boundaries. At the recommendations of experts certain elements were deleted or added, based on detailed knowledge of conservation status. A total of 3,298 Element Occurrences (EO's)[2] were considered by the planning team for inclusion in the portfolio. A large number of GIS data layers were also compiled by ERO staff. ERO data management staff will archive the entire ecoregional database and related metadata. The Implementation Team will establish a methodology for updating the database and the portfolio.

3.2 SELECTION OF CONSERVATION TARGETS

As in other ecoregions, we adopted a "coarse filter/fine filter" approach to selecting conservation targets. We identified specific elements known to us on the ground (fine filter) and supplemented this by identifying large-scale targets (associations of widespread communities in relatively intact landscapes) where we might expect more common species and unknown occurrences of species to be captured (coarse filter). We targeted 74 plant, 30 vertebrate and 110 invertebrate species for conservation within the ecoregion. One Hundred and Forty-two terrestrial and palustrine communities were also targeted within this plan. These conservation targets have been listed in Appendix II of this report. Map 4 (Central Appalachian Ecoregion Element Occurrences) illustrates the full set of element occurrences for these various elements of biological diversity in the Central Appalachian Forest ecoregion. This map includes both viable and non-viable occurrences from the Heritage databases.

3.2.1 Species

All G1-G3 and T1-T2 species were initially considered targets. Based on conservation significance as assessed by Expert Team members, some G3G4 species and some T3 species

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

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

MAP 4 CENTRAL APPALACHIAN ECOREGION ELEMENT OCCURRENCES were considered as conservation targets, also. According to nationally established practice, some G1-G3 species were eliminated as targets based on age of last record. Records for species older than 20 years were dropped, resulting in the elimination of some target elements, especially cave fauna. In West Virginia alone, over 50 species of G1-G3 cave fauna were not included because the records of occurrence were over 20 years old. A list of species dropped from consideration appears in Appendix III.

The list of targets was supplemented by G4-G5 species known to be endemic to the ecoregion, vulnerable to decline, currently in steep decline, or occurring as significant disjuncts. Endemic and declining species were considered as primary targets, because experts felt that a significant portion of the gene pool of the species was severely threatened within this ecoregion. Significant disjuncts were targeted because experts felt that such populations represented either an important part of the genetic diversity of the species or incipient speciation.

In addition to this list of primary targets, we developed a "secondary target" list. Elements were listed as secondary targets because experts were concerned for the long-term viability of these elements and wanted to evaluate the effectiveness of an assembled portfolio of sites (based on primary targets) in capturing these secondary targets. We made an assumption, using our coarse filter/fine filter approach, that our suite of portfolio sites would sweep in secondary targets. By identifying secondary target elements and their site locations, we could then evaluate our assumption that secondary targets of conservation concern would be swept in. A short list of migratory birds (Table 1) was considered as secondary targets. The Bird Expert Team developed this list by first identifying birds occurring in the Central Appalachian Forest which are of conservation concern as measured by having a Partners in Flight risk score of 18 or over. The Expert Team then considered whether or not the habitats of the Central Appalachian Forest ecoregion made a significant contribution to the survival of a particular species at risk. Only this subset of 10 birds that fit both criteria appears as the secondary bird target list.

Based on the professional opinion of the other Expert Teams, other G4-G5 species were also included as secondary targets (Table 2).

Table 1. Central Appalachian Forest birds—secondary targets.

Wood Thrush	Worm-Eating Warbler
Golden-Winged Warbler	Kentucky Warbler
Black-Throated Blue Warbler	Bobolink
Prairie Warbler	Henslow's Sparrow
Cerulean Warbler	Saw-Whet Owl

Table 2. List of other secondary targets in the Central Appalachian Forest.

Scientific Name	**Common name**
Abies balsamea	Balsam fir
Juniperus communis	Old-field juniper
Taxus canadensis	Canadian yew

Carex collinsii	Collin's sedge
Anthroba mommouthia	
Calephelis borealis	Northern Metalmark
Calopteryx amata	Superb Jewelwing
Erynnis persius persius	Persius Dusky Wing
Ophiogomphus alleghaniensis	Allegheny Snaketail
Stylurus scudderi	Zebra Clubtail
Pseudosinella gisini	
Phanetta subterrancea	
Stygobromus sp.7	Shenandoah Spinosid Amphipod
Pseudotremia alecto	A Millipede
Pseudotremia fulgida	Greenbrier Valley Cave Millipede
Pseudotremia princeps	South Branch Valley Cave Millipede
Pseudotremia sublevis	A Millipede
Trichopetalum packardi	Packard's Blind Cave Millipede
Tricopetalum weyerensis	Grand Caverns Blind Cave Millipede

The Central Appalachian Forest planning team considered information from The Nature Conservancy's Population Viability Assessment Workshop (Morris et al. 1999) in trying to determine how many species occurrences to select to meet our overall conservation goals. Though it may be possible to ensure species survival with as few as 5 high quality occurrences, such a strategy would likely work only for species with low year-to-year variation in population size and with few exogenous disturbances. Based on the recognition that this condition rarely ever obtains, and understanding that not all occurrences chosen for the portfolio will be successfully conserved, the Expert Teams decided that a minimum of 20 occurrences rangewide should be selected in relevant portfolios. The number of relevant portfolios depends on the rangewide distribution of the species. Given our minimum goal of 20 occurrences, it made sense to select all viable occurrences of G1 and G2 species (since the maximum number of occurrences for a G2 species rangewide would be 20). On this basis, we recommended variable numbers of element occurrences for conservation of G3 species, depending upon our estimate of the proportional share of "responsibility" borne by the Central Appalachian Forest ecoregion. For species restricted to this ecoregion, our goal would be 20 occurrences—the ecoregion bears all of the responsibility for conserving this species. For species where the range is shared with only one or two other ecoregions (a limited distribution), we reasoned that we would select 10 occurrences for inclusion in the portfolio. Where the Central Appalachian Forest bears less responsibility—for species with widespread distributions (3 or more ecoregions) and for peripheral species—we selected only 5 occurrences for the portfolio. It is important to note that such a methodology works only if other ecoregional plans make similar assumptions about conservation goals. We hope to be able to evaluate the contributions made by other relevant portfolios once plans for all of these ecoregions are complete.

In selecting occurrences for some species, we encountered a problem with the way occurrences are entered into the Biological Conservation Database (BCD[3]*). For a significant number of plant and animal species, occurrences may represent only one individual in a local population, an entire isolated local population, a local population which is part of a metapopulation, or an entire metapopulation. Using expert advice from the Natural Heritage Programs, we tried to sort element occurrences and classify them in the portfolio in a manner reflecting which one of these situations was represented. We clustered element occurrences that we felt represented single individuals within a local population. Depending on the species, these occurrences were clustered into isolated local populations or into metapopulations. An isolated local population was counted as one element occurrence. A metapopulation was counted as 2.5 isolated local populations for meeting our goals. Experts felt that a viable metapopulation made a larger contribution to the survival of the species as a whole, because metapopulations are inherently more resilient and usually larger and more robust than isolated local populations.*

In order to stratify our selection of element occurrences, we used ecoregional subsections or sections where appropriate. In many cases, however, we recognized significant migratory or other biological barriers as stratifying influences in order to capture as much genetic variation within the species as possible. In those cases, we used these other biological barriers as stratification boundaries.

Another concept used in selecting element occurrences of plants and animals was the idea of "Irreplaceable" occurrences. Irreplaceable occurrences were those identified by experts as the ones that were deemed absolutely necessary to ensure long term survival of the species. Typically, such occurrences were exceptional examples. We selected irreplaceable occurrences first before trying to ensure stratification of occurrence selection. Table 3 summarizes our conservation goals for species occurrences.

Table 3: Conservation goals for species based on rarity (Element rank) and viability.

Element Rank	Target occurrences
G1 – Imperiled	all viable occurrences
G2 – Threatened	all viable occurrences
G3 – Rare	All irreplaceable occurrences and 20 occurrences for restricted species, 10 for limited species, and 5 for widespread and peripheral species
G4 and G5 Widespread	Select 5 occurrences of these endemic, disjunct or vulnerable species

[3] The Biological Conservation Database (BCD) is a proprietary product of The Nature Conservancy used by all Natural Heritage Programs in the Central Appalachian Ecoregion for recording data on elements of biological diversity.

3.2.2 Terrestrial and Palustrine Communities

Community targets were set at the *association* level of The Nature Conservancy's national classification (Grossman et al. 1998). The association is defined by the overstory and understory species composition and environmental setting. The Heritage databases contained 798 Element Occurrences from a possible 142 associations. The quality and size of the Element Occurrence database varied dramatically by state. Virginia contributed a large fraction of the total Element Occurrences, followed by Pennsylvania, Maryland, and West Virginia. In West Virginia, rare community occurrences, other than shale barrens, were few. As many as 75% of rare communities in West Virginia may not be represented in the database.

Since most Element Occurrences were listed with local names and not names from the National Vegetation Classification, the Ecology Expert Team crosswalked local names to National names to provide consistency. Where this was not possible due to insufficient information, the Element Occurrence was not used in selecting portfolio sites. In many cases the recommendation was simply to acquire more information on the Element Occurrence so that it could be better evaluated at a later date.

We assessed viability of terrestrial and palustrine communities by assessing size, condition, and landscape context of the community in question. The size assessment involved an evaluation of an ideal size for the community type and comparing the community EO to that ideal. Our condition analysis used a combination of adjacent land cover quality and expert opinion on occurrence quality. We evaluated landscape context by talking to experts about the integrity of natural process drivers within and near the occurrence being evaluated.

Viable terrestrial and palustrine community occurrences were then selected by stratifying across ecoregional subsections or groups of subsections, depending on the rangewide distribution of that community. For large and small patch communities[4], our numerical goal was based on an estimated ability for the community to persist and its rangewide distribution. For matrix-forming forest communities[5], we set a goal of two occurrences per ecoregional subsection, or related stratification unit. A full explanation of this selection process appears in Appendix IV.

3.2.3 Aquatic Communities

Our initial approach to identifying aquatic communities as conservation targets in the Central Appalachian Forest ecoregion was to conduct expert interviews to identify "no regrets" aquatic communities. After determining that this approach was not feasible, we attempted a coarse scale target identification process (Moyle et al. 1999). Using this methodology 8-digit HUC's (the US Environmental Protection Agency's Hydrologic Unit Classification (HUC) that identifies large

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[4] Large and small patch communities are those communities dependent on a local environmental feature or set of features not representing the norm for growing conditions of the region. Large patch communities may occupy areas ranging in size from 100-10,000 acres; small patch communities fall typically in the range of 1-100 acres. Examples of large patch communities would be ridgetop barrens or limestone outcrop forest. Examples of small patch communities would be cedar glades on mafic rock outcrops or ombrotrophic bog communities.

[5] Matrix-forming communities are those common forest communities that contribute to the dominant forest communities of the ecoregion. Small and large patch communities would be imbedded within the matrix.

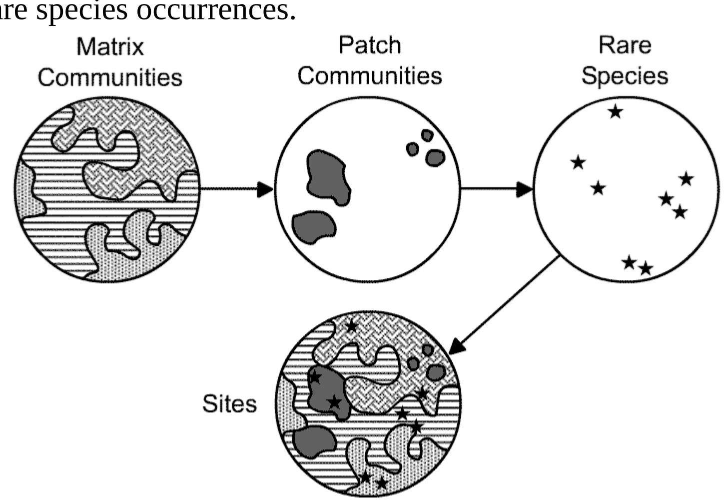
watersheds) were analyzed for relative quality based on land cover, number of dams, point source discharges and other variables assessing degree of hydrologic alteration. This coarse scale target identification process did not adequately separate subwatersheds of high quality from those of lesser quality. Ultimately, we used our matrix community sites and sites where we had known aquatic rarities as surrogates for aquatic community targets. Twenty-nine of our target elements were classified as aquatic. Clearly, the Core Team will need to continue to refine the aquatic community targets as we move forward. The Core Team set a goal of having an adequate aquatic community classification and an acceptable list of aquatic community sites for the portfolio by March 2001.

4.0 PORTFOLIO DEVELOPMENT AND ASSESSMENT

4.1 LANDSCAPE-SCALE SITE SELECTION PROCESS

Matrix communities, large and small patch communities and rare species typically nest and interdigitate to form complex mosaics reflecting the environmental heterogeneity of the landscape. Thus, virtually all sites are mosaics of community types. Perhaps the ideal reserve consists of a large, viable example of matrix forest communities embedded with many and diverse large and small patch communities and rare species occurrences (*Figure 1*).

Figure 1. The ideal conservation site consists of a mosaic of matrix, large and small patch communities, and rare species occurrences.



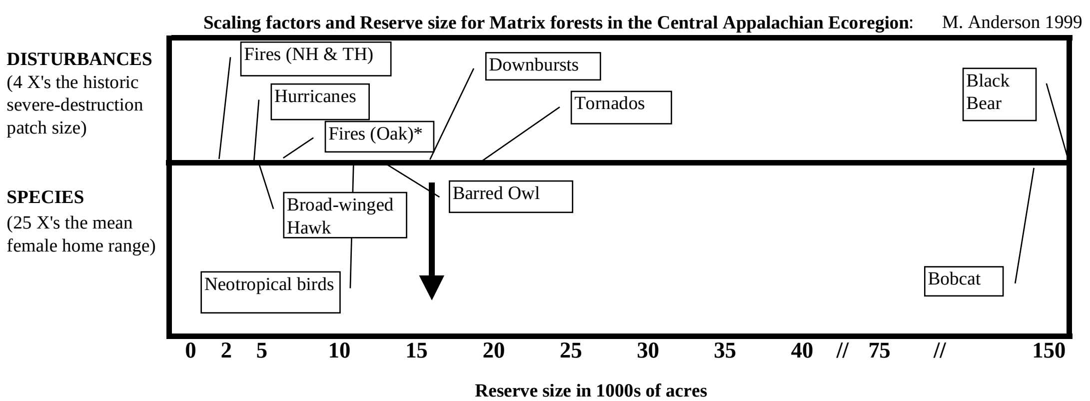
In reality, not all types of patch communities or rare species are found within the large matrix forest blocks. Thus, we needed to develop reserves at a variety of scales, some targeting matrix communities and others targeting patch communities or species not accounted for by the matrix sites[6]. Because sites needed to represent matrix communities are much larger than those needed to preserve patch and species targets, and because good matrix sites will also include many of the

[6] Sites capturing these localized species or community occurrences are referred to as “standard sites”.

smaller targets, it made sense to begin portfolio assembly by selecting matrix forest sites, and to conduct a "sweep analysis" to see what other targets were captured.

Matrix forming communities in the Central Appalachians include 8 terrestrial forest types and their various successional stages. Baker (1992) and Peters et al. (1997) call for scaling a matrix forest reserve to be a small multiple of the maximum disturbance patch size for the matrix forest (i.e., maximum disturbance patch size X 4). The minimum size goal for a viable occurrence was set at 15,000 acres based on the size necessary for an occurrence to absorb and recover from characteristic, large, infrequent disturbances (e.g. tornadoes, fires, insect outbreaks—see *Figure 2*). The Terrestrial and Palustrine Community Expert team evaluated these disturbance regimes and, based on their knowledge of matrix forests in the ecoregion, selected 15,000 as the minimum size. This size serves to maximize the probability that the occurrence retained and maintained a full complement of all its associated fauna with multiple breeding populations (See *Figure 2*). This included, in particular, forest dwelling birds, a diverse canopy, soil insect fauna, various herptiles, and mammals. Black bear and bobcat were not considered in the evaluation of minimum block size, because they use multiple blocks, which can be relatively fragmented. In addition to size the qualifying criteria for a matrix community site also specified that the occurrence:

- be in good or recoverable condition,
- have an old growth core area if possible, and
- contain high or complementary diversity of both species and landscapes as determined by the *Ecological Land Unit* approach (intact watersheds were viewed as a plus but were not a requirement).



Factors to the left of the arrow should be encompassed by a 25,000 acre reserve NH = N. hardwoods (Maple-Beech-Birch)
TH = Transitional Hardwoods (High elevation Red Oak or Red Oak -Sugar Maple)
* Oak forests are dependent on relatively high-frequency, moderate fires, info on catastrophic fires is sketchy
Neotropical estimates based on Robbins et al. 1989, see text for full explanation.

Figure 2. Illustrative justification for selecting matrix blocks of at least 15,000 acres in size.

4.1.1 The Ecological Land Unit Approach to Ensuring Landscape-scale Diversity

Ecological Land Units (ELU's) are georeferenced locations representing unique combinations of soil parent material, topographic position, slope, elevation, and aspect conditions. For the

Central Appalachian Forest ELU's were generated by intersecting polygons of the above data layers to create smaller polygons representing unique combinations (See Map 5). ELU's have been used in this plan as a means of testing whether or not selected matrix blocks capture the diversity of physical conditions which may lead to different matrix forest types. The diversity of physical conditions is used as a *surrogate* for the actual diversity of matrix forming forest types and assumes that this diversity of forests is determined by major divisions in ELU types.

We then used ELU's for two purposes: 1) To evaluate our ability to capture different forest growing conditions, and, by inference, different types of matrix forest blocks, and 2) To provide us with knowledge about what types of growing conditions were underrepresented in our matrix forest block selection process.

It is important to recognize that these matrix blocks are not sites. They are really intermixed occurrences of matrix forming communities (with a lot of embedded patch communities) bounded by roads or other fragmenting features. Site planning has been conducted on only a few of these blocks. Site conservation planning will result in sites that will range from considerably smaller than the block to significantly larger. Since we have done very little site planning, and there are no site boundaries, we have been treating these matrix blocks as surrogates for landscape-scale sites whose boundaries will be defined later.

Based on an initial screening for minimum area, 213 blocks were assessed both quantitatively and qualitatively as to their current condition (see Map 6). Based on expert meetings (see Appendix V for description of methodology), the original 213 sites were reduced to 57 qualifying potential matrix blocks, with these blocks further ranked as *Preferred* or *Alternative* (See Map 7). *Preferred* blocks were those thought to be most likely to meet the conservation goals for the ecoregion. *Alternative* blocks were those blocks less likely to meet the conservation goals or just other blocks which might serve to meet conservation goals if, for some reason, a *Preferred* block was determined not to be suitable upon consideration within a detailed Site Conservation Planning process.

For each of the 57 qualifying blocks, we tabulated the extent and type of all ELUs within the block boundaries. Next we used standard quantitative ordination, classification, and cluster analysis programs (DECORANA, TWINPAN, CLUSTAN available in the PC-ORD for Windows software) to aggregate the blocks into groups within which the blocks were relatively interchangeable as to their ELU features. From this analysis, we distinguished 10 groups of 2 – 7 blocks each. We also identified 3 outlier blocks that were not interchangeable with any of the other potential matrix sites with respect to their ELU composition (See Map 8). The block groups often corresponded with the subsection boundaries. This was expected as the subsection boundaries were created based on areas of similar abiotic features. However, certain subsections lumped together (i.e. Northern and Southern High Allegheny Mts.) while several of the larger ones were split (i.e. Appalachian Ridges) into finer groups based on this ELU analysis[7]. This analysis suggested that a minimum of 1 site from each of the groups would be necessary to fully

[7] Forest ecology experts we interviewed corroborated the fact that the lumping and splitting that we did matched well with their first-hand knowledge of forest diversity, i.e., ELU's may capture environmental diversity and forest diversity more accurately than Bailey's subsections within the Central Appalachian Forest Ecoregion.

MAP 5: CENTRAL APPALACHIAN ECOREGION ECOLOGICAL LAND UNITS

MAP 6: CENTRAL APPALACHIAN ECOREGION BLOCK SIZE

MAP 7: CENTRAL APPALACHIAN ECOREGION CANDIDATE MATRIX FOREST OCCURRENCES

MAP 8: CANDIDATE MATRIX FOREST OCCURRENCES BY ECOLOGIAL LAND UNIT GROUP represent the diversity of matrix forest sites across all bedrock, topography and elevation gradients within the ecoregion.

Within each block group, the individual blocks were assessed and compared as to their relative condition, EO diversity, ELU diversity, complementarity, feasibility for protection, threat and proximity to other features. This was done in small working groups at an extended Core Team meeting. Unavoidably, variation within the block-groups was not always identical, some groups being remarkably homogeneous and others having a fair amount of heterogeneity with respect to ELU composition. To account for differences in the internal variation, some block-groups required several blocks to fully represent their features while others needed only a single block. Only 1 block was actually eliminated from the set, all other blocks were assigned a *Preferred* or *Alternative* status. *Preferred* blocks formed the first iteration matrix community sites and were assumed to represent a minimum solution that maximized occurrence viability and representation of all major gradients and sources of variation. *Alternative* blocks were prioritized as reasonable alternative sites to the *Preferred* sites, should protection of a *Preferred* area prove unfeasible or require supplementation by more sites within each block-group. The final set of *Preferred* sites consisted of 28 matrix forest occurrences distributed across the ecoregion.

4.1.2 Representatives of matrix forest occurrences

By examining the distribution patterns of matrix forest and comparing this pattern to the pattern of Ecological Land Units, it appears that the full range of ecological variation within the ecoregion may not be captured in the matrix forest occurrences. We know that these occurrences in most all cases have as their cores managed areas occupying steep slopes or other rough terrain (See Map 4, Central Appalachian Ecoregion Managed Land).

In order to examine representativeness, we summarized the amount of area for each ELU occurring within management areas. We then examined the difference between the expected distribution of ELU's, based on their relative proportion within the ecoregion, and the observed distribution across the managed areas. For example, the expected areal extent of "low elevation, acidic flat summits" should equal its proportional occurrence in the entire ecoregion times the actual area for the whole ecoregion. As managed areas covered 9,979 ha of this ELU, there is less (2%) of the ELU in managed areas than would be expected from proportional representation. Some patterns are dramatic. For example, 59.7% of mid-elevation acidic shale cliffs and 93.8% of high elevation, calcareous dry flats (93.8%) fall within managed areas. In total, 86 of the 252 ELUs found in CAP were covered disproportionately less than expected. Managed areas disproportionately represent high and mid elevation, acidic ridges and slopes.

Managed areas disproportionately avoid low elevation calcareous substrates, wet and dry flats, lakes and rivers. These are not surprising trends, given the history of land use and conservation in the ecoregion. Managed areas are located where soils are less fertile and, therefore, agriculture has not been the dominant land use. Therefore, the ELUs with which agriculture has a strong relationship will be disproportionately under-protected. The typical ELU description for agriculture is: low elevation (73%), calcareous sedimentary or shale (60%), and dry flat (68%).

Most of these ELUs are found in the Northern Great Valley and Great Valley of Virginia, where a majority of the subsections are in agriculture (52% and 68% respectively) and few managed areas exist. Experts noted that viable forest communities for these types no longer exist and we would need to consider landscape scale restoration of forest in order to address this gap in portfolio coverage.

4.2 SELECTING SPECIES AND PATCH COMMUNITY SITES

The survey sites of all selected occurrences that were not contained within the matrix sites of the portfolio were designated as separate portfolio sites. Clusters of sites, particularly those with overlapping 1000-acre buffers were often grouped into larger sites or will be reassessed in the future as larger scale sites. When all sites and target occurrences had been identified, the complete portfolio was measured against the conservation goals set for each species and community. Viable secondary targets were selected at sites where a primary target had already been selected.

4.3 SITES SELECTED FOR THE PORTFOLIO

Of the total of 57 potential matrix forest occurrences evaluated (*Preferred* plus *Alternative* sites), 28 were selected for the portfolio based on size, contained target occurrences, habitat diversity, and condition. These 28 matrix forest occurrences represent one solution to the question of "What portfolio of sites will conserve multiple viable examples of the 8 matrix communities?" Other solutions are possible and it is very likely that, as conservation activity moves forward, substitution will occur among the matrix forest sites within the portfolio.

Collectively, the 28 matrix "sites" total 2.5 million acres, accounting for about 10.6% of the 23.9 million-acre ecoregion. These matrix forest occurrences contain 824 viable occurrences of conservation targets (47% of the known viable occurrences in the ecoregion).

The other 53% of the target occurrences fall within 439 separate sites, two of which are landscape-scale macrosites in West Virginia. Boundaries for most of these sites will need further definition through Site Conservation Planning. The areas represented on Map 9 (Central Appalachian Ecoregion Portfolio and Action Plan) show site points buffered by 1000 acres as well as 10-year Action Sites. Future site conservation planning will likely combine some of these sites into larger conservation areas.

Currently the portfolio consists of 467 sites.

4.4 LINKAGES

The above portfolio of sites captures all of our currently known viable target occurrences that can be used to meet our conservation goals. When each of these sites has been designed and site

MAP 9: CENTRAL APPALACHIAN ECOREGION PORTFOLIO AND ACTION PLAN boundaries defined that incorporate all of our land based strategies, these sites will still be isolated islands in a sea of predominantly working forest and rural residential land. The ecoregional planning team assumes that this portfolio of islands will, in itself, not preserve the biodiversity of the ecoregion if land use between sites becomes a barrier to species movement. We feel that biodiversity will only be protected through a network of preserves/cores that are adequately buffered by and connected through corridors of compatibly managed land. Fortunately, much of the existing land use does provide the necessary connections. Among these connections, the Ecology Expert Team identified the front ridge on the north side of the Great Valley as a corridor of special conservation significance. However, a key activity in the next three years will be to look at issues of site linkage and species movement and develop a plan for how to minimize the potential effects of site isolation. The Joint Central Appalachian Ecoregional Office will lead this effort.

4.5 STATUS TOWARD REACHING CONSERVATION GOALS

Although the portfolio captures 1,742 element occurrences, conservation goals were often not met. In most cases there were not enough documented viable occurrences of conservation targets to allow us to reach our goals.

4.5.1 Species

After selecting occurrences based on the standards described in Table 3, minimal goals were met for 37 plant species out of 73, 73 invertebrate species out of 103, and 13 vertebrate species out of 20. However, most of these species where goals were met were for G1 and G2 species, where the team specified that the goal was met if all viable occurrences were conserved. Therefore, for G1 and G2 species, goals were automatically met. If a goal of 20 viable occurrences had been used for G1 and G2 species, the totals for goals met drop to 15 species of plants (out of 73), 4 species of invertebrates (out of 103), and 4 species of vertebrates (out of 20). Please see Appendix VI for goals set for each species and the extent to which goals were met.

Our list of target species included 12 plant, 4 invertebrate, and 7 vertebrate species listed under the Federal Endangered Species Act. According to the standards we set for long term species survival, 18 of the 23 Federally-listed species would be adequately conserved in the Central Appalachian Forest portfolio. Please see Appendix VII for a list of these species and notation on which species were adequately or inadequately represented in the portfolio.

The group of secondary targets included 4 plants, 15 invertebrates, and 10 vertebrates. Of these secondary targets, goals were met for none of the plants, one of the invertebrates and six of the vertebrates. The plant secondary targets should receive consideration by the Core Team as primary targets, because they were not swept in by the portfolio. The same could be said for the invertebrate secondary targets, except for the one species where goals were met. The ten vertebrate secondary targets were all birds. The Bird Expert team felt that six of the bird species were adequately conserved by the portfolio of sites, especially considering the habitat offered by matrix block forests. However, the bird secondary target list included four species found in grasslands and early successional scrublands. Since the portfolio did not capture these community types adequately, the Bird Expert Team felt that Golden-winged warbler, Prairie warbler, Bobolink, and Henslow's sparrow should be considered for primary target status by the Core Team.

For the next iteration of the portfolio the planning team needs to review the goals set for species and possibly modify them. If better information allows the team to relax goals, the number of species meeting goals could increase. In many cases, additional inventory may yield more occurrences for the portfolio. Also, many occurrences were left out of the portfolio based on insufficient information on the current quality of the occurrence. Gathering more information on these species should help meet ecoregional goals.

4.5.2 Terrestrial Communities

Numerical goals for 45 out of the 143 targeted terrestrial plant communities were met. We reached our goals most often for rare plant communities, like shale barrens and cedar glades, or for wetland plant communities. Goals were met less often for common plant communities where less data was typically available. Please see Appendix VIII for goals set for each community and the extent to which goals were met.

Based on this information, we now are able to focus new inventory on underrepresented terrestrial communities.

For matrix communities we set an initial goal of at least two matrix blocks for each of 7 of the subsections: Northern Allegheny Mountains, Southern/Central Allegheny Mountains, Western Low Mountains, Eastern Low Mountains, Northern Ridge and Valley, Southern Ridge and Valley, and Northern Blue Ridge and the Allegheny Mountain Plateau subsections. However, we modified our goals according to the level of stratification suggested by our ELU analysis. With the modified goals, we were able to select sufficient matrix forest in each subregion.

4.5.3 Aquatic Sites

Fourteen out of 28 of the matrix forest sites in the portfolio contained 82 selected Element Occurrences for aquatic elements. Forty-seven of the standard sites outside matrix forest contained 72 selected Element Occurrences for aquatic elements. Of the approximately 55,000 miles of stream in the Central Appalachian Forest ecoregion, 4,286 miles of stream are contained within matrix block sites. 152 lakes and reservoirs totaling 4949 acres are also contained within matrix forest occurrences in the portfolio. Although these statistics cannot be used to assess our progress in meeting goals for aquatic elements, they do indicate that the portfolio already captures some portion of the aquatic diversity of the ecoregion.

4.6 OWNERSHIP/MANAGEMENT STATUS OF THE PORTFOLIO

The approximate area covered by the portfolio is 3,011,000 acres. Of this area, 2,530,000 acres occurs within matrix blocks. Therefore, standard sites cover an additional 481,000 acres. The Federal government manages approximately 46% of matrix block acreage and various state governments an additional 18%. The majority of the remaining area of matrix block sites is privately-owned. For standard sites the ownership and management status pattern is almost exactly reversed. Two-thirds of standard sites are in private ownership and one-third is publicly-owned.

5.0 STRATEGY DEVELOPMENT AND IMPLEMENTATION

During the portfolio selection process, state teams selected Element Occurrences for inclusion in the portfolio based on goals set by the Core Team and Expert Teams. In addition to selecting Element Occurrences, state teams (composed of state conservation scientists and State Directors) identified which sites should be prioritized for action within the next 10 years. These "10-year Action Sites" are those sites where it is feasible to take action to achieve measureable *improvement* in the conservation targets, the threats to those targets, or the conservation capacity at the site as evaluated by the Measures of Success spreadsheet. Improvements would result, at the minimum, in retaining the current quality of the conservation targets. These sites not only have a high probability of successful conservation action, but they are often the sites where reduction in threat status is most needed.

Based on these criteria, the state teams selected 10 matrix block sites, 2 additional landscape-scale sites (macrosites), and 98 standard sites for 10-year action. State Chapters will now proceed to develop threats assessments and strategies for action at these sites over the next few years, with the expectation of achieving positive conservation results within 10 years. However, the portfolio contains an additional 339 standard sites and 18 landscape-scale sites. These other portfolio sites will require some level of monitoring to ensure that these sites remain part of the portfolio for the Central Appalachian forest in the future. The Joint Central Appalachian Ecoregional Office will develop methodologies to ensure that these sites can be retained in the portfolio.

6.0 ONGOING WORK

The Central Appalachian Forest ecoregion is exceedingly rich in biological diversity. The ecoregion enjoys a relatively rich data set thanks to the work of the participating Natural Heritage programs and their partners. Even with this richness, more work needs to be done in identifying additional Element Occurrences and sites for conservation. Our goals for conserving species and natural communities within this ecoregion were rarely met. Only about one in seven sites has been prioritized for conservation action by The Nature Conservancy within the next 10 years. Success in conserving a portfolio of sites for this ecoregion will require great efficiency and agility. These observations lead us to a number of recommendations regarding how to implement this plan and improve upon it:

1. Conduct additional inventory to help meet goals for ecoregional conservation.
   Additional inventory for species occurrences could help us meet goals for many species. There is great potential through further inventory in Pennsylvania, West Virginia, and Virginia to identify additional viable occurrences of species to help meet conservation goals.

2. Ensure that data collected are entered into the Biological Conservation Database.
   Particularly for community data in Maryland and West Virginia, many terrestrial community datasets have been gathered, but not yet entered into the Biological Conservation Database. This ecoregional team has worked almost exclusively with data entered into the database. The Central Appalachian Forest made a decision not to include data that had yet to be entered into BCD, because these data had not been fully quality controlled.

3. Obtain some form of agreement to capture data for western Pennsylvania.
   Currently, we only have four sites identified in western Pennsylvania, based on an early designation of "no regrets sites" and our matrix block analysis. We need to develop some form of agreement with the Western Pennsylvania Conservancy that will allow those Element Occurrences to become part of the portfolio assembly process.

4. By March 2001 develop a system for classifying aquatic communities.
   The Joint Central Appalachian Program Office will lead an effort to develop and implement a system of aquatic community classification in order to develop a full list of candidate sites for aquatic community conservation by March 2001.

5. Develop a better system for prioritizing cave sites based on cave-dwelling invertebrates.
   By May of 2001, Tom Smith, Director of the Virginia Natural Heritage Program, will engage Dr. Dave Culver and Dr. John Holsinger to construct a better system for prioritizing such cave sites. Tom Smith's action depends on the availability of funding to engage these cave biologists. Within one year of finishing the prioritization methodology, implement that methodology to better prioritize cave sites in the Central Appalachian Forest ecoregion.

6. Hold a follow-up meeting of the Central Appalachian Forest Core Team.
   By April 2001, hold a Central Appalachian Forest Core Team meeting to assess progress in completing plans for 10-year Action Sites and to address issues of aquatic communities, cave conservation, and monitoring of portfolio sites not on the 10-year Action Site list. Review progress in reducing threats, increasing conservation capacity, and enhancing biodiversity health for all portfolio sites. Review strategic direction, particularly for multi-site threats.

7. Ensure Core Team continuity.
   Make sure that the Core Team always has a leader to facilitate action on the plan.

7.0 REFERENCES

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8.0 ACKNOWLEDGMENTS

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APPENDIX I--PLANNING TEAMS

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

Jim Thorne, Director of Conservation Programs, PA Chapter (Lead)
Steve Buttrick, Director of Conservation Science and Stewardship, ERO (Co-leader)
Mark Anderson, Regional Ecologist and later Director of Eastern Conservation Science, ERO (replaced Steve Buttrick as Co-leader)
Randy Gray, State Director, PA Chapter (Sponsor)
Rodney Bartgis, Director, Joint Central Appalachian Program, MD/DC and WV Chapters
Ashton Berdine, Ecologist, TNC and MD Natural Heritage and later WV Chapter
John Bender, Associate Director of Land Protection, MD/DC Chapter
Tony Davis, Director of the Pennsylvania Science Office, PA Natural Diversity Inventory-East, PA Chapter
Judy Dunscomb, Director of Science and Stewardship, VA Chapter
Jean Fike, Ecologist, PA Natural Diversity Inventory-Central, PA DCNR Bureau of Forestry
Michael Lipford, State Director, VA Chapter
Brian McDonald, Director of WV Natural Heritage
Doug Samson, Director of Science and Stewardship, MD/DC Chapter
Tom Smith, Director of VA Natural Heritage
Paul Trianosky, State Director, WV Chapter
Nat Williams, State Director, MD/DC Chapter

Terrestrial and Palustrine Communities Expert Team
Mark Anderson, Regional Ecologist, ERO (Lead)
Ashton Berdine, Ecologist, TNC and MD Natural Heritage
Tony Davis, Director of the Pennsylvania Science Office, PA Natural Diversity Inventory-East, PA Chapter
Jean Fike, Ecologist, PA Natural Diversity Inventory-Central, PA DCNR Bureau of Forestry
Gary Fleming, Ecologist, VA Natural Heritage
Jim Thorne, Director of Conservation Programs, PA Chapter
Dean Walton, Ecologist, WV Natural Heritage
Jeff Wagner, Ecologist, PA Natural Diversity Inventory-West, Western Pennsylvania Conservancy

Plant Expert Team
Rodney Bartgis, Director, Joint Central Appalachian Program, MD/DC and WV Chapters (Lead)
P.J. Harmon, Botanist, WV Natural Heritage
John Kunsman, Botanist, Pennsylvania Science Office, PA Chapter
Chris Ludwig, Botanist, VA Natural Heritage
Ed Thompson, Western MD Staff, MD Natural Heritage

Animal Expert Team
Judy Dunscomb, Director of Science and Stewardship, VA Chapter (Lead)
Scott Blackburn, Zoologist, WV Natural Heritage
Charles Bier, PA Natural Diversity Inventory-West, Western Pennsylvania Conservancy
Dan Feller, Zoologist, MD Natural Heritage
Steve Roble, Zoologist, VA Natural Heritage
Ed Thompson, Western MD Staff, MD Natural Heritage

Bird Expert Team
Judy Dunscomb, Director of Science and Stewardship, VA Chapter (Lead)
Dan Brauning, Ornithologist, PA Game Commission
Lise Hanners, Ecologist, CT Chapter
Dave Mehlman, Ornithologist, TNC Wings of the Americas Program
Steve Roble, Zoologist, VA Natural Heritage
Ed Thompson, Western MD Staff, MD Natural Heritage

APPENDIX II—List of Conservation Targets

1. Vertebrates

GNAME	GCOMNAME	GRANK
NEOTOMA MAGISTER	ALLEGHENY WOODRAT	G3G4
MYOTIS LEIBII	EASTERN SMALL-FOOTED MYOTIS	G3
GLAUCOMYS SABRINUS FUSCUS	VIRGINIA NORTHERN FLYING SQUIRREL	G5T2
CORYNORHINUS TOWNSENDII VIRGINIANUS	VIRGINIA BIG-EARED BAT	G4T2
ANEIDES AENEUS	GREEN SALAMANDER	G3G4
PLETHODON PUNCTATUS	WHITE-SPOTTED SALAMANDER	G3
MYOTIS SODALIS	INDIANA OR SOCIAL MYOTIS	G2
PLETHODON NETTINGI	CHEAT MOUNTAIN SALAMANDER	G2
PERCINA REX	ROANOKE LOGPERCH	G2
PLETHODON SHENANDOAH	SHENANDOAH SALAMANDER	G1
NOTURUS GILBERTI	ORANGEFIN MADTOM	G2
NOTROPIS SEMPERASPER	ROUGHHEAD SHINER	G2G3
RHINICHTHYS BOWERSI	CHEAT MINNOW	G1G2
SCARTOMYZON ARIOMMUS	BIGEYE JUMPROCK	G2
ETHEOSTOMA OSBURNI	CANDY DARTER	G3
CLEMMYS MUHLENBERGII	BOG TURTLE	G3
PLETHODON HUBRICHTI	PEAKS OF OTTER SALAMANDER	G2
THRYOMANES BEWICKII ALTUS	APPALACHIAN BEWICK'S WREN	G5T2Q
AMBLOPLITES CAVIFRONS	ROANOKE BASS	G3
GYRINOPHILUS SUBTERRANEUS	WEST VIRGINIA SPRING SALAMANDER	G1Q
SOREX PALUSTRIS PUNCTULATUS	SOUTHERN WATER SHREW	G5T3
MICROTUS CHROTORRHINUS CAROLINENSI	SOUTHERN ROCK VOLE	G4T3

2. Plants

GNAME	GCOMNAME	GRANK
PTILIMNIUM NODOSUM	HARPERELLA	G2
ILEX COLLINA	LONG-STALKED HOLLY	G3
ECHINACEA LAEVIGATA	SMOOTH CONEFLOWER	G2
HELENIUM VIRGINICUM	VIRGINIA SNEEZEWEED	G2
LIATRIS TURGIDA	TURGID GAY-FEATHER	G3
MARSHALLIA GRANDIFLORA	LARGE-FLOWERED BARBARA'S-BUTTONS	G2

PRENANTHES CREPIDINEA	NODDING RATTLESNAKE-ROOT	G3G4
RUDBECKIA TRILOBA VAR PINNATILOBA	PINNATE-LOBED BLACK-EYED SUSAN	G4T2?
SYNOSMA SUAVEOLENS	SWEET-SCENTED INDIAN-PLANTAIN	G3G4
ARABIS PATENS	SPREADING ROCKCRESS	G3
ARABIS SEROTINA	SHALE-BARREN ROCKCRESS	G2
CARDAMINE FLAGELLIFERA	BITTER CRESS	G3
PARONYCHIA VIRGINICA VAR VIRGINICA	YELLOW NAILWORT	G4T1T2
SILENE VIRGINICA VAR ROBUSTA		G5T1Q
PAXISTIMA CANBYI	CANBY'S MOUNTAIN-LOVER	G2
HYPERICUM MITCHELLIANUM	BLUE RIDGE ST. JOHN'S-WORT	G3
GAYLUSSACIA BRACHYCERA	BOX HUCKLEBERRY	G2G3
EUPHORBIA PURPUREA	GLADE SPURGE	G3
TRIFOLIUM STOLONIFERUM	RUNNING BUFFALO CLOVER	G3
TRIFOLIUM VIRGINICUM	KATE'S-MOUNTAIN CLOVER	G3
MONARDA FISTULOSA SSP 1	SMOKE HOLE BERGAMOT	G5T1
PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	G2
STACHYS CLINGMANII	CLINGMAN'S HEDGE-NETTLE	G2
ILIAMNA REMOTA	KANKAKEE GLOBE-MALLOW	G1Q
ILIAMNA COREI	PETERS MOUNTAIN MALLOW	G1Q
SIDA HERMAPHRODITA	VIRGINIA MALLOW	G2
PHLOX BUCKLEYI	SWORD-LEAVED PHLOX	G2
POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	G3
ACONITUM RECLINATUM	WHITE MONKSHOOD	G3
CLEMATIS ADDISONII	ADDISON'S LEATHERFLOWER	G2
CLEMATIS COACTILIS	VIRGINIA WHITE-HAIR LEATHER-FLOWER	G2G3
CLEMATIS VITICAULIS	MILLBORO LEATHERFLOWER	G1
DELPHINIUM EXALTATUM	TALL LARKSPUR	G3
SPIRAEA VIRGINIANA	VIRGINIA SPIRAEA	G2
BUCKLEYA DISTICHOPHYLLA	PIRATEBUSH	G2
HEUCHERA ALBA	WHITE ALUMROOT	G2Q
PARNASSIA GRANDIFOLIA	LARGE-LEAVED GRASS-OF-PARNASSUS	G3
VIOLA APPALACHIENSIS	APPALACHIAN BLUE VIOLET	G3
VITIS RUPESTRIS	ROCK GRAPE	G3
CAREX LUPULIFORMIS	FALSE HOP SEDGE	G3G4
CAREX POLYMORPHA	VARIABLE SEDGE	G3
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	G3
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	G3
ALLIUM OXYPHILUM	LILLYDALE ONION	G2G3Q
CLINTONIA ALLEGHANIENSIS	HARNED'S CLINTONIA	G1Q
HELONIAS BULLATA	SWAMP-PINK	G3
TRILLIUM PUSILLUM	LEAST TRILLIUM	G3
TRILLIUM PUSILLUM VAR	VIRGINIA LEAST TRILLIUM	G3T2

VIRGINIANUM		
CLEISTES BIFARIA	SPREADING POGONIA	G3G4
ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	G2G3
PLATANTHERA LEUCOPHAEA	EASTERN PRAIRIE WHITE-FRINGED ORCHID	G2
POA LANGUIDA	DROOPING BLUEGRASS	G3G4Q
POA PALUDIGENA	BOG BLUEGRASS	G3
POTAMOGETON HILLII	HILL'S PONDWEED	G3
POTAMOGETON TENNESSEENSIS	TENNESSEE PONDWEED	G2
CYSTOPTERIS LAURENTIANA	LAURENTIAN BLADDER FERN	G3G4
GYMNOCARPIUM APPALACHIANUM	APPALACHIAN OAK FERN	G3
LYCOPODIELLA MARGUERITIAE	NORTHERN PROSTRATE CLUBMOSS	G2
STREPTOPUS AMPLEXIFOLIUS	CLASPING TWISTED-STALK	G4G5
ARETHUSA BULBOSA	SWAMP-PINK	G4G5
VACCINIUM OXYCOCCUS	SMALL CRANBERRY	G4G5
ASTRAGALUS DISTORTUS	OZARK MILK-VETCH	G4G5
LARIX LARICINA	AMERICAN LARCH	G4G5
CALLA PALUSTRIS	WILD CALLA	G4G5
CYPERUS HOUGHTONII	HOUGHTON'S UMBRELLA-SEDGE	G4G5
CYPERIPEDIUM CANDIDUM	SMALL WHITE LADY'S SLIPPER	G4G5
ERYSIMUM CAPITATUM	WESTERN WALLFLOWER	G4G5
HUDSONIA TOMENTOSA	SAND HEATHER	G4G5
ANDROMEDA POLIFOLIA GLAUCOPHYLL	BOG ROSEMARY	G5T5
CAREX PAUCIFLORA	FEW-FLOWERED SEDGE	G4G5
JUNCUS FILIFORMIS	THREAD RUSH	G4G5
JUNCUS TRIFIDUS	HIGHLAND RUSH	G4G5
AGROSTIS MERTENSII	ARCTIC BENTGRASS	G5
ORYZOPSIS CANADENSIS	CANADA MOUNTAIN-RICEGRASS	G4G5
CHIELANTHES EATONII	EATON LIPFERN	G5?
CRYPTOGRAMMA STELLERI	FRAGILE ROCKBRAKE	G4G5
ASPLENIUM SEPTENTRIONALE	NORTHERN SPLEENWORT	G4G5

Secondary Targets:

CAREX COLLINSII	COLLINS' SEDGE	G4G5
ABIES BALSAMEA	BALSAM FIR	G5
JUNIPERUS COMMUNIS	OLD-FIELD JUNIPER	G5
TAXUS CANADENSIS	CANADIAN YEW	G5

3. Invertebrates

GNAME	GCOMNAME	GRANK
TRICHODRILUS CULVERI		G1G2
STYLODRILUS BEATTIEI	A CAVE LUMBRICULID WORM	G1G2
CAECIDOTEA PRICEI	PRICE'S CAVE ISOPOD	G3
CAECIDOTEA FRANZI	FRANZ'S CAVE ISOPOD	G1
CAECIDOTEA HOLSINGERI	HOLSINGER'S CAVE ISOPOD	G3
CAECIDOTEA HENROTI	HENROT'S CAVE ISOPOD	G2
CAECIDOTEA CANNULUS	AN ISOPOD	G2
CAECIDOTEA SIMONINI		G1
CAECIDOTEA SP 1	ROCK SPRINGS CAVE ISOPOD	G1
CAECIDOTEA SP 3	JOHN FRIEND'S CAVE ISOPOD (MD)	G3
ANTROLANA LIRA	MADISON CAVE ISOPOD	G1
STYGOBROMUS BIGGERSI	BIGGERS' CAVE AMPHIPOD	G1G2
STYGOBROMUS GRACILIPES	SHENANDOAH VALLEY CAVE AMPHIPOD	G2
STYGOBROMUS PIZZINII	PIZZINI'S CAVE AMPHIPOD	G2
STYGOBROMUS FRANZI	FRANZ'S CAVE AMPHIPOD	G2
STYGOBROMUS EMARGINATUS	GREENBRIER CAVE AMPHIPOD	G3
STYGOBROMUS MORRISONI	MORRISON'S CAVE AMPHIPOD	G2
STYGOBROMUS STEGERORUM	MADISON CAVE AMPHIPOD	G1
STYGOBROMUS ABDITUS	JAMES CAVE AMPHIPOD	G1
STYGOBROMUS BAROODYI	ROCKBRIDGE COUNTY CAVE AMPHIPOD	G2
STYGOBROMUS CONRADI	BURNSVILLE COVE CAVE AMPHIPOD	G1G2
STYGOBROMUS ESTESI	CRAIG COUNTY CAVE AMPHIPOD	G1
STYGOBROMUS SPINOSUS	BLUE RIDGE MOUNTAIN AMPHIPOD	G2G3
STYGOBROMUS STELLMACKI	STELLMACK'S CAVE AMPHIPOD	G1
STYGOBROMUS SPINATUS	SPRING CAVE AMPHIPOD	G3
STYGOBROMUS PARVUS	MINUTE CAVE AMPHIPOD	G1
STYGOBROMUS REDACTUS	AN AMPHIPOD	G1
STYGOBROMUS CULVERI		G1
CRANGONYX DEAROLFI	PENNSYLVANIA CAVE AMPHIPOD	G1G2
CAMBARUS NERTERIUS	A CRAYFISH	G2
CAMBARUS ELKENSIS	ELK RIVER CRAYFISH	G2
MIKTONISCUS RACOVITZAE	RACOVITZA'S TERRESTRIAL CAVE ISOPOD	G2
SINELLA AGNA		G2
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	G3
CICINDELA PATRUELA	A TIGER BEETLE	G3
PSEUDANOPHTHALMUS LALLEMANTI	CAVE BEETLE	G1
PSEUDANOPHTHALMUS GRANDIS	A CAVE BEETLE	G3
PSEUDANOPHTHALMUS GRANDIS GRANDIS	A CAVE BEETLE	G3T3

PSEUDANOPHTHALMUS HYPERTRICHOSIS	A CAVE BEETLE	G3
PSEUDANOPHTHALMUS FUSCUS		G2
PSEUDANOPHTHALMUS POTOMACA POTOMACA	SOUTH BRANCH VALLEY CAVE BEETLE	G1T1
PSEUDANOPHTHALMUS AVERNUS	AVERNUS CAVE BEETLE	G1
PSEUDANOPHTHALMUS EGBERTI	NEW RIVER VALLEY CAVE BEETLE	G1
PSEUDANOPHTHALMUS HORTULANUS	GARDEN CAVE BEETLE	G1
PSEUDANOPHTHALMUS HUBBARDI	HUBBARD'S CAVE BEETLE	G1
PSEUDANOPHTHALMUS INTERSECTUS	CROSSROADS CAVE BEETLE	G1
PSEUDANOPHTHALMUS LIMICOLA	MUD-DWELLING CAVE BEETLE	G1
PSEUDANOPHTHALMUS NELSONI	NELSON'S CAVE BEETLE	G1
PSEUDANOPHTHALMUS PARVICOLLIS	THIN-NECK CAVE BEETLE	G1
PSEUDANOPHTHALMUS PETRUNKEVITCHI	PETRUNKEVITCH'S CAVE BEETLE	G1
PSEUDANOPHTHALMUS PONTIS	NATURAL BRIDGE CAVE BEETLE	G1
PSEUDANOPHTHALMUS PUNCTATUS	SPOTTED CAVE BEETLE	G1
PSEUDANOPHTHALMUS QUADRATUS	STRALEY'S CAVE BEETLE	G1
PSEUDANOPHTHALMUS HOFFMANI	A GROUND BEETLE	G1G2
PSEUDANOPHTHALMUS PUSIO	A GROUND BEETLE	G1?
PSEUDANOPHTHALMUS GRACILIS	A GROUND BEETLE	G1
PSEUDANOPHTHALMUS SP 6	A GROUND BEETLE	G1
PSEUDANOPHTHALMUS SP 7	A GROUND BEETLE	G1
PSEUDANOPHTHALMUS SP 8	A GROUND BEETLE (HUBBARDI GROUP)	G1
PSEUDANOPHTHALMUS SP 11	(PUSIO GROUP)	G1
PSEUDANOPHTHALMUS SP 15	MARYLAND CAVE BEETLE	G1
PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	G2
SATYRIUM KINGI	KING'S HAIRSTREAK	G3G4
INCISALIA IRUS	FROSTED ELFIN	G3G4
SPEYERIA DIANA	DIANA	G3
SPEYERIA IDALIA	REGAL FRITILLARY	G3
MEROLONCHE DOLLI	DOLL'S MEROLONCHE	G3
PAPAIPEMA SP 1	FLYPOISON BORER MOTH	G2
PROPERIGEA SP 1	A NOCTUID MOTH	G2G3Q
CHAETAGLAEA CERATA	A NOCTUID MOTH	G3G4
GOMPHUS ABBREVIATUS	SPINE-CROWNED CLUBTAIL	G3G4
GOMPHUS VIRIDIFRONS	GREEN-FACED CLUBTAIL	G3
LANTHUS PARVULUS	NORTHERN PYGMY CLUBTAIL	G3G4
AESHNA MUTATA	SPATTERDOCK DARNER	G3G4
APOCHTHONIUS COECUS	A PSEUDOSCORPION	G1
KLEPTOCHTHONIUS HENROTI	GREENBRIER VALLEY CAVE	G1

	PSEUDOSCORPION	
KLEPTOCHTHONIUS ANOPHTHALMUS	A PSEUDOSCORPION	G1
KLEPTOCHTHONIUS SP 1	A PSEUDOSCORPION	G1
CHITRELLA SUPERBA	A PSEUDOSCORPION	G1
MUNDOCHTHONIUS HOLSINGERI		G1
ALASMIDONTA VARICOSA	BROOK FLOATER	G3
ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3
FUSCONAIA MASONI	ATLANTIC PIGTOE	G2
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	G3G4
LASMIGONA HOLSTONIA	TENNESSEE HEELSPLITTER	G2G3
LASMIGONA SUBVIRIDIS	GREEN FLOATER	G3
PLEUROBEMA COLLINA	JAMES SPINYMUSSEL	G1
POLYGYRISCUS VIRGINICUS	VIRGINIA COIL	G1
TRIODOPSIS PLATYSAYOIDES	CHEAT THREETOOTH	G1
FONTIGENS OROLIBAS	BLUE RIDGE SPRINGSNAIL	G3
FONTIGENS TARTAREA	ORGAN CAVESNAIL	G2
FONTIGENS BOTTIMERI	APPALACHIAN SPRINGSNAIL	G3
PROCOTYLA TYPHLOPS	A PLANARIAN	G1G2
SPHALLOPLANA PRICEI	REFTON CAVE PLANARIAN	G1
MACROCOTYLA HOFFMASTERI	HOFFMASTER'S CAVE PLANARIAN	G3
BUOTUS CAROLINUS	A MILLIPEDE	G1
DIXIORIA FOWLERI	A MILLIPEDE	G2
SEMIONELLUS PLACIDUS	A MILLIPEDE	G3
LYCAENA EPIXANTHES	BOG COPPER	G4G5
TRIODOPSIS PICEA	SPRUCE KNOB THREE-TOOTH	G3
LEUCORRHINA HUDSONICA	HUDSONIAN WHITEFACE	G5
HELICODISCUS DIADEMA	SHAGGY COIL	G1
HELICODISCUS LIRELLUS	RUBBLE COIL	G1

Secondary Targets:

ANTHROBIA MONMOUTHIA		G3G4
CALEPHELIS BOREALIS	NORTHERN METALMARK	G3G4
CALOPTERYX AMATA	SUPERB JEWELWING	G3G4
ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	G4T2T3
OPHIOGOMPHUS ALLEGHANIENSIS	ALLEGHENY SNAKETAIL	G3Q
PHANETTA SUBTERRANEA		G3
PSEUDOSINELLA GISINI		G3

PSEUDOTREMIA ALECTO	A MILLIPEDE	G1
PSEUDOTREMIA FULGIDA	GREENBRIER VALLEY CAVE MILLIPEDE	G2
PSEUDOTREMIA PRINCEPS	SOUTH BRANCH VALLEY CAVE MILLIPEDE	G1
PSEUDOTREMIA SUBLEVIS	A MILLIPEDE	G1
STYGOBROMUS SP 7	SHERANDO SPINOSID AMPHIPOD	G2
STYLURUS SCUDDERI	ZEBRA CLUBTAIL	G3G4
TRICHOPETALUM PACKARDI	PACKARD'S BLIND CAVE MILLIPEDE	G3Q
TRICHOPETALUM WEYERIENSIS	GRAND CAVERNS BLIND CAVE MILLIPEDE	G3Q

4. Terrestrial and Palustrine Plant Communities

ECOGROUP	Descriptive name
MARSH	Baltic rush-tussock sedge marsh
CONIFER FOREST: MID/LOW ELEVATION:RIDGES & SLOPES	Shortleaf pine/heath forest of dry, acidic steep slopes
CONIFER FOREST: MID/LOW ELEVATION:RIDGES & SLOPES	Carolina hemlock forest
MIXED FOREST: MID/LOW ELEVATION: HEMLOCK	Eastern hemlock-yellow birch-black cherry forest
DECIDUOUS FOREST: MESIC: LOW SLOPES & COVES	Sugar maple-white ash-basswood-bluebead cove forest
RIVERSHORE: GRASSLAND	Torturous sedge gravel rivershore
AQUATIC: LAKE/POND	Mud plantain muddy ponds
WETLAND SHRUB THICKET	Smooth alder shrub thicket
CONIFER SWAMP: MID/LOW ELEVATION	Eastern hemlock-great laurel swamp
WETLAND SHRUB THICKET	Meadowsweet-dewberry shrub swamp
MARSH	Baltic rush-prairie sedge marsh
BARREN: GREENSTONE	White ash - Shagbark hickory woodlands
WETLAND SHRUB THICKET	Buttonbush semipermanantly flooded shrub swamp
BARREN: CALCAREOUS	Little bluestem calcareous grassy opening
MIXED FOREST: MID/LOW ELEVATION	Eastern hemlock-tuliptree forest
SHRUB SUMMIT:MID/LOW ELEVATION	Scrub oak summits
CONIFER FOREST: MID/LOW: MIDSLOPE: HEMLOCK-PINE	White pine-eastern hemlock dry forest:northern type
BARREN: PITCH PINE	Pitch pine/black chokeberry low-mid elevation ridgetop
BARREN: PITCH PINE	Pitch pine/scrub oak/black chokeberry low-mid elevation Ridgetop
MIXED FOREST: MID/LOW ELEVATION: HEMLOCK	Eastern hemlock-tuliptree-great laurel forest
MIXED FOREST: MID/LOW ELEVATION	Mixed pine-chestnut oak xeric forest (large patch to matrix)
DECIDUOUS FOREST: MESIC: N. HARDWOOD	Maple-Beech-Birch-Cherry northern hardwoods (matrix)
	Saxifrage-stonecrop rocky summit
SUMMIT: GRASS BALD	High elevation sparse summit
RIVERSHORE: SHRUB THICKET	Alder-ninebark thickets
DECIDUOUS FOREST: HIGH ELEVATION	High elevation red oak/blueberry-flame azalea forest
RIVERSHORE: SHRUB THICKET	River birch-willow thickets
SHRUB SUMMIT:HIGH ELEVATION	Mountain laurel-black huckleberry summit
SEEP: ACIDIC	Jewelweed-beebalm-coneflower seep
CLIFF: CALCAREOUS	Spleenwort-cliffbrake calcarous cliff

DECIDUOUS FOREST:MID/LOW XERIC:SLOPE:ALKALINE	Yellow oak-sugar maple-red bud forest of calcareous upper slopes and summits
BARREN: TALUS SLOPE	White ash-Basswood-dogwood alkaline talus slope
SWAMP: DECIDUOUS	Red maple-black gum swamp
BARREN: CALCAREOUS	Chinquapin oak-redbud calcareous woodland (northern type?)
SWAMP: DECIDUOUS	Pin oak-swamp white oak swamp
CONIFER SWAMP: MID/HIGH	Red spruce-hemlock/great laurel swamp
RIVERSHORE: GRASSLAND	Big bluestem-wild indigo riverside prairie
WOODED FEN	Red maple wooded fen
SWAMP: DECIDUOUS	Red maple-black ash swamp
MIXED SWAMP: MID/HIGH	Eastern hemlock-red maple-great laurel swamp
WOODED MARSH	Red maple wooded sedge/fern marsh
MIXED SWAMP: MID/HIGH	Red spruce-red maple/winterberry swamp
WETLAND SHRUB THICKET	Speckled alder-arrow wood-bluejoint shrub swamp
BARREN: TALUS SLOPE	Chestnut oak-black birch-virginia creeper wooded talus slopes
BARREN: TALUS SLOPE	Hemlock-black birch/mt maple wooded talus & scree
BARREN: PITCH PINE	Pitch pine-Scarlet oak low-mid elevation ridgetop
WETLAND SHRUB THICKET	Chokeberry-winterberry-mt holly shrub swamp
FEN: CALCAREOUS	Prairie sedge-tussock sedge fen
BARREN: CALCAREOUS	Side oats gramma calcareous glade opening
BARREN: PITCH PINE	Little bluestem-poverty grass low to mid elevation outcrop Opening
FEN: CALCAREOUS	sedge-cottongrass peatland fen
BOG	Sphagnum-cottongrass bog
BARREN: CALCAREOUS	White cedar/Red cedar wooded calcareous outcrops (southern type?)
BARREN: CALCAREOUS	Chinquapin oak-red cedar calcareous woodland (southern type?)
DECIDUOUS FOREST: XERIC: CHESTNUT OAK	Red oak-Chestnut oak acid mid-high elevation, rocky slopes
CONIFER FOREST: MID/LOW: MIDSLOPE: HEMLOCK-PINE	White pine-blueberry forest of low elevation slopes and hills
CONIFER FOREST: MID/LOW ELEVATION:VALLEY& FLATS	Red cedar successional forest
SHRUB SUMMIT:HIGH ELEVATION	Mountain laurel-great laurel summits
DECIDUOUS FOREST: HIGH ELEVATION	Yellow birch-skunk current/polypody forest
WETLAND SHRUB THICKET	Highbush blueberry shrub swamp
BOG	leatherleaf bog (reconstituted)
DECIDUOUS FOREST: FLOODPLAIN	Red maple-green ash forested swamp
DECIDUOUS FOREST:SUCCESSIONAL	Successional Paper birch forest
MIXED FOREST: MID/LOW ELEVATION	Pine-Northern hardwood forest
CONIFER FOREST:HIGH	Red Spruce-great laurel forest

ELEVATION:STEEP SLOPES	
MIXED FOREST: HIGH ELEVATION: SPRUCE	Red spruce-yellow birch-black cherry forest
CONIFER FOREST:HIGH ELEVATION:STEEP SLOPES	Red Spruce /Southern mt. Cranberry forest
SUMMIT: HEATH BALD	Blueberry-black chokeberry heath
BARREN: PINE	Table mt pine-pitch pine mid elevation xeric ridgetop
DECIDUOUS FOREST: XERIC: CHESTNUT OAK	Red oak-Chestnut oak acidic mid-high elevation, rocky summits
BARREN: CALCAREOUS	Chinquapin oak-ragwort calcareous woodland
FEN: MAFIC	Canada burnet mafic fen
CLIFF: GREENSTONE	Ninebark high elevation greenstone cliffbase
CONIFER FOREST: MID/LOW ELEVATION:CALCAREOUS SOILS	Northern white cedar forest
CONIFER SWAMP: MID/HIGH	Red spruce high elevation wooded wetland
SUMMIT: GRASS BALD	Wild oat-three seeded cinquefoil grassy opening
ROCKY SUMMIT: HIGH ELEVATION	Saxifrage-goldenrod rocky summit (acidic type?)
SUMMIT: GRASS BALD	Poverty grass-goldenrod grassy opening
ROCKY SUMMIT: HIGH ELEVATION	Saxifrage-goldenrod rocky summit (mafic type?)
BARREN: SHALE	Red cedar-white ash alkaline shale woodland
CONIFER FOREST: RED PINE	Red pine-poverty grass forest
MIXED FOREST: HIGH ELEVATION: SPRUCE	Red spruce-Mt ash woodlands
BARREN: SHALE	Chestnut oak-virginia pine/hairgrass acidic shale woodland (northern type)
BARREN: SHALE	Virginia pine-red cedar/Pennsylvania sedge shale woodlands (northern type)
BARREN: SHALE	Virginia pine/ragwort/houstonia shale woodland (southern type)
BARREN: SHALE	Chestnut oak-virginia pine/ragwort acidic shale woodland (southern type)
BARREN: PINE	Virginia pine -Chestnut oak low to mid elevation sandstone pavement barren
BARREN: SHALE	Pennsylvania sedge-poverty grass acidic shale opening
BARREN: CALCAREOUS	White cedar/Red cedar wooded calcareous outcrops (northern type)
DECIDUOUS FOREST:SUCCESSIONAL	Successional Tree-of-heaven forest
SEEP: CALCAREOUS	Skunk cabbage-marsh marigold seep
CONIFER FOREST: MID/LOW: MIDSLOPE: HEMLOCK-PINE	White pine-eastern hemlock/great laurel dry forest:southern Type
DECIDUOUS FOREST: MID/LOW: XERIC: OAK-HICKORY	Oak-hickory-Fraxinus dry-mesic, rich forests
MIXED FOREST: MID/LOW ELEVATION	Virginia pine - Oak xeric forest
MIXED FOREST: MID/LOW	Successional virginia pine-mixed oak forest

ELEVATION	
DECIDUOUS FOREST:SUCCESSIONAL	Red maple upland forest
DECIDUOUS FOREST: MESIC: LOW SLOPES & COVES	Beech-maple-tuliptree forest (matrix,large patch)
DECIDUOUS FOREST: MESIC: LOW SLOPES & COVES	Sugar maple-white ash-basswood cove forest (matrix/large patch)
MIXED FOREST: MID/LOW ELEVATION	White pine-oak-beech dry forest(large patch to matrix)
DECIDUOUS FOREST:MID/LOW XERIC:SLOPES	Black oak-white oak-hickory/dogwood forest:(matrix) dry, dry-mesic, low elevation
DECIDUOUS FOREST: MESIC: LOW SLOPES & COVES	Oak-maple-beech-tulip tree mesic forests (matrix)
DECIDUOUS FOREST: MID/LOW: XERIC: OAK-HICKORY	White oak-red oak-hickory/dogwood forests: (matrix) gentle to moderate slopes, valleys
DECIDUOUS FOREST: XERIC: CHESTNUT OAK	Chestnut oak-scarlet oak/ericad forest: (matrix) xeric, S & SW facing slopes
DECIDUOUS FOREST: XERIC: CHESTNUT OAK	Chestnut oak-black oak/ericad forest: (matrix) xeric, S & SW facing slopes
DECIDUOUS FOREST: MID/LOW: MIXED MESOPHYTIC	Mixed mesophytic forest (matrix)
DECIDUOUS FOREST: XERIC: CHESTNUT OAK	Chestnut oak-red oak/ericad forest: (matrix) N slopes
MIXED FOREST: MID/LOW ELEVATION	Hemlock/white pine-red oak-mixed hardwood forest
RIVERSHORE	Tapegrass submersed rivershore
SHRUB SUMMIT:HIGH ELEVATION	Bramble-goldenrod thicket
WET MEADOW	Canada bluejoint-Reed canarygrass meadow
WET MEADOW	Canada bluejoint meadow
RIVERSHORE:SHALLOWS	Tape-grass shallow shore
MARSH	Bulrush marsh
MARSH	Three way sedge basin marsh
WET MEADOW	Carex stricta wet meadow
RIVERSHORE:SHALLOWS	Water-willow shallow shore
AQUATIC: LAKE/POND	Pickerelweed-arrow arrum emergent vegetation
AQUATIC: LAKE/POND	Water lily emergent vegetation
AQUATIC: LAKE/POND	Spatterdock emergent vegetation
RIVERSHORE:SHALLOWS	River-weed shallow shore
OUTCROP	Lichen dominated shaded outcrops
OUTCROP	Lichen dominated sandstone cliff, outcrops and talus
RIVERSHORE: SHRUB THICKET	Black willow thickets
MARSH	Canada bluejoint-tussock sedge meadow
CONIFER FOREST: MID/LOW ELEVATION:RIDGES & SLOPES	Virginia pine/heath forest of extremely steep, dry, SW facing ridges
WETLAND SHRUB THICKET	Buttonbush shrub swamp
MARSH	Cattail marsh

SEEP: ACIDIC	Golden saxifrage forested seep
MIXED FOREST: MID/LOW ELEVATION	White pine-oak-tulip tree dry forest
RIVERSHORE: GRASSLAND	Reed canarygrass-bluejoint floodplain meadow
DECIDUOUS FOREST:SUCCESSIONAL	Successional tuliptree forest
DECIDUOUS FOREST:SUCCESSIONAL	Successional black Locust disturbed forests
DECIDUOUS FOREST:SUCCESSIONAL	Successional pin cherry forest
DECIDUOUS FOREST:SUCCESSIONAL	Successional aspen/grey birch forest
RIVERSHORE:SPARSE	Goldenrod-aster scoured rivershore
CLIFF: ACIDIC	Spleenwort acidic cliff
SEEP: ACIDIC	Nasturium-water speedwell-spring cress forested spring
WET MEADOW	Goldenrod-aster-dewberry wet field
RIVERSHORE:SPARSE	Loosestrife-dogbane scoured rivershore
DECIDUOUS FOREST: FLOODPLAIN	Silver maple-American elm-cottonwood floodplain forest
CONIFER FOREST: MID/LOW ELEVATION:VALLEY& FLATS	Virginia pine successional forest
DECIDUOUS FOREST: FLOODPLAIN	Sycamore-river birch-jewelweed floodplain forest

APPENDIX III—SPECIES NOT INCLUDED BECAUSE OF AGE OF RECORD OR DATA QUALITY

Latin Name	Common Name	G-Rank
GYMNOCARPUM APPALACHIANUM	APPALACHIAN CHAIN FERN	G3
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	G3
COLIAS INTERIOR POP 1	PINK-EDGED SULPHUR BUTTERFLY	G5T1T2Q
EPHEMERA TRIPLEX	WEST VIRGINIA BURROWING MAYFLY	GH
GLYPHYALINIA RADERI	MARYLAND GLYPH SNAIL	G2
GOMPHUS VIRIDIFRONS	GREEN-FACED CLUBTAIL	G3
MEROLONCHE DOLLI	DOLL'S MEROLONCHE	G3
PARAVITREA REESI	ROUND SUPERCOIL	G3
APOCHTHONIUS PAUCISPINOSUS	DRY FORK VALLEY CAVE PSEUDOSCORPION	G1
ARRHOPALITES CLARUS		G2G4
ARRHOPALITES SP 2	A COLLEMBOLA	G1
ARRHOPALITES SP 3	A COLLEMBOLA	G1
BATRIASYMMODES PARKI	AN ANTLOVING BEETLE	G1G2
CAECIDOTEA SINUNCUS	AN ISOPOD	G1
CHITRELLA REGINA	ROYAL SYARINID PSEUDOSCORPION	G1
CONOTYLA VISTA	CAVE MILLIPEDE	G1G2
CRANGONYX SP 2		G2
DONNALDSONCYTHERE TUBEROSA	CAVE SHRIMP	G3G4
FONTIGENS SP 1	MCCLUNG CAVE SNAIL	G1
FONTIGENS TURRITELLA	GREENBRIER CAVESNAIL	G1
HOROLOGION SPEOKITES	ARBUCKLE CAVE GROUND BEETLE	GH
ISLANDIANA SP 1	A CAVE SPIDER	G1
ISLANDIANA SPEOPHILA	CAVERN SHEETWEB SPIDER	G1
KENKIA HOFFMASTERI		G2
KLEPTOCHTHONIUS HETRICKI	ORGAN CAVE PSEUDOSCORPION	G1
KLEPTOCHTHONIUS ORPHEUS	ORPHEUS CAVE PSEUDOSCORPION	G1
KLEPTOCHTHONIUS PROSERPINAE	PROSERPINA CAVE PSEUDOSCORPION	G1
LITOCAMPA FIELDINGI	DIPLURAN	G2G3
LITOCAMPA SP 1	DIPLURAN	G1
MACROCOTYLA HOFFMASTERI	HOFFMASTER'S CAVE FLATWORM	G2G3
PHAGOCATA ANGUSTA	CAVE PLANARIAN	G1G2
POECILOPHYSIS WOLMSDORFENSIS	CAVE MITE	G3
PSEUDANOPHTHALMUS HADENOECUS	TIMBER RIDGE CAVE BEETLE	G1
PSEUDANOPHTHALMUS HIGGINBOTHAMI	A CAVE BEETLE	G2G3
PSEUDANOPHTHALMUS KREKELERI	RICH MOUNTAIN CAVE BEETLE	GH
PSEUDANOPHTHALMUS MONTANUS	DRY FORK VALLEY CAVE BEETLE	G1
PSEUDANOPHTHALMUS POTOMACA	A CAVE BEETLE	G1
PSEUDANOPHTHALMUS POTOMACA POTOMACA	SOUTH BRANCH VALLEY CAVE BEETLE	G2G3T2T3
PSEUDANOPHTHALMUS POTOMACA SENECAE	SENECA CAVE BEETLE	G2G3T1
PSEUDANOPHTHALMUS SP 1	A BEETLE	G1
PSEUDANOPHTHALMUS SP 2	A BEETLE	G1
PSEUDANOPHTHALMUS SP 3	A BEETLE	G1
PSEUDANOPHTHALMUS SUBAEQUALIS	GREENBRIER VALLEY CAVE BEETLE	G1
PSEUDOSINELLA CERTA	GANDY CREEK CAVE SPRINGTAIL	G1
PSEUDOSINELLA SP 1	A SPRINGTAIL	G1
PSEUDOSINELLA TESTA	SHELLED CAVE SPRINGTAIL	G1G2
PSEUDOTREMIA LUSCIOSA	GERMANY VALLEY CAVE MILLIPEDE	G1
PSEUDOTREMIA SP 1	GENERAL DAVIS CAVE MILLIPEDE	G1?
SINELLA AGNA	A CAVE SPRINGTAIL	G2G3
SPHALLOPLANA CULVERI	CULVER'S PLANARIAN	G1
STYGOBROMUS BIGGERSI	BIGGERS' CAVE AMPHIPOD	G2G4
STYGOBROMUS COOPERI	COOPER'S CAVE AMPHIPOD	G1
STYGOBROMUS FRANZI		G2G3
STYGOBROMUS GRACILIPES	SHENANDOAH VALLEY CAVE AMPHIPOD	G2G4
STYGOBROMUS MORRISONI	MORRISON'S CAVE AMPHIPOD	G2G3
STYGOBROMUS NANUS	POCAHONTAS CAVE AMPHIPOD	G1
STYGOBROMUS POLLOSTUS	AN AMPHIPOD	G2G3
STYGOBROMUS SP 1	AN AMPHIPOD	G2
STYGOBROMUS SP 2	COBURN CAVE AMPHIPOD	G1
STYGOBROMUS SP 3	DYERS CAVE AMPHIPOD	G1
STYLODRILUS BEATTIEI	AN OLIGOCHAETE	G2G3

TRICHODRILUS CULVERI	AN OLIGOCHAETE	G1G2
TRICHOPETALUM KREKELERI	WEST VIRGINIA BLIND CAVE MILLIPEDE	G1
TRICHOPETALUM WHITEI	LURAY CAVERNS BLIND CAVE MILLIPEDE	G2Q

APPENDIX IV - SELECTION OF CONSERVATION TARGET OCCURRENCES—THE ISSUE OF VIABILITY

Determining which occurrences should become the points around which to construct a reserve portfolio is a central question in ecoregional planning. To protect conservation investments in sites, we must set criteria for what constitutes a "viable" occurrence of the element. Viability is defined as the ability of an element occurrence (EO) to persist over time. This means that the occurrence is in good condition and has sufficient size and resilience to survive occasional natural and human stresses. The predicted viability of a species or community occurrence is currently addressed through the development and application of element occurrence ranks (*EO Ranks*). As recently defined, EO Ranks are meant to provide a succinct assessment of *estimated viability* based on the occurrence's size, condition, and landscape context (Element Occurrence Data Standards, Working Draft, February 5, 1997, The Nature Conservancy in cooperation with the Network of Natural Heritage Programs and Conservation Data Centers). These criteria apply to animal and plant species as well as communities, although they are assessed differently for each element type.

Size is a quantitative measure of the area and/or abundance of an occurrence. Components of this factor for species include area, population abundance, population density and area of occupancy, and population fluctuation (average population and minimum population in the worst foreseeable year). For communities size is simply a measure of the occurrence's patch size.

Condition is an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued existence of the occurrence. For animal and plant species this includes reproduction (evidence of regular, successful reproduction; age distribution for long-lived species). For species and communities it includes species composition and biological structure (presence of exotics), ecological processes (changes in hydrology or natural fire regime, etc.), degree of human disturbance, and abiotic factors (stability of substrate, water quality, etc.).

Landscape context is an integrated measure of the quality of biotic and abiotic factors, structures, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components of this factor include landscape structure and extent (e.g. pattern, connectivity, measure of fragmentation/patchiness, measure of genetic connectivity) and condition of the surrounding landscape (i.e. development/maturity, species composition and biological structure, ecological processes, abiotic physical factors).

Under the new EO standards, size, condition, and landscape context are integrated to create the EO Rank, which is defined as follows:

A = excellent estimated viability
B = good estimated viability
C = fair estimated viability
D = poor estimated viability

These ranks are routinely assigned by the Network of Natural Heritage Programs, and updated and maintained in BCD. Appropriate thresholds for size, condition and landscape context vary for each element type, as defined by *EO Rank specifications* written by experts on each species or community.

IV.1.0 Application to Species

In many cases, occurrences of species had either not been assigned an EO Rank or had been given a rank of “E”, meaning that the occurrence is extant but has not been evaluated for a rank. In both cases these occurrences were eliminated from consideration as target occurrences unless there was documentation on population size, condition, and landscape context. Species occurrences were considered viable if they had a Natural Heritage Program Element Occurrence Rank of A, B, or C. D ranks were considered unviable.

IV.2.0 Application to Terrestrial Communities

In general, range-wide element occurrence rank specifications have not yet been developed for natural communities so very few community occurrences have EO Ranks. Since occurrence viability is so important in developing a long-term portfolio, we found it necessary to develop interim specifications that could be applied to broad groups of communities. We determined that the most meaningful way to group communities for viability assessment should be based on the typical patch size in which they occur on the landscape.

IV.2.1 PATCH SIZE

Communities vary greatly in terms of their size of occurrence and ecological specificity, with some types covering huge areas of varying topography, geology, and hydrology, while others exist only in small patches under unique environmental conditions. Based on these qualities, we classified all communities into one of three types, referred to as *matrix*, *large patch* and *small patch*. Matrix (or dominant), communities form extensive cover, often blanketing 80% of the undeveloped land, and covering 100 to 1 million contiguous acres. These types have broad ecological amplitude and are driven by regional scale processes. They are important as coarse filters for wide ranging fauna such as large herbivores, predators, forest interior, and migratory birds. Examples include Oak-maple-tulip tree mesic forest, White oak-red oak-hickory/dogwood forest, Chestnut oak-black oak/ericad forest, and Mixed mesophytic forest.

Nested within the matrix forests are smaller scale "patch" communities with more specific ecological amplitudes and often more restricted species. Large patch communities may form extensive cover and ususally are related to some unusual edaphic or disturbance regime; usually their boundaries are correlated with a single dominant local process such as a hydrologic regime or fire regime. These communities often have a set of characteristic fauna associated with them, and likely serve as resource patches for fauna associated with the matrix communities. Examples include Eastern helmlock-yellow birch-black cherry forest, Sugar maple-white ash-basswood-bluebeard cove forest, Scrub oak summits, and Red spruce-great laurel forest. Even more restricted are small patch communities which have very specific ecological amplitudes and occur where a number of local conditions come together in a precise way. Although their boundaries are often easy to delineate, these community types are usually inextricably linked to the landscapes in which they occur. Thus they may not be viable over the long term without preservation of the larger system in which they are embedded. Small patch communities often occur in stressful or unusual conditions, serving as refuges for species which are poor competitors (including many rare species). They also serve as a coarse filter for a very specific invertebrate fauna. Examples in the Central Appalachian Forest include Baltic rush-tussock sedge marsh, Shortleaf pine-heath forest, Mud plantain muddy ponds, and Smooth alder shrub thicket.

Of the 142 community associations in the Central Appalachian Forest, about 5% are matrix types, 40% are large patch types and 55% are small patch types. If we consider the communities relatively equal in biodiversity value, then clearly most of the biodiversity of the ecoregion is concentrated in the patch communities, making them natural targets for reserve selection. However with regard to land cover, the 8 matrix forests likely cover close to 75% of the remaining natural landscape, while the large patch may cover an estimated 20%, and the small patch communities probably cover less than 5% of the landscape. Clearly the matrix types are important targets for the maintenance of the biological integrity and fundamental structure of the region. Note also that most matrix and some large patch communities are mainly threatened by degradation and fragmentation while small patch communities are generally more susceptible to the hazards of rarity. Thus the different occurrence types call for different viability criteria and conservation strategies.

IV.2.2 TERRESTRIAL COMMUNITY VIABILITY

Classifying community types by patch size enabled us to set reasonable thresholds for the size, condition and landscape context of viable occurrences. The relative weights of these criteria differed based on whether the community was a matrix, large or small patch type. In addition to being stable, persistent and resilient over time, our coarse/fine filter strategy makes it necessary for community occurrences to be functional as coarse filters for all associated common and uncommon species. By maximizing our viability thresholds we believed we could achieve both goals. The thresholds we set and their justifications are described below.

IV.2.2.1 *Size*

The size of an occurrence is fundamental in predicting both 1) the stability and resilience of the community occurrence and 2) the diversity of species within the occurrence (both component plant species and all associated faunal species). The theoretical reasoning behind this is relatively straightforward although the actual acreage needs are still somewhat elusive.

IV.2.2.1.1 Size Effects on Stability, Persistence and Resilience

Essentially communities are dynamic systems driven by the demographics of the component species. For the communities to persist over time and space, the species within them must find adequate resources for consumption and have adequate area to establish, reproduce, disperse and die. As these functions require area, the stability and resilience of an occurrence increases with size.

For matrix forming communities the concept of minimum dynamic area (Pickett and Thompson 1978) is useful for referencing the area needed to maintain the internal dynamics of the system. In the Central Appalachian Forest these dynamics and processes include single tree gap replacement, shifts in successional states following natural catastrophic disturbances, or larger scale mortality caused by chronic stress (including pollution and degradation). Major stress and disturbance factors in this region include storms, insect outbreaks, disease, fire, acid deposition and drought. These may range in effect from less than an acre to over 5 million acres (Stevens 1996, Mello 1987).

For patch communities, which occur in a more discrete and scattered way, a metapopulation model is more useful in thinking about long term persistence. The focus then becomes identifying which occurrences are *sources* (Pulliam 1988), e.g. good habitat where local reproductive success is greater than local mortality and the occurrence may be a source of emigrating propagules, and which occurrences are *sinks*, e.g. poorer habitats with populations maintained from immigrating sources. We assumed that occurrences that are large and in good condition are generally sources.

IV.2.2.1.2 Size Effects on Diversity

Large occurrences are generally more diverse in associated species for several reasons. Firstly, large occurrences are often correlated with more landscape diversity, more available habitats and microhabitats (patch communities), and more internal variation within the community itself. Secondly, and especially for matrix communities, the larger the occurrence the more likely it is to be utilized by area-sensitive species. This includes species with very large home ranges, such as large predators with territories defined by the abundance of prey species. Small home range species often avoid small occurrences of forest also as they are more vulnerable to predation or parasitism by edge related predators. Additionally, many small home range species are loosely colonial and prefer to inhabit patches of habitat which contain other members of their species. Thirdly, although many small occurrences may provide enough area for the day to day movements of many species, seasonal movements such as migrations or, more importantly, dispersal by juveniles or seeds may become restricted within small occurrences and ultimately isolate the population. Lastly, low density populations may be absent from small occurrences by chance alone, as the probability of the species encountering the patch decreases the smaller and more isolated the occurrence is. As our coarse filter target implies both the common and uncommon species, this last point is reason enough to be cautious about small isolated occurrences as a central point for building a portfolio.

Table IV-1. Minimum patch sizes for various community and patch types.

PATCH TYPE	MINIMUM SIZE (acres)			
	Forest	Woodland	Shrub	Herbaceous
Large Patch	100	100	50	50
Small Patch	20	10	5	1

Based on the above reasoning and examples, we set size minimums (see Table IV-1) for viable occurrences of patch communities in the Central Appalachian Forest ecoregion.

The size of a community occurrence is a standard field in the Heritage element occurrence database. However, since there were few records of matrix communities in BCD and since good matrix occurrences should be contiguous, we used *block* size as a surrogate. Blocks are contiguous areas bounded by roads, powerlines, and shorelines.

IV.2.2.2. Condition

A variety of observable features affect the condition of a community occurrence, primary among them are fragmentation, invasion by exotics, anthropogenic manipulation of the occurrence (e.g. cutting, grazing, mowing), poor habitat quality, poor soil integrity, and subsequent poor development of the community. These factors are quite interrelated although they are discussed separately below.

Forman (in Hunter 1996) has described the overall process of fragmentation as having four phases 1) dissection of an area by roads or other fragmenting features, 2) perforation of the area by conversion of pieces of the natural system to agriculture, developed land or clearcut, 3) fragmentation as the perforation stages grows more extensive and pieces of the natural systems become isolated from one another and 4) attrition where the new "matrix" of converted features comes to dominate the area in terms of extent and connectivity. Although we evaluate an occurrence based on its current state, fragmentation is a dynamic process and its current state may indicate a position along this trajectory.

A major issue in measuring the fragmentation of a matrix (or any) community occurrence was determining which features: highways, dirt roads, powerlines, railroads, trails, etc. are fragmenting and which are not. Evidence is accumulating to suggest that virtually all of the features listed are fragmenting to some species and some populations. It is perhaps easier to conceive of the cumulative effect of a variety of fragmenting features as a filter for certain species. Species which are disproportionately affected by fragmentation include those that are naturally rare and occur in small, low-density populations; those that have low reproductive rates and are slow to recover from a disturbance; those that are poor dispersers; those that are wide ranging and require a lot of contiguous cover; and those that are dependent on unpredictable or patchy resources (Meffe & Carroll 1994).

A second effect of fragmentation is an increase in "edge" in relation to total area. This is a problem because the conditions on the edge are often quite different than in the interior of a community. Typically, edge habitats have increased solar radiation, wind desiccation, and evaporation rates. Subsequently tree mortality is higher on the edge leading to expansion of the edge habitat over time. Edge habitat often provides access into a community by small predators and brood parasites such as foxes, skunks, raccoons and cowbirds which can be particularly destructive to low nesting or interior nesting birds. Additionally, the edge conditions often provide routes for certain exotic species which may displace or compete with native species. The negative effects of edge habitat have been a major contributor to the corridors controversy as long narrow corridors connecting sites together effectively increase the amount of edge habitat.

IV.2.2.2.1 Multigenerational Features, Biological Legacies and Reservoirs

A second measure of condition is the evaluation of an occurrence for features which take multiple generations to develop. In forests, for example, these may include the presence of: 1) fallen logs and rotting wood , 2) a well developed moss/herbaceous understory, 3) structural complexity in the canopy and understory layers, 4) a well-developed and mature soil condition, 5) seed banks, and 6) redundancies that stabilize critical cycles (e.g. nutrient cycles, micorrhizal interactions and pollination/dispersal vectors). In forested systems, often the single best predictor of these features is the presence of old trees (e.g."old growth") however the development of many of these features may take considerably longer than the life span of a single cohort of trees (sometimes hundreds to thousands of years). As very few current restoration efforts can guarantee success over such long time frames it is crucial to identify and target these occurrences for conservation action.

IV.2.2.2.2 Solution to Assessment of Community Viability

We evaluated condition differently for matrix and patch communities. For each potential matrix block we rated the block as high, medium, or low in terms of the following attributes:

> <u>Roadedness</u>—whether or not the forest had connecting interior roads of a certain size
> <u>Current forest condition</u> (including cutting history, % land in clear cut, agriculture or development)
> <u>Amount and extent of old growth</u>
> <u>Condition of streams when known</u>

For patch communities we ranked each occurrence on a simple 3 point scale:

> 1 = high, no signs of anthropogenic disturbance, no exotics, no obvious fragmenting features.
> 2 = moderate, some signs of anthropogenic disturbance, exotics, some fragmenting features.
> 3 = poor, obvious signs of anthropogenic disturbance, lots of exotics, obvious fragmenting features.

We also had a flag for certain forest patch types to indicate that the occurrence represented an old growth site (defined here as having trees 180 years old or greater).

IV.2.2.3 *Landscape Context*

The surrounding landscape is particularly an issue for the patch community types and rare species. For these targets, the presence of the occurrence in the landscape often indicates a particular intersection of environmental features such as local hydrologic regime, water chemistry, local disturbance regime, bedrock or soil type, and available propagule sources. Alteration of any of these features, most of which are maintained by processes outside the actual occurrence, may result in loss of the occurrence at the site. This concept is well understood by many applied ecologists who have observed the degradation and disappearance of many interesting community occurrences when fire regimes were altered (e.g. pine barrens); the surrounding hydrology was interrupted (e.g. fens and pond shores); water chemistry was altered from agricultural runoff (e.g. freshwater wetlands and ponds); and 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 ecological regimes, as lowland features tend to accumulate, concentrate and depend on materials from outside their own systems. Conversely, high elevation or locally elevated features or systems on poor substrate types may be more biologically isolated and thus more tolerant of degradation or changes in the surrounding landscape.

For each patch community occurrence we ranked the quality of the 1000 acres surrounding it on a 1-4 scale:
1 - surrounded by 1000+ acres of intact matrix or large patch communities
2 - surrounded by forest or undisturbed communities but may have developed land or clearcutting nearby
3 - surrounded by fragmented forest, agricultural land or rural development
4 - surrounding area intensely developed

When the condition of the landscape was unknown we approximated it by examining the size of the surrounding block (see below) that contained the occurrence. We used the assumption that if the occurrence were contained in a block less than 1000 acres there was reason to be skeptical of its long-term persistence. Additionally we assumed that if the occurrence fell within a selected matrix site its landscape condition was probably good. We also examined the spatial patterns of the patch community occurrences to identify concentrations of good occurrences. These concentration areas likely indicate areas with intact large-scale landscape processes suggesting that we adopt a landscape or matrix-like approach to conservation in these areas.

IV.2.2.4 Synthesis of the Criteria

For patch communities, four possible combinations of landscape context, current condition and size were used to identify primary target occurrences (Table IV-2). First we systematically and objectively applied the criteria to all occurrences in the database, then we reviewed the results in detail with state Heritage ecologists and TNC staff during a series of state by state meetings. During this review process approximately 50% of occurrences were precluded as targets based on further information about the occurrence. The condition combinations were intended to maximize the probability that the occurrence was viable, functional as a coarse filter, and was associated with a reasonably intact site.

For example: for large patch forest communities, an occurrence was included as a conservation target if its condition was 1, landscape context was 1, and its size was greater than 100 acres. However, if its landscape context was 3 then its condition had to be 1 and its size had to be greater than 200 acres.

Table IV-2: Acceptable criteria combinations for community occurrences in the Central Appalachian Forest Ecoregion.

Viability Criteria Combination	**Current Condition** (1-3)	**Landsca Context** (1-4)	**Size:** Large Patch		**Size:** Small Patch (acres)			
			Forest / Woodland	Shrub / Herb.	Forest	Woodland	Shrub	Herb
Comb. 1	1	1	100	50	20	10	5	>0
Comb. 2	2	1	100	50	20	10	5	>0
Comb. 3	1	2	100	50	20	10	5	>0
Comb. 4	1	3	200	100	50	50	10	>5

For selecting matrix communities the criteria and minimum thresholds are:

Size: 15,000 acre block OR 3 adjacent 5,000 acre blocks

Condition: Minimum developed land, agriculture and road density OR (when not possible) continuous forest history and minimum developed land, agriculture and road density. Presence of old growth an asset.

Diversity: Maximum patch/landscape diversity OR representative/complementary to other blocks

IV.2.3 ESTABLISHMENT OF CONSERVATION GOALS FOR TERRESTRIAL COMMUNITIES

IV.2.3.1 Stratification of the Ecoregion and Occurrence Placement

Once we decided which elements to target and what qualified as a viable occurrence, we had to decide how many occurrences were needed to preserve the element in the ecoregion, and what spatial stratification was necessary to represent its environmental and genetic variation. We determined that the number of occurrences should be driven by the spatial representation goals for each element. To determine the proper placement and distribution of occurrences it was necessary to first examine the patterns of ecological and species diversity within the ecoregion. In particular, identifying what the major ecological gradients are and how they are distributed across the landscape is useful in thinking about placement of a reserve system. Using maps and discussion, we examined patterns of elevation, climate, soil types, topographic diversity, bedrock types, disturbance regimes, land use, and community distribution.

We found the US Forest Service subsections (Keys et.al. 1996) to be a good unit for representing variations in environmental gradients and community distributions. To make the subsections more useful as a stratification tool we developed a hierarchical model partitioning the ecoregion into increasingly finer units using the same methodology and data we used to define the ecoregion itself (Table IV-3). In general, the ecoregions, subregions and sections represent statistical clusters of USFS subsections, that are more related to each other in terms of community types than to other subsections. This was based on community/subsection intersection tables developed by TNC and Heritage ecologists for the US Forest Service.

Table IV-3: Stepwise stratification of the USFS subsections.

Central Appalachian Ecoregion						
Allegheny Mountains				**Ridge and Valley/Northern Blue Ridge**		
High Allegheny Mountains		**Low Allegheny Mt and Valley**.		**Ridge and Valley**		**Northern Blue ridge**
N Allegheny Mts. M221Bb M221Bf	S/Central Allegheny Mts. M221Ba M221Bc	Western low Mts M221Be	Eastern Low Mts. M221Bd	N Ridge and valley M221Ac M221Ad	S. ridge and valley M221Aa M221Ab	N Blue ridge M221Da

To set spatial representation goals for community occurrences we overlaid the estimated subsection distribution of the community on the hierarchical model of ecoregion gradients, and examined the intersection of community distribution and ecoregion gradients. The hierarchical nature of the model allowed us to stratify some community types more finely (the restricted and limited types - see below) and others more coarsely (widespread and peripheral types).

IV.2.3.2 Distribution and Restrictedness

Because of the variation in occurrence size, how characteristic a community is of an ecoregion is not a function of its dominance or abundance within the ecoregion but rather of its restrictedness and fidelity to that ecoregion. To gauge how many occurrences of each community we wanted to protect, and how intensively we needed to stratify their distribution, we grouped the communities into four groups based on the relative restrictedness of the element to the ecoregion. Communities that were restricted (endemic) to the ecoregion, and thus depend entirely on protection efforts within the ecoregion for long term conservation, were allotted more occurrences and these were stratified more rigorously with regard to spatial distribution. Conversely, widespread occurrences, which ultimately will be conserved by a group of ecoregions acting in concert, were allotted fewer occurrences within the ecoregion and these were stratified less rigorously. Ultimately stratification of widespread communities will be based on a multi-ecoregion stratification scheme.

We examined the distribution of each community both within the ecoregion and across its range. We assigned each community association to one of four common distribution patterns relative to the Central Appalachian Forest ecoregion: **Restricted** (e.g. the community occurs only within the ecoregion), **Limited** (the community typically occurs within the region but also occurs in one or two adjacent regions), **Widespread** (the community is typical of the ecoregion but also occurs in more than two other ecoregions, and **Peripheral** (the community does occur within the ecoregion but the core of its distribution is within another ecoregion). Range information was based largely on our analysis of community by subsection maps, supplemented with range maps of the dominant species or key indicator species, and maps of associated habitat features such as particular bedrock types, climatic isoclines, and distribution of high elevation summits.

IV.2.3.3 Synthesis: Setting benchmark numbers

To set benchmark levels for number and stratification of community occurrences we began by discussing the dynamics of a hypothetical restricted small patch community which occurred throughout the ecoregion. First, we decided that as a bare minimum we would need some occurrences in each of the 4 major subregions to insure representation of the internal and landscape context variability of the type, buffer against degradation in one subregion or another, and to allow for possible geographic range shifts over time (Hunter 1996). Thus, we set the minimum stratification level for a restricted community at 4 (meaning we wanted some occurrences in each of the four subregions). Next we assumed that at least a handful of source occurrences in each subregion would be necessary to insure some connectivity between occurrences as well as buffer against the effects of chance events which might unexpectedly eliminate certain occurrences. Thus, we set a bare minimum of 5 occurrences per subregion, which totals 20 occurrences for the ecoregion stratified into 4 subregions which we adopted as a reasonable minimum benchmark for the type. From this number we worked backwards to the other types decreasing the numbers and stratification levels for the larger and less restricted community types (Table IV-4).

Table IV-4: Minimum conservation benchmarks for communities as a function of patch size and restrictedness.

	Patch Size	
Minimum stratification level	Large Patch 4	Small Patch 5
Restricted 4	16	30
Limited 2	8	10
Widespread 1	4	5
Peripheral 1	4	5

Our final set of numbers represents the **Minimum Conservation Benchmark** for each community type. Attempting to meet these benchmarks will provide us with a solid twenty years of conservation effort and should stimulate some excellent inventory, protection work and partnerships. However, we do not know if they are truly adequate to preserve biodiversity in the ecoregion. We are in relative agreement about one point; that these numbers are not likely to decrease and are very likely to need upward revision as the future unfolds.

To some extent these benchmarks might be thought of as an "equation" of which the actual portfolio is the "solution". Note that there may be many acceptable portfolios that provide adequate solutions to the equation. The actual location of the reserve sites is fixed only by the availability and location of target element occurrences from matrix to small patch to species. The minimum conservation benchmarks also allow us to systematically assess, for any version of the portfolio, the degree to which it meets the goals.

The sub-selection and exact spatial arrangement of the target element occurrences is left to the understanding and judgment of the state Heritage Programs, TNC Field Offices, and other partners. We hope this will stimulate experimentation and maintain flexibility in the face of shifting opportunities. Several theoretical approaches to finer-scale arrangement of the target EOs were discussed including:

- Clustering target occurrences to provide maximum connectivity between patches.
- Stratifying target occurrences across subsections to insure representation of each subsection.
- Stratifying target occurrences across major subregional gradients (elevation, soil types etc.) to insure good representation of internal variability
- Selecting only the "best" target occurrences (defined variously from state to state) regardless of spatial arrangement.
- Prioritizing target occurrences that occur within close proximity of Matrix sites.
- Selecting any occurrences based on opportunity and feasibility.

These issues, while interesting, are, at this stage, mainly theoretical since for most communities we do not have enough target occurrences available to meet our goals in each subregion, let alone to sub-select from. Additionally, target occurrences that are already protected or target patch occurrences,which nest within matrix or other larger sites, are already preselected for inclusion. Thus, at this stage of development we are rather limited in our ability to arrange the occurrences into idealized configurations. For the purposes of the current portfolio all target occurrences are selected whether part of a matrix site, a cluster of patch sites, or on its own with a 1000 acre buffer surrounding it.

IV.2.3.4 Summary

Our general model for setting community conservation goals (Table 6) was:

- Determine the typical patch size of the community type in the ecoregion (matrix/large patch/small patch)
- Determine natural rangewide distribution of the community to one of the 4 groups relative to the ecoregion (restricted, limited, widespread, peripheral)
- Determine natural distribution of the community type within the ecoregion (subregion, elevation, geology, etc.)
- Stratify the natural distribution of the type in a weighted manner.

RESTRICTED:	4 subregions
LIMITED:	2 subregions
WIDESPREAD:	no stratification necessary
PERIPHERAL:	case by case

Set minimum conservation benchmarks as a function of patch size and restrictedness.
The 8 matrix communities usually occur in mosaics with each other, in various successional stages and with patch communities. These mosaics reflect stand variation due to environmental gradients, forest practices, historical events, and disturbances. Taking into account the importance of these communities in the health and functioning of the ecoregion and the scale at which they normally occur and their pattern of occurrence in mosaics, the minimum conservation threshold (conservation goal) for matrix communities is 2 matrix blocks (sites) in each of 7 subregions (Northern Allegheny Mountains, Southern/Central Allegheny Mountains, Western

Low Mountains, Eastern Low Mountains, Northern Ridge and Valley, Southern Ridge and Valley, and Northern Blue Ridge).

First, the attributes of total area, total core area, number and miles of dangling roads, percent developed land, percent agriculture, percent natural cover, etc were summarized in a report for each block. Next, we evaluated each block for logging/spraying/management history, other anthropogenic impacts, disturbance history, notable diversity etc. in a series of state by state expert interview sessions consisting of state TNC field office staff, state natural heritage ecologists, and various state and federal land managers. At each state meeting, the boundaries of the blocks were also adjusted to reflect better information provided by the experts on the type and use of local roads. All blocks were ranked on a 5-level scale from #1 "Yes the block qualifies" to #5 "No the block does not qualify"

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APPENDIX V—SELECTING MATRIX BLOCKS

To evaluate which matrix blocks should be selected for the portfolio, we assembled and integrated a variety of GIS datalayers and developed a series of 8 x 6 foot wall maps of the ecoregion at 1:320,000 scale. We then conducted a series of interviews with state Heritage ecologists and appropriate TNC field office staff to evaluate and discuss each potential matrix site. The datalayers consisted of:

- The set of all Natural Heritage element occurrence points for the ecoregion filtered by the target occurrence criteria into target occurrences and non-target occurrences. The filtered occurrences were overlaid on each of the following 3 maps:
- A map of the ecoregion tessellated into "blocks" bounded by roads, transmission lines, and major shorelines (lake and river polygons) from USGS 1:100,000 DLGs. Paved and unpaved roads from class 1 to 4 as well as railroads and powerlines were displayed with various line symbols.
- A generalized land cover map of the ecoregion, developed from GAP and MRLC classified 30 meter Landsat TM imagery, showing forest, nonforest, agriculture, urban, cleared/disturbed, and water categories.
- A color-shaded relief map of the ecoregion developed from 90 meter USGS Digital Elevation Models overlaid with managed area parcels (conservation lands) from various sources.
- A map showing the Ecological Land Units (ELU's) for each prospective matrix block.

We analyzed the information in a series of joint Heritage/TNC meetings, conducted state-by-state. Using a variety of paper maps, atlases, imagery, and reports we looked at every block larger than 15,000 acres and assessed the boundaries and interior roads to determine if they were truly barriers. Based on these assessments and field knowledge we split or aggregated blocks to form new block boundaries. During the meetings we compiled the following attributes for each of these blocks based on expert opinion and data analysis

Identifiers:	Block name Block ID Subsection Subregion
Size:	Acreage after blocks were grouped or split based on field knowledge of roads and trails
Condition:	Amount of old growth General condition of forest including amount of clear cut, agriculture and developed land Roadedness, amount and type of dangling inroads Roadedness rank (high-medium-low)
Diversity:	Known element occurrences (number and types) Other potential element occurrences Amount of upland diversity (high-medium-low)

Amount of wetland diversity (high-medium-low)
Geologic features of note
Types and condition of streams
Known conservation sites
Amount of managed area
ELU types
ELU diversity

At this point, our purpose was not to collect truly objective and comparable data on each block but to review the blocks systematically using the available experts, maps, and reports to produce a final potential site rating for each block. Blocks were ranked into 5 categories: "Yes" (meets all the criteria), "Maybe Yes", "Maybe", "Maybe No", and "No". The Yes blocks as well as a few Maybe Yes blocks were selected as the matrix blocks for the first iteration of the portfolio. It is important to note that blocks ranked Maybe Yes, Maybe and Maybe No often reflect our level of knowledge about these blocks rather than an absolute statement of their appropriateness for inclusion in the portfolio.

Essentially the approach used to select matrix community sites had 5 sequential steps:

1) Develop a set of all potential matrix sites based on a GIS analysis of road-bounded areas greater than 15 thousand acres (referred to here as "matrix blocks").
2) Determine which matrix blocks qualify for inclusion by assessing the boundaries and condition of each potential block and removing from the complete set those blocks which are unsuitable (e.g. have been repeatedly logged and sprayed, have dead aquatic features due to acid mine drainage, have killer threats or are otherwise in poor condition).
3) Assess the remaining qualifying blocks for their ELU composition and aggregate them into block-groups based on similarities in their ELU composition.
4) Prioritize and rank the blocks within each block-group based on their EO diversity and representation, ELU diversity and representation, condition, proximity to other features, feasibility of protection work and threat.
5) Determine the minimum set of matrix blocks needed to fully represent each matrix block group and select the highest priority blocks for inclusion in the first iteration matrix community sites.

APPENDIX VI—ANALYSIS OF MET/UNMET GOALS FOR SPECIES[8]

1. Vertebrates

GCOMNAME	GRANK	DIST.	LOCAL	META	TOTAL	GOAL	SURPLS	DEFICIT
ALLEGHENY WOODRAT	G3G4	W	2	4	12	5	7	0
EASTERN SMALL-FOOTED MYOTIS	G3	W	24	0	24	5	19	0
VIRGINIA NORTHERN FLYING SQUIRREL	G5T2	R	0	6	15	20	0	5
VIRGINIA BIG-EARED BAT	G4T2	L	8	1	10	10	0	0
GREEN SALAMANDER	G3G4							
WHITE-SPOTTED SALAMANDER	G3	R	0	1	3	20	0	17
INDIANA OR SOCIAL MYOTIS	G2	W	22	1	25	20	5	0
CHEAT MOUNTAIN SALAMANDER	G2	R	0	4	10	20	0	10
ROANOKE LOGPERCH	G2	R	0	0	0	20	0	20
SHENANDOAH SALAMANDER	G1	R	4	0	4	20	0	16
ORANGEFIN MADTOM	G2	L	1	1	4	20	0	16
ROUGHHEAD SHINER	G2G3	R	2	1	5	20	0	15
CHEAT MINNOW	G1G2	R	1	0	1	20	0	19
BIGEYE JUMPROCK	G2	L	0	0	0	20	0	20
CANDY DARTER	G3	L	0	0	0	10	0	10
BOG TURTLE	G3	W	2	0	2	5	0	3
PEAKS OF OTTER SALAMANDER	G2	R	0	1	3	20	0	17
APPALACHIAN BEWICK'S WREN	G5T2Q							
ROANOKE BASS	G3	P	0	0	0	5	0	5
WEST VIRGINIA SPRING SALAMANDER	G1Q	R	1	0	1	20	0	19
SOUTHERN WATER SHREW	G5T3	L	0	3	8	10	0	2
SOUTHERN ROCK VOLE	G4T3	L	0	2	5	10	0	5

[8] Goals analysis here assumes need for 20 occurrences for G1 and G2 species. Distribution abbreviations: R=Restricted to ecoregion, L=Limited to 2-3 ecoregions, W=Widespread, 4 or more ecoregions, P=Peripheral to this ecoregion. "Local" refers to the number of local populations selected for the portfolio and "Meta" refers to the number of metapopulations selected for the portfolio (using the assumption that 1 Meta = 2.5 Local populations). Surplus or Deficit refers to whether extra (Surplus) or not enough (Deficit) occurrences were selected.

2. Plants

GNAME	GCOMNAME	GRANK	DIST	LOCAL	META	TOT	GOAL	SURPLS	DEFICIT
PTILIMNIUM NODOSUM	HARPERELLA	G2	W	4	0	4	5	0	1
ILEX COLLINA	LONG-STALKED HOLLY	G3	L	6	0	6	10	0	4
ECHINACEA LAEVIGATA	SMOOTH CONEFLOWER	G2	L	19	0	19	20	0	1
HELENIUM VIRGINICUM	VIRGINIA SNEEZEWEED	G2	R	14	0	14	20	0	6
LIATRIS TURGIDA	TURGID GAY-FEATHER	G3	L	0	0	0	10	0	10
MARSHALLIA GRANDIFLORA	LARGE-FLOWERED BARBARA'S-BUTTONS	G2	L	2	0	2	20	0	18
PRENANTHES CREPIDINEA	NODDING RATTLESNAKE-ROOT	G3G4	W	0	0	0	5	0	5
RUDBECKIA TRILOBA VAR PINNATILOBA	PINNATE-LOBED BLACK-EYED SUSAN	G4T2?	P	1	0	1	5	0	4
SYNOSMA SUAVEOLENS	SWEET-SCENTED INDIAN-PLANTAIN	G3G4							
ARABIS PATENS	SPREADING ROCKCRESS	G3	W	0	0	0	5	0	5
ARABIS SEROTINA	SHALE-BARREN ROCKCRESS	G2	R	51	0	51	20	31	0
CARDAMINE FLAGELLIFERA	BITTER CRESS	G3	P	0	0	0	5	0	5
PARONYCHIA VIRGINICA VAR VIRGINICA	YELLOW NAILWORT	G4T1T2	R	13	0	13	20	0	7
SILENE VIRGINICA VAR ROBUSTA		G5T1Q	L	0	0	0	20	0	20
PAXISTIMA CANBYI	CANBY'S MOUNTAIN-LOVER	G2	L	28	0	28	20	8	0
HYPERICUM MITCHELLIANUM	BLUE RIDGE ST. JOHN'S-WORT	G3	L	1	0	1	10	0	9
GAYLUSSACIA BRACHYCERA	BOX HUCKLEBERRY	G2G3	L	16	0	16	20	0	4
EUPHORBIA PURPUREA	GLADE SPURGE	G3	W	2	2	7	5	2	0
TRIFOLIUM STOLONIFERUM	RUNNING BUFFALO CLOVER	G3	L	11	0	11	10	1	0
TRIFOLIUM VIRGINICUM	KATE'S-MOUNTAIN CLOVER	G3							
MONARDA FISTULOSA SSP 1	SMOKE HOLE BERGAMOT	G5T1	R	10	0	10	20	0	10
PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	G2	W	2	0	2	20	0	18
STACHYS CLINGMANII	CLINGMAN'S HEDGE-NETTLE	G2	P	2	0	2	20	0	18

ILIAMNA REMOTA	KANKAKEE GLOBE-MALLOW	G1Q	L	5	0	5	20	0	15
ILIAMNA COREI	PETERS MOUNTAIN MALLOW	G1Q							
SIDA HERMAPHRODITA	VIRGINIA MALLOW	G2	W	1	0	1	20	0	19
PHLOX BUCKLEYI	SWORD-LEAVED PHLOX	G2	L	13	0	13	20	0	7
POLEMONIUM VANBRUNTIAE	JACOB'S LADDER	G3	L	9	1	12	10	2	0
ACONITUM RECLINATUM	WHITE MONKSHOOD	G3	L				10		
CLEMATIS ADDISONII	ADDISON'S LEATHERFLOWER	G2	R	20	0	20	20	0	0
CLEMATIS COACTILIS	VIRGINIA WHITE-HAIR LEATHER-FLOWER	G2G3	R	26	0	26	20	6	0
CLEMATIS VITICAULIS	MILLBORO LEATHERFLOWER	G1	R	18	0	18	20	0	2
DELPHINIUM EXALTATUM	TALL LARKSPUR	G3	W	5	1	8	5	3	0
SPIRAEA VIRGINIANA	VIRGINIA SPIRAEA	G2	P	1	0	1	5	0	4
BUCKLEYA DISTICHOPHYLLA	PIRATEBUSH	G2	L	5	0	5	20	0	15
HEUCHERA ALBA	WHITE ALUMROOT	G2Q	R	11	0	11	20	0	9
PARNASSIA GRANDIFOLIA	LARGE-LEAVED GRASS-OF-PARNASSUS	G3	W						
VIOLA APPALACHIENSIS	APPALACHIAN BLUE VIOLET	G3							
VITIS RUPESTRIS	ROCK GRAPE	G3							
CAREX LUPULIFORMIS	FALSE HOP SEDGE	G3G4							
CAREX POLYMORPHA	VARIABLE SEDGE	G3	L	3	3	10	10	0	0
CAREX SCHWEINITZII	SCHWEINITZ'S SEDGE	G3	W	2	0	2	5	0	3
SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	G3	W	16	0	16	5	11	0
ALLIUM OXYPHILUM	LILLYDALE ONION	G2G3Q	R	13	0	13	20	0	7
CLINTONIA ALLEGHANIENSIS	HARNED'S CLINTONIA	G1Q	R	4	0	4	20	0	16
HELONIAS BULLATA	SWAMP-PINK	G3	W	13	0	13	5	8	0

3. Invertebrates

GNAME	GCOMNAME	GRANK	DIST	LOCAL	META	TOTA	GOAL	SURPLS	DEFICIT

						L			
TRICHODRILUS CULVERI		G1G2							
STYLODRILUS BEATTIEI	A CAVE LUMBRICULID WORM	G1G2							
CAECIDOTEA PRICEI	PRICE'S CAVE ISOPOD	G3	L	0	0	0	10	0	10
CAECIDOTEA FRANZI	FRANZ'S CAVE ISOPOD	G1	R	3	0	3	20	0	17
CAECIDOTEA HOLSINGERI	HOLSINGER'S CAVE ISOPOD	G3	R	8	0	8	20	0	12
CAECIDOTEA HENROTI	HENROT'S CAVE ISOPOD	G2	L	2	0	2	20	0	18
CAECIDOTEA CANNULUS	AN ISOPOD	G2	R	6	0	6	20	0	14
CAECIDOTEA SIMONINI		G1	R	1	0	1	20	0	19
CAECIDOTEA SP 1	ROCK SPRINGS CAVE ISOPOD	G1	R	0	1	2	20	0	18
CAECIDOTEA SP 3	JOHN FRIEND'S CAVE ISOPOD (MD)	G3	R	0	1	2	20	0	18
ANTROLANA LIRA	MADISON CAVE ISOPOD	G1	R	3	0	3	20	0	17
STYGOBROMUS BIGGERSI	BIGGERS' CAVE AMPHIPOD	G1G2	R	2	0	2	20	0	18
STYGOBROMUS GRACILIPES	SHENANDOAH VALLEY CAVE AMPHIPOD	G2	R	4	0	4	20	0	16
STYGOBROMUS PIZZINII	PIZZINI'S CAVE AMPHIPOD	G2	L	1	0	1	19	0	19
STYGOBROMUS FRANZI	FRANZ'S CAVE AMPHIPOD	G2	R	12	2	1 7	20	0	3
STYGOBROMUS EMARGINATUS	GREENBRIER CAVE AMPHIPOD	G3	R	12	0	1 2	20	0	8
STYGOBROMUS MORRISONI	MORRISON'S CAVE AMPHIPOD	G2	R	0	0	0	20	0	0
STYGOBROMUS STEGERORUM	MADISON CAVE AMPHIPOD	G1	R	2	0	2	20	0	18
STYGOBROMUS ABDITUS	JAMES CAVE AMPHIPOD	G1	R	2	0	2	20	0	18
STYGOBROMUS BAROODYI	ROCKBRIDGE COUNTY CAVE AMPHIPOD	G2	R	2	0	2	20	0	18
STYGOBROMUS CONRADI	BURNSVILLE COVE CAVE AMPHIPOD	G1G2	R	3	0	3	20	0	17
STYGOBROMUS ESTESI	CRAIG COUNTY CAVE AMPHIPOD	G1	R	1	0	1	20	0	19
STYGOBROMUS SPINOSUS	BLUE RIDGE MOUNTAIN AMPHIPOD	G2G3	R	4	0	4	20	0	16
STYGOBROMUS STELLMACKI	STELLMACK'S CAVE AMPHIPOD	G1	R	1	0	1	20	0	19
STYGOBROMUS SPINATUS	SPRING CAVE AMPHIPOD	G3	R	6	0	6	20	0	14
STYGOBROMUS PARVUS	MINUTE CAVE AMPHIPOD	G1	R	2	0	2	20	0	18
STYGOBROMUS REDACTUS	AN AMPHIPOD	G1	R	1	0	1	20	0	19
STYGOBROMUS CULVERI		G1	R	3	0	3	20	0	17
STYGOBROMUS SP 7	SHERANDO SPINOSID AMPHIPOD	G2	R	2	0	2	20	0	18
CRANGONYX DEAROLFI	PENNSYLVANIA CAVE AMPHIPOD	G1G2	R	3	0	3	20	0	17
CAMBARUS NERTERIUS	A CRAYFISH	G2	R	5	0	5	20	0	15

CAMBARUS ELKENSIS	ELK RIVER CRAYFISH	G2	R	2	0 2	20	0	18
MIKTONISCUS RACOVITZAE	RACOVITZA'S TERRESTRIAL CAVE ISOPOD	G2	R	3	0 3	20	0	17
PSEUDOSINELLA GISINI		G3	R	5	0 5	20	0	15
SINELLA AGNA		G2						
CICINDELA ANCOCISCONENSIS	A TIGER BEETLE	G3						
CICINDELA PATRUELA	A TIGER BEETLE	G3	W	2	0 2	5	0	3
PSEUDANOPHTHALMUS LALLEMANTI	CAVE BEETLE	G1	R	1	0 1	20	0	19
PSEUDANOPHTHALMUS GRANDIS	A CAVE BEETLE	G3	R	5	0 5	20	0	15
PSEUDANOPHTHALMUS GRANDIS GRANDIS	A CAVE BEETLE	G3T3	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS HYPERTRICHOSIS	A CAVE BEETLE	G3	R	6	0 6	20	0	14
PSEUDANOPHTHALMUS FUSCUS		G2	R	1	0 1	20	0	19
PSEUDANOPHTHALMUS POTOMACA POTOMACA	SOUTH BRANCH VALLEY CAVE BEETLE	G1T1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS AVERNUS	AVERNUS CAVE BEETLE	G1	R	1	0 1	20	0	19
PSEUDANOPHTHALMUS EGBERTI	NEW RIVER VALLEY CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS HORTULANUS	GARDEN CAVE BEETLE	G1	L	1	0 1	20	0	19
PSEUDANOPHTHALMUS HUBBARDI	HUBBARD'S CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS INTERSECTUS	CROSSROADS CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS LIMICOLA	MUD-DWELLING CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS NELSONI	NELSON'S CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS PARVICOLLIS	THIN-NECK CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS PETRUNKEVITCHI	PETRUNKEVITCH'S CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS PONTIS	NATURAL BRIDGE CAVE BEETLE	G1	R	1	0 1	20	0	19
PSEUDANOPHTHALMUS PUNCTATUS	SPOTTED CAVE BEETLE	G1	R	1	0 1	20	0	19
PSEUDANOPHTHALMUS QUADRATUS	STRALEY'S CAVE BEETLE	G1	R	0	0 0	20	0	20
PSEUDANOPHTHALMUS HOFFMANI	A GROUND BEETLE	G1G2	R	0	0 0	20	0	20

PSEUDANOPHTHALMUS PUSIO	A GROUND BEETLE	G1?	R	0	0	0	20	0	20
PSEUDANOPHTHALMUS GRACILIS	A GROUND BEETLE	G1	R	1	0	1	20	0	19
PSEUDANOPHTHALMUS SP 6	A GROUND BEETLE	G1	L	0	0	0	20	0	20
PSEUDANOPHTHALMUS SP 7	A GROUND BEETLE	G1	R	0	0	0	20	0	20
PSEUDANOPHTHALMUS SP 8	A GROUND BEETLE (HUBBARDI GROUP)	G1	R	2	0	2	20	0	18
PSEUDANOPHTHALMUS SP 11	(PUSIO GROUP)	G1	R	0	0	0	20	0	20
PSEUDANOPHTHALMUS SP 15	MARYLAND CAVE BEETLE	G1	R	2	0	2	20	0	18
ERYNNIS PERSIUS PERSIUS	PERSIUS DUSKY WING	G4T2T3	W	1	0	1	5	0	4
PYRGUS WYANDOT	SOUTHERN GRIZZLED SKIPPER	G2	W	7	0	7	20	0	13
SATYRIUM KINGI	KING'S HAIRSTREAK	G3G4							
INCISALIA IRUS	FROSTED ELFIN	G3G4	W	1	0	1	5	0	4
CALEPHELIS BOREALIS	NORTHERN METALMARK	G3G4	W	8	0	8	5	3	0
SPEYERIA DIANA	DIANA	G3	W	0	0	0	5	0	5
SPEYERIA IDALIA	REGAL FRITILLARY	G3	W	3	1	5	5	0	0
MEROLONCHE DOLLI	DOLL'S MEROLONCHE	G3							
PAPAIPEMA SP 1	FLYPOISON BORER MOTH	G2	L	4	0	4	20	0	16
PROPERIGEA SP 1	A NOCTUID MOTH	G2G3Q							
CHAETAGLAEA CERATA	A NOCTUID MOTH	G3G4	W	1	0	1	5	0	4
GOMPHUS ABBREVIATUS	SPINE-CROWNED CLUBTAIL	G3G4							
GOMPHUS VIRIDIFRONS	GREEN-FACED CLUBTAIL	G3	W	1	0	1	5	0	4
LANTHUS PARVULUS	NORTHERN PYGMY CLUBTAIL	G3G4							
OPHIOGOMPHUS ALLEGHANIENSIS	ALLEGHENY SNAKETAIL	G3Q	L	0	0	0	10	0	10
AESHNA MUTATA	SPATTERDOCK DARNER	G3G4	W	5	0	5	5	0	0
CALOPTERYX AMATA	SUPERB JEWELWING	G3G4	W	1	0	1	5	0	4
STYLURUS SCUDDERI	ZEBRA CLUBTAIL	G3G4	W	0	0	0	5	0	5
ANTHROBIA MONMOUTHIA		G3G4	R	4	0	4	20	0	16
PHANETTA SUBTERRANEA		G3	L	2	0	2	10	0	8
APOCHTHONIUS COECUS	A PSEUDOSCORPION	G1	R	1	0	1	20	0	19
KLEPTOCHTHONIUS HENROTI	GREENBRIER VALLEY CAVE PSEUDOSCORPION	G1	R	3	0	3	20	0	17
KLEPTOCHTHONIUS ANOPHTHALMUS	A PSEUDOSCORPION	G1	R	0	0	0	20	0	20
KLEPTOCHTHONIUS SP 1	A PSEUDOSCORPION	G1	R	0	0	0	20	0	20
CHITRELLA SUPERBA	A PSEUDOSCORPION	G1	R	0	0	0	20	0	20
MUNDOCHTHONIUS HOLSINGERI		G1	R	0	0	0	20	0	20
ALASMIDONTA VARICOSA	BROOK FLOATER	G3	W	0	0	0	5	0	5

ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3	L	14	0	14	10	4	0
FUSCONAIA MASONI	ATLANTIC PIGTOE	G2	L	8	0	8	10	0	2
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	G3G4	W	14	0	14	5	9	0
LASMIGONA HOLSTONIA	TENNESSEE HEELSPLITTER	G2G3							
LASMIGONA SUBVIRIDIS	GREEN FLOATER	G3	W	4	0	4	5	0	1
PLEUROBEMA COLLINA	JAMES SPINYMUSSEL	G1	L	20	0	20	20	0	0
POLYGYRISCUS VIRGINICUS	VIRGINIA COIL	G1	R	0	0	0	20	0	20
TRIODOPSIS PLATYSAYOIDES	CHEAT THREETOOTH	G1	R	4	0	4	20	0	16
FONTIGENS OROLIBAS	BLUE RIDGE SPRINGSNAIL	G3	R						
FONTIGENS TARTAREA	ORGAN CAVESNAIL	G2	R	4	0	4	20	0	16
FONTIGENS BOTTIMERI	APPALACHIAN SPRINGSNAIL	G3							
PROCOTYLA TYPHLOPS	A PLANARIAN	G1G2							
SPHALLOPLANA PRICEI	REFTON CAVE PLANARIAN	G1							
MACROCOTYLA HOFFMASTERI	HOFFMASTER'S CAVE PLANARIAN	G3	R	1	0	1	20	0	19
PSEUDOTREMIA FULGIDA	GREENBRIER VALLEY CAVE MILLIPEDE	G2	R	5	0	5	20	0	15
PSEUDOTREMIA PRINCEPS	SOUTH BRANCH VALLEY CAVE MILLIPEDE	G1	R	1	0	1	20	0	19
PSEUDOTREMIA ALECTO	A MILLIPEDE	G1	R	0	0	0	20	0	20
PSEUDOTREMIA SUBLEVIS	A MILLIPEDE	G1	R	1	0	1	20	0	19
TRICHOPETALUM PACKARDI	PACKARD'S BLIND CAVE MILLIPEDE	G3Q	R	4	0	4	20	0	16
TRICHOPETALUM WEYERIENSIS	GRAND CAVERNS BLIND CAVE MILLIPEDE	G3Q	R	9	0	9	20	0	11
BUOTUS CAROLINUS	A MILLIPEDE	G1	R	1	0	1	20	0	19
DIXIORIA FOWLERI	A MILLIPEDE	G2	R	1	0	1	20	0	19
SEMIONELLUS PLACIDUS	A MILLIPEDE	G3							
LYCAENA EPIXANTHES	BOG COPPER	G4G5	D	2	0	2	5	0	3
TRIODOPSIS PICEA	SPRUCE KNOB THREE-TOOTH	G3	R	2	1	5	20	0	15
LEUCORRHINA HUDSONICA	HUDSONIAN WHITEFACE	G5	D	1	0	1	5	0	4
HELICODISCUS DIADEMA	SHAGGY COIL	G1	L	0	0	0	20	0	20
HELICODISCUS LIRELLUS	RUBBLE COIL	G1	L	0	0	0	20	0	20

APPENDIX VII—CONSERVATION STATUS OF FEDERALLY-LISTED SPECIES

Vertebrates

CONSERVED?	GNAME	GCOMNAME	USESA*	USESADATE
Yes	PLETHODON NETTINGI	CHEAT MOUNTAIN SALAMANDER	LT	89-09-18
No	PERCINA REX	ROANOKE LOGPERCH	LE	89-09-18
Yes	CORYNORHINUS TOWNSENDII VIRGINIANUS	VIRGINIA BIG-EARED BAT	LE	79-11-30
Yes	PLETHODON SHENANDOAH	SHENANDOAH SALAMANDER	LE	89-08-18
Yes	GLAUCOMYS SABRINUS FUSCUS	VIRGINIA NORTHERN FLYING SQUIRREL	LE	85-07-01
No	CLEMMYS MUHLENBERGII	BOG TURTLE	(LT-T(S/A))	
Yes	MYOTIS SODALIS	INDIANA OR SOCIAL MYOTIS	LE	67-03-11

Invertebrates

CONSERVED?	GNAME	GCOMNAME	USESA*	USESADATE
Yes	ANTROLANA LIRA	MADISON CAVE ISOPOD	LT	82-10-04
Yes	PLEUROBEMA COLLINA	JAMES SPINYMUSSEL	LE	88-08-22
No	TRIODOPSIS PLATYSAYOIDES	CHEAT THREETOOTH	LT	78-07-03
Yes	POLYGYRISCUS VIRGINICUS	VIRGINIA COIL	LE	78-07-03

Plants

CONSERVED?	GNAME	GCOMNAME	USESA*	USESADATE
Yes	ARABIS SEROTINA	SHALE-BARREN ROCKCRESS	LE	89-07-13
Yes	ILIAMNA COREI	PETERS MOUNTAIN MALLOW	LE	86-05-12
Yes	TRIFOLIUM STOLONIFERUM	RUNNING BUFFALO CLOVER	LE	87-06-05
Yes	PLATANTHERA LEUCOPHAEA	EASTERN PRAIRIE WHITE-FRINGED ORCHID	LT	89-09-28
Yes	SPIRAEA VIRGINIANA	VIRGINIA SPIRAEA	LT	90-06-15
No	ERYSIMUM CAPITATUM	WESTERN WALLFLOWER	(PS)	
Yes	ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	LT	94-10-06
Yes	ECHINACEA LAEVIGATA	SMOOTH CONEFLOWER	LE	92-09-08
Yes	PTILIMNIUM	HARPERELLA	LE	88-09-28

	NODOSUM			
No	HELONIAS BULLATA	SWAMP-PINK	LT	88-09-09
Yes	SCIRPUS ANCISTROCHAETUS	NORTHEASTERN BULRUSH	LE	91-05-07
Yes	HELENIUM VIRGINICUM	VIRGINIA SNEEZEWEED	C	96-02-28

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

Appendix VIII -- Goals Met/Unmet for Large and Small Patch Terrestrial Communities

This table is better viewed in its original Excel format:

Appendix VIII (XLS)