CHESAPEAKE BAY LOWLANDS ECOREGIONAL PLAN

Conservation Science Support—Northeast and Caribbean

The Chesapeake Bay Lowlands Plan is a first iteration. The draft report that was distributed in hardcopy for review on 6/27/2002 is included on the CD. No updates were made to that version.

CSS is now developing a standard template for ecoregional plans, which we have applied to the CBY ecoregional plan report. Some of the CBY results have been edited or updated for this version.

Click on index in the navigation plane to browse the report sections. Note: The Bibliography (still slightly incomplete) contains the references cited in all report sections except for the Marine references, which have their own bibliography.

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

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

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

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

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

EXECUTIVE SUMMARY*

Description of the Ecoregion

The Chesapeake Bay Lowlands (CBY) ecoregion is centered on the Chesapeake Bay and includes most of Delaware, all of the coastal plain in Maryland and the District of Columbia, and coastal Virginia south to the James River. The ecoregion ends at the Atlantic Ocean on the east and the Piedmont to the west, where Interstate 95 follows the Fall Line through much of Maryland and Virginia, closely approximating the western boundary of the ecoregion.

The landscape of the ecoregion east of the Bay – the Delmarva Peninsula - is dominated by agriculture and characterized by low, flat sandy plains cut by wide, slow-flowing rivers bordered by extensive swamp forests and tidal marshes. To the west of the Bay, a broad plain with generally low slopes and gentle drainage divides is dissected by a series of major rivers – the Patuxent, the Potomac, the Rappahannock, the York and the James – that form a series of large, parallel peninsulas running into the Bay. The western shore in Maryland (especially the northern portion) is dominated by urban/suburban development around and between Washington, D.C., Baltimore and Annapolis. The western shore in Virginia is a lightly-developed, heavily forested area impacted by urban/suburban development near Richmond and Newport News-Hampton.

The CBY ecoregion also includes 140 miles of Atlantic coastline along the Delmarva Peninsula characterized by a complex and dynamic patchwork of barrier islands, salt marshes, tidal flats and large coastal bays, with significant development impacts at Ocean City, Maryland and several beach towns in Delaware. Subdivided by the Conservancy from the much larger Outer Coastal Plain Mixed Forest Province mapped by Bailey, CBY grades into the North Atlantic Coast ecoregion on the south shore of the Delaware Bay, and with the Mid-Atlantic Coastal Plain below the mouth of Chesapeake Bay.

Conservation Targets

Five major types of conservation targets were identified in the CBY ecoregion: 1) matrix forest blocks; 2) aquatic ecosystems; 3) "significant conservation areas" in tidal waters (for estuarine, coastal and marine targets); 4) natural communities, and; 5) species. Matrix forest blocks fell into six block-groupings, as defined by Ecological Land Units. Streams and rivers were classified into 11 different system types, based on their geological, hydrological and biological characteristics. Ten species and four habitat types were included as estuarine, coastal and marine targets in Significant Conservation Areas. At least 113 natural community targets in 18 vegetation groups were identified in the ecoregion. Fifty eight plant and animal species were selected as Primary targets in CBY, including 15 federally listed as Endangered or Threatened. Occurrences of 46 Secondary species targets were also evaluated at portfolio sites.

Ecoregional Portfolio

The full ecoregional portfolio includes 20 matrix forest blocks, 51 aquatic ecosystem occurrences (37 Tier 1, 14 Tier 2), 18 Significant Conservation Areas (14 Tier 1, 4 Tier 2) for estuarine, coastal & marine targets, and 274 sites for species (303 viable occurrences) and natural communities (233 viable occurrences).

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* Samson, D.A., M.G. Anderson et al. 2003. Chesapeake Bay Lowlands Ecoregional Conservation Plan; First Iteration, Edited. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA

Excluding the aquatic ecosystem occurrences, the total area of the ecoregion encompassed by all portfolio sites combined is about 2,461,000 acres, with 966,00 ac in matrix forest blocks, 1,276,986 ac in SCA's, and 218,000 ac in sites harboring species and natural community targets (i.e., named in Natural Heritage Program BCD's). This represents 22.7% of the total area (land and water) of the ecoregion. The total portfolio area for only matrix forest blocks and Natural Heritage sites combined (i.e., terrestrial sites only), represents 15.7% of the land area only of the ecoregion.

Conservation Goals

The current portfolio includes just 25% of the natural community occurrences needed to meet goals set for CBY, based on community patch size and rangewide distribution. Among the 18 vegetation groups, success ranged from below 10% to above 80 percent. Among individual natural community association across groups, only nine met or exceeded the numerical goal set for that community type. The overall success rate for portfolio occurrences of Primary species was about 38%, varying among species from as low as zero to as high as 200%. Conservation goals were met or exceeded for only three animal and five plant species targets. Many species targets had fewer than half of the number of portfolio occurrences that were set as the conservation goal for that species in the ecoregion.

Threats

Not surprisingly, many of the species and natural community targets in this ecoregion occur in aquatic, wetland or shoreline habitats. Direct threats to these conservation targets were judged to be minimal, given their location in areas not suitable for development or natural resource extraction. Many of these sites, however, are threatened by poor water quality, due to agricultural runoff (esp. on Delmarva Peninsula) and urban/suburban runoff on the western shore (esp. in MD). Future threats to water quantity at these sites may be of greater concern, due to depletion of both surface and deep groundwater aquifers from domestic and municipal wells, crop irrigation, and climate change.

Threats to upland sites and matrix forest blocks vary across the ecoregion, depending on their location in the human landscape. Sites and matrix forest blocks located in rural areas and/or with high proportions of low, wet woods (esp. on Delmarva and in VA), are lightly impacted by agriculture, logging and roads, while sites and blocks in southern MD are seriously threatened by all of the impacts associated with encroaching urban/suburban development.

The Chesapeake Bay has been seriously degraded by excessive runoff of nutrients, sediments and toxic chemicals from millions of acres of farm land and developed land in the watershed. Poor water quality in the Bay is both the cause and the consequence of severely diminished submerged aquatic vegetation (SAV) beds and oyster reefs. Overfishing of both finfish and shellfish stocks have depleted a number of the species characteristic of the Bay. The coastal bays along the Atlantic, especially the northern bays in Delaware and Maryland, have been, and continue to be, degraded by many of the same threats affecting the Chesapeake Bay. Probably the single greatest threat to all of these tidal systems, and to many of the freshwater aquatic sites further upstream, is significant sea level rise. An increase in the intensity and frequency of Atlantic storms and other regional weather events as a result of global climate change would also damage many natural areas and ecological systems in the ecoregion.

Conservation Implementation

The Delaware, Maryland/DC and Virginia chapters have committed to work on a suite of *10 Year Action* sites in the ecoregion that includes 13 matrix forest blocks and 99 Natural Heritage sites, 36 of which occur within those same matrix forest blocks. The combined estimated acreage for these Action sites is just over 900,000 acres (838,620 ac in matrix forest blocks, 63,000 (est.) in Heritage sites), or about 12% of the land area of the ecoregion.

None of the aquatic ecosystem occurrences or Significant Conservation Areas in the CBY ecoregional portfolio were selected, per se, as *10 Year Action* sites. However, the Conservancy has done, and continues to do, considerable conservation work in and around a number of the aquatic ecosystem occurrences identified in this Plan, including a number that occur within matrix forest blocks selected as *10 Year Action* sites.

The Nature Conservancy already owns land and is taking conservation action at 21 sites in the portfolio, and is engaged in implementing conservation strategies with partners at more than __ additional portfolio sites in the ecoregion. More importantly, Conservancy staff are engaged in community-based conservation at five project areas in CBY. These landscape-scale initiatives collectively encompass all of part of seven matrix blocks, dozens of portfolio sites for species or natural communities (or both), and several aquatic ecosystem occurrences. They also contribute to the health and protection of several of the Significant Conservation Areas downstream.

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OVERVIEW OF THE ECOREGIONAL PORTFOLIO*

Conservation Targets

As in other ecoregions, we adopted a "coarse filter/fine filter" approach to selecting conservation targets. In the Chesapeake Bay Lowlands ecoregional portfolio, the coarse filter consisted of three types of large-scale targets: matrix forest blocks, aquatic ecosystems, and estuarine, coastal & marine targets assembled in "significant conservation areas." The fine filter consisted of natural (terrestrial) communities, and plant and animal species. A brief description of each of these target groups is presented below.

Matrix Forest Blocks: Areas of at least 10,000 acres and 60% natural forest vegetation cover that are relatively unimpacted by interior roads, agriculture or development. Blocks are presumed to be dominated by matrix-forming natural communities, with the spatial and temporal structure and composition of the forest determined primarily by regional disturbance processes. Matrix forest blocks are intended to act as coarse filters for common native species, and often contain embedded occurrences of smaller (large, linear and small patch) natural communities and rare species populations. Six broad types of matrix forest blocks were identified in CBY, based on surficial geology and landform/topography.

Aquatic Ecosystems: Generally, networks of freshwater stream segments within local watersheds that support diverse and viable communities of native aquatic species (vertebrates, invertebrates, plants), as a result of good water quality and good habitat quality in the adjacent upland or watershed. Occurrences may be of variable length, and may include mainstem stream segments alone, or mainstem segments plus adjacent tributaries. Different aquatic ecosystems are presumed to occur in the different freshwater system types – defined by geology, hydrology, chemistry and biology - found in the ecoregion. Freshwater systems in CBY were classified into 11 types, two tidal and nine non-tidal.

Estuarine, Coastal and Marine Targets: Species and habitat types common in, and significant for ecosystem functioning of, tidal waters and adjacent coastal uplands in the Chesapeake Bay and Atlantic coastal bays. Ten species and four habitat types were identified as conservation targets; habitat types included submerged types (e.g., SAV, oyster reefs), emergent types (e.g., tidal wetlands) and terrestrial types (e.g., dunes and beaches). Diverse aggregations of multiple, abundant targets, in water of good or high quality, were defined as "Significant Conservation Areas" in CBY.

Natural (Terrestrial) Communities: Natural (terrestrial) community targets were set at the *association* level of the National Vegetation Classification and included all types known to occur in the ecoregion. Natural communities were categorized into four size groups: *matrix-forming*, *large patch*, *linear patch* and *small patch*, based on their typical size and the scale of the processes affecting their structure and composition. In CBY, 113 natural communities belonging to 18 vegetation groups were identified as ecoregional targets, with at least 38 others as potential targets.

Plant and Animal Species: Species targets were designated as Primary or Secondary targets, generally according to their global rarity. Primary targets included most globally rare (G1-G3G4)

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plants and animals native to the ecoregion, all federally listed species, and other special cases (e.g., significant disjuncts, rapidly declining species) where appropriate. Secondary species targets were generally G4 or G5 species that were in decline or otherwise vulnerable in the ecoregion. Only viable populations of Primary targets were explicitly included in the portfolio; the capture success of portfolio sites for occurrences of Secondary targets was assessed subsequently. In CBY, 58 species of plants and animals were identified as Primary targets, while 46 were identified as Secondary targets.

Portfolio Occurrences

The complete Chesapeake Bay Lowlands ecoregional portfolio includes 20 matrix forest blocks, 51 aquatic ecosystem occurrences, 18 Significant Conservation Areas (SCA's) for estuarine, coastal and marine targets, and 274 sites for target plant and animal species and natural communities (Map 1, Table o1). Portfolio occurrences for each of the conservation target groups are described in more detail below.

The majority of the matrix forest blocks occur in Maryland, with three in Virginia and four in Delaware; three of the latter overlap into Maryland (Map 2). They range from 10,500 to 225,000 acres in size (966,000 ac total), averaging about 48,000 acres. They group into 6 general types based on an analysis of ecological land unit composition (below; Map 2). Thirteen of the blocks were selected as 10 Year Action sites (Map 2).

The aquatic ecosystem occurrences range from small, linear segments to large, local networks or lengthy stream corridors (Map 3). They occur throughout the three states, in each of the four Ecological Drainage Units, and in every freshwater system type. Thirty three of the occurrences were categorized as Tier 1, the highest quality, and 17 were categorized as Tier 2.

Significant Conservation Areas (SCA's) ranged in size from 1300 to 262,000 acres (1,276,986 ac total), and occur throughout the salinity gradient in the ecoregion, from freshwater (i.e., Susquehanna) to saline (e.g., Cape Henlopen, Lower Bay, Lower Eastern Shore; Map 4). Eleven SCA's fall all or in part in Virginia (including Nanjemoy and Blackwater/Bay Islands), while nine occur in Maryland and one occurs in Delaware.

Two hundred and thirty three viable occurrences of natural communities (Map 5), and 303 viable occurrences of plant and animal species (Map 6) were included in the portfolio, at 274 sites (i.e., places assigned a name by a state Natural Heritage Program). Almost 20% of these occurred within a matrix forest block (Map 1, Table o1). Including 36 of these within blocks, 99 sites for natural community and species targets were chosen as 10 Year Action sites.

Note that portfolio occurrences of several different conservation targets cluster together at a number of places in the ecoregion. Most notable are areas where matrix forest blocks, aquatic ecosystems, natural community and species occurrences occur together upstream of a Significant Conservation Area. These include Blackbird-Millington and Redden-Ellendale in Delaware, Nanticoke (DE and MD) and Nassawango in Maryland, and A.P. Hill and Dragon Run in Virginia. Occurrences of at least three conservation targets cluster together at numerous other places in the ecoregion (Map 1).

Table o1. Total number of ecoregional portfolio occurrences/sites by target type and state, and numbers of current Conservancy preserves and community-based projects in CBY.

Target Type	Number of Sites/Occurences			
	DE	MD	VA	CBY
Matrix Forest Blocks (# of 10Yr Action)	4[a] (4)	16[a] (9)	3 (3)	20 (13)
Aquatic Ecosystem Occurrences (# of Tier 1)	16[b] (15)	21[b] (14)	19 (9)	51 (33)
Significant Conservation Areas (# of Tier 1)	1 (1)	10[c] (6)	10[c] (7)	18 (14)
Species & Natural Communities (# in matrix blocks)	54 (13)	117 (27)	103 (16)	274 (56)
10 Year Action	18 (6)	44 (14)	37 (16)	99 (36)
Partner Lead	21 (4)	35 (10)	31	87 (14)
Portfolio	15 (3)	38 (3)	33	86 (6)
Community-Based Projects	2[d]	2[d]	2	5
Current Conservancy "Preserves" (Sites)	5	17	5	27
Number not in CBY portfolio	1	5	0	6

[a] Three blocks fall in both DE and MD
[b] Five occurrences extend across DE-MD border
[c] Three SCA's fall both in MD and VA
[d] Nanticoke River falls in both DE and MD

Portfolio Area

Excluding the aquatic ecosystem occurrences (for which a "size" determination is problematic; below), and arbitrarily assigning 1,000 ac to each of the 218 Natural Heritage (i.e., species and natural community) sites outside of matrix forest blocks, the total area encompassed by the combined portfolio occurrences is about 2,461,000 acres, or approximately 23% of the total area (land and water) of the ecoregion. If the open water area of the ecoregion is omitted, and only matrix forest blocks and Natural Heritage sites (i.e., "land" sites) are added together, they represent almost 16% of the land area-only of the ecoregion.

Calculating additional portfolio acreage by including the aquatic ecosystem occurrences would depend explicitly on how the "size" of these sites is defined for conservation planning purposes. With a total of about 2300 miles of streams and rivers selected for the portfolio (see Aquatic Ecosystem section below), the total additional acreage would be about 56,000 ac, 279,000 ac, or 736,000 ac, if the occurrences were arbitrarily assigned a corridor width of 200 ft, 1000 ft, or a half-mile, respectively. If the conservation area of each occurrence were to be defined as the entire upstream watershed, 1-2 million acres would likely be added to the portfolio. At the same time, because a moderate number of the aquatic ecosystem occurrences fall partially or fully within matrix forest blocks (Map 3), any estimate of acreage coverage for aquatic ecosystem targets – regardless of the calculation method - would have to be discounted by that overlap.

Portfolio Implementation

Ten-Year Action Agenda

The actual ecoregional conservation "agenda" for The Nature Conservancy for the near future (i.e., 10 years), encompasses an area - and total number of sites - quite a bit smaller than the total portfolio described above. The three states in the ecoregion combined have committed to work on a set of 10 Year Action sites that include 13 matrix forest blocks and 99 Natural Heritage sites, 36 of which occur within those same matrix forest blocks (Table o1). Thus, if the 63 Heritage sites outside of the blocks are given an arbitrary size of 1,000 ac each, and the Action matrix forest blocks total 838,620 ac (below), the 10Year Action agenda for the Conservancy totals just over 900,000 acres, or about 12% of the land area of the ecoregion.

As of April, 2002, the Conservancy had not committed to including any aquatic ecosystem occurrences or Significant Conservation Areas, per se, on the list of 10Year Action sites for the ecoregional portfolio. The Conservancy has done, and continues to do, considerable conservation work in and around a number of the aquatic ecosystem occurrences identified in this Plan, including a number that occur within matrix forest blocks. Similarly, a number of Conservancy preserves and project areas in every state contribute to the downstream health and protection of several of the Significant Conservation Areas (discussed above).

Current Conservation Portfolio and Community-Based Project Areas

Across the three states in the ecoregion, there are currently 27 named preserves or "traditional" conservation sites, totaling about 16,330 acres, with 1600 ac in Delaware, 9650 ac in Maryland, and 5,080 in Virginia (24,575 ac at the Virginia Coast Reserve not included). Most of the existing preserves in each state were identified as harboring viable ecoregional targets and have been included in the CBY portfolio, some as 10Year Action sites (Table o1, Appendix 1). But several did not qualify for portfolio status, including five in Maryland (totaling 1224 ac), and one in Delaware (totaling 560 ac). The Conservancy's current total land ownership at sites in the CBY portfolio, then, is just under 40,000 acres. This is about 4.4% of the total land area identified in matrix forest blocks and Natural Heritage sites (above), but represents only 0.5% of the total land area of the ecoregion.

In addition, there are five staffed community-based conservation project areas in the ecoregion, with two in each state (one overlapping Maryland and Delaware). These include Delaware Bayshores (which overlaps into NAC ecoregion) and the Nanticoke River in Delaware, the Nanticoke River and Nassawango Creek in Maryland, and Chesapeake Rivers and the Virginia Coast Reserve (VCR) in Virginia. The Virginia Coast Reserve, established over 15 years ago as one of the first models for community-based conservation and sustainable economic development in the country, has a staff of 18. Each of the other landscape-scale projects in CBY has only one staff currently, although the Delaware Bayshores office in New Jersey (established earlier than, and independent of, the Delaware-based project office) has __ staff.

These Conservancy community-based project areas in CBY extend over large areas (100,000+ acres) of land and water, often encompassing one or more matrix forest blocks and aquatic ecosystem occurrences, as well as multiple portfolio occurrences of species and natural community targets (Map 1). They also fall upstream of and thus contribute to the health and protection of, several Significant Conservation Areas (above). Thus, while not identified as "portfolio sites" per se in the ecoregional planning process here, these priority conservation projects will integrate multiple target types and occurrences at different scales across diverse natural and anthropogenic landscapes and state boundaries. Taken together, these project areas undoubtedly encompass more than half of the total area of all of the portfolio occurrences (except SCA's) combined.

ACKNOWLEDGEMENTS*

Edited Version and Plan Template

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

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

With this version, the Chesapeake Bay Lowlands Ecoregional Plan is now transferred to the Mid-Atlantic Division of The Nature Conservancy for all future updates and revisions.

Methodologies

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

CBY Planning Team and Working Groups

Planning for the Chesapeake Bay Lowlands ecoregion and the development of this Plan would not have been possible without the generous participation and cooperation of the **Maryland Natural Heritage Program**, the **Delaware Natural Heritage Program** and the **Virginia Natural Heritage Program**. Staff from these partner agencies participated in, and/or contributed to, almost every major section of the Plan. The Plant and Animal Targets Working Groups were made up entirely of Natural Heritage botanists, zoologists and ecologists from the three states (see below), who developed the lists of Target Species and assessed or reviewed the viability of all species occurrences. Natural Heritage community ecologists from each state (see below) formed the Natural Communities Working Group, led initially by Leslie Sneddon and then later by Bob Zaremba.

All of the Biological and Conservation Database records for Species and Natural Community occurrences were provided to the Conservancy by the Natural Heritage Programs (NHP's) in MD, DE and VA. Our deepest thanks go out to the NHP Data Managers in Delaware (Karen Bennett), Maryland (Lynn Davidson) and Virginia (Steve Carter-Lovejoy) for their great

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cooperation in filling multiple data requests from the Conservancy's Eastern Conservation Science Center.

Natural Heritage Program staff in the three states also provided most of the review and assessment of potential and final matrix forest blocks, including delimiting and revising block boundaries. They also provided important input on site locations and quality for Aquatic Ecosystem target occurrences, and assisted with the identification of target species and habitats and Significant Conservation Areas for estuarine, coastal and marine targets. Natural Heritage Program staff also participate fully in the identification of the Conservancy's 10-Year Action Sites at meetings in each of the three states. Most importantly, more than 90 percent of the direct and indirect costs of Natural Heritage program staff participation in the Conservancy's CBY ecoregional planning process were covered by these agencies, a tremendous partnership contribution to the Conservancy's work. Our deepest thanks to all of our NHP colleagues.

<u>Plant Targets Working Group</u>

Kathy McCarthy (chair), MD

Bill McAvoy, DE

Allen Belden, VA

<u>Animal Targets Working Group</u>

Jim McCann (chair), MD

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<u>Natural Communities Working Group</u>

Bob Zaremba (ECS, TNC)

Leslie Sneddon (TNC & ABI)

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<u>Matrix Forest Blocks & 10Yr Action Site selection</u>

Bill, Pete, Kitt, and Karen Bennett (DE)

Kathy, Jim, Jason, Scott Smith, Dave Brinker,

and Chris Frye (MD)

Allen, Chris, Phil, and Chris Ludwig (VA)

This Plan would also not have been possible without the strong support provided by the Conservancy's **Eastern Conservation Science Center** over two and a half years. This group was effectively a core sub-unit of the ecoregional planning team, providing information management and analysis services essential to developing the entire ecoregional portfolio. These efforts included obtaining, analyzing and maintaining spreadsheet and geospatial databases, and producing almost all of the GIS analyses and maps used in the planning process. We thank Shyama Khana for her phenomenal ability to manage and manipulate Excel databases, juggling multiple states and ecoregions all at once. We thank Arlene Olivero for her mind-bursting wizardry with GIS data layer analysis and mapping, including hundreds of hours pioneering watershed condition analyses for aquatic targets. Dan Morse gets big cheers for doing the bulk of the work producing the great maps that appear in this Plan. Charles Ferree and Greg Kehm provided helpful GIS analyses at several points in the planning process.

The Conservancy's **Freshwater Initiative** staff made a tremendous contribution to the aquatic targets portion of this Plan. Jennifer Perot spent many months developing and mapping the freshwater aquatic system classification for the ecoregion. She also conducted the expert workshops in Delaware and Maryland, and drafted much of the text describing this work. Following Jen's departure, Mark Bryer joined the planning team as the aquatic ecosystems expert. Mark and Ryan Smith (in TNC's Southeast Regional Office) conducted the expert workshop in Virginia and refined the target selection results. Mark joined Arlene Olivero and

Mark Anderson in applying and interpreting the watershed condition analysis, and he also drafted and edited text for the aquatics targets section of this Plan.

We thank Paula Jasinski of Chesapeake GIS, Inc., for her tremendous work almost single-handedly developing the estuarine, coastal and marine portion of this Plan. Paula spent countless hours talking to experts around the Chesapeake Bay region and slaving away in ArcView to produce the pioneering analysis presented in this Plan. Although she was paid for her professional service, she also put in considerable additional work that went unrecorded and unbilled. We are deeply grateful for her contributions to this Plan. Mike Beck, of the Conservancy's Coastal Waters Program, set the standard for marine/coastal planning with the Northern Gulf of Mexico Ecoregional Plan, which we used as a model for our approach in CBY. Mike provided important advice, key references, and timely reviews of draft planning maps and documents, for which we thank him.

Finally, our special thanks to the Plan's Sponsor, Nat Williams, State Director of the Maryland/DC Chapter. Aside from a early contribution from the Conservancy's national office (made by Cary Nicholas, the Divisional Director in mid-2000), all of the direct costs and a large portion of the indirect costs of producing this Plan were covered by the Maryland/DC Chapter.

Chesapeake Bay Lowlands Ecoregional Planning Team

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INTRODUCTION TO THE PLAN*

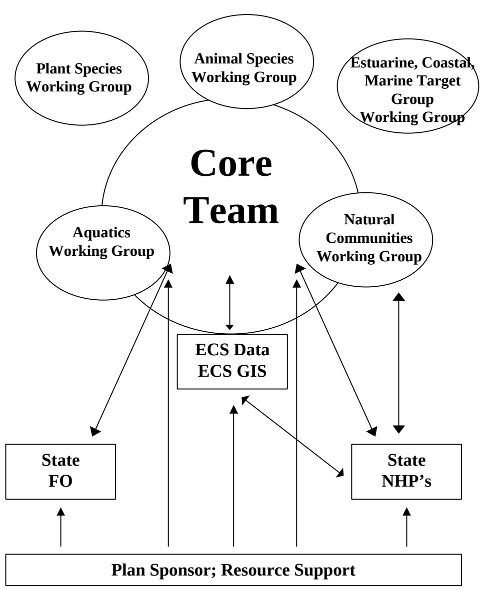
Organization of the Planning Team and Working Groups

Ecoregional Planning Team

The Chesapeake Bay Lowlands ecoregional planning effort was organized around a "core" team consisting of one representative from each state Conservancy chapter and Natural Heritage Program (see figure). Team members facilitated the transfer of data and information from each chapter and Natural Heritage Program (NHP) to the Eastern Conservation Science Center (ECS; in the Eastern Resource Office, Boston), where most of the database development, management and analysis, and geospatial data layer management, analysis and mapping occurred. Most of the target identification and selection, and viability analysis was done by target-specific working groups, the composition and function of which varied among conservation targets (below). The Director of Conservation Science of the Maryland/DC Chapter was the overall team leader, and the State Director was the plan sponsor. The MD/DC Chapter provided most of the direct and indirect financial and resource support necessary to produce the ecoregional portfolio and Plan. Members of the each of the working groups are listed in the Acknowledgements, and the planning tasks and evaluations carried out by the working groups are presented in much greater detail below.

Working Groups

Target identification and selection, some data assembly, and viability assessments for each of the five conservation target groups were carried out by target-specific "working groups" that overlapped with, but worked separately from, the ecoregional planning core team (Fig. 1). The working group for Matrix Forest communities included ECS staff – who did all of the mapping and most of the geospatial and ecological land unit analyses – plus core team members, and additional Conservancy and Natural Heritage Program staff, who assessed matrix forest block boundaries and condition.



Most of the work on Estuarine, Coastal and Marine targets and Significant Conservation Areas in tidal waters was carried out by a GIS consultant (trained as a marine scientist), working with the team leader and with the head of the Conservancy's Coastal Waters Program. The development of the portfolio for this conservation target group also involved considerable input and review from academic experts, public agency biologists and others, through a series of "experts meetings" and numerous individual consultations.

The development of Aquatic Ecosystem targets was led primarily by staff from the Conservancy's Freshwater Initiative program, with considerable assistance from ECS staff, especially for the geospatially-derived watershed condition analysis. Identification of Aquatic

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Ecosystem occurrences was largely accomplished through a series of experts meetings with academic and public agency biologists in each state.

Compilation of an initial Natural Community classification for the CBY ecoregion was done by a community ecologist hired as a short-term consultant, working with Natural Heritage Program (NHP) Community Ecologists from Delaware, Maryland, and Virginia. All of the subsequent planning for Natural Communities was handled by the ECS Community Ecologist, with considerable additional participation by the state NHP Community Ecologists.

The working groups for Species targets consisted entirely of Natural Heritage Program botanists (for plant targets) and zoologists (for animal targets) from each of the three states in the ecoregion. The team leaders for each of the Species working groups were also the NHP representatives to the core planning team.

This Ecoregional Plan Report

This report includes the results of the first iteration assessment of the ChesapeakeBay Lowlands ecoregion, last revised in June 2002. The report has been reorganized to include methods chapters developed in 2003 as part of a standard template for ecoregional plans in the Northeast. The estuarine, coastal and marine analysis methods used in CBY have not yet been standardized. Note that the standard methods chapters are meant to be relatively independent of one another, and so occasionally repeat some concepts or definitions.

Following a general description of the ecoregion are several chapters that describe methods and results for various ecoregional targets:

- Focal species
- Terrestrial ecosystems and patch communities
- Matrix-forming ecosystems
- Freshwater aquatic systems
- Estuarine, coastal, and marine systems

INTRODUCTION TO THE ECOREGION*

The Natural Setting

Location and Physiography

The Chesapeake Bay Lowlands (CBY) ecoregion includes most of Delaware, all of the coastal plain in Maryland (and in Washington, D.C.), and coastal Virginia south to the James River. As modified by the Conservancy, the CBY ecoregion is centered around the Chesapeake Bay and occupies a portion of Bailey's Outer Coastal Plain Mixed Forest Province (US Forest Service; 19xx). Fed from as far away as southern New York by the Susquehanna River, the Bay is one of the largest estuaries in the world, varying from 5 to 30 miles in width and running 195 miles from northeastern Maryland to its mouth in eastern Virginia. The Bay contains numerous large islands and "necks" along its length, especially along the eastern shore, and major sounds and straits also occur near the broad mouths of several rivers.

The landscape of the ecoregion east of the Bay – the Delmarva Peninsula - is characterized by low, very flat, sandy plains cut by wide, slow-flowing rivers with extensive tidal reaches and broad expanses of tidal marsh. To the west of the Bay, lies a broad plain with generally low slopes and gentle drainage divides, except where steep slopes have developed due to stream erosion. The major rivers feeding the Bay from the west – the Patuxent, the Potomac, the Rappahannock, the York and the James – form a series of large, parallel upland peninsulas running northwest to southeast into the Bay.

Along the Atlantic coast of the Delmarva Peninsula, a string of barrier islands (and/or narrow north-south running peninsulas) stretch almost 140 miles from Cape Henlopen in Delaware to Fisherman's Island at the mouth of the Bay in Virginia, creating a series of large coastal bays ("back bays"). A complex and dynamic patchwork of islands, saltmarshes, tidal flats and open water, the coastal bay systems in CBY make up an area about one-tenth the size of the mainstem Bay and its tributaries.

Climate

The climate of the ecoregion is mild temperate, with cool, wet winters and warm, humid summers. Temperatures are moderated by the Bay and the ocean, producing an annual climate pattern more typical of southern locations. Annual precipitation averages 40-50 inches, with mean monthly temperatures above freezing in winter months, and in the upper 70's in summer months. Hurricanes and nor'easters (winter storms) affect the region but are infrequent. Extensive winter freezes, when major rivers and even the upper Chesapeake Bay ice-over, occur every 10-20 years.

Vegetation and Characteristic Plant Species

The typical upland, mesic forest (especially on western shore of Bay) in CBY is dominated by American beech, oaks (esp. white), tulip poplar and hickory, with red maple increasingly abundant. Drier upland forests are dominated by oaks, and sometimes hickory, with dogwood, arrowood, and laurel common in the sub-canopy layer, and huckleberries and blueberries ubiquitous throughout. Early successional stands on dry uplands are often dominated by Virginia pine. The extensive floodplain and slope-bottom habitats on the western shore support sweet

* Samson, D.A., M.G. Anderson et al. 2003. Chesapeake Bay Lowlands Ecoregional Conservation Plan; First Iteration, Edited. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA

gum, red maple, and tulip poplar, with sycamore, birch and ironwood common along riparian edges.

In uplands on the Delmarva Peninsula, loblolly pine forests - both natural and planted - predominate, with oaks (esp. southern red, white, willow), hickory, red maple, and American holly common. Virginia pine typically dominates dry upland habitats recovering from disturbance. In lower, wetter areas, red maple and sweet gum are more abundant, along with black gum, but loblolly pine and American holly remain common where inundation is seasonal. Highbush blueberries and sweet pepperbush predominate in the shrub layer, while sweetbay magnolia reaches into the sub-canopy. Black gum and green ash become common in tidally influenced swamps on Delmarva, and some areas contain sizable stands of Atlantic white cedar.

Vines such as greenbriars, poison ivy, and Virginia creeper can be found throughout the ecoregion. Bald cypress reaches its northernmost extent in southern Delaware and on Maryland's lower Eastern Shore, and Atlantic white cedar also occurs in a few nontidal floodplain swamps along some of the larger rivers on the Delmarva Peninsula.

Freshwater and brackish marshes cover hundreds of thousands of acres in the CBY ecoregion. In freshwater areas, a mix of pickerweed and arrowarum often predominates, with spatterdock also covering large areas. Other common species found in these marshes include smartweed, rice cutgrass, cattails, bulrush, sweetflag, rosemallow, wildrice, and big cordgrass. Brackish and saline marshes typically are characterized by zones of vegetation – high marsh and low marsh - corresponding to the elevational variation in tidal reach. Brackish high marshes typically contain meadow cordgrass and spikegrass, and the small shrubs marshelder and groundselbush, and may have needlerush, cattails, rosemallow, switchgrass, threesquare, and big cordgrass, while brackish low marshes are dominated by smooth cordgrass. Tens of thousands of acres of fresh and brackish marshes in the ecoregion have been invaded and degraded by common reed (*Phragmites*), which often forms monospecific stands 15-20 feet tall. More saline marshes in the southern end of the Bay are characterized by meadow cordgrass and spikegrass, marshelder, groundselbush, and needlerush in the higher zone, with smooth cordgrass dominating the lower zone.

Typical mid-Atlantic maritime woodlands, shrublands, interdunal wetlands, and dune vegetation communities characterize the extensive barrier island habitats along the Atlantic coast from Delaware to Virginia. Eastern red cedar, pitch pine and loblolly pines are common in the woodlands, along with abundant wax-myrtle/bayberry shrubs and beach heather in the ground layer. Dominant dune grasses include *Ammophila breviligulata* and *Panicum amarum*.

Pre-Colonial Landscape

The terrestrial landscape that existed around the Chesapeake Bay prior to the arrival of European settlers in the mid-1600's is poorly documented. Presumably, the region was primarily mature, mixed deciduous forest, with small areas of cleared land and disturbed forest around Native American settlements. Population densities of Native Americans were relatively low, and concentrated near river and Bay shorelines and other water sources.

The frequency of weather-related, large-scale disturbances (hurricanes, nor'easters, tornadoes, windstorms) in CBY presumably hasn't changed significantly in the last 500 years, but the frequency (and scale or scope?) of major pest and disease outbreaks probably increased dramatically with the introduction of alien species (e.g., chestnut blight). Natural wildfires have likely never been a significant disturbance process in the Mid-Atlantic coastal plain, except in drier upland habitats and/or during extended droughts. Native Americans certainly used fire to clear settlement areas and garden plots, and to manage habitat for game species, but such impacts were mostly confined to areas of only a few tens of acres. The most significant alteration of natural processes on a small - but ubiquitous - scale that took place following European colonization may have been the virtual elimination of beaver during the 18th and 19th centuries. On the other hand, the pre-colonial population density of beaver may have been held in check by Native Americans and the large predators now absent from the ecoregion.

Documented virgin (never logged) forest stands are rare in the eastern United States and almost non-existent in the Chesapeake Bay Lowlands ecoregion. The single known example in the ecoregion is at Belt Woods, a state-owned natural area near Bowie, Maryland. The never-cut tract measures only 40 acres (selective logging occurred in surrounding stands), is bounded on the south by a major highway, and on the west by a major amusement park, so edge effects are significant. While known for supporting a significant number of forest interior dwelling bird species, this tiny remnant "island" in a sea of urban/suburban development is clearly not a "virgin" forest. Anecdotal reports suggest that other small old-growth stands occur in the ecoregion, but these have not been systematically documented, either by Natural Heritage Program staff or other researchers.

Common, Characteristic and Significant Animal Species

The ecoregion supports populations of all of the common vertebrate animal species typical of low elevation habitats in the Mid-Atlantic. In Maryland, vertebrate diversity includes 62 species of mammals, 292 birds, 42 reptiles, 38 amphibians and ?? freshwater fish (numbers exclude marine mammals and sea turtles). All of the vertebrates found in Delaware probably also occur in Maryland, while a few more typically southern species are found in the Virginia portion of the ecoregion. The four large mammals – woodland bison, elk, cougar and wolf – that have been extirpated from most of the eastern United States since European settlement, probably all occurred in the CBY ecoregion. Black bear, now found primarily in the Appalachian mountains, were also common in the coastal plain until being extirpated in the late 1800's. Numbers of species in many of the invertebrate taxa in the ecoregion, even in well-known groups (e.g., Lepidoptera, Odenata, Hymenoptera), are unknown.

Given the predominance of the Chesapeake Bay and numerous major tidal rivers, species "characteristic" of the ecoregion would include muskrat, bald eagles, osprey, Canada geese, great blue herons, many species of diving and dabbling ducks, gulls and other shorebirds. Aquatic species representative of the ecoregion include rockfish, spot, yellow perch, several shad and herring species, blue crab, oyster, diamondback terrapin and horseshoe crab. Many of the aquatic reptiles (turtles, snakes) and amphibians common in the Mid-Atlantic are likely more abundant in CBY than in adjacent Piedmont areas, simply because of the greater abundance of aquatic, riverine and wetland habitats.

Only three taxa are known to be endemic to the ecoregion, the Seth Forest Water Scavenger Beetle (*Hydrochus* sp.), the Delmarva fox squirrel (*Sciurus niger cinereus*) and the Maryland darter (*Etheostoma sellare*). The latter species is presumed extinct, as it was last recorded in the mid-1960's and recent field work failed to confirm any individuals in the last known location. The beetle is currently know from only one wetland locality on Maryland's Eastern Shore. The federally listed Delmarva fox squirrel has been the subject of research, habitat restoration and reintroduction projects on the Peninsula in recent years, but remains threatened by timber cutting and residential development. Rare species for which the CBY ecoregion provides critical habitat include the Puritan and Northeastern beach tiger beetles (*Cicindela puritana* and *Cicindela dorsalis dorsalis*), Chermock's Mulberry Wing (*Poanes massasoit chermocki*), a lamprid firefly (*Photuris bethaniensis*) and perhaps several species of groundwater amphipods in the genus *Stygobromus*. Numbers of occurrences of these rare species are discussed in the Species Targets section below.

The Human Setting

Urban/Suburban Patterns and Population

Defined by the Chesapeake Bay and the Atlantic Ocean, the Chesapeake Bay Lowlands ecoregion is heavily influenced by four major "Fall-Line" cities along its northern and western boundaries – Wilmington, Baltimore, Washington, D.C. and Richmond (Map 7). Overlapping or paralleling Interstate 95 for most of its length in the three states, the ecoregional boundary captures half or more of the significant metropolitan areas around all four of these cities. At the southern end, the Newport News-Hampton area of Virginia is also captured in CBY, while the much larger Norfolk-Virginia Beach metropolitan area across the mouth of the James River falls just outside of the ecoregion. The Capital, White House, and Washington Monument are in the CBY ecoregion, but the Worldwide Office of The Nature Conservancy falls just outside the ecoregional boundary.

Other distinct small cities or large towns in the ecoregion, that is those that fall beyond the zone of influence of the major metropolitan areas, include Annapolis, Waldorf/St Charles, Salisbury, Cambridge, Easton, Aberdeen, Havre de Grace and Elkton in Maryland, Dover and Seaford in Delaware, and Fredericksburg (on boundary), Williamsburg and Gloucester Point in Virginia. The long stretch of Atlantic shoreline from Rehobeth Beach, Delaware south to West Ocean City, Maryland, while not a city or urban area per se, swells with several hundred thousand beach vacationers every weekend from May to September.

The ecoregion includes most of the land area of all three counties in Delaware (82.6% of Delaware overall), 13 of Maryland's 23 counties and portions of 4 others (55% of Maryland), and all of 15 counties in Virginia, plus the greater part of two others and a portion of 5 more (12.3% of Virginia; Map 7). Major transportation routes within or affecting the ecoregion include: Interstate 95 (western boundary), national Routes 301 (Wilmington, DE, through Maryland to Virginia) and 50 (Washington, D.C. through Eastern Shore to Ocean City, MD) and 13 (north to south on Delmarva Peninsula). The 22-mile long Chesapeake Bay Bridge-Tunnel connects the southern tip of the Delmarva Peninsula to the Norfolk-Virginia Beach metropolitan area at the mouth of the Chesapeake Bay (Map 7).

The human population in the ecoregion is estimated to have been 4,630,800 as of the 1990 national census (2000 census data are not yet available); 507,000 (11% of CBY total) in Delaware, 1,176,800 (25%) in Virginia, and 2,581,600 (64%) in Maryland. Given that Delaware, Virginia and Maryland make up 14%, 41% and 45% of the land area of the ecoregion, respectively, population densities are much higher in Maryland (472 per sq. mi.) than in Delaware (319) or Virginia (263). Average population densities are much higher on Maryland's western shore (1,186 per sq. mi.), than on Virginia's western shore (286) or the Delmarva Peninsula as a whole (167; see also land cover/land use information below).

Trends in population growth in the ecoregion over the last 40 years, together with projections of expected population growth over the next 50 years, illustrate the enormity of the challenge for doing natural area conservation in the Chesapeake Bay Lowlands ecoregion (Map 8a-d). The rural landscapes that dominated the ecoregion in 1960 had already given way by 1990 to the sprawling reach of suburban development in much of Maryland west of the Bay, extensive patches around large cities and towns in Delaware, and around Richmond and Newport News-Hampton in Virginia (Map 8a and b).

More subtle, but more pervasive, is the transformation of hundreds of thousands of acres throughout the ecoregion from rural to "exurban" landscapes between 1960 and 1990 (Map 8a vs. b). This new demographic term describes rural areas dotted with low-density residential developments populated by people who generally commute to work in the large cities. Such developments inevitably lead to new commercial developments (stores, gas stations, etc.) being built nearby, and over time necessitate new and widened roads, highways, bridges and other infrastructure.

The growth of fully urban landscapes, and the spread of suburban communities into formerly rural areas, is expected to continue for the next five decades in CBY (Map 8c and d). Most of the western shore of Maryland, large portions of southern, eastern, central and northern Delaware, and much of Virginia within 25 miles of Washington, D.C., Richmond and Newport News-Hampton, will be dominated by urban/suburban development by 2020. Within 20 years, large expanses of rural landscapes within the ecoregion are forecast to be confined to only a handful of places: the land between the Rappahannock and upper York tributaries and an area north of the James in Virginia, southern Dorchester County, Worcester County and eastern Somerset County in Maryland, and a small area west of Delaware Bay in northern Delaware (Map 8c). By 2050, these few remaining areas will have shrunk even further, with at least half of the ecoregion covered by urban/suburban development, and most of the rest strongly influenced by these high-density areas (Map 8d). Total population in the ecoregion is predicted to increase 27% to 5,895,500 by 2020, and 56% to 7,237,750 by 2050[1].

Land Cover/Land Use

Not surprisingly, over 30 percent of the nearly 17,000 square miles within the CBY ecoregion is made up of open water (Table i1). Considering only the terrestrial land area, 51% of the ecoregion is forested (uplands and wetlands), and 57.5% is in natural vegetation of one kind or another. One-third of the land area of the ecoregion is devoted to agricultural uses, and almost 8% is developed for residential, commercial or industrial use.

Land cover and use, however, varies dramatically between the three major geographic areas of the ecoregion – the Delmarva Peninsula, Maryland's western shore (north of the Potomac River) and the western shore of Virginia (south of Potomac River). Agriculture dominates the Delmarva Peninsula, with forest cover there well below the average for the ecoregion (Table i1). Conversely, in Virginia below the Potomac, fully two-thirds of the land is forested (uplands and wetlands combined), while less than a quarter is in row crops or pasture. Forested and total natural cover in Maryland north of the Potomac is about the same as for the ecoregion as a whole, but agricultural land takes up only about a fifth of the land area. With over 340,000 acres of tidal marshes on the Delmarva Peninsula, this region has three times the cover of emergent

[1] Projections are based on predicted number of future Household Units (Theobald 2001) multiplied by 2.4, the current average for number of people per household in CBY.

wetlands found on Virginia's western shore, and almost five times the acreage that occurs in Maryland west of the Chesapeake Bay.

The impact of urban/suburban development in the Washington-Baltimore megalopolis is evident in the land cover statistics for Maryland north of the Potomac River, where almost 19% of the land is in residential, commercial or industrial use (Table i1). The corresponding cover value in Virginia is only about a third of Maryland's, while on Delmarva, less than 4% of the land is in residential, commercial or industrial development. Because of its pervasive agricultural landscape, however, the Delmarva Peninsula is actually just over 50% developed, while less than one-third of the western shore of Virginia is classified as developed.

Satellite-derived land cover/land use data in this ecoregion, however, fails to clearly distinguish natural forest stands from active timber lands, which typically consist of loblolly pine monocultures ("pine plantations") or stands where "natural" regeneration has produced stands that are 80-90% pine. Therefore, most of the "coniferous" forest cover acreage, and an undetermined proportion of the "mixed" forest cover acreage, especially on Delmarva and on the western shore of Virginia, likely represents "farmed" forests, the "naturalness" of which is open to debate.

Given the population growth predictions for the ecoregion (above, Map 8a-d) land cover/land use patterns and proportions are expected to change correspondingly over the next several decades. The greatest changes will occur on Maryland's western shore and in Delaware, while the least change is expected in the western and southern portions of the Delmarva Peninsula, and in the central portion of Virginia's western shore (Map 8c and d).

Table i1. Land cover/land use (%) in the ecoregion, by major geographic subregions and overall.

Land Cover/Land Use	Delmarva Peninsula	North of Potomac R	South of Potomac R.	CBY Ecoregion
Water[1]	33.1	31.1	26.8	30.6
Residential	2.8	13.9	4.0	5.4
Commercial/Indust.	1.1	4.9	2.3	2.3
Forested	28.8	49.0	60.1	43.7
Deciduous	11.9	31.5	27.8	
Coniferous	10.7	6.9	10.5	
Mixed	6.2	10.6	21.8	
Forested Wetland	10.1	4.6	5.9	7.6
Emergent Wetland	10.1	2.1	3.2	6.1
Agriculture	46.0	21.5	22.3	33.0
Other[2]	1.0	4.0	2.3	2.0
Total Natural[3]	49.3	55.7	69.3	57.5
Total Developed[4]	50.7	44.3	30.7	42.5
Total land area[5] (ac)	3,435,421	1,481,296	2,619,537	7,536,255
Total area[6] (ac)	5,134,853	2,149,472	3,579,219	10,863,545

[1]Water excluded in calculations below this line
[2]Includes barren, quarry, transitional, grass categories
[3]Includes deciduous, coniferous, mixed, transitional, forested wetland, emergent wetland categories
[4]Includes low residential, high residential, commercial/industrial, barren, quarry, hay-pasture, row crop, grass categories
[5]Water excluded

[6]Water included

Managed Areas vs. Protected Natural Areas

Caveats

Although highly desirable for ecoregional conservation planning, determining how much of an ecoregion – or any large area – is "protected natural area" is a challenging and complicated task, for many reasons. Incomplete or absent data and information present many obstacles, and technical constraints add additional uncertainty to *the goal of knowing how much land is owned and managed as natural area* in a given geographic region. These constraints also make it difficult to determine the *number* of named managed areas – that is, how many *separate* state parks, state forests, wildlife management areas, national wildlife refuges, private nature preserves, etc., occur in a given region. More specifically, problems include:

1. state-by-state lists of public and private "natural" lands or managed areas (with acreages), may or may not be available, and even where they are, they are not segregated by ecoregion; processing such lists is tedious, so GIS-based approaches are now routinely used
2. GIS data layers typically include lands not managed as natural areas (e.g., military installations, county parks, agricultural easements)
3. amount (% or acreage) and type (i.e., forest, grassland, wetlands, etc.) of *actual* natural area within each managed area parcel are usually unknown or undetermined
4. GIS data layers for managed areas are formatted by parcels – individual polygons of circumscribed land area – rather than by management unit (e.g., state park, national wildlife refuge, etc.); each named management unit may consist of one or many parcels
5. GIS data layers for managed area parcels may lack information about; 1) ownership; 2) type (federal, state, etc.); 3) larger management unit (i.e., unit parcel is part of)
6. managed areas are cut by ecoregional boundaries; if polygon is "clipped," unit may be "in" but acreage is reduced; if polygon is not clipped, acreage is overestimated
7. creating a "complete" managed area data layer for an ecoregion typically involves combining multiple data layers from separate sources, but different sources may have digitized some of the same managed area polygons; when multiple versions of the same polygon are superimposed, they rarely match exactly, so reconciliation is necessary, usually involving elimination of small areas of mismatch ("slivers").

In addition, smaller managed areas, of a few acres to a few tens of acres, may or may not provide viable, functional natural habitat for plant and animal species, even where a good proportion of the property is covered by native vegetation. For example, a 20 ac, undeveloped state park or private nature preserve may contain viable small patch communities (e.g., seeps, bogs) and associated native animal populations. But a 20 acre county park with a visitor center, parking area and trails through 12 acres of upland mesic woods would have no viable natural community occurrences and contribute little to maintaining local populations of native plants and animals (both scenarios assume that the managed areas are isolated from other natural habitat by surrounding development). Establishing a minimum size threshold for inclusion of managed areas in ecoregional conservation planning analyses might be a reasonable way to go, but no research has been done on this issue.

General conclusions about analyses of managed area data drawn from all of these constraints include: 1) the number of managed area *units* will always be fewer than the number of managed area *parcels*; 2) the actual "natural area" on the ground within managed areas analyzed in conservation planning will be *significantly less* than the total acreage of managed area measured; 3) smaller managed areas (i.e., those under 100 ac, and especially those under 50 ac) are likely to be relatively unimportant for maintaining native species and natural communities in the ecoregion.

With these caveats in mind, in CBY we took the same managed area approach used by the Conservancy in other ecoregions; GIS data for all managed areas[12] in CBY were compiled from Natural Heritage Programs and other sources, and acreage totals were determined for each of the major landowners – federal, military, state, county, municipal, and private. This analysis suggests that approximately 687,000 acres, or 9.1% of the ecoregion, is "protected" land owned by public agencies and private organizations (Table i2, Map 9). Just over half of the total managed area in CBY is federal property (including military lands), making up about 4.6% of the land area of the ecoregion, while almost a third consists of state lands (2.7% of the ecoregion). Private organizations hold only about 10% of the total managed area land in the ecoregion, which accounts for less than 1.0% of the total land area of CBY. County and municipal managed areas together account for only about 6% of all managed area lands, or barely 0.5% of the ecoregion

Table i2. Managed area total acreage[1] by parcel size category and ownership in the ecoregion.

	Size Category (in acres)							
Ownership	**>5,000**	**>1,000**	**>500**	**>100**	**>10**	**All**	**%[2]**	**% of CBY[3]**
Federal (571)[4]	34,509	88,894	106,586	130,015	136,586	137,487	20.0	1.8
Military (88)	179,420	199,141	205,944	212,178	213,022	213,103	31.0	2.8
State (592)	27,554	139,804	166,527	199,684	206,320	207,029	32.2	2.7
County (661)	0	5,555	9,571	25,654	36,139	37,455	5.5	0.5
Municipal (211)	0	0	0	1,890	3,486	4,015	0.6	<0.1
Private[5] (277)	18,148	48,787	51,712	65,709	70,905	71,194	10.4	0.9
Unident. (763)	0	0	1,849	8,906	14,964	16,911	2.5	0.2
Total	259,631	482,181	542,188	644,038	681,421	687,193	100.0	9.1
Total # parcels	20	133	217	674	1717	3163		

[1]Parcel polygons were clipped at ecoregional boundary, and thousands of slivers (mismatched areas of polygon overlap) removed from the data set.
[2]Percent of total managed area acreage for ecoregion.
[3]Percent of total land area of ecoregion (see Table i1).
[4]Total number of parcels in that ownership.
[5]More than 200 agricultural easement parcels totaling more than 30,000 acres (all in DE) were eliminated from the analysis.

More than 60% of the total federal acreage in CBY consists of military lands, which represent over 30% of all managed area lands, and almost 3% of the land area of the ecoregion (Table i2,

[2] A natural area of land under unified protective (or potentially protective) conservation management such as a public or private park, forest, wildlife refuge, range district, nature preserve, research natural area, military range, etc. May encompass a single contiguous area or disjunct parcels, but must be under unified management (Biological and Conservation Database glossary)

Map 9). Military bases dominate among the largest individual managed area parcels in the ecoregion, making up 69% of all lands larger than 5,000 ac, including 11 of the 20 largest individual parcels (Table i3, Map 9).

Table i3. Managed area parcels larger than 5,000 ac in CBY ecoregion, ranked by size.

MANAGED AREA NAME	ACRES	OWNER	GAP	STATE
Fort A.P. Hill	74645.0	US Dept. of Defense (Army)	4	VA
Aberdeen Proving Grounds	28510.8	US Dept. of Defense (Army)	3	MD
Blackwater NWR	15888.2	US Fish & Wildlife Service	2	MD
Fort George G. Meade	13343.2	US Dept. of Defense (Army)	3	MD
Great Cypress Swamp	12465.4	Delaware Wildlands (private)	0	DE
Deal Island WMA	11631.9	MD Forests & Parks	3	MD
Aberdeen Proving Grounds	10125.5	US Dept. of Defense (Army)	3	MD
Naval Weapons Station, Yorktown	9695.1	US Dept. of Defense (Navy)	0	VA
Camp Peary	8637.8	US Dept. of Defense (Navy)	0	VA
Fishing Bay WMA	8585.8	MD Forests & Parks	3	MD
Fort Belvoir	8581.5	US Dept. of Defense (Army)	0	VA
Fort Eustis	8072.5	US Dept. of Defense (Army)	0	VA
Mockhorn Island WMA	7336.1	VA Dept. Game & Inland Fisheries	3	VA
Assateague Island National Seashore	6973.6	National Park Service	2	MD
Quantico Marine Corps DEC	6500.5	US Dept. of Defense (Navy)	4	VA
Patuxent Naval Air Station	6164.7	US Dept. of Defense (Navy)	3	MD
Assateague Island National Seashore	5977.2	US Fish and Wildlife Service	2	VA
Virginia Coast Reserve	5682.7	The Nature Conservancy	2	VA
National Agricultural Research Center	5669.7	Min. Agric., Forestry & Fisheries	4	MD
Bloodsworth Island Naval Reservation	5143.8	US Dept. of Defense (Navy)	0	MD

State-owned managed area lands are represented by only three parcels larger than 5,000 ac in the ecoregion, and private conservation lands by two parcels, including one owned by The Nature Conservancy at the Virginia Coast Reserve (Table i3). Taken together, the twenty parcels larger than 5,000 ac represent almost 38% of the total managed area land in the ecoregion.

According to the managed areas data layers at the time they were compiled for this ecoregion, The Nature Conservancy owned a total of about 31,300 ac in 114 separate parcels in CBY, including 1208 ac in Delaware (9 parcels; number of sites unknown), 5529 ac at 16 sites in Maryland and 24,575 ac at a single site in Virginia, the Virginia Coast Reserve (3 parcels totaling about 1300 ac were unlabeled, but assumed to also be at VCR). Actual Conservancy land ownership in the ecoregion as of 2001 was quite a bit higher, based on data provided by state chapters (see Conservation Activities & Implementation, below).

Note that the size distribution of managed areas in CBY is significantly log-normal – a large number of small parcels and a few very large parcels. Over 45% of all parcels are under 10 ac in size, and almost 80% are under 100 acres. But the former set of managed areas taken together represents only 0.8% of the total managed area acreage in the ecoregion, and the total for all managed areas less than 100 ac each represents only 6.3% of the total for CBY. Thus, 93% of the managed area lands in the ecoregion are large enough (> 100 ac) to potentially support small patch and some large patch natural communities and their associated species, especially if those parcels are fully covered by native vegetation, or minimally developed or converted to other uses.

GAP Status Analysis

Another approach for trying to arrive at a good estimate of the true amount of "protected natural area" lands in the ecoregion is to use GAP analysis data. GAP programs funded by the US Fish & Wildlife Service cover all of the states in CBY, and draft GAP Status data are available for some of the managed areas in the ecoregion. In the GAP approach, managed areas are assigned a Status rank of 1 (highest) to 4 (lowest) as follows:

1. An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency and intensity) are allowed to proceed without interference or are mimicked through management.
2. An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities.
3. An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.
4. Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. Allows for intensive use throughout the tract. Also includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown.

The available draft data shows that, not surprisingly given the strict criteria, very little of the managed area in the CBY ecoregion is categorized as Status 1; less than 1% of the total acreage, all of which occurs on state land (Table i4). Of the 543,42 acres of managed area in CBY that have been assigned a GAP rank, about 28% has been scored as Status 2 or higher. All of the Conservancy lands in CBY except a single parcel (360 ac) in Delaware are categorized as Status 2 lands (data not shown). Among owner types, 79% of Private managed area acreage is in Status 2, while 56% of Federal (non-military) lands are categorized at that level (ignoring lands lacking a GAP Status rank). Notably, only 23% of State managed areas that have been categorized met the criteria for Status 2, while 40% of County lands were at that level. And while many of the largest managed area parcels in the ecoregion are military bases, no Military lands have a GAP Status rank of 2 or higher (Table i4). Finally, just over 420,000 acres of managed areas in CBY (61% of the total) rank as GAP Status 3 or higher, representing just 5.6% of the total land area of the ecoregion.

All of the analyses above suggest that at least 5% – and perhaps as much as 8% - of the land area of the ecoregion consists of protected managed area parcels larger than 100 ac in size, and characterized by native vegetation and natural habitats having the capacity to support viable occurrences of native species and natural communities.

Table i4. Managed area total acreage[1] by GAP Status[2] and owner type in the ecoregion.

GAP Status	0	4	3	2	1	Total
Ownership						
Federal (571)	32,054	12,565	34,079	58,790	0	137,487
Military (88)	55,100	81,260	76,743	0	0	213,103
State (592)	16,406	942	145,313	38,600	5,767	207,029
County (661)	686	21,702	93	14,974	0	37,455
Municipal (211)	1,449	2,457	0	110	0	4,015
Private (277)	26,289	3,185	6,157	35,562	0	71,194
Unident. (763)	11,785	0	4,375	751	0	16,911
Total	143,769	122,111	266,760	148,786	5,767	687,193
Total # parcels	1,205	588	841	548	11	3163

[1]Same managed area database as used for Tables i2 & i3, above.
[2]GAP Status data are from draft reports only, and subject to revision.

PLANNING METHODS FOR ECOREGIONAL TARGETS: SPECIES[*]

Coarse-filter and fine-filter targets

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

Primary species targets

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

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

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

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

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

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

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

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

Secondary species targets

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

Developing the target list

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

Table SPP1. Criteria for selecting species targets

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

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

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

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

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

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

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

Setting Minimum Conservation Goals for Species Targets

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

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

Quantitative global minimums

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

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

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

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

Distribution and Stratification goals

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

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

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

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

Assessing the Viability of Local Populations

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

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

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

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

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

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

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

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

RESULTS FOR SPECIES*

Modification to Standard Method

Viability Analysis and Ranking in CBY

In CBY, unlike in neighboring ecoregions, each target occurrence judged to be viable was also assigned a Priority ranking of "Low", "Medium" or "High". This priority ranking was meant to further identify those occurrences in greatest need of conservation, or which were under greatest threat, or which occurred at a high-quality site that captured other conservation targets or biodiversity features of conservation interest (e.g., non-target state-rare species, high-quality natural community occurrences, etc.). Not surprisingly, Priority ranks often paralleled EO Ranks, since EO Ranks generally reflect the quality of the habitat in which target occurrences are found. In some cases, though, A-ranked target occurrences were given a Priority of "Low" (e.g., where they already occurred on protected land with appropriate ecological management) and C-ranked occurrences were assigned a Priority of "High" (e.g., where it was the only occurrence in the state, or where numerous other state-rare species or a unique natural community occurred at the same site).

Conservation Goals for Species in CBY

Table sp5. Conservation goals for species based on rarity and distribution.

	GRank		
Distribution	**G1**	**G2**	**G3**
Restricted (R)	20	20	30
Limited (L)	10-20	10-20	10-20
Widespread (W)	5-10	5-10	5-10
Peripheral (P)	–	5	5-10

G3 species that are Restricted to the CBY ecoregion, although more common and therefore more likely to survive into the future, will not be included in any other ecoregion's portfolio. Thus, 30 occurrences was set as the conservation goal for this category of target, rather than the more typical 20.

Where the range of a globally rare target species extends across more than one ecoregion, we made the assumption that occurrences of that target would be included in the portfolios of each of those other ecoregions. It is important to note that this approach to setting conservation goals works only if other ecoregional planning efforts make similar assumptions when setting conservation goals for those portfolios. We plan to evaluate the contributions made by neighboring ecoregions once all of these portfolios are complete.

* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for species. Based on Samson, D.A. 2002. Chesapeake Bay Lowlands Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Targets Selected

Primary

Fifty eight species of plants and animals were selected as Primary conservation targets in the Chesapeake Bay Lowlands ecoregion, including 10 vertebrates, 16 invertebrates and 32 plants (Table sp1). Of these, seven (5 animals, 2 plants) are ranked G1 or G1G2 (or equivalent ranks, such as G3T1, etc.), 18 (5 animals, 13 plants) are ranked G2 or G2G3, and 33 (16 animals, 17 plants) are ranked G3 or G3G4. Seven (5 animals, 2 plants) of the CBY Primary species conservation targets are federally listed as Endangered, while eight (4 animals, 4 plants) are federally listed as Threatened (Table sp1).

Among Primary species targets, seven animal species (the Delmarva Fox Squirrel and six invertebrates) and one plant species have distributions Restricted to the ecoregion (Table sp1). With seven additional Primary animal targets classified as having Limited distributions, just over half (14/26) of animal conservation targets are found only in CBY and/or one other adjacent ecoregion. Among Primary plant targets, however, only five species (16%) are Restricted or Limited in their distributions, while almost three-quarters of the species are either Peripheral to the ecoregion or Widespread in their distribution.

Table sp1. Primary species conservation targets, with global ranks and rangewide distributions.

Scientific Name	Common Name	Global Rank[1]	Rangewide Distribution
Animals-Vertebrates			
Acipenser brevirostrum	Shortnose Sturgeon	G3 (E)	W
Acipenser oxyrinchus	Atlantic Sturgeon	G3	W
Aimophila aestivalis	Bachman's Sparrow	G3	P
Caretta caretta	Loggerhead	G3 (T)	P
Charadrius melodus	Piping Plover	G3 (E)	W
Clemmys muhlenbergii	Bog Turtle	G3 (T)	P
Corynorhinus rafinesqui	Rafinesque's Big-Eared Bat	G3G4	P
Melospiza georgiana nigrescens	Coastal Plain Swamp Sparrow	G5T3	L
Picoides borealis	Red-Cockaded Woodpecker	G3 (E)	P
Sciurus niger cinereus	Delmarva Fox Squirrel	G5T3 (E)	R
Animals-Invertebrates			
Aeshna mutata	Spatterdock Darner	G3G4	W
Alasmidonta heterodon	Dwarf Wedgemussel	G1G2 (E)	W
Callophrys hesseli	Hessel's Hairstreak	G3G4	L
Callophrys irus	Frosted Elfin	G3	L
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2 (T)	L
Cicindela puritana	Puritan Tiger Beetle	G1G2 (T)	L
Epitheca spinosa	Robust Baskettail	G3G4	P

Hydrochus sp 1	Seth Forest Water Scavenger Beetle	G1	R
Photuris bethaniensis	A Lampyrid Firefly	G1?	R
Poanes massasoit chermocki	Chermock's Mulberry Wing	G4T1	R
Problema bulenta	Rare Skipper	G2G3	L
Satyrium kingi	King's Hairstreak	G3G4	P
Somatochlora provocans	Treetop Emerald	G3G4	L
Stygobromus araeus	Tidewater Interstitial Amphipod	G2G3	R
Stygobromus indentatus	Tidewater Amphipod	G2G3	R
Stygobromus phreaticus	Northern Virginia Well Amphipod	G2G3	R
Plants			
Aeschynomene virginica	Sensitive Joint-Vetch	G2 (T)	L
Agalinis acuta	Sandplain Gerardia	G1 (E)	P
Agalinis auriculata	Earleaf Foxglove	G3	P
Agalinis skinneriana	Pale False Foxglove	G3	P
Amaranthus pumilus	Seabeach Amaranth	G2 (T)	P
Carex decomposita	Cypress-Knee Sedge	G3	P
Carex lupuliformis	False Hop Sedge	G3G4	W
Chamaecrista fasciculata var. *macrosperma*	Large-seeded marsh senna	G5T2	R
Chelone cuthbertii	Cuthbert Turtlehead	G3?	P
Coreopsis rosea	Rose Coreopsis	G3	P
Cypripedium kentuckiense	Southern Lady's-Slipper	G3	P
Desmodium ochroleucum	Creamflower Tick-Trefoil	G2G3	P
Euphorbia purpurea	Glade Spurge	G3	P
Fimbristylis perpusilla	Harper's Fimbristylis	G2	L
Gaylussacia brachycera	Box Huckleberry	G2G3	P
Helonias bullata	Swamp-Pink	G3 (T)	P/L
Hypericum adpressum	Creeping St. John's-Wort	G2G3	W
Isotria medeoloides	Small Whorled Pogonia	G2G3 (T)	W
Juncus caesariensis	New Jersey Rush	G2	P
Litsea aestivalis	Pondspice	G3	P
Monotropsis odorata	Sweet Pinesap	G3	P
Muhlenbergia torreyana	Torrey's Dropseed	G3	P
Nuphar lutea ssp sagittifolia	Cape Fear Spatterdock	G5T2	P
Oxypolis canbyi	Canby's Dropwort	G2 (E)	P
Panicum hirstii	Hirsts' Panic Grass	G1	L
Polygonum glaucum	Sea-Beach Knotweed	G3?	P

Pycnanthemum torrei	Torrey's Mountain Mint	G2	W
Rhexia aristosa	Awned Meadowbeauty	G3	P
Rhynchospora inundata	Drowned Hornedrush	G3G4	P
Schizaea pusilla	Curly-Grass Fern	G3	P
Scirpus etuberculatus	Canby Bulrush	G3G4	P
Trillium pusillum var. *virginianum*	Virginia Least Trillium	G3T2	L

[1]Federal rank in parentheses; E = Endangered, T = Threatened

Four animal species and ten plant species on the initial Primary Target list (i.e., ranked G1-G3 and with documented occurrences in CBY) were downgraded to the Secondary target list, or were dropped entirely from the portfolio, again based on expert opinion of the Working Groups. All of the species added to or removed from the Primary Target list, and the reason for their inclusion or exclusion, are presented in Table sp2.

Table sp2. Plant and animal species added to, or dropped from, the Primary Target list.

Scientific Name	Common Name	GRank	Reason
	Species Added		
Animals			
Picoides borealis	Red-cockaded woodpecker	G3	signif. native species
Melospiza georgiana nigrescens	Coastal plain swamp sparrow	G3	signif. native species; in decline
Corynorhinus rafinesquei	Refinesque's big-eared bat	G3G4	signif. native species
Plants			
Carex decomposita	Cypress-knee sedge	G3	signif. native species
	Species Dropped		
Animals			
Elliptio lanceolata	Yellow lance	G2G3	should be ranked G4 or G5
Meropleon titan	A noctuid moth	G2G4	should be ranked G4 or G5
asmigona subviriLdis	Green floater	G3	should be ranked G4 or G5
Lampsilis cariosa	Yellow lampmussel	G3G4	should be ranked G4 or G5
Plants			
Schwalbea americana	Chaffseed	G2	extirpated from ecoregion
Alnus maritima	Seaside alder	G3	Secondary list; abundant in CBY
Sabatia kennedyana	?	G3	single EO is introduction
Pycnanthemum setosum	Awned mountain mint	G3?	should be ranked G4 or G5
Carx barratii	Barrett's sedge	G3G4	should be ranked G4
Carex mitchelliana	Mitchell's sedge	G3G4	may be common; need more info
Juglans cinerea	Butternut	G3G4	may be common; need more info

Scleria reticularis	Reticulated nutrush	G3G4	should be ranked G4 or G5
Cardamine longii	Long's bittercress	G3Q	may be common; need more info
Bidens bidentoides var. mariana	Maryland bur-marigold	G3T3	Secondary list; abundant in CBY

As would be expected in this coastal plain ecoregion, the vast majority of the Primary targets are species that occur in, or are associated with, aquatic, wetland or shoreline habitats. Five of the ten vertebrate targets, 14 of the 16 invertebrate targets, and 21 of the 32 plant targets (69% overall) would be categorized as aquatic, wetland or shoreline habitat species. Some of the invertebrate species, while not aquatic species per se, utilize host plant species that grow in aquatic or wetland habitats (e.g., Hessel's hairstreak). The proportion of Secondary species targets that are found in aquatic, wetland or shoreline habitats is even higher than that for Primary species targets (see below).

Secondary

Forty six species of plants (8) and animals (38; 17 vertebrates and 21 invertebrates) native to the ecoregion were identified as secondary conservation targets (Table spr3). Secondary targets are generally state- but not globally rare species for which there is some concern about their long-term viability within the ecoregion, due to declining populations, increasing threats, and so on. The majority of these species in CBY are ranked G4 or G5, although three of the secondary plant species are ranked G3 (or G3T3). The latter are all Restricted or Limited species that grow in tidal waters at a moderately large number of sites in the ecoregion; in spite of their rarity rank, their viability status in CBY is secure because their habitats are under low levels of threat.

Table sp3. Secondary species conservation targets, with global ranks and rangewide distributions.

Scientific Name	Common Name	Global Rank	Rangewide Distribution
Animals-Vertebrates			
Ambystoma mabeei	Mabee's Salamander	G4	L
Ambystoma tigrinum	Tiger Salamander	G5	W
Anas rubripes	American Black Duck	G5	W
Botaurus lentiginosus	American Bittern	G4	W
Certhia americana	Brown Creeper	G5	P
Circus cyaneus	Northern Harrier	G5	W
Haematopus palliatus	American Oystercatcher	G5	W
Helmitheros vermivorus	Worm-Eating Warbler	G5	W
Hyla gratiosa	Barking Treefrog	G5	P
Laterallus jamaicensis	Black Rail	G4	W
Limnothlypis swainsonii	Swainson's Warbler	G4	P
Oporornis formosus	Kentucky Warbler	G5	W
Protonotaria citrea	Prothonotary Warbler	G5	W
Rana virgatipes	Carpenter Frog	G5	P

Rynchops niger	Black Skimmer	G5	W
Sitta pusilla	Brown-Headed Nuthatch	G5	P
Wilsonia citrina	Hooded Warbler	G5	W
Animals-Invertebrates			
Alasmidonta undulata	Triangle Floater	G4	W
Anax longipes	Comet Darner	G5	L
Argia bipunctulata	Seepage Dancer	G4	W
Atlides halesus	Great Purple Hairstreak	G5	P
Cicindela abdominalis	A Tiger Beetle	G5	P
Cicindela dorsalis media	White Tiger Beetle	G4	L
Cicindela gratiosa	A Tiger Beetle	G5	P
Cicindela lepida	Little White Tiger Beetle	G4	P
Cordulegaster erronea	Tiger Spiketail	G4	L
Enallagma dubium	Burgundy Bluet	G5	W
Enallagma pallidum	Pale Bluet	G4	W
Enallagma weewa	Blackwater Bluet	G5	W
Gomphus rogersi	Sable Clubtail	G4	W
Isoparce cupressi	Cypress Sphinx	G4	P
Leptodea ochracea	Tidewater Mucket	G4	W
Libellula flavida	Yellow-Sided Skimmer	G5	W
Ligumia nasuta	Eastern Pondmussel	G4G5	W
Nannothemis bella	Elfin Skimmer	G5	W
Nehalennia irene	Sedge Sprite	G5	W
Stylurus laurae	Laura's Clubtail	G4	L
Tachopteryx thoreyi	Gray Petaltail	G4	L
Plants			
Alnus maritima	Seaside Alder	G3	L
Bidens bidentoides var. *mariana*	Maryland Bur-marigold	G3T3	R
Carex vesicaria	Inflated Sedge	G5	P
Eriocaulon parkeri	Parker's Pipewort	G3	L
Lysimachia thyrsiflora	Water Loosestrife	G5	P
Minuartia caroliniana	Pine-Barren Sandwort	G5	W
Rhynchospora harperi	Harper Beakrush	G4	W
Rhynchospora oligantha	Few-Flowered Beaked-Rush	G4	P

One group of Secondary species, the birds, deserves special attention. The Conservancy's Partners in Flight (PIF) program has developed a list of native bird species for each ecoregion that they recommend be considered as conservation targets in the respective ecoregional portfolios. In CBY, the Animal Working Group reviewed the Partners in Flight list (Table sp4), but made their own determination of which birds should be Secondary targets and which should not. Six of the species recommended by Partners in Flight were designated as Secondary targets in CBY (Piping plover was a Primary target), while six others were not included as targets (Table sp4). However, seven additional bird species not on the PIF list for CBY were included as Secondary targets in the ecoregional portfolio (Table sp3).

Table sp4. Bird species recommended as conservation targets in CBY by Partners in Flight and those species included as Primary or Secondary targets.

PIF Conservation Target Species	Target Status in CBY Portfolio
American Black Duck	Secondary
Black rail	Secondary
Piping plover	Primary
Willet	none
Chuck-will’s widow	none
Brown-headed nuthatch (local pops.)	Secondary
Wood thrush	none
Prairie warbler	none
Prothonotary warbler	Secondary
Worm-eating warbler	Secondary
Kentucky warbler	Secondary
Saltmarsh sharp-tailed sparrow	none
Seaside sparrow	none

Portfolio Results

Primary Targets

For the 58 Primary species targets in CBY, 303 of 437 (69%) known occurrences were judged to be viable, and were included in the portfolio (Table sp6, Map 6). Three Primary animal targets (Rafinesque's Big-Eared Bat, Coastal Plain Swamp Sparrow, Red-Cockaded Woodpecker) and one Primary plant target (Cypress-Knee Sedge) had no occurrences recorded in BCD in the ecoregion. Two additional Primary animal targets (Shortnose Sturgeon, Atlantic Sturgeon), and one Primary plant target (Sandplain gerardia) did not have any viable occurrences in the ecoregion, so no portfolio sites exist for these seven species targets. Notably, too, 16 other species targets (6 animals, 10 plants) are represented by only a single viable population in the ecoregion. Thus, only 60% (35) of all Primary species targets in the ecoregion are represented by more than one occurrence in the portfolio (Table sp6).

Table sp6. Total number of occurrences, portfolio occurrences, and priority occurrences of Primary species conservation targets in the ecoregion.

		Number of Occurrences		
Scientific Name	Common Name	Total	Viable	Priority[1]

Animals-Vertebrates				
Acipenser brevirostrum	Shortnose Sturgeon	3	0	0
Acipenser oxyrinchus	Atlantic Sturgeon	1	0	0
Aimophila aestivalis	Bachman's Sparrow	1	1	1
Caretta caretta	Loggerhead	4	4	4
Charadrius melodus	Piping Plover	22	13	13
Clemmys muhlenbergii	Bog Turtle	4	1	1
Corynorhinus rafinesqui	Rafinesque's Big-Eared Bat	0	0	0
Melospiza georgiana nigrescens	Coastal Plain Swamp Sparrow	0	0	0
Picoides borealis	Red-Cockaded Woodpecker	0	0	0
Sciurus niger cinereus	Delmarva Fox Squirrel	30	30	13
Total		**65**	**49**	**32**
Animals-Invertebrates				
Aeshna mutata	Spatterdock Darner	1	1	1
Alasmidonta heterodon	Dwarf Wedgemussel	5	3	2
Callophrys hesseli	Hessel's Hairstreak	4	3	2
Callophrys irus	Frosted Elfin	7	4	4
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	33	23	14
Cicindela puritana	Puritan Tiger Beetle	16	14	14
Epitheca spinosa	Robust Baskettail	3	2	2
Hydrochus sp 1	Seth Forest Water Scavenger Beetle	1	1	1
Photuris bethaniensis	A Lampyrid Firefly	7	7	7
Poanes massasoit chermocki	Chermock's Mulberry Wing	1	1	1
Problema bulenta	Rare Skipper	5	5	4
Satyrium kingi	King's Hairstreak	5	4	2
Somatochlora provocans	Treetop Emerald	4	3	3
Stygobromus araeus	Tidewater Interstitial Amphipod	8	2	0
Stygobromus indentatus	Tidewater Amphipod	3	2	1
Stygobromus phreaticus	Northern Virginia Well Amphipod	1	1	0_
Total		**104**	**76**	**58**
Total – Animals		**169**	**125**	**90**
Plants				
Aeschynomene virginica	Sensitive Joint-Vetch	23	15	14
Agalinis acuta	Sandplain Gerardia	1	0	0
Agalinis auriculata	Earleaf Foxglove	1	1	1
Agalinis skinneriana	Pale False Foxglove	2	2	2
Amaranthus pumilus	Seabeach Amaranth	7	7	7

Carex decomposita	Cypress-Knee Sedge	0	0	0
Carex lupuliformis	False Hop Sedge	13	5	3
Chamaecrista fasciculata var *macrosperma*	Large-seeded marsh senna	2	2	1
Chelone cuthbertii	Cuthbert Turtlehead	5	2	2
Coreopsis rosea	Rose Coreopsis	3	3	1
Cypripedium kentuckiense	Southern Lady's-Slipper	1	1	1
Desmodium ochroleucum	Creamflower Tick-Trefoil	1	1	1
Euphorbia purpurea	Glade Spurge	1	1	1
Fimbristylis perpusilla	Harper's Fimbristylis	34	34	27
Gaylussacia brachycera	Box Huckleberry	6	5	4
Helonias bullata	Swamp-Pink	51	36	19
Hypericum adpressum	Creeping St. John's-Wort	14	10	5
Isotria medeoloides	Small Whorled Pogonia	13	2	1
Juncus caesariensis	New Jersey Rush	20	10	8
Litsea aestivalis	Pondspice	2	1	1
Monotropsis odorata	Sweet Pinesap	4	2	1
Muhlenbergia torreyana	Torrey's Dropseed	1	1	1
Nuphar lutea ssp sagittifolia	Cape Fear Spatterdock	5	3	0
Oxypolis canbyi	Canby's Dropwort	1	1	1
Panicum hirstii	Hirsts' Panic Grass	1	1	1
Polygonum glaucum	Sea-Beach Knotweed	15	8	8
Pycnanthemum torrei	Torrey's Mountain Mint	4	1	1
Rhexia aristosa	Awned Meadowbeauty	7	2	2
Rhynchospora inundata	Drowned Hornedrush	7	5	4
Schizaea pusilla	Curly-Grass Fern	1	1	1
Scirpus etuberculatus	Canby Bulrush	4	3	3
Trillium pusillum var. *virginianum*	Virginia Least Trillium	18	12	5
Total – Plants		**268**	**178**	**127**
Total – All species		**437**	**303**	**217**

[1]Occurrences at 10Year Action and Partner Lead sites.

At the other end of the scale, four animal targets and nine plant targets have more than 10 known occurrences in the ecoregion, and for all of those species except one plant (False hop sedge), at least 10 of their populations were included in the portfolio as viable (Table spr6). All four of these animal targets had more than 20 total occurrences, and two (Delmarva fox squirrel, Northeastern beach tiger beetle) also had at least 20 occurrences that were viable. Among the abundant plant targets, four species also had more than 20 known occurrences, but for only two of those were 20 or more of their respective populations viable. Forty two targets had fewer than the average number of known occurrences (7.5 for 58 species, or 8.1 if species with no occurrences in CBY are excluded) and 45 had fewer than the average number of viable occurrences (5.2 for 58 species, or 5.6 for 54 species). The average number of occurrences per species for plant targets in CBY (8.4) was higher than the average for animal targets (6.5) if all species are included, but less so if species without occurrences are excluded (8.6 for plants vs. 7.3 for animals).

The proportion of known occurrences that were viable and included in the portfolio was slightly higher for animals as a group (74%) than for plants (66%). Among species, proportional viability varied considerably, for both rarer and more common species (Table sp6). For nine animal targets and 13 plant targets, all known occurrences in the ecoregion were judged to be viable and included in the portfolio.

Conservation focus on both animal and plant species targets in CBY is high; separately by group or combined, 72% of the viable occurrences known in CBY occur at sites identified as 10Year Action or Partner Lead sites (Table sp6). Many of these populations are at current Conservancy preserves, state-owned natural areas, forests or parks, or on federal lands (parks, national seashores, military bases). Fully half (26) of all species with occurrences in CBY have all of their viable populations identified as conservation priorities in the next 10 years, and nine other species have all but one viable population already protected or targeted for conservation.

Secondary Targets

For the 46 Secondary species targets in CBY, there were 376 known occurrences (i.e., in state BCD's) of which 294 (78%) were judged to be viable (Table sp7). Eight Secondary animal targets (4 birds, a tiger beetle and 3 odonates) and one plant target (Water loosestrife) had no occurrences recorded in BCD in the ecoregion. One Secondary species (Cypress sphinx) had no viable occurrences, and seven additional species (5 animals, 2 plants) had only one viable occurrence in the ecoregion. Thus the overall proportion of Secondary species which had two or more viable occurrences in CBY (65%) was similar to that for Primary species (60%).

As with Primary targets, the distribution of numbers of occurrences per species for Secondary targets was strikingly bimodal; only nine species (6 vertebrates, 3 plants) had more than 10 total occurrences each, and only six of those (3 animals, 3 plants) had more than 20 (Table sp7) in the ecoregion. Only a single animal Secondary target (Carpenter frog) had more than 20 viable occurrences (3 others had more than 10), while all three plant Secondary targets with more than 20 total occurrences also had more than 20 viable occurrences. Thirty six Secondary species – including all of the invertebrates – had fewer than the average number of total occurrences (8.2 for 46 species, 10.2 if species without occurrences are excluded). Thirty six species also had less than the average number of viable occurrences (6.4 for 46 species, 7.9 for 37 species). Secondary plant targets had strikingly higher average numbers of total and viable occurrences per species (20.5 and 16.1, respectively) than did Secondary animal targets (5.6 for total, 4.3 for viable only), and these differences remained if species without occurrences were excluded from the calculations. As expected, the average number of total and viable occurrences was higher for Secondary than for Primary species, both within plants and animals and for all species combined. And while overall proportional viability of occurrences was higher for Secondary than Primary targets, animal (78%) and plant (79%) Secondary targets did not differ.

Slightly more than half of all viable occurrences of Secondary targets were captured at sites included in the portfolio for viable occurrences of Primary species or natural communities (Table sp7). Secondary animal targets were captured at a higher rate (64%) than plant targets (47%), and within animals, proportional capture of invertebrates (78%) was higher than for vertebrates (58%). Many of the sites where Secondary targets were captured were also identified as 10Year Action or Partner Lead sites, so 79% of all Secondary species occurrences (73% of plants, 82% of animals) captured in the portfolio are found at sites currently protected or targeted for conservation activity in the near future. Overall, 44% of the known populations of Secondary targets (34% of plants, 52% of animals) occur at priority conservation sites in the ecoregion.

Table sp7. Total, viable, portfolio, and priority occurrences of Secondary species conservation targets.

		Number of Occurrences			
Scientific Name	**Common Name**	**Total**	**Viable**	**Portfolio[1]**	**Priority[2]**
Animals-Vertebrates					
Ambystoma mabeei	Mabee's Salamander	7	5	2	2
Ambystoma tigrinum	Tiger Salamander	21	16	8	6
Anas rubripes	American Black Duck	0	0	0	0
Botaurus lentiginosus	American Bittern	7	6	1	0
Certhia americana	Brown Creeper	4	4	1	1
Circus cyaneus	Northern Harrier	25	16	3	3
Haematopus palliatus	American Oystercatcher	9	9	9	9
Helmitheros vermivorus	Worm-Eating Warbler	0	0	0	0
Hyla gratiosa	Barking Treefrog	14	13	10	7
Laterallus jamaicensis	Black Rail	10	7	1	0
Limnothlypis swainsonii	Swainson's Warbler	4	3	2	1
Oporornis formosus	Kentucky Warbler	0	0	0	0
Protonotaria citrea	Prothonotary Warbler	0	0	0	0
Rana virgatipes	Carpenter Frog	26	25	20	16
Rynchops niger	Black Skimmer	15	5	5	4
Sitta pusilla	Brown-Headed Nuthatch	2	2	2	2
Wilsonia citrina	Hooded Warbler	7	5	3	3
Total		**151**	**116**	**67**	**54**
Animals-Invertebrates					
Alasmidonta undulata	Triangle Floater	1	1	1	0
Anax longipes	Comet Darner	4	2	2	2
Argia bipunctulata	Seepage Dancer	5	5	3	3
Atlides halesus	Great Purple Hairstreak	8	3	3	2
Cicindela abdominalis	A Tiger Beetle	1	1	0	0

Cicindela dorsalis media	White Tiger Beetle	2	1	1	1
Cicindela gratiosa	A Tiger Beetle	0	0	0	0
Cicindela lepida	Little White Tiger Beetle		6	6	6
Cordulegaster erronea	Tiger Spiketail	0	0	0	0
Enallagma dubium	Burgundy Bluet	6	5	5	5
Enallagma pallidum	Pale Bluet	2	2	2	2
Enallagma weewa	Blackwater Bluet	5	5	4	3
Gomphus rogersi	Sable Clubtail	3	2	1	1
Isoparce cupressi	Cypress Sphinx	1	0	0	0
Leptodea ochracea	Tidewater Mucket	5	5	3	1
Libellula flavida	Yellow-Sided Skimmer	0	0	0	0
Ligumia nasuta	Eastern Pondmussel	2	1	0	0
Nannothemis bella	Elfin Skimmer	7	7	5	4
Nehalennia irene	Sedge Sprite	1	1	1	1
Stylurus laurae	Laura's Clubtail	0	0	0	0
Tachopteryx thoreyi	Gray Petaltail	2	2	1	1
Total		**61**	**49**	**38**	**32**
Total – Animals		**212**	**165**	**105**	**86**
Plants					
Alnus maritima	Seaside Alder	66	60	40	27
Bidens bidentoides var. mariana	Maryland Bur-marigold	30	21	1	1
Carex vesicaria	Inflated Sedge	4	2	1	1
Eriocaulon parkeri	Parker's Pipewort	55	39	14	10
Lysimachia thyrsiflora	Water Loosestrife	0	0	0	0
Minuartia caroliniana	Pine-Barren Sandwort	1	1	1	1
Rhynchospora harperi	Harper Beakrush	7	5	3	3
Rhynchospora oligantha	Few-Flowered Beaked-Rush	1	1	1	1
Total – Plants		**164**	**129**	**60**	**44**
Total – All Species		**376**	**294**	**165**	**130**

[1]Occurrences found at sites included in portfolio for viable Primary species targets and/or natural communities.
[2]Occurrences at 10Year Action and Partner Lead sites.

Progress Towards Conservation Goals

The 303 viable occurrences of Primary species targets in CBY represented 38 percent of the maximum conservation goal for species in the ecoregion (Table sp8). Achievement of goals among species varied dramatically, from as low as zero (5 vertebrates, 2 plants) to as high as 200% (1 plant). Conservation goals were met or exceeded for only three animal and five plant species, while 22 animal and 20 plant targets fell below 50% of their individual maximum conservation goals (Table sp8). This in spite of the fact that conservation goals for 38 of the 58 species were set at 10 or fewer occurrences in the ecoregion.

Among groups, vertebrates and invertebrates had similar success rates, but both were notably lower than plants as a group (Table sp8). If the four target species (3 animals, 1 plant) which had no occurrences at all in the ecoregion are omitted, the average achievement of goals increases to 41% for vertebrates, to 31% for all animals as a group, and to 41% for all species targets together. Since 69% of all known occurrences of species targets in the ecoregion were judged to be viable (above), the overall "deficit" in reaching goals is due primarily to insufficient records of species occurrences, and less to poor viability of the known populations.

Table sp8. Total number of viable occurrences, conservation goal, and percent of goal for Primary species conservation targets in the ecoregion.

Scientific Name	Common Name	Viable	Goal	%[1]
Animals-Vertebrates				
Acipenser brevirostrum	Shortnose Sturgeon	0	5–10	0
Acipenser oxyrinchus	Atlantic Sturgeon	0	5–10	0
Aimophila aestivalis	Bachman's Sparrow	1	5–10	10
Caretta caretta	Loggerhead	4	5–10	40
Charadrius melodus	Piping Plover	13	5–10	130
Clemmys muhlenbergii	Bog Turtle	1	5–10	10
Corynorhinus rafinesqui	Rafinesque's Big-Eared Bat	---	5–10	0
Melospiza georgiana nigrescens	Coastal Plain Swamp Sparrow	---	10–20	0
Picoides borealis	Red-Cockaded Woodpecker	---	5–10	0
Sciurus niger cinereus	Delmarva Fox Squirrel	30	30	100
Total		**49**	**80–130**	**29**
Animals-Invertebrates				
Aeshna mutata	Spatterdock Darner	1	5–10	10
Alasmidonta heterodon	Dwarf Wedgemussel	3	5–10	30
Callophrys hesseli	Hessel's Hairstreak	3	10–20	15
Callophrys irus	Frosted Elfin	4	10–20	20
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	23	10–20	115
Cicindela puritana	Puritan Tiger Beetle	14	10–20	70
Epitheca spinosa	Robust Baskettail	2	5–10	20
Hydrochus sp 1	Seth Forest Water Scavenger Beetle	1	20	5
Photuris bethaniensis	A Lampyrid Firefly	7	20	35
Poanes massasoit chermocki	Chermock's Mulberry Wing	1	20	5
Problema bulenta	Rare Skipper	510–20	25	
Satyrium kingi	King's Hairstreak	45–10	40	
Somatochlora provocans	Treetop Emerald	310–20	15	

Stygobromus araeus	Tidewater Interstitial Amphipod	2	20	10
Stygobromus indentatus	Tidewater Amphipod	2	30	7
Stygobromus phreaticus	Northern Virginia Well Amphipod	1	20	5
Total		**76**	**210–290**	**27**
Total – Animals		**125**	**290–420**	**28**
Plants				
Aeschynomene virginica	Sensitive Joint-Vetch	15	10–20	75
Agalinis acuta	Sandplain Gerardia	0	5	0
Agalinis auriculata	Earleaf Foxglove	1	5–10	10
Agalinis skinneriana	Pale False Foxglove	2	5–10	20
Amaranthus pumilus	Seabeach Amaranth	7	5	140
Carex decomposita	Cypress-Knee Sedge	---	5–10	0
Carex lupuliformis	False Hop Sedge	5	5–10	50
Chamaecrista fasciculata var macrosperma	Large-seeded marsh senna	2	30	7
Chelone cuthbertii	Cuthbert Turtlehead	2	5–10	20
Coreopsis rosea	Rose Coreopsis	3	5–10	30
Cypripedium kentuckiense	Southern Lady's-Slipper	1	5–10	10
Desmodium ochroleucum	Creamflower Tick-Trefoil	1	5	20
Euphorbia purpurea	Glade Spurge	1	5–10	10
Fimbristylis perpusilla	Harper's Fimbristylis	34	10–20	170
Gaylussacia brachycera	Box Huckleberry	5	5–10	50
Helonias bullata	Swamp-Pink	36	10–20	180
Hypericum adpressum	Creeping St. John's-Wort	10	5–10	100
Isotria medeoloides	Small Whorled Pogonia	2	5–10	20
Juncus caesariensis	New Jersey Rush	10	5	200
Litsea aestivalis	Pondspice	1	5–10	10
Monotropsis odorata	Sweet Pinesap	2	5–10	20
Muhlenbergia torreyana	Torrey's Dropseed	1	5–10	10
Nuphar lutea ssp sagittifolia	Cape Fear Spatterdock	3	5	60
Oxypolis canbyi	Canby's Dropwort	1	5	20
Panicum hirstii	Hirsts' Panic Grass	1	10–20	5
Polygonum glaucum	Sea-Beach Knotweed	8	5–10	80
Pycnanthemum torrei	Torrey's Mountain Mint	1	5–10	10
Rhexia aristosa	Awned Meadowbeauty	2	5–10	20
Rhynchospora inundata	Drowned Hornedrush	5	5–10	50
Schizaea pusilla	Curly-Grass Fern	1	5–10	10

Scirpus etuberculatus	Canby Bulrush	3	5–10	30
Trillium pusillum var. *virginianum*	Virginia Least Trillium	12	10–20	60
Total – Plants		**178**	**210–360**	**47**
Total – All species		**303**	**500–780**	**38**

[1]For goals given as ranges, percent calculated based on maximum value in range.

Natural Heritage Sites for Species and Natural Community Targets

The 536 natural community and Primary species target occurrences in the CBY portfolio (above; Map 1) are found at 274 different named Natural Heritage Program sites in the three states (Table sp9; see Appendix sp1 for details). Almost every Heritage site in the portfolio has at least one viable occurrence of a Primary species target (data not shown), and 99 Heritage sites had at least one viable occurrence of a natural community target.

The number of natural community types in Maryland included in the ecoregional portfolio is low - though with good field sampling effort per type – reflecting the incomplete status of the natural community classification in that state (Table sp9). While Delaware has the most diverse natural community portfolio, Virginia has a greater number of documented occurrences (especially per type) and the largest number of Heritage sites for viable natural communities. Details of occurrences of natural community targets by site are available in the state-specific Excel spreadsheets used for portfolio review, and which have been provided to each state Chapter and Natural Heritage Program.

Unlike with natural communities, Maryland had the largest number of Primary species captured at portfolio sites (Table sp9), perhaps reflecting both the amount of land area in CBY and the landscape and habitat heterogeneity provided by having lands on both the western and eastern shores of the Chesapeake Bay. Documentation of Primary species occurrences, relative to the number of target species, was similar across states. Somewhat surprisingly, Delaware had the largest number of Secondary species captured at portfolio sites, and by far the largest total number of occurrences of Secondary species. Details on the numbers of occurrences of each Primary and Secondary species target state by state are provided in Appendix sp2.

Table sp9. State-by-state summary of Natural Heritage sites, natural communities, and Primary and Secondary species in the ecoregional portfolio.

Total Number	DE	MD	VA
Natural Heritage Sites	54	117	103
Natural Community Types	37	16	31
Natural Community Occurrences (Sites)	68 (36)	53(19)	95(44)
Primary Species Targets	23	34	20
Primary Species Occurrences	79	128	96
Secondary Species Targets[1]	26	22	17
Secondary Species Occurrences[1]	98	47	21

[1]Only those captured at portfolio sites.

PLANNING METHODS FOR ECOREGIONAL TARGETS: TERRESTRIAL ECOSYSTEMS AND COMMUNITIES*

Coarse-filter and fine-filter targets

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

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

Ecosystem and community targets: Introduction

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

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

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

Ecosystems and communities

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

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

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

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

Ecosystems and scale

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

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

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

Ecosystems and physical setting

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

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

Developing the target list

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

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

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

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

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

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

Auxiliary information on each ecosystem

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

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

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

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

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

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

Methods for developing auxiliary information

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

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

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

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

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

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

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

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

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

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

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

Table COMM2. Ecological Land Unit variables

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

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

[3] While the variables that we used are physical ones, the classes were based on biological considerations (e.g., tree distribution, for Elevation Zone).
[4] Incomplete as of July 2003, but see Ferree 2003.

Setting Minimum Conservation Goals for Ecosystem Targets

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

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

Quantitative global minimums

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

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

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

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

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

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

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

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

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

Distribution goals

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

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

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

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

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

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

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

Assessing the Viability of Individual Ecosystem Examples

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

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

Locating examples of patch-forming communities

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

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

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

Viability screening criteria

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Combining the viability criteria

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

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

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

Addressing Gaps in the Data

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

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

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

Red Oak / Eastern Rockcap Fern Woodland
[Red Oak Talus Slope Woodland]
Description: Open, bouldery, acidic talus slope woodlands in the Northern Appalachian and Lower New England / Northern Piedmont ecoregions. Habitat (large talus and boulders) rather than geography differentiates this association from *Quercus rubra / Vaccinium spp. / Deschampsia flexuosa* Woodland (CEGL006134). Ericads generally lacking, vines and ferns more characteristic. Common associates are species of *Corydalis, Woodsia, Dryopteris* as well as *Parthenocissus quinquefolia, Polypodium virginianum, Tsuga canadensis, Pinus strobus*. 6/98 NAP Very open to moderately closed canopy, heterogeneous composition of *Quercus rubra, Acer saccharum, Betula nigra, Betula alleghaniensis, Betula papyrifera, Betula populifolia, Fagus grandifolia, Acer rubrum*. Scattered and clumped tall shrubs/small trees include *Acer spicatum, Acer pensylvanicum, Rubus spp., Viburnum acerifolium* (occasional), *Ribes* spp. Prevalent component of vines are *Parthenocissus quinquefolia, Parthenocissus vitacea, Toxicodendron radicans, Celastrus scandens, Polygonum cilinode*. Scattered ferns and herbs are *Dryopteris marginalis, Polypodium virginianum, Pteridium aquilinum, Carex pensylvanica, Corydalis sempervirens (*localized*), Solidago bicolor, Solidago caesia*, and others. Acidic talus slopes of low-elevation valleys. Substrate is bouldery talus derived form acidic bedrock. Elevation range is roughly 500-2000 feet. Groundcover is exposed talus, moss-covered boulders and deciduous litter.
LNP Scale: Small to large patch **Distribution**: Limited
TNC Ecoregions: 61:C, 62:C, 63:C
References:

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

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

Red Oak / Blueberry species / Wavy Hairgrass Woodland
[Central Appalachian High Elevation Red Oak Woodland]
Description: Dry, open, rocky slope or summit woodlands in the Northern Appalachian, Lower New England / Northern Piedmont and Central Appalachians ecoregions. Open, stunted to somewhat closed canopy of *Quercus rubra*. *Quercus prinus* may be codominant. Common associates are *Quercus alba, Betula lenta* and *Acer rubrum* with minor component of *Quercus velutina, Betula populifolia, Betula papyrifera* and *Pinus rigida*. Tall-shrub layer is often lacking but may include *Acer spicatum, Sambucus racemosa, Rhus typhina, Kalmia latifolia, Hamamelis virginiana, Viburnum nudum var. cassinoides, Rhododendron* spp. Ericaceous shrubs and graminoids are characteristic. Well-developed low-shrub cover of *Vaccinium angustifolium, Vaccinium pallidum, Gaylussacia baccata, Kalmia angustifolia*. Scattered grasses include *Deschampsia flexuosa, Danthonia spicata, Carex pensylvanica*, and herbs *include Gaultheria procumbens, Aralia nudicaulis*. Herbs: *Pteridium aquilinum, Aralia nudicaulis, Maianthemum canadense, Aster acuminatus, Corydalis sempervirens, Deschampsia flexuosa, Carex pensylvanica, Polypodium virginianum*. Environmental setting: Talus slopes, rocky slopes and summits of low, moderate or high elevations. Soils are shallow, well-drained, nutrient-poor acidic gravels and coarse sands. Exposed bedrock prominent. Grades into *Quercus prinus* Forest, *Pinus rigida* woodlands or sparsely vegetated rocky summits (*Pinus strobus, Quercus rubra) / Danthonia spicata* Sparsely Wooded Herbaceous Vegetation CEGL005101.
LNP Scale: Small patch or large patch? **Distribution:** Widespread
TNC Ecoregions: 59:C, 61:?, 62:C, 63:C
References: Thompson and Sorenson 2000

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

RESULTS FOR TERRESTRIAL COMMUNITIES AND SYSTEMS*

Development of a Vegetation Classification for CBY

The initial draft of 164 NVC associations thought to occur in CBY was carefully evaluated by state ecologists, and 86 were judged not to occur in the ecoregion. About 20 associations not previously identified as within CBY were added, and several new associations were described for consideration for inclusion in a revised NVC. A tentative total of 95 associations known or thought to occur in the CBY ecoregion were described through this effort. Every association within CBY was also categorized into a coarser scale vegetation system or **group** (see below), of which 17 were initially identified. These results were reviewed by the participating ecologists and assembled into a single document for CBY natural communities.[1]

In the course of assembling Natural Heritage program Element Occurrence data (EORs), linking ("tagging") occurrences to NVC associations, and conducting viability analyses (see below) over several months, additional consultations occurred between ECS ecologists and state Community Ecologists, which resulted in a slightly revised ecoregional classification. Eighteen additional associations were included in the classification, and another vegetation group (Dune Woodlands) was added for CBY. Thus, a total of 113 associations in 18 groups were included in this plan (Appendix nc1). An additional 38 NVC associations are under consideration for inclusion in a future revised community classification for the ecoregion. For comparison, 126 associations were described for CAP and 153 for LNE. Thus, in spite of its relatively small size and limited topographic relief, and the short distance from northern to southern boundaries within the ecoregion, CBY contains a comparable number of vegetation associations relative to neighboring ecoregions.

Natural communities in CBY range from dry upland forests, to forested and herbaceous wetlands, to barrier island dunes and beaches (Table nc1). Not surprisingly in this ecoregion, almost a quarter of the described associations are tidal marsh communities, and the diversity of wetlands associated with dunes along the coast is also high. Moving inland, the diversity of nonalluvial forests and herbaceous coastal plain pond communities ("Delmarva bays") is also high, each making up almost a tenth of the total number. Tidal forests and shrublands, on the other hand comprise very few distinct associations. There is only one sea-level fen community currently described (Table nc1).

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* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for terrestrial communities and systems. Based on Samson, D.A. 2002. Chesapeake Bay Lowlands Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

[1] See Sneddon, Zaremba, et al. draft with latest editing notations as of 1/02/2002.

Table nc1. Numbers of natural community types in CBY by vegetation group, patch type and rangewide distribution.

			Patch Types[1]				Rangewide Distribution[2]				
No.	**Group Name**	**Number of NVC Types**	**Mat.**	**LgP**	**LnP**	**SmP**	**W**	**P**	**L**	**R**	**U**
1	Dry-Mesic Oak Forests	5	1	5		1	3				2
2	Mesic Hardwood Forests	6	1	1		3	2		1	3	1
3	Evergreen or Mixed Coastal Plain Forests	6	1			2			2		4
4	Alluvial Forests and Shrublands	6				6			2	3	1
5	Cypress-Gum Swamps	2			1	2		1		1	
6	Nonalluvial Wetland Forests	10		6		9	2		2	6	
7	Woody Vegetation of Coastal Plain Ponds	4				4	1		1	3	
8	Herbaceous Coastal Plain Ponds	10				10	5		2	4	
9	Sea-level Fens	1				1			1		
10	Freshwater Nontidal Marshes	5		1	2	3	4	1			
11	Tidal Swamp Forests	2			2					2	
12	Tidal Shrublands	2			2		2				
13	Tidal Marshes	27	1	11	7	19	13	1	3	5	6
14	Submerged Saline Tidal	3		1	1	3	3				
15	Maritime Shrub	7		2	1	6	2		3	2	
16	Interdunal Wetlands	9			2	8	4		2	3	
17	Dune Grasslands/Beaches	4		1	2	4	2		2		
18	Dune Woodlands	4		2		3			3	1	
Total for Ecoregion		113	4	30	20	84	43	3	24	33	14

[1]Mat. = matrix; LgP = large patch; LnP = linear patch; SmP = small patch
[2]W = widespread; P = peripheral; L = limited; R = restricted; U = unknown

Three (possibly four) associations within CBY were described as matrix forming (Table nc1). These are: the mixed oak/black huckleberry-blueberry forest community (Dry-Mesic Oak Forests group), the beech-white oak-tulip poplar-hickory forest community (Mesic Hardwood Forests group), and the loblolly pine-southern red oak/dangleberry forest community (Evergreen or Mixed Coastal Plain Forests) (see Appendix nc1). The smooth cordgrass/algae (*Ascophyllum nodosum*) community was also categorized as a matrix-forming type in CBY, because tidal marshes cover tens of thousands of acres of shoreline habitat in the Chesapeake Bay and Atlantic coastal bays. Aside from the obvious differences in dominant ecological processes, species composition, energy and nutrient flow, etc., the applicability of the matrix-forming vegetation concept – which was developed for terrestrial forests – to tidal wetland communities remains to be determined.

The 30 communities that can or do occur as large patches on the landscape make up about 25% of all known NVC associations in CBY (Table nc1). They occur in nine of the 18 different vegetation groups, but more than two-thirds are found in only three groups; Dry-Mesic Oak Forests, Nonalluvial Wetland Forests, and Tidal Marshes. Given the hundreds of embayments, and thousands of tributary rivers and streams around the Chesapeake Bay in the ecoregion, as well as long, narrow barrier islands along the Atlantic coast, it is not surprising that almost 20% of all confirmed natural communities in the ecoregion occur as linear patch types associated with tidal areas along rivers and bays, and with barrier islands (Table nc2).

Table nc2. Numbers of natural community associations in CBY by vegetation group, documented by Heritage occurrences (EORs) and judged to be viable portfolio occurrences for the ecoregion (see Appendix nc1 for details).

		NVC Types		Total Occurrences		Viable Occurrences	
No	**Group Name**	**in CBY**	**w/EORs**	**All**	**Tagged**	**All**	**Tagged**
1	Dry-Mesic Oak Forests	5	3	3	3	2	2
2	Mesic Hardwood Forests	6	5	27	25	15	13
3	Evergreen or Mixed Coastal Plain Forests	6	6	42	18	34	13
4	Alluvial Forests and Shrublands	6	2	2	2	2	2
5	Cypress-Gum Swamps	2	1	6	4	2	2
6	Nonalluvial Wetland Forests	10	8	43	41	25	25
7	Woody Vegetation of Coastal Plain Ponds	4	3	32	32	21	21
8	Herbaceous Coastal Plain Ponds	10	7	32	26	22	21
9	Sea-level Fens	1	1	9	9	8	8
10	Freshwater Nontidal Marshes	5	0	6	0	3	0
11	Tidal Swamp Forests	2	2	7	7	5	5
12	Tidal Shrublands	2	1	2	2	1	1
13	Tidal Marshes	27	15	59	58	41	40
14	Submerged Saline Tidal	3	0	0	0	0	0
15	Maritime Shrub	7	3	5	4	4	4
16	Interdunal Wetlands	9	7	34	26	31	24
17	Dune Grasslands/Beaches	4	2	10	5	8	4
18	Dune Woodlands	4	2	17	8	9	6
Total for Ecoregion		113	68	336	270	233	191

At the other end of the gradient, 75% (84) of the natural communities in CBY were categorized as small patch types (or which can occur as small patches; Table nc1), a result that is consistent with the patterns seen in surrounding ecoregions (see plans for Central Appalachian Plateau and Lower New England/Northern Piedmont ecoregions). Among vegetation groups, small patch communities are particularly prevalent in Alluvial Forests and Shrublands, Nonalluvial Wetland

Forests, Coastal Plain Ponds (both Woody and Herbaceous), Tidal Marshes, and the four vegetation groups that make up barrier island systems (Table nc1, Appendix nc1).

For 28 associations, the patch size was either uncertain or believed to be intermediate between patch types (Appendix nc1); hence the number of associations tallied by patch size exceeds the total number of associations with the ecoregion (Table nc1). For about a third of the associations, the patch type was assigned based on best available knowledge, but with less certainty than for the majority of the communities. For a small number of associations the patch size was completely unknown at the time of this assessment, but these cases were too few to affect the overall results presented here.

Data Assembly

Natural community data were assembled at the ECS Office for the three states within the ecoregion. A total of 356 occurrences were initially in this dataset: 119 for DE, 83 for MD, and 154 for VA. Each occurrence was crosswalked or “tagged” to the NVC classification by the state Heritage ecologist, or by staff from ECS with review by the state ecologist. Each association was also categorized to one of the 18 vegetation systems or groups.

Unlike many community occurrences in other ecoregions, most community occurrences documented by the Natural Heritage Programs in CBY were very detailed and scaled similarly to associations within the NVC, so that occurrences could be effectively tagged to specific associations (Table nc2, Appendix nc1). Others were a mosaic of identifiable associations and could be considered to be occurrences of multiple associations. For some associations, however, it was not possible to crosswalk them to the CBY classification given available data. In such cases, where it was clear that the occurrence was high quality and identifiable to the courser-scale, group level of classification, occurrences were analyzed at the vegetation group level. Most of these “untagged” occurrences (66, or 20% of the total) are thought to belong to one of the documented NVC associations—rather than a new type—in CBY (Appendix nc1).

In several cases, a documented Heritage occurrence was determined not to represent a natural community and so was set aside from the analysis. There were several BCD occurrence records where the habitat of a rare species which occurred in an anthropogenic setting had been described as a natural community by the field biologist; these were discarded. It also became apparent that duplicate records existed in several state databases, due to differences in nomenclature for early community EORs; these, too, were eliminated. Twenty records were eliminated for these several reasons.

Slightly more than half of the known associations in CBY have been recorded in field surveys conducted by the Natural Heritage Programs and documented in Element Occurrence Records (EORs) in Delaware, Maryland or Virginia. Of the 336 natural community EORs available in CBY that were evaluated for inclusion in the ecoregional portfolio, 270 could be clearly tagged to an NVC association (Table nc2). This facilitated both the viability analysis and the process of setting ecoregional conservation goals. Natural community occurrences were fully tagged to NVC associations in six of the vegetation groups; in several other groups all but one or two occurrences belonged to one or another association (Table nc2). However, in several groups (esp., Evergreen or Mixed Coastal Plain Forests, Dune Grassland/ Beaches, and Dune Woodlands), half or more of the available occurrences could not be clearly assigned to one of the NVC associations within that group (Table nc2). Additional fieldwork will be necessary to be able to classify these occurrences to specific NVC associations.

Several of the CBY natural community groups (esp., Tidal Marshes, Coastal Plain Ponds – both Woody and Herbaceous – Nonalluvial Wetland Forests, and Evergreen or Mixed Coastal Plain Forests) have received far more field sampling effort than others (Table nc2). But several of those groups also have a large number of associations, so the number of occurrences sampled per association is not high; across all groups, 3–5 EORs (average = 4) are currently available for each of the documented natural communities in CBY. No EORs have been recorded for Submerged Saline Tidal communities as a group, and none of the six EORs for Freshwater Nontidal Marshes have been tagged to one of the five NVC associations known to occur in the ecoregion (Table nc2).

Modifications to the Standard Methods

Combining Viability Criteria in CBY

For CBY, the viability criteria of size, condition, and landscape context were combined according to Table nc3 below. In addition, a fourth criterion was initially applied to natural community records in the Heritage database:

Age of element occurrence records: All element occurrence records with a LASTOBS (last observation) date before 1988 were assigned at most a “?,” because it was unclear if the occurrence data remained valid.

Table nc3. Natural community (small, large, and linear patch) viability ranking grid.

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

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

Setting Numerical and Distribution Goals in CBY

As in other ecoregions, CBY was divided into groups of subsections to reflect the range of physiographic variability throughout the ecoregion. Unlike other ecoregions, CBY was constructed as a subdivision of Bailey’s Outer Coastal Plain Mixed Forest Province, centered around one major environmental feature, the Chesapeake Bay. Subsection boundaries (created by Bailey) in CBY, therefore do not always correspond to the ecoregional boundaries; several subsections that border the Bay fall entirely within CBY, while several other subsections extend beyond CBY into adjacent ecoregions (Table nc4).

For purposes of stratification, the CBY ecoregion was divided into three areas, based on the US Forest Service sectional divisions (Bailey 1994). Two of these sections (232A, 232C) have only one subsection each (with 232Ch extending beyond the ecoregion), while the third (232B) has four subsections (two of which extend beyond the ecoregion; Table nc4).

Table nc4. Sectional and subsection classification (USFS categories) and geographic extent in CBY ecoregion.

Section Category	CBY area covered	Geographic extent
Middle Atlantic Coastal Plain: 232A		
232Ad	Western shore, MD; northern DE	CBY only
Coastal Plains & Flatwoods: 232B		
232Br	Western shore, VA	CBY, VA and NC in MAC
232Bt	Central Delmarva Peninsula, MD and DE	CBY and southern edge of NAC
232Bx	Eastern shore, bayside, MD and VA	CBY only
232Bz	Atlantic coast lowlands, DE, MD, VA	CBY only
Atlantic Coastal Flatlands: 232C		
232Ch	Western shore bayside, MD and VA	CBY, VA and NC in MAC

The combination of stratification levels across the ecoregion and minimum number of occurrences per section produces a set of numerical conservation goals for natural community targets in CBY that ranges from four to 15 (Table nc5).

Table nc5. Minimum conservation goals for CBY patch natural communities as a function of patch size and rangewide distribution of the type.

Patch-forming Ecosystems Rangewide Distribution	Minimum Stratification (# sections)	Patch Size	
		Large or Linear (4)	Small (5)
Restricted	3	12	15
Limited	2	8	10
Widespread	1	4	5
Peripheral	1	4	5

Portfolio Results

Two hundred and thirty three (69%) of the total natural community occurrences were judged to be viable (Table nc6) and included in the CBY ecoregional portfolio as conservation targets (Map 5). Of these, 191 are classified in 62 different NVC associations (see Appendix nc1 for details). Forty two additional untagged occurrences in 11 of the vegetation groups were viable and included in the portfolio (Appendix nc1); some of these may represent known NVC associations which have no documented occurrences in CBY at present.

Most of the portfolio occurrences are found in Delaware and Virginia. Within Virginia, occurrences are well distributed on the Delmarva Peninsula, but on the western Shore, occurrences are clumped around the York and James rivers, at Fort A. P. Hill and at a few scattered sites along the western shoreline of the Potomac River (Map 4). The numbers of viable occurrences within the 18 vegetation groups is discussed in more detail below.

Progress Towards Goals

The current portfolio identifies just 25% of the natural community occurrences needed to meet the replication goals set for CBY, based on community patch size and rangewide distribution. Among vegetation groups, identification of viable occurrences ranged from less than 10% to 80% and above, but 14 of the 18 vegetation groups did not exceed 30% of goals (Table nc6). Among individual NVC associations across groups, only nine types met or exceeded the numerical goal set for that community type (Appendix nc1). Twenty four associations met the stratification goal (i.e., occurred in 1, 2 or 3 different ecoregional sections), including eight of the nine associations that met the numerical goal (Appendix nc1).

In order to identify enough viable examples of each community type to meet the replication goals of this plan there must be: 1) adequate (or complete) sampling among all community associations; 2) sufficient sampling of occurrences within associations (i.e., numerous replicates) relative to patch type and rangewide distribution; 3) good viability of documented occurrences. For example, Sea-level Fens (one community type only) are well-sampled, and all but one of the occurrences was judged to be viable, so that portfolio representation of this community is high (Table nc6). Similarly, for Evergreen or Mixed Coastal Plain Forests, all of the six associations have been well-sampled (average of 7 EORs per type), and many of those were viable, yielding a success rate of almost 90% for the portfolio.

Where community associations lack field documentation, or only a few occurrences have been recorded, or where viability of known occurrences is low—or some combination of all of these factors—success at identifying sufficient occurrences will be poor. For example, no occurrences have been recorded to date for Submerged Saline Tidal communities, and minimal sampling has been done for most of the community associations in the Dry-Mesic Oak Forests, Alluvial Forests and Shrublands, and Maritime Shrub groups (i.e., an average of less than 1 EOR per NVC type within the group; Table nc6). In other groups, sampling effort has been good across all/most NVC associations (i.e., 3-5 EORs per type), but viability of the recorded occurrences was only moderate (e.g., Mesic Hardwood Forests, Nonalluvial Wetland Forests, Woody Vegetation of Coastal Plain Ponds, Herbaceous Coastal Plain Ponds), so there is a large deficit for these types in the portfolio.

Table nc6. Assessment of success towards identifying replicate viable examples for each natural community target, by group, as measured against minimum conservation goals for each association.

		NVC Association		Total Occurrences		Success by Group	
No.	**Group Name**	**in CBY**	**w/EORs**	**All**	**Viable**	**Goal**	**%**
1	Dry-Mesic Oak Forests	5	3	3	2	20	10
2	Mesic Hardwood Forests	6	5	27	15	50	30
3	Evergreen or Mixed Coastal Plain Forests	6	6	42	34	39	87
4	Alluvial Forests and Shrublands	6	2	2	2	65+	3
5	Cypress-Gum Swamps	2	1	6	2	20	10
6	Nonalluvial Wetland Forests	10	8	43	25	115	22
7	Woody Vegetation of Coastal Plain Ponds	4	3	32	21	55	21
8	Herbaceous Coastal Plain Ponds	10	7	32	22	95	38
9	Sea-level Fens	1	1	9	8	10	80
10	Freshwater Nontidal Marshes	5	0	6	3	23	13
11	Tidal Swamp Forests	2	2	7	5	24	21
12	Tidal Shrublands	2	1	2	1	8	13
13	Tidal Marshes	27	15	59	41	156	26
14	Submerged Saline Tidal	3	0	0	0	25	0
15	Maritime Shrub	7	3	5	4	67	6
16	Interdunal Wetlands	9	7	34	31	82	38
17	Dune Grasslands/Beaches	4	2	10	8	33	24
18	Dune Woodlands	4	2	17	9	42	21
Totals for Ecoregion		113	68	336	233	929	25

In some cases where the sampling effort was good and the viability of occurrences was high (e.g., Tidal Swamp Forests, Interdunal Wetlands), the identification of enough replicates still fell short of the conservation goal, because for communities Restricted to CBY the numerical goal is high relative to field efforts to date (Table nc6). For example, several of the small patch Interdunal Wetlands communities with Limited or Restricted distributions (Appendix nc1), have conservation goals of 10 to 15, respectively. Although there are an average of almost 5 EORs per NVC community type in state Natural Heritage Program databases—and 90% of the known occurrences were judged to be viable—we only identified 38% of the occurrences judged necessary to conserve this target.

This assessment of unmet goals for natural communities in CBY points to a need to improve some aspects of the ecoregional vegetation classification, and to conduct additional inventories for many vegetation associations. At the same time, we assume that many additional but undocumented community occurrences needed to meet goals in CBY may be found at sites included in the portfolio because they harbor occurrences of other biodiversity targets. For example, viable occurrences of alluvial forests, tidal communities, and dune and barrier beach vegetation associations are likely to be captured at portfolio sites identified for other targets. Similarly, viable examples of some of the upland forest associations are assumed to be present in the matrix forest blocks included in the portfolio.

Conversely, the lack of occurrences for some community associations no doubt reflects the fact that viable examples of some types may now be rare or absent in the ecoregion, and/or degraded or reduced in size such that finding viable occurrences is problematic. Thus there is also a need to explore the restoration potential for some communities that are no longer present in CBY at appropriate, representative scales. Restoration may be particularly appropriate or possible at landscape level portfolio sites identified for other biodiversity features, such as matrix forests/blocks and aquatic features.

A brief summary of the progress towards identifying viable occurrences of natural communities in the CBY portfolio is presented below, with observations on inventory needs, likelihood of additional occurrences at other portfolio sites, and restoration potential.

Dry upland forests: (Groups 1 and 2; 11 associations, goal = 70, portfolio = 17). Progress poor. May actually not be very many good examples of these communities left to document. Large patch types will be most difficult to find. Best remaining examples may be on current portfolio sites. Some associations may need restoration to meet goals.

Mixed upland forests: (Group 3; 6 associations, goal = 39, portfolio = 34). Progress very good. Much attention given to Loblolly and Virginia pine Communities. Many occurrences are not tagged to specific associations. Additional field work may be needed at these occurrences to make meaningful connections to vegetation types.

Alluvial forests: (Group 4; 6 associations, goal = 65+, portfolio = 2). Progress minimal. All of these are likely small patch and there should be a fair number around and along the numerous rivers. Many of these areas are in matrix blocks. Should be possible to capture these with more focused inventory. There are likely to be additional alluvial forest associations in CBY.

Gum and Cypress forests: (Group 5; 2 associations, goal = 20, portfolio = 2). Progress poor. There may not be many of these left to document that are sizable. There are several more associations under consideration for inclusion in the classification.

Nonalluvial forests: (Group 6; 10 associations, goal = 115, portfolio = 25). Progress fair. Quite a lot of subdivision of these communities. Some types may warrant lumping, resulting in reduced goals. Examples left in CBY may be in poor condition. A fair number of associations are large patch and may not be represented on the landscape in large units anymore. Restoration may be needed for some associations.

Coastal plain ponds: (Group 7 and 8; 14 associations, goal = 150, portfolio = 43). Progress fair. There are a large number of vegetation associations in Delmarva bays; some of them exist as very small occurrences and in mosaics. It was difficult to crosswalk these occurrences because data were often collected for the physical feature and were only partially expressed floristically. There are likely many more associations present in the occurrences documented already. This part of the classification needs work. Some associations currently acknowledged in the National Vegetation Classification may be too small or detailed to be effective classification entities.

Sea level fens: (Group 9; 1 type, goal = 10, portfolio = 8). Progress great. As a globally rare community, this has been the focus of inventories. Should be possible to find at least two more and meet goal.

Freshwater nontidal marshes: (Group 10; 5 associations, goal = 23, portfolio = 3). Progress poor. These marshes have not been a focus for inventory work. Some of these communities are successional. Furthermore, there are likely to be many more associations identified in CBY.

Woody tidal communities: (Groups 11 and 12; 4 associations, goal = 32, portfolio = 6). Progress poor. There may not be many of these communities remaining, of good size. These types are all large patch. Many remaining occurrences should be in matrix blocks. Restoration should be considered.

Tidal marshes: (Group 13; 27 associations, goal = 156, portfolio = 41). Progress fair. Many of the communities in this group are very finely divided and should/will be combined. There are a few new associations to consider as well, however. Inventory work has been good and there is likely to be a fair number associated with protected areas and sites identified for the portfolio for other reasons.

Subtidal communities: (Group 14; 3 associations, goal = 25, portfolio = 0). Progress none at all. No inventory work has been conducted for these communities. Marine sites selected for the portfolio should include examples of all of these associations. Restoration is likely needed in some.

Maritime shrubs: (Group 15; 7 associations, goal = 67, portfolio = 4). Progress poor. Not much attention has been paid to these communities. Most are likely on protected land or at sites identified for the portfolio for other targets.

Interdunal wetlands: (Group 16; 9 associations, goal = 82, portfolio = 31). Progress fair. There seems to be a large number of communities for this group, some of which may warrant combining. There has been good inventory work done within this group to date. Most additional occurrences are likely to be on protected land, which may, however, not be managed for these communities.

Dunes: (Group 17 and 18; 8 associations, goal = 75, portfolio = 17). Progress fair. Most remaining examples are likely to be on protected land or at sites identified for the portfolio for other biodiversity features. It may be difficult to find good examples for some of the large patch types. Restoration may be needed for some associations.

PLANNING METHODS FOR ECOREGIONAL TARGETS: FRESHWATER AQUATIC ECOSYSTEMS AND NETWORKS*

Introduction

Freshwater biodiversity conservation is vital to The Nature Conservancy's mission of biodiversity conservation. Compelling documentation of the perils facing freshwater biodiversity indicate that many of the most endangered species groups in the U.S. are dependent on freshwater resources. Approximately 70% of freshwater mussels, 52% of crayfish, 42% of amphibians and 40% of freshwater fish are classified as vulnerable or higher with respect to extinction risks. Additionally, water itself is a critical resource to terrestrial species and ecosystems and its patterns of drainage and movement have shaped the larger landscape in the Northeast.

Freshwater rivers, streams, lakes and ponds are diverse and complex ecological systems. Their permanent biota is comprised of fish, amphibians, crayfish, mussels, worms, sponges, hydras, hydromorphic plants, mosses, algae, insects, diatoms and a large number of microscopic protists adapted to life in freshwater. As with terrestrial species the patterns of species distributions occur at many scales and correspond both broad climatic and historic factors as well as very local factors such as stream size and velocity, bottom substrate, water chemistry and dissolved oxygen concentrations.

The objective of the freshwater analysis was to identify the most intact and functional stream networks and aquatic lake/pond ecosystems in such a way as to represent the full variety of freshwater diversity present within an ecoregion.

Geographic Framework for Aquatic Assessments

Patterns of freshwater diversity corresponds most directly with major river systems and the large watershed areas they drain. These drainage basins cut across the TNC Ecoregions that were developed based on terrestrial processes. In order to assess freshwater systems we needed a separate stratification framework of regions and drainage basins that made ecological sense for aquatic biodiversity patterns. To this end, we adopted an existing national map of freshwater ecoregions developed by the World Wildlife Fund[1] after Maxwell's Fish Zoogeographic Subregions of North America.[2] Within each freshwater ecoregion, the Nature Conservancy's Freshwater Initiative developed a further stratification level of Ecological Drainage Units. The

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* Olivero, A.P. (author) and M.G. Anderson, and S.L. Bernstein (editors). 2003. Planning methods for ecoregional targets: Freshwater aquatic ecosystems and networks. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

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

[1] Abell et al. 2000.
[2] Maxwell et al. 1995

Freshwater Ecoregions and Ecological Drainage Units together serves as an analog to the terrestrial ecoregions and subsections for the Northeast.

Zoogeographic Subregions/Freshwater Ecoregions: describe continental patterns of freshwater biodiversity on the scale of 100,000-200,000 sq. miles. These units are distinguished by patterns of native fish distribution that are a result of large-scale geoclimatic processes and evolutionary history.[3] For North America, we adopted the freshwater ecoregions developed by the World Wildlife Fund.[4] Examples include the St. Lawrence Subregion, North Atlantic to Long Island Sound Subregion, Chesapeake Bay Subregion, and South Atlantic Subregion.

Ecological Drainage Units (EDUs): delineate areas within a zoogeographic sub-region that correspond roughly with large watersheds ranging from 3,000–10,000 square miles. Ecological drainage units were developed by aggregating the watersheds of major tributaries (8 digit HUCs) that share a common zoogeographic history as well as local physiographic and climatic characteristics. These judgements were made by staff of TNC's Freshwater Initiative after considering USFS Fish Zoogeographic Subregions, USFS Ecoregions and Subsections, and major drainage divisions.[5] Ecological drainage units are likely to have a distinct set of freshwater assemblages and habitats[6] associated with them. Depending on the amount of ecological variation within them, some large river systems such as the Connecticut River were divided into more than one EDU.

Finer-Scale Classification of Aquatic Ecosystems and Networks

Within the geographic framework of the zoogeographic subregions and ecological drainage units there exits a large variety of stream and lake types. If you contrast equal sized streams, some develop deep confined channels in resistant bedrock and are primarily fed by overland flow while others are fed by groundwater and meander freely through valleys of deep surficial deposits. Variation in the biota also exists as the stream grows in size from small headwater streams to large deep rivers near the mouth. We needed a way to systematically describe and assess the many types of stream networks and aquatic features that was both ecologically meaningful and possible to create and evaluate in an 18 month time frame. For these purposes, and in conjunction with the Freshwater Initiative, we developed a multiple scale biophysical watershed and stream reach classification within Ecological Drainage Units. This classification framework is based on three key assumptions about patterns in freshwater biodiversity.[7]

- Aquatic communities exhibit distribution patterns that are predictable from the physical structure of aquatic ecosystems[8]
- Although aquatic habitats are continuous, we can make reasonable generalizations about discrete patterns in habitat use and boundaries distinguishing major transitions[9]
- By nesting small classification units (watersheds, stream reaches) within large climatic and physiographic zones (EDUS, Freshwater Ecoregions), we can account for community

[3] Maxwell et al. 1995
[4] Abell et al. 2000
[5] Higgens et al. 2002
[6] Bryer and Smith 2001
[7] Higgins et al. 1998
[8] Schlosser 1982; Tonn 1990; Hudson et al. 1992
[9] Vannote et al. 1980; Schlosser 1982; Hudson et al. 1992

diversity that is difficult to observe or measure (taxonomic, genetic, ecological, evolutionary context)[10]

Multiple-Scale Watershed Classification: Aquatic Ecological System Types: Watersheds contain networks of streams, lakes, and wetlands that occur together in similar geomorphologic patterns, are tied together by similar ecological processes or environmental gradients, and form a robust cohesive and distinguishable unit on a map. When a group of watersheds of similar size occur under similar climatic and zoographic conditions and share a similar set of physical features such as elevation zones, geology, landforms, gradients and drainage patterns they may be reasonably expected to contain similar biodiversity patterns patterns.[11] The following four primary physical classification variable were chosen for use in the watershed classification because they have been shown to strongly affect the form, function, and evolutionary potential of aquatic systems at watershed level scales.

Primary Classification Variables

1. Size: Stream size influences flow rate and velocity, channel morphology, and hydrologic flow regime.
2. Elevation Zones: Elevation zones corresponds to local variation in climate. Climatic differences are correlated with differences in forest type, types of organic input to rivers, stream temperature, flow regime, and some aquatic species distribution limits.
3. Geology: Bedrock and surficial geology influence flow regime through its effect on groundwater vs. surface water contribution, stability of flow, water chemistry, sedimentation and stream substrate composition, and stream morphology.
4. Gradient and Landform: Gradient and landform influence stream morphology (confined/meandering), flow velocity, and habitat types due to differences in soil type, soil accumulation, moisture, nutrients, and disturbance history across different landforms. For example, the morphology of streams differs substantially between mountains and lowland areas due to contrast in the degree of landform controls on stream meandering. Lower gradient streams also vary in substrate composition, as in New England, low gradient streams typically have sand, silt and clay substrates while high gradient streams typically have cobble, boulder, and rock substrates.

Stream size is among the most fundamental physical factors related to stream ecology. The *river continuum concept* provides a qualitative framework to describe how the physical size of the stream is related to river ecosystem changes along the longitudinal gradient between headwaters and mouth.[12] See Figure 1 at the end of this chapter for an illustration of the river continuum concept.

Stream size measures based on drainage area are highly correlated with other recognized measures of stream size such as stream order, the number of first order streams above a given segment, flow velocity, and channel. In the Northeast U.S., TNC used the following stream size

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[10] Frissell et al. 1986; Angermeier and Schlosser 1995

[11] Tonn 1990, Jackson and Harvey 1989, Hudson et al. 1992, Maxwell et al. 1995, Angermeier and Winston 1998, Pflieger 1989, Burnett et al. 1998,Van Sickle and Hughes 2000, Oswood et al 2000, Waite et al. 2000, Sandin and Johnson 2000, Rabeni and Doisy 2000, Marchant et al 2000, Feminella 2000, Gerritsen et al 2000, Hawkins and Vinson 2000, Johnson 2000, Pan et al 2000

[12] Vannote et al. 1980

classes: size 1) headwaters to small streams with 0-30 sq. mi. drainage areas, size 2) medium streams with 30-200 sq. mi. drainage areas, size 3) large mid-reach streams and small rivers with 200-1000 sq. mi. drainage areas; and size 4) very large river systems with > 1000 sq. mi. drainage areas. For different landscapes and regions, ecologically significant class breaks in stream size can differ, but relationships between stream size and potential river reach ecosystems appear to hold. For example relationships between stream size, stream order, and reach level community types in the Northeast are as follows:

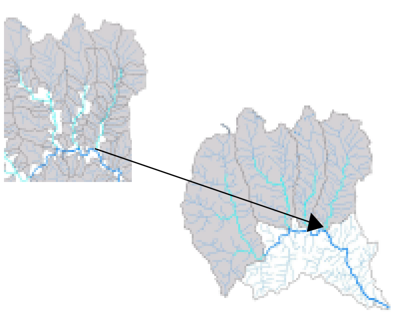
Table 1: Generalized Stream Size and Community Relationships

STREAM SIZE	STREAM ORDER	Stream reach level community occurrence
1	1-2	Rocky headwater
1(2)	1-3	Marshy headwater
2,3	3-4	Confined river
3,4	4+	Unconfined river

See the Appendix at the end of this chapter for more detailed descriptions of potential biological assemblages of fish, macroinvertebrates, and plants associated with specific types of the above generalized stream community types in Vermont.

Watersheds of streams in the four size classes were used as system classification units. These units serve as "coarse filters" to represent the species, ecological processes, and evolutionary environments typical of that size stream network or watershed. Watersheds are defined as the total area draining to a particular river segment. Watersheds themselves are a physically defined unit, bounded by ridges or hilltops. We derived a set of watersheds in GIS for each river segment. The individual reach watersheds were then agglomerated into larger watershed sampling units. Watersheds were agglomerated above the point where a stream of a given size class flowed into a stream of a larger size class. The resultant watersheds represented the direct drainage area for each river in a size class. The agglomerated watersheds were used as sampling units in the further size 1, size 2, size 3, and size 4 system classification.

Example of how size 1 watersheds are agglomerated into size 2 watersheds at the point where a size 2 river merges into a size 3 river.



Watersheds were grouped into similar aquatic system groups within each size class according to the physical characteristics of bedrock and surficial geology, elevation, and landform within the watershed. A statistical analysis of the elevation, geology, and landform landscape characteristics within each watershed was performed by sampling the Ecological Land Units (ELUs) within watersheds. The ELU dataset classifies each 90m cell in the landscape according to its elevation zone, bedrock and surficial geology, and landform. Elevation zones were based on the general distribution of dominant forest types in the region, as this climax vegetation provides a proxy for the climatic variation across the region. The bedrock and surficial geology classes were based on an analysis of the ecological properties of bedrock and soils in terms of chemistry, sediment texture, and resistance.[13] The bedrock included acidic sedimentary and metasedimentary rock, acidic granitic, mafic/intermediate granitic, acidic shale, calcareous, moderately calcareous, and ultramafic bedrock. The surficial types included coarse or fine surficial sediment. The landform model was developed by M. Anderson according to how terrestrial communities were distributed in the landscape. The landform model had 6 primary units (steep slopes and cliffs, upper slopes, side slopes and coves, gently sloping flats, flats, and hydrologic features) that differentiate further into 17 total landform units. Landforms control much of the distribution of soils and vegetation types in a landscape as each different landform creates a slightly different environmental setting in terms of the gradient, amount of moisture, available nutrients, and thermal radiation. The results of the statistical cluster analysis (TWINSPAN), was adjusted by hand, to yield a final set of watershed aquatic ecological system types which were used as the coarse filter aquatic targets.[14]

Figures 2 and 3 below show an example landscape with superimposed ELUs, watersheds, and derived watershed system types. The Moosup and Pachaug watersheds are imbedded in a very similar landscape dominated by acidic granitic bedrock, low elevation flats and gentle hills, large areas of wet flats and coarse grained sediment flats along the rivers. The Westfield Middle Branch watershed is located in a very different landscape dominated by acidic sedimentary bedrock, gentle hills and sideslopes ranging from low to mid elevation, fewer areas of wet flats, more confined channels, and higher gradient streams. The Moosup and Pachaug would serve as interchangeable members of size 2 watershed system type 3, while the Westfield would represent a different size 2 watershed system type of 9. We would expect these systems to have different aquatic habitats and ecological potentials due to their different environmental setting.

[13] Anderson 1999
[14] For more information on the detailed GIS and statistical methods used to build the stream network, stream reach classification, and watershed classification, see Olivero 2003.

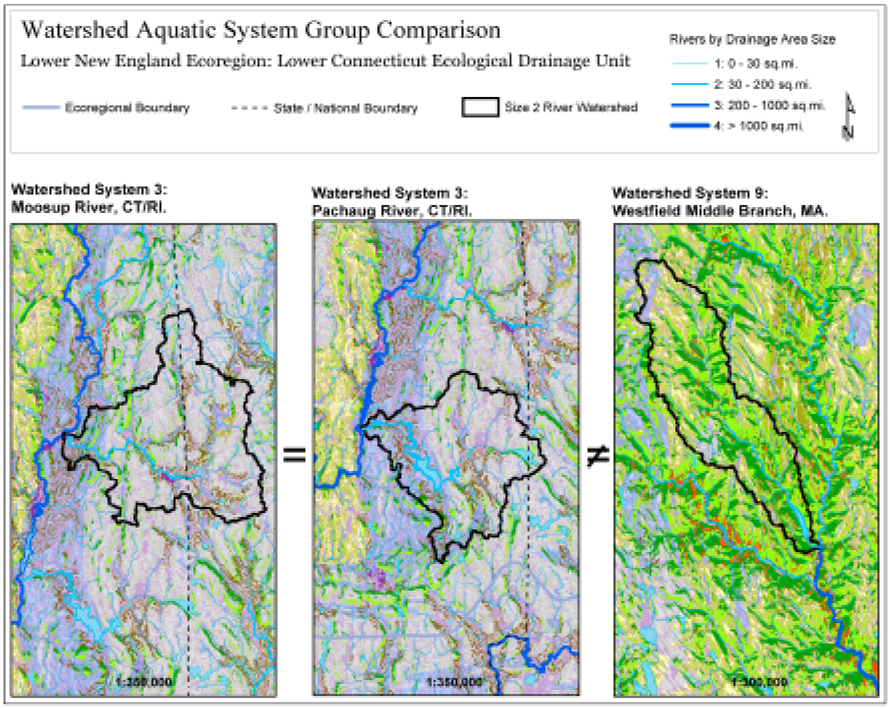


Figure 2: Watershed Aquatic System Group Comparison

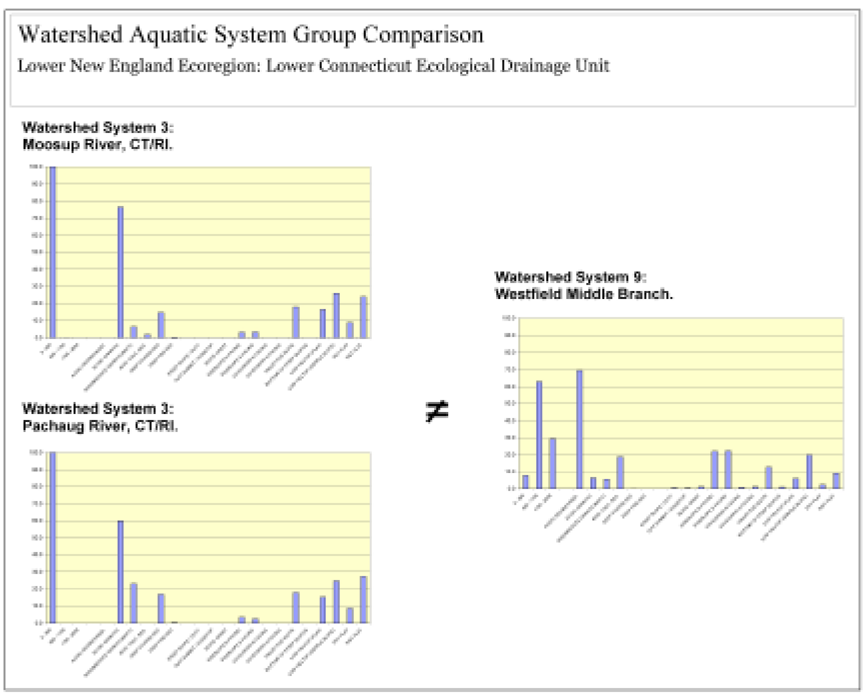


Figure 3: Watershed Aquatic System Component Summary

Stream Reach Classification: Macrohabitats A reach is defined as the individual segment of a river between confluences or as the shoreline of a lake. A stream reach classification was performed using physical variables known to structure aquatic communities at this scale and that can be modeled in a GIS. These variables include factors such as stream or lake size, gradient, general chemistry, flashiness, elevation, and local connectivity[15]. The physical character of macrohabitats and their biological composition are a product of both the immediate geological and topographical setting, as well as the transport of energy and nutrients through the systems. Macrohabitats represent potential different aquatic communities at the reach level and are useful on ecoregional and site conservation planning as a surrogate for biological aquatic communities at this scale

Table 2 : Macrohabitat Classification

Driving processes, modeled variables, GIS datasets, and modeled classes used to define Macrohabitats.[16]

Ecosystem Attribute	Modeled Variable	Spatial Data	Classes/Glass Breaks
Zoogeography	1) Region 2) Local Connectivity	1) Ecological Drainage Unit 2) Hydrography	1) Ecological Drainage Unit break 2) upstream and downstream connectivity to 1 = stream, 2=lake, 3=ocean
Morphology	1) Size (drainage area) 2) Gradient	Hydrography and DEM	1) 0-30 sq. mi., 30-200 sq. mi., 200-1000 sq. mi., > 1000 sq. mi. 2) 1=0-.5%, 2=.5-2%, 3=2-4%, 4=4-10%, 5=>10%
Hydrologic Regime	Stability/Flashiness and Source	Hydrography, Physiography, Geology	Stable or Flashy (complex rules based on stream size, bedrock, and surficial geology)
Temperature	Elevation	DEM	1=0-800ft 2=800-1700ft 3=1700-2500ft 4=2500ft+ [17]
Chemistry	Geology and Hydrologic Source	Geology	is cal-neutral for size 1-2's if > 40% calcareous; is cal-neutral for size 3-4's if 30% is calcareous

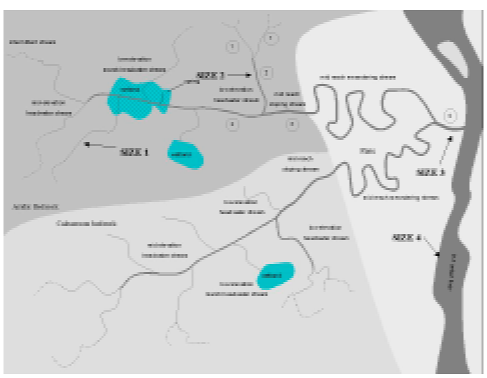


Figure 4: Anatomy of a Stream Network Macrohabitat Model

Selecting Aquatic Targets

The team selected both fine scale and coarse scale conservation targets. The aquatic fine-scale species targets such as rare and declining species (e.g. dwarf wedgemussel) are discussed in the section of this plan on Species Targets. In addition to rare and declining species, aquatic species

[15] The macrohabitat model is based on work done by Seelbach et al. 1997, Higgins et al. 1998, and Missouri Gap Valley Segment Classification 2000.
[16] See the documentation on TNC Freshwater Initiative web site's science page (www.freshwaters.org) or the methods section of Olivero 2003 for more information on the GIS tools and scripts used to develop these attributes.
[17] Breaks from ecoregional ELU analysis

targets should also include consideration of regional-scale migratory fish (e.g., Atlantic salmon) whose life history needs extend beyond the boundaries of the planning area and who may face a unique set of threats (e.g. lack of fish passage at mainstem dams).

The focus of our coarse filter target selection was the watershed size 2 and size 3 level aquatic system classification. The size 2 and 3 watersheds were chosen as the coarse scale targets because 1) they represented an intermediate scale of river system which recent literature has emphasized as the scale where many processes critical to populations and communities occur,[18] 2) the size 1 watersheds and reach classification were well correlated with the larger scale size 2 and 3 watershed types, and 3) they provided management "units" around which TNC felt the core of a site conservation planning effort would operationally develop.

Setting Goals

Goals in ecoregional planning define the number and spatial distribution of on-the-ground occurrences of conservation targets that are needed to adequately conserve the target in an ecoregion. Setting goals for aquatics biophysical systems in ecoregional planning is a much less well developed process than setting goals for terrestrial communities because we have not yet defined the exact biological communities associated with each watershed ecosystem type.

In terrestrial settings, the minimum number of viable occurrences needed in the portfolio for each terrestrial community is related to the patch size and restrictedness of the target. The minimum number of occurrences needed is determined by the relative increase in probability of environmental or chance events reducing the ecological integrity of the target community. Because we have not developed biological community descriptions of our surrogate coarse filter watershed system targets, and as a result have not applied specific biologically based viability standards to these targets; the TNC team set conservative initial minimum goals.

Representation Goals

An initial minimum representation goal of one example of each size 2 and size 3 watershed type was set. It is unlikely one example is truly enough for all watershed ecosystem types, so the ecoregional team was allowed to use their professional judgement to add additional examples of system types into the portfolio given that 1) the team had strong feelings other examples were needed to represent the diversity within the system, 2) there were equally intact interchangeable units for which priority of one or the other could not be decided, or 3) if there were other compelling reasons to include more examples of a system type (i.e. additional very critical area for species level aquatic target; could create a good terrestrial/aquatic linkage; another example was needed to fill out regional connectivity network; active partners already working on the example and TNC could gain partnerships by expanding our work and including this example even if it wasn't the most intact example).

More specific abundance goals will have to be set in future iterations of the plan once the biological descriptions and distinctiveness between and within watershed types are more fully understood. Research should also be done to determine how the changes in number of examples of various size classes influences how many examples of each size class should be included in the portfolio.

[18] Fausch et al 2002

Connectivity Goals

Connectivity of aquatic ecological systems is based on the absence of physical barriers to migration or water flow. Connectivity is of critical importance for viable regional and intermediate-scale fish and community targets and for maintaining processes dependent on water volume and flooding. The regional scale connectivity goal was to provide at least one "focus network" of connected aquatic ecological systems from headwaters to large river mouth for each size 3 river type where a regional wide-ranging species was present. A secondary intermediate scale connectivity goal was to provide the best pattern of connectivity for intermediate-scale potadromous fish, intermediate scale communities, and processes. The goal for these intermediate scale targets was to provide at least one connected suite of headwaters to medium sized river. Again, here the focus was on functional connections at the mouth of a size 2 river and some functional connections from the size 2 to its size 1 tributaries.

Assessing Viability

Viability refers to the ability of a species to persist for many generations or an Aquatic Ecological System to persist over some specified time period. In aquatic ecosystems, viability is often evaluated in the literature by a related term "biotic integrity". Biotic integrity is defined as the ability of a community to support and maintain a balanced, integrated, adaptive community of organisms having species compositions, diversity, and functional organization comparable to that of a natural habitat of the region.[19]

A myriad of anthropogenic factors contribute to lower viability and biologic integrity of aquatic systems. Dams and other hydrologic alteration, water quality degradation from land use change, and introduced species all have well documented negative impacts on the structure and functioning of aquatic ecosystems. Dams alter the structure and ecosystem functioning by 1) creating barriers to upstream and downstream migration, 2) setting up a series of changes upstream and downstream from the impoundment including changes in flow, temperature, water clarity; and 3) severing terrestrial/aquatic linkages critical for maintaining the riparian and floodplain communities. The spread of human settlement has intensified agriculture, road building, timber harvest, draining of wetlands, removal of riparian vegetation, and released many harmful chemicals into the environment. This land use alteration has led aquatic habitats to become fragmented and degraded through increased sedimentation, flow and temperature regime alteration, eutrophication, and chemical contamination. Introduced nonindigenous species have also had negative impacts as they compete with indigenous species for food and habitat, reduce native populations by predation, transmit diseases or parasites, hybridize, and alter habitat. Introductions and expansions of nonindigenous species are causing an increasing threat to aquatic systems and are usually extremely difficult if not impossible to undo.

Quality Assessment

Assessing the viability and condition of the coarse scale watershed system targets presented a unique challenge. In the Northeast U.S., State level Index of Biotic Integrity ranks and datasets only exist in Pennsylvania and Maryland, and even these focus only on wadeable rivers. Although some water quality and biomonitoring data existed in various states, this information was not readily available or in a standardized comparable format across states. Viability thresholds for condition variables related to the biological functioning of aquatic ecosystems

[19] Moyle and Randal 1998

have also not been extensively researched and developed, with the exception of impervious surface thresholds. There was also limited time and funding to compile and analyze existing instream sample data and its relation to the intactness and functioning of aquatic ecosystems.

Given these challenges, a two phase approach was taken. First, available spatial data was used to perform a GIS condition screening analysis to rank all watersheds and individual stream segments according to landscape factors that previous research has shown are correlated with biological integrity of aquatic communities.[20] Second, this preliminary assessment was refined and expanded during a series of expert interviews conducted with scientists and resource managers across the planning region. Experts were asked to comment on the TNC aquatic classification, identify threats and local conditions that were not modeled in the GIS screening, and highlight location of best examples of high-quality aquatic sites in the ecoregion.

The GIS screening analysis was used as a surrogate, but standardized, method of evaluating current condition of the aquatic ecosystems. It used landscape variables such as percent developed land, road density, density of road/stream crossings, percent agriculture, dam density, dam storage capacity, drinking water supply density, and point source density. These variables were divided into three generally non-correlated impact categories 1) Land cover and Road Impact to represent changes in permeable surfaces and other threats from roads, urbanization, or agriculture; 2) Dam and Drinking Water Supply Impacts to represent changes in hydrologic regime and migration barriers from dams; and 3) Point Source Impact to represent potential point source chemical alteration threats.

Ordinations were run on a subset of variables in the Land cover and Road Impact, Dam and Drinking Water Supply Impact, and Point Source Impact categories to develop a rank for each size 2 watershed in each impact category. The ordination ranks were used to highlight the most intact watershed examples within each watershed system type. Three variables, percent developed land, percent agriculture land, and total road density per watershed area, were also used to develop a simplified overall “landscape context” rank for each size 2 watershed. See Table 3 for the landscape context component rank criteria. The overall Landscape Context watershed rank was determined by worst individual component category score.[21]

Table 3: Watershed Landscape Context Ranking

Landscape Context Rankings			
Rank	%Developed	% Agriculture	Road Density (mi.rd./sq.mi. watershed
1	<1%	<3%	<1
2	1-2%	3-6%	1-2.5
3	2-6%	6-10%	2.5-3.5
4	6-15%	>10%	>3.5
5	>15%		

At the aquatic expert interviews, experts at the state level were engaged for information on local conditions that could not be modeled in a GIS such as stocking, channelization, introduced

[20] Fitzhugh 2000

[21] For more information on the reach and watershed level condition variables and statistical ranking analysis, see Olivero 2003.

species, dam operation management techniques, and local water withdrawal. TNC field offices hosted a series of expert workshops to engage aquatic experts with land or resource management agencies, academic institutions, private consulting firms, and/or non-profit organizations based in the region. At these meetings experts provided input on previous work conducted by TNC such as the aquatic classification, GIS condition screening, and conservation planning approach. Experts were also specifically asked to delineate areas of aquatic biological significance on maps and provide descriptions of these areas by filling out a description form (see Appendix 2) on each area of aquatic biological significance.

Assembling the Portfolio

A portfolio assembly meeting was held with one or two representatives from each of the TNC state offices in the ecoregion. Prior to this meeting, each state had prioritized Size 2, 3, and 4 Aquatic Ecological System examples within their state for each watershed system group. Each office ranked occurrences based on the GIS screening analysis and expert information, such as best example of an intact system, presence of rare species, presence of native fish community, presence of excellent stream invertebrates, great condition, or free from exotics.

At the portfolio assembly meeting, field office representatives discussed and compared examples of given system groups that crossed state boundaries to select examples for the portfolio. The team was asked to identify the Portfolio Type Code categories for selected examples (Table 4 and 5). The team also identified the regional connected focus networks that would be part of the plan.

A considerable amount of professional judgement was exercised in assembling the conservation portfolio. In relatively intact landscapes where there were many high quality examples of each Aquatic Ecological System type, we included more than one instance of each watershed system in the conservation portfolio. In these cases, priorities for conservation action may depend on opportunity and imminence of threat. Conversely, in some degraded landscapes, there were few or no high quality examples of certain system types. In these areas, we recognize that restoration may be necessary to elevate the condition of systems included in the portfolio.

Table 4: Portfolio Type Code

PORT-S1c	Best available example of a stream/river system type and part of a regional or intermediate scale connected stream network
PORT-S1	Best available example of a stream/river system type but disjunct/not part of a focus connected stream network
PORT-S2c	Additional good example of a stream/river system type and part of a regional or intermediate scale focus connected stream network, but not the best example of its system type
PORT-S2	Additional good example of a stream/river system (often included the headwaters in all matrix sites) but disjunct from larger focus connected network
PORT-Sxc	Connector. Not an excellent or additional good best example of a stream/river system. It is considered as part of the portfolio as a connector segment in a focus connected stream network. These connectors usually are the lower mainstem reaches in a focus network that are highly altered but needed for connectivity. This connector occurrence is necessary to meet regional connectivity needs

Table 5: Confidence Code

1	High Confidence. We have high confidence that these expert recommended systems are both important and viable as aquatic conservation targets. Confidence 1 AESs often fall within the optimal condition analysis (% natural cover, road density, dams) as well.
2	Lower Confidence. These occurrences are only *conditionally* in the portfolio. Confidence 2 occurrences require more evaluation before we would take conservation action at these sites. They appear to be good aquatic conservation areas and appear to be necessary additions to the portfolio, but we need more information on these sites.

AQUATICS APPENDIX 0

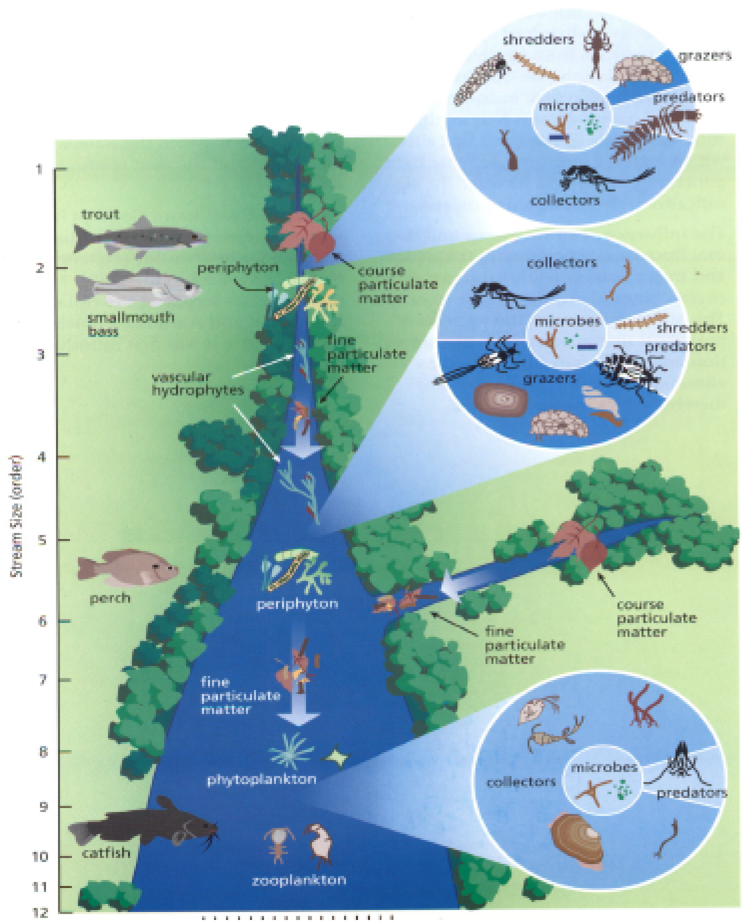


Figure 1: River Continuum in Size

AQUATICS APPENDIX 1

Proposed Aquatic Biota Relationship to Upper Connecticut and Middle Connecticut Ecological Drainage Units Aquatic Classification Units. Based primarily on Vermont Community Classification (Langdon et al 1998, St. Lawrence Ecoregional Aquatics Classification (Hunt 2002), and New York Community Classification (Reschke 1990). Compiled by Mark Anderson 3/2001.

TYPE	CHARACTERISTICS	ELU signature
SIZE 1 STREAM NETWORKS	**Riffles (50%) Pools (50%) Occur on all elevation/slope classes Cool – cold water, Headward erosion, Minimal deposition, Leaf shredders dominant**	**Size 1 Watershed, 0-30 sq. mi.**
A: SIZE 1, HIGH GRADIENT	Cold water over eroded bedrock, Energy source is terrestrial leaf litter, Shaded with 75-100% canopy cover, Mosses and Algae, few rooted plants. Substrate is boulder cobble gravel	Watershed dominated by slopes > 2% . Features: Sideslopes, steep slopes, cliffs, coves, gentle slopes
SIZE 1, HIGH GRADIENT, ACIDIC BEDROCK Plants: acid tolerant bryophytes, non vegetated areas Macroinverts: acid tolerant leaf shredders, low species diversity: Caddisflies (*Parapsyche, Palegapetus*)-Stoneflies (*Capniidae*)-Non-biting midges (*Eukiefferella*), Mayflies (*Eurylophella*).Other preferential taxa Caddisflies?(*Symphitpsyche*), Stoneflies (*Leuctridae, Taenionema, Chloroperlidae, Peltoperla*), Water strider (pools). Possible taxa Alder flies, Beetles (*Psephenidae*), Mollusca (*Elliptio*), Mayflies (*Heptagenidae*).		Watershed composed primarily of acidic bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ‘ Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak –pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700’ elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800’ elevation zone, Deciduous or Mixed
SIZE 1 HIGH GRADIENT CIRCUM-NEUTRAL BEDROCK Plants: circumneutral, *acid intolerant* bryophytes, non vegetated areas Macroinverts: circumneutral , *acid intolerant* leaf shredders: Mayflies (*Rithrogenia*)-Caddisflies (*Symphitopsyche?, Glossosoma*)-Flies (*Simulium, Antocha*) Stoneflies (*Peltoperla, Chloroperlidae, Malikrekus, Capniidae, Agnetina*), Beetles (*Oulimnius, Optioservus, Ectopria*), Non-biting midges (*Crictopus, Polypedilum*), Mayflies (*Ephemerella, Serratella*), Flies (*Hexatoma*), water striders (pools)		Watershed composed primarily of calcareous bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ‘ Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak –pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700’ elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800’ elevation zone, Deciduous or Mixed
B: SIZE 1, LOW GRADIENT (MARSHY) STREAMS	Cool to cold water small brook that flows through a flat marsh, fen, swamp or other wetland. Energy source is leaf litter, may be open or shaded. Substrate is clay-silt-sand dominated, Sand >silt/clay, cold, usu associated with springs, Complete canopy cover of dense veg, alder, willows, dogwood, cedar, marsh veg:	Watershed dominated by flats < 0-2 % Slopes Features: wet flats, valley bottoms, dry flats, marshes and bogs
SIZE 1, LOW GRADIENT, ACIDIC BEDROCK Plants Potamogeton sp, Brasenia schreberii, Vallisneria sp, Myriophylum sp Macroinvert Indicators: Mollusca (*Pisidium*)-Caddisflies (*Polycentropus*)-Mayflies (*Litobrancha*)-Dragon/damselflies (*Cordulegaster*)		Watershed composed primarily of acidic bedrock types
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ‘ Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak –pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700’ elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800’ elevation zone, Deciduous or Mixed
SIZE 1, LOW GRADIENT , CIRCUMNEUTRAL BEDROCK Plants: Potamageton spp, Elodia, Nymphaea		Calc bedrock Slope 0-2%

	Macroinverts: Flies (*Tipula, Atherix, Simulum*)-Non-biting midges (*Apsectrotnypus, Rheocricotopus*)-Crustacae (*Hyallela*)-Mollusca (*Pisidium*)-Mayflies (*Stenonema*) (Vt type 7 (very low, in Champlain valley))	
	MID to HIGH ELEVATION: very cold, fast moving water, typically found in northern hardwood or spruce fir setting. Fish: Brook trout	Watershed mostly above 1700 ‘ Conifers prominent
	LOW ELEVATION: cold fast moving water, typically found in Pine-hardwoods, Oak –pine, or Oak –hardwoods setting. Fish: Brook trout, Slimy sculpin, Blacknose dace	Watershed mostly within the 800-1700’ elevation zone, Deciduous or Mixed.
	VERY LOW ELEVATION: cool fast moving streams, typically found in Oak-ericad, Oak hickory, Pine – Oak settings. Fish: Brook trout, Slimy sculpin, Blacknose dace, others?	Watershed mostly within the 0- 800’ elevation zone, Deciduous or Mixed
SIZE 2 MIDREACH STREAM	**Riffles, Pools and Runs, Open or partial canopy, Algal shredders/scrapers usually well represented, low to very low elevations only. Generally slightly alkaline**	**Size 2 Watershed: 30-200 sq.mi.**
Sloping, confined channel, midreach stream in low mountains.	Riffles (33%), Runs (33%), Pools (33%) (VT macro type 3 and 4) Average 35%-45% canopy, Typically in mountainous areas Plants: emergents, macrophytes, algae and bryophytes Macroinvertebrates: Algae shredders and scrapers: (Vt type 3) mt areas: Stoneflies (*Chloroperlidae*)-Caddisflies (*Dolophilodes, Rhychophila*)-Flies (*Hexatoma*)-Beetles (*Oulimnius*) Generally poor mussel diversity, with acid tolerant species. Other preferential Taxa: Caddisflies (*Brachycentrus, Lepidostoma, Apatania, Symphitopsyche?, Polycentropus*), Beetles (*Promoresia, Optioservus*), Non-biting midges (*Eukiefferella, Tvetenia, Parachaetocladius, Micropsectra, Microtendipes, Polypedilum*), Mayflies (*Epeorus, Rhithrogena*), Dragon/damseflies (*Gomphidae*), Stoneflies (*Capniidae, Peltoperla, Leuctridae, Agnetina, Isogenoides*). Fish: Brook trout, Blacknose dace, Longnose dace, Creek chub, Longnose sucker, White sucker,	Slope >2 Or stream on slope-bottom flat Elev 800-1700’
Sloping, confined channel, midreach stream in very low valleys.	Riffles (33%), Runs (33%), Pools (33%) (VT macro type 3 and 4) Average 35%-45% canopy, Typically in lower reaches of small rivers, gen in lower valleys of major watersheds, Plants:emergents, macrophytes, alge and bryophytes. Macroinverts: (Vt type 4 lower valleys) Stoneflies (*Chloroperlidae*)-Caddisflies (Dolophilodes, Rhychophila)-Flies (*Hexatoma*)-Beetles (*Oulimnius*) Mayflies (*Isonychia*), Non-biting midges (*Polypedilum*), Beetles (*Dubiraphia, Promoresia*). Other possible taxa: Beetles (*Psephenidae*), Alder flies (*Corydalidae*), Dragon/damseflies (good diversity; *Calyopterygidae*), Mollusca (Elliptio, Pyganodon, Sphaerium, questionably Margaritifera), Mayflies (Ephemeridae), Crustacea (Cambaridae) (green stoneflies (Chloroperlidae), Dolophilodes, Hexatoma, Rhychophila, Oulimnius). Poor NYHP understanding of assemblage. (Promoresia, Neoperla, Chimarra, Stenelmis) Fish: transitional cold/warm species: Blacknose dace, Longnose dace, White sucker, Creek chub, Flathead minnow, Bluntnose minnow	Slope >2 Or stream on slope-bottom flat Elev 0-800’
Flat meandering midreach stream	Runs (50%), Pools (50%) (VT macrotype 6) Average 35% canopy, broader valleys with low slopes of large drainage areas Plants: Alders, willow along banks, Floodplain forest and other rivershore communities Macroinvertebrates: Beetles (*Dubiraphia*)-Non-biting midges (*Polypedilum*)-Mayflies (*Leptophelbidae*)-Mollusca (*Pisidium*)-Odonota (*Aeshinidae*) Broad winged damselflies *Calopterygidae*, Narrow winged damselflies *Coenagrionidae*, Clubtails	Slope 0-2% (wetflats) and not a slope bottom flat

			Gomphidae)-Caddisflies (*Hydaphylax, Dubiraphia, Polypedilum)* Fish, warmwater species, coldwater absent: Bluntnose minnow, Creek chub, Blacknose dace, Tessellated darter, White sucker.	
		Midreach stream entering large lakes	Need more information, Mollusca (*Potamilus, Lampsilis, Leptodea, Pyganodon, Sphaerium, Pisidium*)-Mayflies (*Hexagenia*)-Beetles (*Dubiraphia*)-Caddisflies (*Phylocentropus*)-Crustacea (*Gammarus*)-Non-biting midges (*Polypedilum*)-Flies (*Spheromias, Culicoides*) Fish 80 + warmwater species in Lake Champlain region	Under 150' elev???
LARGE, SIZE and SIZE 4 RIVERS				**Size 3: 200-1000 sq.mi.; Size 4: > 1000 sq.mi.+**
		Large main channel river	Each river and drainage basin should be treated separately Fish include American shad, Atlantic salmon, and other warmwater species	
SPECIAL SITUATIONS			Small patch situation that may not be predictable but are usually associated with one or several of the main types. For example backwater sloughs are primarily associated with 3-5 order meandering streams.	
			1: Seeps (treated through palustrine veg class)	
			2: Backwater slough (associated with 3-5 order meandering streams)	
			3: Lake outlet and inlet streams (need clarity from lake classification)	
			4: Subterranean stream (associated with limestone bedrock, EOs present)	
			5: Intermittent stream (associated with 1^{st} order streams)	

AQUATICS APPENDIX 2

Specific Information on Nominated Areas of Aquatic Biological Significance

Expert Name(s):

____

Site Code:

____

(Please write your initials, date of description (mmddyy), and sequential letter for sites you describe). For example: **GS020802A** = (George Schuler - Feb. 8, 2002 – first site described)

Site Name:

____

Describe any current Conservation Work being done at this site:

____

____

Who is/are the lead contact person(s) for additional information about this site?

Name ______________________________

Agency/Address____________________________________

Email _________________________ Phone ____

Name ______________________________

Agency/Address____________________________________

Email _________________________ Phone ____

Biological description (e.g., native species assemblages, indicator or target species, unique biological features, important physical habitat, etc.):

____

____

____

Key Ecological Processes: (e.g., the dominant disturbance processes that influence the site such as seasonal flooding or drought, ice scouring, groundwater recharge, seasonal precipitation events, etc.)

____

____

____

Major stresses: Using the following list, rank the major stresses at this site:

Habitat destruction or conversion

B. Habitat fragmentation

C. Habitat disturbance ______

D. Altered biological composition/structure

E. Nutrient loading ___

F. Sedimentation

G. Extraordinary predation/parasitism/disease

H. Modification of water levels; changes in flow

I. Thermal alteration

J. Groundwater depletion

K. Resource depletion

L. Extraordinary competition for resources

M. Toxins/contaminants _____

N. Exotic species/invasives

O. Other: ______________________________

Major sources of stress: Using the following list, circle up to 3 sources of stress at this site:

A. **Agricultural** (Incompatible crop production, livestock, or grazing practices)
B. **Forestry** (Incompatible forestry practices)
C. **Land Development** (Incompatible development)
D. **Water Management** (Dams, ditches, dikes, drainage or diversion systems, Channelization, Excessive groundwater withdrawal, Shoreline stabilization)
E. **Point Source Pollution** (Industrial discharge, Livestock feedlot, Incompatible wastewater treatment, Marina development, Landfill construction or operation)
F. **Resource Extraction** (Incompatible mining practices, Overfishing)
G. **Recreation** (Incompatible recreational use, Recreational vehicles)
H. **Land/Resource Management** (Incompatible management of/for certain species)
I. **Biological** (Parasites/pathogens, Invasive/alien species)
J. **Other:**

____

Further description of stresses or sources of stress:

____

____

TNC RANKING - Site Description:

Describe each site according to each of the three components of viability below (i.e., size, condition, landscape context). Once described, attach a status rating (i.e., Very Good,

Good, Fair, Poor) for each of the three components and provide written justification for your assessment.

Size: (e.g., describe the species and specific life history stages (if known) that use the site and any information about specific life history stages):

____

____

Condition: (e.g., describe aspects of biotic composition, local anthropogenic impacts, degree of invasive species, etc.):

____

____

Landscape (Waterscape?) Context: (e.g., describe the altered flow regime, connectivity with other aquatic habitats, watershed impacts, unique or notable physical features, landscape setting, etc):

____

____

Additional Comments not captured by this survey:

____

____

RESULTS FOR AQUATIC SYSTEMS[*1]

Modifications to Standard Method

The CBY aquatic ecosystem analysis was done before the standard methodology outlined in the chapter Planning Methods for Freshwater Aquatic Ecosystems and Networks was developed. Much of the analysis and thinking developed during the CBY plan contributed to this methodology; however you will notice certain pieces of the standard methodology missing or done differently in the CBY Plan. The original CBY methods are explained in detail below. Notable differences are as follows:

Aquatic Ecological Systems: In CBY the Aquatic Ecological Systems were not developed using a statistical clustering of multiple scaled watersheds based on underlying ecological land unit (ELU) types. Rather, they were delineated in a much more interactive manner by Jen Perot, the GIS Analyst/Freshwater Ecologist for this part of the project. Jen Perot looked for hydrologically connected stream reaches sharing the same four macrohabitat attributes: size, connectivity, gradient, and hydrologic/chemical regime. By identifying repeating patterns of reaches sharing these four attributes, she was able to group the reaches into 12 generalized system types. Although different system types were not defined specifically within each river size class, the resultant system types do generally represent rivers within a narrow size range. For example, system 12 includes only very large rivers, while other system types represent headwaters (1, 2, 7) and still others represent headwaters to creek/small river sizes (3, 5, 6, 8, 9, 10, 11). The system types were reviewed and modified by experts and served as our coarse-filter aquatic ecosystem targets.

Condition Analysis: The CBY condition analysis was very similar to the standard method. Both a watershed and reach level GIS condition analysis were performed. During these GIS analyses, the data was also summarized using PCA ordination within system types according to the three impact areas of landcover/roads, dams and drinking water, and point sources. An expert interview and review process to highlight areas of aquatic biological significance was also performed. CBY departed from the standard method in that 1) only one size of watershed was used in the GIS watershed ranking classification, 2) no formal non-system relative ranking was performed although various non-relative ranking maps of specific condition variables were generated, and 3) the reach condition statistics were used to derive PCA system relative reach ranks.

Selecting Targets and Setting Goals: Both representation and connectivity goals were set; however, they were defined slightly differently than in the standard Aquatic Methods section. The representation goal was essentially the same: capture at least one example of each aquatic ecosystem type within each EDU. The connectivity goal was not based specifically on migratory species needs and on identifying connected examples of all types from headwaters to ocean. However, the CBY connectivity goals did suggest giving preference to selecting aquatic ecosystem types that maintained a high level of internal connectivity and connectivity to other aquatic ecosystems within the larger drainage network.

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[*] Perot, J. and A.P. Olivero, 2003. Results for aquatic systems. Chesapeake Bay Lowlands Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.
[1] The text in this section is presented as a compilation of reports prepared by other colleagues and/or members of the planning team during the 1st iteration plan.

Portfolio Assembly: Instead of a TNC field office representative from each state serving at the final assembly meeting, Mark Bryer of TNC FWI represented VA and DE. Doug Samson represented MD. Mark Anderson and Arlene Olivero also participated and contributed to the assembly meeting. The codes assigned to portfolio examples varied in CBY from those documented in the Aquatics Methods section. First, CBY portfolio examples were coded into Tier 1 and Tier 2, which are analogous to S1 and S2 in the standard Methods section.[2] Second, portfolio examples were not coded "C" for being part of a connected focus network and were also not assigned a confidence code.

Classification Results

Ecological Drainage Units

EDUs were distinguished in the CBY ecoregion by two major factors, zoogeography[3] and physiography. Major physiographic distinctions primarily reflect the section levels assigned by the Forest Service.

Major freshwater zoogeographic regions that influenced EDU delineation were the Long Island Sound Subregion or WWF Atlantic Freshwater Ecoregion and Chesapeake Bay Subregion/Freshwater Ecoregion. As a result, the Delmarva Peninsula is divided into 2 EDUs: an Eastern EDU with streams draining into the Delaware Bay or Atlantic Ocean, and a Western EDU, with streams draining into the Chesapeake Bay. There are no major physiographic distinctions in the ecoregion according to the Forest Service. However, the western shore of Maryland and Virginia was broken into two EDUs to account for faunal differences in the Chesapeake Bay drainages. Drainages from just south of the Susquehanna to the Potomac drainage formed a Northern EDU. The Southern EDU is comprised of drainages from the Great Wicomico River south to the James River drainage.

Macrohabitats

Aquatic communities are best defined by analyzing biological data to identify assemblages of aquatic species. In most ecoregions, though, there are not sufficient biological data to characterize the diversity and distribution of aquatic communities at a scale appropriate for conservation planning in an ecoregion. Macrohabitats are units of streams and lakes that are relatively homogeneous with respect to size, and thermal, chemical, and hydrological regimes. Each macrohabitat type represents a different physical setting thought to contain distinct biological communities and is therefore a distinct conservation target.

Stream macrohabitats were mapped in a GIS across the Chesapeake Bay Lowlands using the three primary spatial data sets: hydrography, geology and elevation. Four stream variables were derived from these layers: stream size, connectivity (network position), gradient, and hydrologic and chemical regime. Lines representing stream reaches were attributed automatically by the

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[2] The standard methods for freshwater aquatic systems do not use the Tier 1 and Tier 2 code names to avoid confusion between the aquatic portfolio site codes and the terrestrial matrix Tier 1 and Tier 2 codes. The terrestrial matrix Tier 1 and Tier 2 examples have undergone a much more rigorous viability screening to determine that both Tier 1 and Tier 2 matrix forests are viable. The ecoregional planning team believed that viability screening of aquatic portfolio occurrences was not as well developed as terrestrial matrix screening, making the confidence in viability much lower for aquatic portfolio sites. Thus the "Tier 1" and "Tier 2" status have different meaning with respect to viability for the freshwater aquatic and terrestrial matrix portfolios in CBY.

[3] Maxwell et al. (1995) and the recently released WWF *Freshwater Ecoregions of North America* (Abell et al. 2000)

software and aggregated into macrohabitat types as unique combinations of the four classification attributes described below.

1. *Stream Size*

We defined five stream size classes based on link number, which is a count of the number of first order streams upstream of a point:

5.	Headwater	Link 1 – 10
6.	Creek	Link 11 – 100
7.	Small river	Link 101 – 1000
8.	Medium river	Link 1001 – 2500
9.	Large river	Link >2500

2. *Connectivity*

Stream connectivity describes the position in the drainage network, which was represented by the link number of the downstream reach. We used the same hydrography data layer and classes for stream connectivity as for stream size.

3. *Gradient*

In CBY we measured only one topographic factor, gradient, that is, the change in elevation of a stream reach over its length. Gradient is a useful single measure of channel morphology because it is correlated to sinuosity, pool-riffle pattern, confinement, substrate size, and water velocity. We calculated the gradient for each stream reach automatically from a digital elevation model (DEM), then averaged the gradient value for each macrohabitat. The four gradient classes used to classify the macrohabitats were:

1.	Very low gradient	<0.005
2.	Low gradient	0.005 – 0.02
3.	Moderate gradient	>0.02 – 0.04
4.	High gradient	>0.04

4. *Hydrologic and Chemical Regime*

We used the surficial and bedrock geology texture and stream size to infer the hydrologic regime and chemistry of each macrohabitat in terms of relative inputs of ground and surface water. The geologic codes in the Chesapeake Bay Lowlands and adjoining Piedmont ecoregion are:

Coastal Plain Surficial Geology Classes:

1	alluvial coarse
2	alluvial fine
3	alluvial/estuarine coarse
4	alluvial/estuarine fine
5	beach & dune
6	eolian sand
7	loam
8	marine fine
9	nearshore coarse
10	peat
11	saline marsh
12	silt/clay

Piedmont Bedrock Geology Classes:

100	acidic sed/metased
200	acidic shale
300	calcareous sed/metased
400	mod calcareous sed/metased
500	acidic granitic
600	mafic/intermediate granitic
700	ultramafic
900	coarse sed

Piedmont Surficial Geology Classes:

101	coarse-grained stratified sediment
102	fine-grained stratified sediment

The hydrologic regime and chemistry were classified for macrohabitats using the following rules:

a. *Rules for 1st through 3rd order streams:* If areal coverage of geology in watershed at and above the reach is >40 % stable (coastal classes: 1, 3, 5, 6 & 9 & bedrock classes: 300, 400, 900), then flow in the reach is stable, otherwise flow is unstable. If areal coverage of geology in watershed at and above reach is >40 % calcareous - neutral (coastal classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 & bedrock classes: 300, 400, 700), then chemistry is calcareous – neutral, otherwise acidic.

This resulted in four possible combinations for the hydrologic and chemical regime macrohabitat type:

5. Stable hydrology, calcareous - neutral chemistry (1, 3, 5, 6, 9 & 300, 400)
6. Unstable hydrology, calcareous - neutral chemistry (2, 4, 7, 8, 10, 12 & 700)
7. Stable hydrology, acidic chemistry (900)
8. Unstable hydrology, acidic chemistry (100, 200, 500, 600)

A fifth code was assigned to reaches at the Coastal Plain Saline Marsh (surficial geology class 11).

b. *Rules for 4th and 5th order rivers:* We assumed stable hydrology and calcareous-neutral chemistry unless:

For hydrologic regime, if areal extent of watershed at or above reach is >70% unstable (2, 4, 7, 8, 10, 12, 100 & 200) then flow in reach unstable, otherwise stable. For chemistry, if areal extent of watershed at or above reach is >70% acidic (100, 200, 500, 600, 900) then chemistry is acidic, otherwise neutral.

c. *Rules for 6th order or larger rivers:* We assumed stable hydrology and calcareous-neutral chemistry for all sixth order or larger rivers.

Aquatic Ecosystems

Where macrohabitats create a detailed and often quite complex picture of physical diversity, aquatic ecosystems are defined at a spatial scale to which experts relate well, and provide a means to generalize about the streams, lakes, and the ecological process that link groups of communities. Aquatic ecosystems are spatial assemblages of aquatic communities that 1) occur together in an aquatic landscape with similar geomorphological patterns; 2) are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains and other lateral environments) or environmental gradients (e.g., temperature, chemical and habitat volume); and 3) form a robust, cohesive and distinguishable spatial unit.

Within the Chesapeake Bay Lowlands ecoregion, there is considerable diversity in the types of macrohabitats. To describe this diversity, we looked for patterns in the macrohabitat types and four attributes used to classify them. Once patterns were observed, hydrologically-connected sets of segments were identified, described, and mapped across the ecoregion as aquatic ecosystems. These preliminary systems were reviewed and modified by experts (during the Viability Analysis process described below), and served as our coarse-filter aquatic targets for CBY.

Over 15,000 miles of nontidal streams and rivers were classified in the ecoregion, along with almost 2,400 miles of tidal waters (Map 3, Table aq7). Not surprisingly, almost half of the total mileage of mapped systems occurs in Virginia (39% nontidal, 6% tidal), with another 40% occurring in Maryland, and about one-sixth in Delaware. Tidal systems are equally abundant in Maryland and Virginia, while just under ten percent of the tidal total occurs in Delaware. About 30 miles of tidal and nontidal systems combined were mapped within the half of Washington, D.C. that falls within the CBY ecoregion.

The CBY ecoregion was initially classified into 12 aquatic system types in the four EDU's (Map 3, Table aq1). A number of reaches located near the Fall Line in central and northeast Maryland, having geological and hydrological characteristics more typical of the Piedmont, were classified as System 11, but were subsequently excluded as being unrepresentative of the CBY ecoregion. In CBY, then, nine systems were classified as nontidal freshwater systems, and two (Systems 4 and 12) were tidal (Table aq1). One drainage in southern Maryland, Zekiah Swamp in Charles County (a tributary to the Potomac River) may represent its own unique system. However, there was insufficient data available to confidently classify it as a separate system, so it was included with System 1 in the present analysis.

Table aq1. Aquatic systems in the Chesapeake Bay Lowlands

System	Geology	Hydrology	Chemistry	Gradient	System Name	Characteristic Fish Species	Examples
1	Silt/clay, alluvial/estuarine fine & loam	Unstable	Neutral	Low, some very low or moderate	***Warmwater Headwaters*** in Northern Coastal Plain on Western Shore	Blacknose dace, creek chubsucker, eastern mudminnow, fallfish, least brook lamprey, pumpkinseed, rosyside dace	Tributaries to the Potomac, Patuxent & Parker, Plum Point, Fishing, Tracys, Muddy, North R., Bacon Ridge Br., Severn Run, Herring Run, Bird R. & Whitemarsh.
2	Loam	Stable	Neutral	Low	Nontidal, stable, neutral, ***cool-water headwater*** stream.	Brook trout, blacknose dace, mottled sculpin	Jabez Branch, Unnamed trib (?)
3	Acidic sed/metased & alluvial coarse	Stable	Acidic to neutral	Very low	Nontidal, stable, acidic to neutral, ***cool-water creek & small river*** size streams. Headwaters in Piedmont. Redwater system.	Banded killifish, brown bullhead, gizzard shad, quillback, shorthead redhorse, warmouth, yellow bullhead, yellow perch	Little Patuxent and Patuxent Rivers
4	Saline marsh	Tidal	Saline	Very low	***Tidal wetlands***		Aberdeen Proving Ground (Romney, Abbey, Mosquito, Back Cr.), Bombay Hook NWR, Little Creek WMA, Trap Cr. & Newport Cr., Cedar Is. WMA, Deer Is. WMA, Ches. Bay Nat Estuarine Research Reserve, Monie Bay, Blackwater R., Blackwater NWR, Fishing Bay WMA
5	Alluvial coarse, silt/clay, saline marsh, peat, eolian sand & marine fine.	Somewhat stable	Acidic	Very low	***Blackwater systems*** - acidic, brown-stained, poorly drained, very low gradient, vegetated headwater and some creek streams.	Banded sunfish, bluespotted sunfish, creek chubsucker, eastern mudminnow, pirate perch, redfin pickerel, tadpole madtom, yellow bullhead	Piankatank, Dragon Run, Buttons Cr. & Pocomoke R.
6	Loam	Somewhat stable	Neutral	Very low	Nontidal, poorly drained, neutral, headwater & creek size streams. ***Historically blackwater systems.***	American eel, bluespotted sunfish, creek chubsucker, eastern mudminnow, fallfish, golden shiner, pirate perch, pumpkinseed, redbreast sunfish, redfin pickerel, swallowtail darter, tadpole madtom	Headwaters and tributaries to the Choptank, Nanticoke and Wicomico Rivers.
7	Loam	Moderately stable	Neutral	Very low, some low	Nontidal, ***moderately stable***, neutral, headwater streams.	American eel, creek chubsucker, easterm mudminnow, fallfish, pirate perch, redbreast sunfish, redfin pickerel	Tributaries to the Elk, Bohemia, Sassafras, Chester & Wye Rivers.
8	Alluvial/estuarine coarse & nearshore coarse	Somewhat stable	Neutral	Very low	Nontidal, somewhat stable, neutral, very low gradient, headwater & creek sized streams ***on coarse material.***	Creek chubsucker, eastern mudminnow, golden shiner, pirate perch, red pickerel	Chicawcomico R., Transquaking R., Annemessex R., Manokin R., Back Cr., Muddy, & Underhill
9	Marine fine & loam	Unstable	Neutral	Very low	Nontidal, unstable, mostly short headwater & creek sized streams ***on fine material***.	No MBSS data	Christina, Appoquinimink, Blackbird, Smyrna, Jones, Leipsic, Murderkill, Mispillion, Cedar, Broadkill, Indian & St. Martin
10	Silt/clay, alluvial/estuarine fine & marine fine	Unstable	Neutral	very low	Nontidal, unstable, neutral, ***warm-water headwater*** & creek sized streams on Southern Coastal Plain		Tributaries to the Chicahominy, James, Mattaponi, Pamunkey & Rappahannock Rivers, and Brick Kiln, Poquoson, Ware, Great Wicomico.
11	Acidic granitic & acidic sedimentary/ metasedimentary	Unstable	Acidic	very low, low or moderate	Headwater & creek size, unstable, ***acidic streams in Piedmont***. Redwater system		Headwaters of Anacostia, Patuxent & Little Patuxent R., Hawlings & Middle Patuxent R., Grays Run, Swan & Gasheys Cr., Principio Cr., Stony Run, Northeast & Little Northeast Cr., Little Elk and Big Elk & Headwaters of Chicahominy R.
12	Loam & alluvial coarse	Tidal	Saline	very low	***Tidal rivers.***		Chester, Bohemia, Elk, Sassafras, Tuckahoe, Choptank, Marshyhope, Nanticoke, Pocomoke, Wicomico, Patuxent, Potomac, Mattaponi, Pamunkey, York, Rappahanock, Chicahominy, and James Rivers

Condition Results

After consideration of available data and expert resources in CBY, we followed a standard two-phase approach to assess the viability of aquatic ecosystem occurrences. First, we used available GIS data to perform a condition analysis and rank all watersheds (that encompass system occurrences) and individual stream segments according to landscape factors known to affect the biological integrity of aquatic communities. Second, we vetted the GIS analysis by holding workshops in Maryland, Delaware and Virginia to solicit expert opinion on the classification of aquatic systems in CBY, and on the location of best examples of high-quality, high diversity aquatic sites in the ecoregion.

GIS Condition Analysis

Condition analysis for watersheds and stream reaches is a subject of considerable ongoing research.[1] Inspired by these sources, we developed a set of attributes for watersheds and stream reaches that allowed us to evaluate watersheds and reaches in terms of variables related to freshwater aquatic condition. For both the watershed and reach level condition, we divided the available condition variables into three separate impact axes for analysis: 1) Land cover and road impact, 2) Dam impact, and 3) Point source impact. We felt it was unwise to try to combine the 3 separate axis ranks into a single summary rank because of disagreement over the relative importance of the 3 axes and the great variation a given watershed or reach could have in its rank for land/cover road impact vs. dam impact, vs point source impact. For the watersheds and reaches within a given system, we used PCA Ordination to develop a watershed and reach level rank in each of the three condition impact axes. We used GIS analysis and visual overlay of the top ranked watersheds and reaches to select 2 or 3 potentially high condition watersheds within each system type within an ecological drainage unit. Experts in each state were asked to review our GIS selected areas of potential high condition and delineate areas of best freshwater aquatic biodiversity significance per system type. The watershed ranks, stream reach ranks, ranking integration and site selection are described below.
Reach Level Statistics

Based on the directional flow coding of the RF3 GIS dataset, we summarized information on both the individual local watershed of a stream reach and its total contributing area upstream. For example, we calculated the % natural cover in the local watershed of a reach and also accumulated for the entire stream network above that given reach the % natural cover. We calculated over 40 condition variables for each reach related to landcover, roads, road stream crossings, various point sources, and element occurrences. These variables were divided into three categories for further analysis - 1) Land cover and road impacts, 2) Dam inpacts, and 3) Point Source impacts.

Reaches were then divided by system type and ranked for each of the three axes using PCA ordination. PCA ordination provided a means to integrate the individual variables within each axis area into a single continuous rank for reaches for a given impact axis. A subset of the most responsive and most different variables within each axis were chosen for inclusion in the PCA

[1] See the excellent literature review by Fitzhugh (2001), Moyle and Randall (1998), and the TNC Freshwater Initiative Reach Level GIS Condition tools.

analysis. The subset of available variables that went into the PCA ordination are listed in Table aq2 below.[2]

Table aq2. Input variables for PCA ordination analysis.

Point Sources: (using superfund sites, PCS, IFD, TRI95)
PTS4NUM: number of point sources in local watershed of the reach
PTS4DEN: density of point sources (#/miles streams) in total upstream watershed of reach
Land Cover/Road:
RD_DENSITY: road density in upstream contributing area(miles/sq. mile)
RSC_DENSITY: road-stream crossings per stream mile in upstream contributing area
INDEV: percent developed within local watershed of reach
UPDEV: percent developed within total upstream watershed of reach
INAGR: percent agricultural within local watershed of reach
UPAGR: percent agricultural within total upstream watershed of reach
INNAT: percent natural within local watershed of reach
UPNAT: percent natural within total upstream watershed of reach
Dam:
DAMS : number of dams in local watershed of the reach
DAMSTORAGE: total dam normal storage in the local watershed of the reach
DAM_DENS: density of dams (#/miles streams) in total upstream watershed of reach
DAMST_DEN: total dam normal storage upstream/miles of streams upstream

After the ordination, the input variables for each reach were reduced into a single PCORD rank output value for each reach for that impact axis. These output values for a given axis were ranked from lowest to highest within each system and divided into 4 quartiles. The "top quartile by system" variable attributes were then coded for reaches to identify, within a given system, the reaches within the top quartile for land cover/roads, point sources, and/or dam impacts (Table aq3).

Table aq3. Output PCA ordination attributes.

dam#: pc ordination raw value on dam axis
lc#: pc ordination raw value on land cover/roads axis
pt#: pc ordination raw value on point source axis
rdam#: ranking of pc ordination value on dam axis within this system type
rlc#: ranking of pc ordination value on land cover/roads axis within this system type
rpt#: ranking of pc ordination value on point source axis within this system type
qdam#: given a 10 if this shed was in the top quartile for dams by system rank value
qlc#: given a 100 if this shed was in the top quartile for land cover/roads by system rank value
qpt#: given a 1 if this shed was in the top quartile for point sources by system rank value
qtopsum: sum of qdam#, qlc#, qpt#
111 = top 10 in qlc#, qdam#, qpt#
110 = top 10 in qlc#, qdam#
101 = top 10 in qlc# and qpt#

[2] The full reach level ranking analysis was only done for systems 10, 9,8,7,6,5, and 1. Systems 2,3,4, 11, and 12 were excluded from the ranking analysis because the system was too rare [systems 2 and 3 had only two occurrences each], because the system was tidal [system 4 and 12], or because the system occurred primarily outside the ecoregion and was not going to be considered in this ecoregion [system 11].

11 = top 10 in qdam# and qpt#
100 = top 10 in qlc#
10 = top 10 in qdam#
1 = top 10 in qpt#
0 = not top 10 in qlc#, qdam#, qpt# within its primary system type

Watershed Level Statistics

For the watershed level condition analysis, we used Maryland draft NRCS 14-Digit Watersheds and small occurrence watersheds delineated by Jen Perot in Delaware and Virginia. NRCS 14-digit watersheds for Delaware and Virginina were not used because they were incomplete and/or of a different scale than the Maryland watersheds. Eighteen variables related to landcover, roads, dams, and point sources were calculated for each watershed. A subset of the variables were selected for inclusion in a PCA ordination for each of the three impact axis – 1) Land cover/roads, 2) dams, 3) point sources. The variables used in the ordination are listed in Table aq4 below.

Table aq4. Input variables for PCA ordination analysis.

Land Cover/Road Impact:
Rdstdismi: average road to stream distance
P_dev: percent developed land cover
P_agr: percent agricultural land cover
P_nat: percent natural land cover
Rdstcmi: number of road stream crossings per stream mile
Rdmip1000a: miles of roads per 1000 acres of occurrence

Point Source Impact:
Cercpmi: number of superfund sites per stream mile
Ifwpmi: number of industrial facilities water discharge per stream mile
Pcspmi: number of pcs facilities water discharge per stream mile
Tripmi: number of tri water discharge (1995-2000 discharges only) per stream mile
Totptpmi: total point sources per stream mile

Dam / Hydrologic Alteration Impact:
Dwspmi: number of drinking water withdrawal locations per stream mile
Damspmi: number of dams per stream mile
Storpmi: average dam storage per stream mile
P414: percent channelized streams
Maxstor: maximum dam size in occurrence

After the ordination, the input variables for each watershed were reduced into a single PCORD rank value for that watershed for that impact axis. These output values were ranked from lowest to highest within the ecoregion. The watersheds were assigned to the primary system type that occurred within them. The "top10 by system" variable attributes was then coded to identify, within a given system, the watersheds with the top 10 ranks in each impact axis area (Table aq5). Note: sometimes more than 10 "top10" watersheds per system are identified due to ties in their PCORD values.

Table aq5. Output PCA ordination attributes.

Prifwisys: primary FWI system type in the occurrence/watershed
Perfwi: percent of streams that are of that primary FWI system type

Dam1: PCORD ordination axis 1 for Dam variables
Tox1: PCORD ordination axis 1 for Toxic variables
lc_1: PCORD ordination axis 1 for land cover and road variables
Damrank: dam ecoregional ranks from ordination
Toxrank: tox ecoregional ranks from ordination
Lc2rank: lc ecoregional ranks from ordination
Damind: individual within system ranks: 10 if the occurrence is in the top 10 for dams for its primary system type occurrences
Toxind: individual within system ranks: 10 if the occurrence is in the top 10 for point sources for its primary system type occurrences
Lc2ind: individual within system ranks: 10 if the occurrence is in the top 10 for land cover for its primary system type occurrences
Sumtop10: summary code for top 10 data within system type (combination of Damind, Toxind, Lc2ind)
111 = top 10 in Damind, Toxind, Lc2ind
110 = top 10 in Damind, Lc2ind
101 = top 10 in Toxind, Lc2ind
11 = top 10 in Damind, Toxind
100 = top 10 in Lc2ind
10 = top 10 in Damind
1 = top 10 in Toxind
0 = not top 10 in Damind, Toxind, Lc2ind within its primary system type

Selection of Potentially High Quality Watersheds from GIS condition analysis

Watersheds were displayed according to their within system ranks on the 3 impact axes (Map 14). The reachs were also mapping by their within system ranks to visualize whether the reach fell in all 3 axes top quartiles (best in land cover/roads, best in dams, best in point sources), 2 of the 3 axes top quartiles, 1 of the 3 axes top quartiles or none of the 3 axes quartiles (Map 14). We looked at the distribution of these "3,2,1, or 0 top quartile ranked reaches" in relation to our highly ranked watersheds (Map 14). This overlay was useful to distinguish/select between watersheds that came out in 1 or 2 of the Top 10 watershed axes areas because we could now investigate the distribution and abundance of the "best or good" quality individual reaches within the watershed. It was also useful to look at the distribution of the individual higher quality ranked reaches that occured outside of watersheds that came up in the Top 10 watershed analysis. These reaches may occur in a less desirable "watershed setting" but may still be of potential conservation interest, particularly if they represent macrohabitats that do not already occur in the "best" selected watersheds.

Before the expert meetings, we attempted to highlight potential areas of high aquatic biological significance based on the GIS analysis. By studying Map 14 and the underlying data, we were able to select 2 to 3 watersheds per system type and their reaches as areas of potentially highest freshwater condition. These 2 or 3 watersheds were selected primarily based on Arlene Olivero visually overlaying the summary "Top 10 watershed" information with the summary "Top quartile reaches" information for a given system. We found very few watersheds occurred in the "Top 10" in all three impact axes (best in land cover/roads, best in dams, and best in point sources), but when these watersheds occurred they were automatically selected as areas of potentially high freshwater aquatics condition. There was disagreement regarding the relative condition of watersheds that fell in 2 of the 3 "top 10 axes" or in just a 1 of the 3 "top 10 axes". These "top 2 or top 1" watersheds were combined with further reach level statistics and other distinguishing information such as containing aquatic eos for further review. For Maryland, we selected 2 or 3 of the highest quality watersheds and their reaches for expert review based on overlay of Maryland IBI data and the raw condition statistics which were ranked across the entire ecoregion at the time. For Delaware and Virginia expert review meetings, rankings were run within system types, rather than across all system types.

Expert Workshops

Freshwater experts (Table aq6) in each state were presented with our Chesapeake Bay freshwater ecosystem classification and viability analysis in a series of workshops. During the workshops, the experts were asked to give their feedback on the classification, and make adjustments based upon their field knowledge of the aquatic ecosystems in the CBY. Once agreement on the classification was reached, we used it as a framework to structure discussions of where important areas of freshwater aquatic biodiversity existed, and especially ensure representativeness across the ecoregion. Using those areas selected in the GIS analysis described above as starting points, we asked the experts to confirm important areas based on their own experience. We used a standardized form to collect data associated with each nominated area (see below). These expert-delineated areas are shown in the portfolio as “expert-recommended areas of aquatic biodiversity significance.” This portion of viability assessment brought critical in-stream biological knowledge into the portfolio design.

Table aq6. List of freshwater experts interviewed during CBY process.

Name	State	Affiliation	Expertise
Paul Kazyak	MD	MD Dept. of National Resources	state-wide knowledge of IBI
Jim McCann	MD	MD Natural Heritage Program	Mussels
Nancy Roth	MD	Versar, Inc.	state-wide knowledge of IBI
Mark Southerland	MD	Versar, Inc.	state-wide knowledge of IBI
Rich Raesly	MD	Frostburg State University	Fish
Richard Orr	MD	U.S. D.A.	Odonates
Stephen McIninch	MD, VA	Virgnia Commonwealth University	Fish
Ellen Dickey	DE	DE Dept. of Natural Resources	Macroinvertebrates
Craig Shiry	DE	DE Dept. of Natural Resources	non-tidal fish
Greg Garman	VA	Virgnia Commonwealth University	Fish
Tony Silvia	VA	VA Dept. of Environmental Quality	water quality monitoring
Shelly Miller	VA	VA Dept. Game and Inland Fish	Fish

Data sheet used to collect information from freshwater experts.

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SPECIFIC INFORMATION ON RECOMMENDED AREAS OF AQUATIC BIOLOGICAL SIGNIFICANCE

Expert Name(s): ____
Site Code: ____
Site Name: ____

Where is the site mapped? GIS paper map gazetteer

Site description (system type(s), unique or notable physical features, landscape setting, etc):

____
____
____
____

Biological significance (native assemblage, target species, any unique biological features, etc.)

____
____
____
____

Viability: Estimate the viability of the site: (rank either Very Good, Good, Fair, Poor)

CONDITION (biotic composition, local anthropogenic impacts, invasive species)	LANDSCAPE CONTEXT (altered flow regime, connectivity, watershed impacts)

Major stresses: Using the following list, circle up to 3 major stresses at this site:

A.

Habitat destruction or conversion

Habitat fragmentation

Habitat disturbance

Altered biological composition/structure

Nutrient loading

Sedimentation

Extraordinary predation/parasitism/disease

Modification of water levels; changes in flow

Thermal alteration

Groundwater depletion

Resource depletion

Extraordinary competition for resources

Toxins/contaminants

Other: ______________________

Form (continued)**.**

Major sources of stress: Using the following list, circle up to 3 sources of stress at this site:

A. **Agricultural** (Incompatible crop production, livestock, or grazing practices)

B. **Forestry** (Incompatible forestry practices)

C. **Land Development** (Incompatible development)

D. **Water Management** (Dams, ditches, dikes, drainage or diversion systems, Channelization, Excessive groundwater withdrawal, Shoreline stabilization)

E. **Point Source Pollution** (Industrial discharge, Livestock feedlot, Incompatible wastewater treatment, Marina development, Landfill construction or operation)

F. **Resource Extraction** (Incompatible mining practices, Overfishing)

G. **Recreation** (Incompatible recreational use, Recreational vehicles)

H. **Land/Resource Management** (Incompatible management of/for certain species)

I. **Biological** (Parasites/pathogens, Invasive/alien species)

J. **Other:** ____

Urgency: How soon could the threats or existing situation at the site lead to destruction of the target elements that brought us there to begin with? Or, given the immediacy and severity of the threats, what is the urgency of protection at the site? Fit response into one of the following categories:

A. 1-2 years
B. 3-5 years
C. 6-10 years
D. 10+ years
E. Currently stable, but situation could change
F. Fully protected over the long term

Comments on viability (restoration required? Need additional data?):
____
____

Recommendations of Conservation Strategies (BMPs, dam removal, etc.):
____
____
____
____

Who is the lead contact person for additional information about this site?

Name ________________________________ Agency/Address____________________________________
Email ______________________ Phone ____

Given threats, probability of success, urgency and everything else discussed, should this site be included in the final suite of sites?

Yes - no regrets!
Provisional - Yes, given our current level of knowledge
No – Site is too threatened, conservation is not feasible here or the conservation targets present at this site are better represented elsewhere.

Portfolio Assembly

Conservation Goals

Our minimum goal was to capture examples of aquatic ecosystems across their ecological and geographic range. Since aquatic ecosystems tend to be large, and there are generally only a few occurrences of each type within each EDU, an initial goal was to conserve one example of each type within each EDU. In addition, we tried to select aquatic ecosystems that displayed a high level of internal connectivity and connectivity to other aquatic ecosystems within the larger drainage network.

The preferred approach to design a portfolio and priority conservation sites is to choose representative sites that conserve aquatic targets in tandem with terrestrial targets. At the Aquatic portfolio assembly meeting, the terrestrial portfolio had already been determined and was available for integration with the potential aquatic portfolio examples that had been verified by the experts.

Portfolio Occurrences

The portfolio of Aquatic Ecosystem occurrences in the CBY ecoregion consists of 51 sites (i.e., local networks of contiguous aquatic communities) identified through an expert-opinion process, including 46 in nontidal freshwater systems, and 5 in tidal systems (Map 3, Table aq7 and aq8). The expert-recommended nontidal occurrences totaled almost 1900 miles, or about 13% of the total mileage of the mapped systems, with another 441 miles of tidal system 12 (but not system 4) also recommended by experts (combined total remains about 13% of all mapped systems).

During the workshops used to select high-quality aquatic ecosystems in CBY, the experts were asked to identify at least one occurrence in each system type in their state, if possible. But the size (i.e., mileage of contiguous segments included) of recommended occurrences was not defined, and the total number of recommended occurrences was not limited, within or among states. Thus, among 10 system types, the final number of expert-selected occurrences in the portfolio varied from 1 to 14 (average of 5), and the average mileage of an occurrence per system type varied from 2 (System 2) to 109 (System 10), with an overall average of 41 miles (not shown in Table aq7).

The proportion of the total mileage of each system type in the ecoregion recommended for the portfolio varied considerably, then, as a function of both the number and size of occurrences recommended, and the total system length in CBY. For the three least common system types (2, 3, and 5), a third or more of the entire system mileage of each was recommended for the portfolio, because the number and/or size of the occurrences identified as high-quality were a significant proportion of the ecoregional total (Table aq7). Similarly, a third of tidal System 12 was expert-recommended, but here multiple occurrences of greater-than-average length compensated for the fact that there are over 1300 miles of this system type in the ecoregion.

Table aq7. Mileage and proportions of aquatic system types, expert-recommended occurrences (all and Tier 1 only) by system type, and state totals, in CBY.

SYSTEM	EDUs	Total in ecoregion		All Expert-Recommended Occurrences				Tier 1 Expert-Recommended Occurrences			
		Miles[1]	%[2] of All Systems	Total Number	Miles[2]	% of System	% of ER Only[3]	Total Number	Miles	% of System	% of ER[4]
Nontidal Freshwater Systems[5]											
1	3,(4)	3323	19	5	234	7	10	3	194	6	9
2	3	6	0	1	2	33	<1	1	2	33	<1
3	3	110	1	2	51	46	2	0	0	0	0
5	(1),2,4	739	4	3	254	34	11	3	254	34	12
6	1,2	2008	12	9	412	21	18	7	381	19	18
7	1,(2)	829	5	3	135	16	6	2	114	14	5
8	1,2,(3)	1320	8	4	27	2	1	0	0	0	0
9	1,2	1720	10	14	219	13	9	7	168	10	8
10	(3),4	4962	29	5	544	11	23	5	544	11	26
CBY, All Nontidal		15018	86	46	1878	13	81	28	1657	11	79
Tidal Systems[6]											
4	1,2,3	1028	6	NA	NA	NA	NA	NA	NA	NA	NA
12	(1),2,3,4	1333	8	5	441	33	19	5	441	33	21
DC, All Systems		30	0	0[7]	0	0	0	0	0		
DE, All Systems		2662	15	14	531	20	23	13	519	19	25
MD, All Systems		6833	39	18	730	11	31	11	589	9	28
VA, All Systems		7853	45	19	1057	13	46	9	990	13	47
CBY, All Systems		17378	100	51	2319	3	100	33	2098	12	100

[1] Reach mileage for wide and/or tidal rivers (i.e., with 2 shorelines in GIS) was adjusted appropriately
[2] All mileage numbers and proportions rounded to whole numbers
[3] Across all systems (i.e., proportion of 2319 miles)
[4] Across all Tier 1 systems (i.e., proportion of 2098 miles)
[5] System 11 occurs largely outside of CBY
[6] Experts did not recommend occurrences for system type 4
[7] No expert workshop was held to select occurrences in DC

Two other systems, on the other hand, had very low percentages of their total lengths included in the portfolio. Warmwater headwaters on Maryland's western shore (System 1) had five occurrences of average size (47 miles) recommended by the experts as high-quality, but that system is the second-most common in CBY. Headwater and creek-sized streams on coarse material (System 8), which had a total length that was more or less average among CBY systems, had four occurrences recommended, but they were quite small (only 7 miles each, on average). Finally, the numbers and sizes of occurrences recommended by experts for the remaining four systems, relative to total system length, were such that between 11 and 21% of each was included in the portfolio (Table aq7).

Conceptually, the planning team could have set a goal of including at least, say, 10 or 20% of the total length of each aquatic system type in CBY in the portfolio to ensure the conservation of rare and common aquatic species and natural communities in the ecoregion. Numerous technical, theoretical and logistical constraints, however, made this approach unfeasible. Thus, among expert-recommended portfolio sites, some systems are considerably (System 8) to somewhat (Systems 1, 10) underrepresented, while several others are notably (i.e., Systems 3, 5, 12) to somewhat (System 6) overrepresented, relative to their proportional composition in the ecoregion as a whole (Table aq7).

Note that, although a larger proportion of all mapped reaches were expert-recommended as portfolio occurrences in Delaware (20%) than in Maryland (11%) or Virginia (13%), the proportional representation in the overall portfolio is higher in Maryland (31%) than in Delaware (23%), and much higher in Virginia (46%), because the mapped total mileage was much higher in the latter two states (Table aq7).

The 51 portfolio occurrences were divided into Tier 1 (33) and Tier 2 (18) sites (Map 3, Table aq8). Tier 1 are those that were identified by experts as the highest-quality occurrences in each system type, judgements that were further supported by the watershed condition analyis (above and Map 14). Tier 2 sites were also identified as good aquatic ecosystem occurrences, but there was less data and information available to support the higher ranking for this group. Although only about 65% of the total number of all expert-recommended occurrences (tidal and nontidal) were designated as Tier 1 sites, several systems (2, 5, 10, 12) had all of their occurrences ranked as Tier 1, and several others had from 77 to 92% of their occurrence mileage ranked as Tier 1. Although two systems (3 and 8) had no selected occurrences designated as Tier 1, their total mileage of expert-recommended occurrences was quite low to begin with. So across all systems (tidal & nontidal), 90% of the total mileage of expert-recommended occurrences occurred at Tier 1 sites (Table aq7). Because so much of the total mileage of all expert-recommended sites combined was ranked as Tier 1, the proportional representation of the different system types among all Tier 1 occurrences was essentially the same as the pattern among systems for all expert-recommended sites (above, and Table aq7).

In CBY, there was greater representation of some aquatic system types than others within matrix forest blocks, because blocks did not fall randomly across the ecoregion. Matrix forest blocks as a group encompass about 12% of the land area of the ecoregion, and so the overall proportional occurrence of aquatic system mileage within all blocks (12%) should and does match that figure (Table aq9). But among systems, several types were over-represented proportional to their mileage in the ecoregion, while others were underrepresented. For example, cool-water headwater streams (System 2) and cool-water creek & small river-sized streams (System 3) had more than 20% of their total mileage occur within matrix forest blocks (Table aq9). This result is perhaps not too surprising, given that these are the two rarest system types in the ecoregion; any capture by a matrix block would likely represent a large proportion of their total mileage. Similarly, more than half of the total mileage of blackwater streams (System 5) in the ecoregion fell within one or more matrix blocks. The third least common system in CBY, blackwater streams occur in the Dragon Run watershed in Virgina - almost all of which fell inside of the Dragon Run matrix forest block - and in the Pocomoke River watershed in Maryland, a large portion of which fell within the Nassawango-Dividing Creek matrix block (Map 15).

Table aq8. Expert-recommended aquatic ecosystems occurrences (Tier 1 and Tier 2) in CBY. See Map 15 for locations.

Site Map Label id	State Interview Sheet id	Site Name	Tier	Primary System	Total Milage	States	EDU	Matrix Name	Miles in Matrix	% in Matrix
1	MD_13_1	Zekiah Swamp	1	1	149	MD	3	Zekiah	70	47
2	MD_1_1	Nanjemoy Creek	1	1	27	MD	3	Nanjemoy	27	100
3	MD_1_4	Jarbonesville Run/Upper St. Mary's	1	1	18	MD	3	St. Marys	13	73
4	MD_1_3	Lyons Creek	2	1	26	MD	3			0
5	MD_1_2	Patuxent River, West Branch	2	1	14	MD	3			0
6	MD_12_1	Little Patuxent, Trib	1	2	2	MD	3	Patuxent WRC	1	91
7	MD_3_2	Patuxent River	2	3	26	MD	3			0
8	MD_3_1	Little Patuxent River	2	3	24	MD	3	Patuxent WRC	11	45
9	MD_5_1	Nassawango Creek	1	5	55	MD	2	Nassawango	44	80
10	MD_5_2	Dividing Creek	1	5	46	MD	2	Nassawango	42	92
11	VA_3	Dragon Run/Piankatank River	1	5	157	VA	4	Dragon Run	153	98
12	DEH_1	Deep Creek	1	6	77	DE	2	Redden - Ellendale	31	40
13	DE_6_2	Gravelly Branch	1	6	65	DE	2	Redden - Ellendale	49	75
14	DE_6_5	Cow Marsh Branch	1	6	4	DE	2			0
15	DE_6_4	James Branch	1	6	88	DE, (MD)	2			0
16	MD_6_5	Upper Choptank/Gravelly Branch	1	6	40	DE, (MD)	2			0
17	MD_6_4	Tuckahoe River	1	6	10	MD	2			0
18	MD_6_1	Marshy Hope Creek	1	6	60	MD, (DE)	2			0
19	MD_6_2	Wicomico River	2	6	16	MD	2			0
20	MD_6_3	Tonytank Creek	2	6	15	MD	2	Nassawango	2	15
21	DE_7_1	Chester Headwaters	1	7	91	DE, (MD)	2	Black Bird Creek / Millington	29	31
22	MD_7_1	Red Lion Branch, Chester River	1	7	25	MD	2			0
23	MD_7_2	Browns Branch, Chester River	2	7	21	MD	2			0
24	VA_19	Underhill Creek/Taylor Creek	2	8	13	VA	2			0
25	VA_10	Sandy Bottom Branch	2	8	6	VA	2			0
26	VA_14	Holt Creek	2	8	4	VA	2			0
27	VA_13	Greens Creek	2	8	4	VA	1			0
28	DE_9_1	Broadkill River	1	9	44	DE	1	Redden - Ellendale	26	59
29	DEH_5	Cow Bridge Branch	1	9	40	DE	1			0
30	DEH_3	Mudstone Branch	1	9	27	DE	1			0
31	DE_9_3	Blackbird Creek	1	9	24	DE	1	Black Bird Creek / Millington	23	96
32	DEH_2	Brown's Branch	1	9	19	DE	1			0
33	DEH_4	Johnson Branch	1	9	9	DE	1			0
34	DEH_6	Chapel Branch	1	9	5	DE	1			0
35	DE_9_2	Black Swamp Branch - Murderkill Trib.	2	9	10	DE	1			0
36	VA_18	Nassawadox Creek	2	9	12	VA	2			0
37	VA_11	Garathy Creek	2	9	8	VA	1			0
38	VA_16	Hungars Creek	2	9	7	VA	2			0
39	VA_15	The Bulf, Eastville	2	9	7	VA	2			0
40	VA_12	Ross Branch	2	9	4	VA	1			0
41	VA_17	Warehouse Creek	2	9	2	VA	2			0
42	VA_8	Fort A.P. Hill Rappahannock River tributaries	1	10	123	VA	4	A.P. Hill, Upper Rappahannock	112	91
43	VA_1	Cat Point Creek	1	10	117	VA	4	Upper Rappahannock	25	22
44	VA_2	Lower Chickahominy River tributaries	1	10	113	VA	4			0
45	VA_7	Doctor's Creek/Marracossic Creek	1	10	111	VA	4	A. P. Hill	23	21
46	VA_9	Pole Cat Creek	1	10	78	VA	4			0
47	MD_12_2	Choptank Mainstem	1	12	100	MD	2			0
48	VA_6	Mainstem Mattaponi River	1	12	110	VA	4	Dragon Run	25	23
49	VA_20	Pamunkey River	1	12	95	VA	4			0
50	VA_5	Mainstem James R. (tidal freshwater zone)	1	12	87	VA	4			0
51	DE_6_3	Nanticoke River	1	12, 6	86	MD, (DE)	2	Nanticoke	37	43

Table aq9. Aquatic ecosystems in matrix forest blocks, expert-recommended occurrences, and expert-recommended occurrences within matrix blocks in CBY.

		In Matrix Blocks		Expert-Recommended		Expert-Recommended in Matrix Blocks		
System[1]	Total in CBY	Miles[2]	% of Total[2]	Miles	% of Total[3]	Miles	% of ER Total[3]	% of Matrix Total[3]
1	3323	326	10	234	7	110	47	34
2	6	2	33	2	27	2	100	100
3	110	27	25	51	46	11	22	41
4	1028	165	16	NA	NA	NA	NA	NA
5	739	391	53	254	34	238	94	61
6	2008	189	9	412	23	91	22	48
7	829	61	7	135	17	29	21	48
8	1320	24	2	27	2	0	0	0
9	1720	88	5	219	13	49	22	56
10	4962	599	12	544	11	161	30	27
12	1333	145	11	441	33	56	13	39
Total	17378	2017	12	2319	14	747	32	37[4]

[1]Experts did not recommend sites for System 4 and System 11 occurs largely outside of CBY.
[2]All mileage numbers and proportions rounded to whole numbers.
[3]Within the system
[4]System 4 mileage excluded from matrix total

Several system types, on the other hand, were notably underrepresented within matrix blocks. Systems 7, 8 and 9 each had less than 10% of their total mileage represented within a matrix forest block (Table aq9). These systems, though, are the most common types in the central and north-central Delmarva Peninsula (in both MD and DE), a landscape dominated by agriculture and small-town development, and lacking the large forested tracts necessary for matrix forest blocks (Map 15).

Note that Systems 10, 1, and 6, which had the greatest total mileage occurring within matrix forest blocks (ignoring System 5), were the three most common types in CBY (Table aq9). The total mileage of these systems that fell within matrix forest blocks, though, was proportional, more or less, to their overall occurrence in the ecoregion. This result was also true for tidal system 12 (Table aq9).

There was also a strong relationship between expert-recommended occurrences and matrix forest blocks. As discussed above, experts selected about 13% of the total mileage of aquatic systems (tidal and nontidal) in CBY on average, with as little as 2% of some systems and as much as 46% of other systems recommended as highest-quality occurrences (above, and Table aq9). But almost one-third of all expert-recommended reaches occurred within a matrix forest block, and several systems (1, 2, and 5) had significant proportions of their expert-recommended occurrences fall within a block (Table aq9). Similarly, although experts recommended only 13% and 11%, respectively, of Systems 9 and 10 for inclusion in the portfolio, 22% and 30% of those system miles, respectively, fell within a matrix forest block (Table aq9).

On the other hand, cool-water creek & small river streams with headwaters in the Piedmont (System 3) and tidal rivers (System 12), were well-represented proportionally among all expert-recommended occurrences, but fell less commonly within matrix forest blocks than the overall average, as would be expected. Two other types, historically blackwater streams (System 6) and moderately stable headwater streams on the Delmarva Peninsula (System 7), occurred in matrix blocks roughly in proportion to their representation among all expert-recommended sites. Only a single system type, headwater and creek-sized streams on coarse material (System 8), had no expert-recommended mileage that fell within a block. As noted above, this system characterizes a landscape that lacks large tracts of intact forest.

Finally, about a third of expert-recommended occurrences ecoregion-wide fell within matrix forest blocks, and 37% of all stream reaches within matrix blocks were expert-recommended (Table aq9). While these similar results might seem to be expected intuitively, the latter statistic is the complex result of: 1) systems that are over-represented (compared to the average) in matrix forest blocks, and which had a large proportion of their total mileage in blocks recommended by experts (i.e., Systems 2, 5); 2) systems under-represented in matrix blocks, but where they did occur, they were recommended by experts (i.e., Systems 7 and 9); 3) systems that were represented in matrix blocks more or less proportionally to their abundance in the ecoregion, but segments of which were recommended by experts within matrix blocks at a higher frequency than outside of matrix blocks (e.g., systems 1, 10, and 12). Put more simply, the sizes of expert-recommended occurrences relative to the total mileage of streams falling within matrix blocks, combined with a strong tendency for recommending occurrences within blocks, means that the abundance of portfolio occurrences within matrix forest blocks (37%) is almost three times higher than the overall abundance (13%) of expert-recommended sites in the ecoregion (Table aq9).

Information Gaps and Strategies for Improvement

Identifying the suite of priority aquatic conservation sites that will represent an ecoregion's aquatic biodiversity requires a comprehensive picture of aquatic ecosystem and biological diversity. However, many ecoregions, including CBY, have limited or currently unavailable spatially-referenced information about the distribution of aquatic species, and generally lack data on natural aquatic assemblages. The use of GIS based macrohabitats, aquatic ecosystems, and expert review to build portfolios will provide conservation planners with significant information regarding patterns of community-level diversity in aquatic ecosystems. But sites based on physically-defined targets should be considered provisional until the biological significance can be verified. The level of confidence in a portfolio developed using the macrohabitat and/or system approach can be improved by consulting with regional and local experts to further determine biological content and significance, conducting field investigation to verify high quality macrohabitat and/or community occurrences, and carrying out biological inventory and analysis to build the biological community classification.

PLANNING METHODS FOR ECOREGIONAL TARGETS: MATRIX-FORMING ECOSYSTEMS*

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

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

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

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

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

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

[1] The concept of coarse filter is discussed in the chapter on Terrestrial Ecosystems and Communities.
[2] Patch-forming ecosystems are discussed in the chapter on Terrestrial Ecosystems and Communities.

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

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

Assessing viability criteria for matrix-forming forest ecosystems

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

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

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

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

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

Size

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

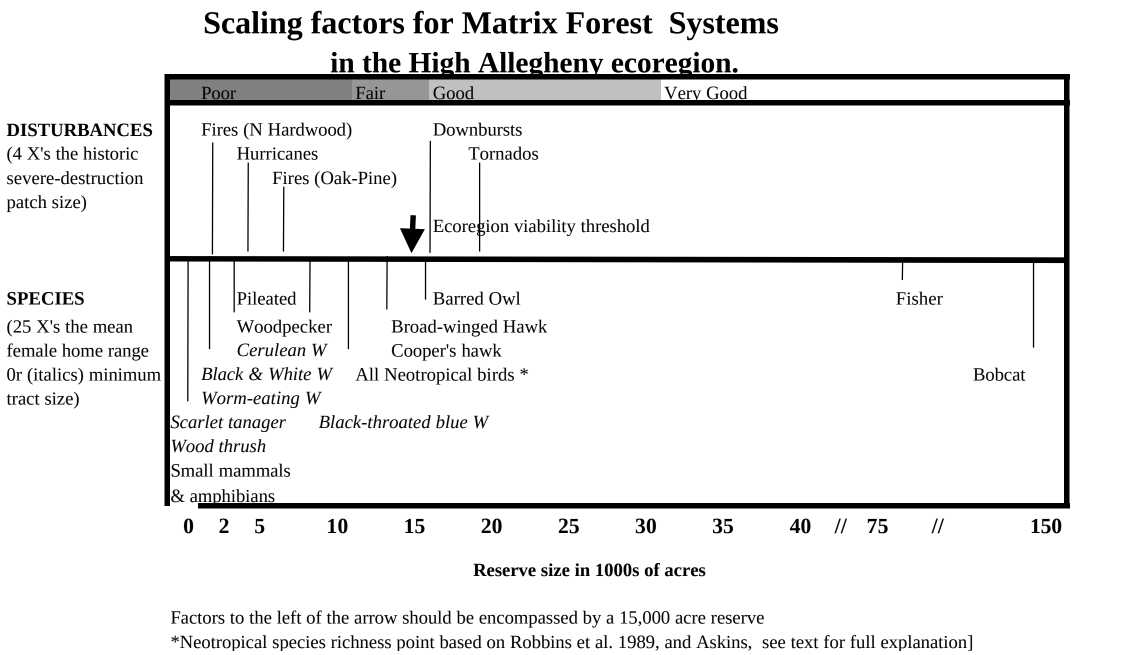

Figure MAT1. Scaling factors for matrix forest systems in the High Allegheny Ecoregion. Note: Fisher and bobcat are included in the figure for context; they were not considered to be interior-forest-requiring species.

Current condition

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Landscape context

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

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

Viability factors summarized

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

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

Locating examples of matrix-forming forests

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

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

Matrix blocks

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

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

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

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

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

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

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

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

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

Collecting expert information on the matrix blocks

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

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

[36] Forman and Alexander 1998.

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

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

Representing forest blocks across all landscape types

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

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

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

[37] Incomplete as of July 2003.

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

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

Table MAT4. Ecological Land Unit variables

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

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

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

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

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

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

Prioritizing and selecting matrix forest areas for the portfolio

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

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

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

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

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

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

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

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

Numeric goals and total acreage

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

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

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

Assumptions and future needs

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

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

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

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

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

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

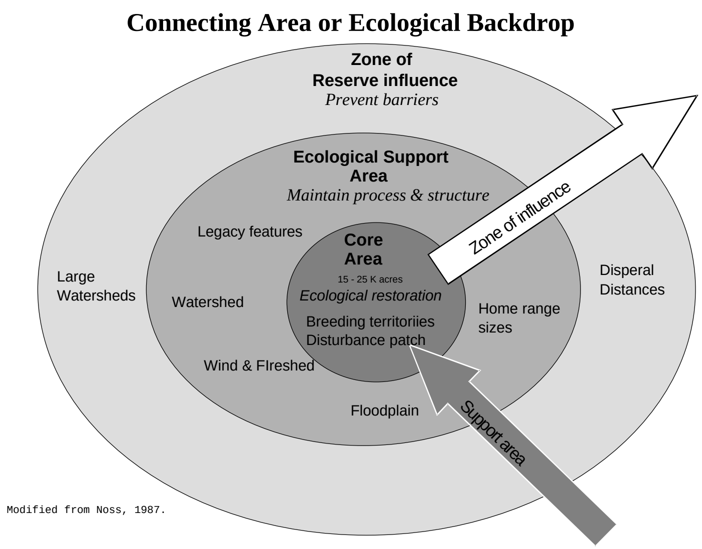

Figure MAT3. Model of protection zones, based on Noss (1987).

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

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

MATRIX SITE: 26

NAME: Merry Meeting Lakes

STATE/S: NH

RANK: Y

SUBSECTION: 221Al Sebago-Ossipee Hills and Plains

COMMENTS:

collected during potential matrix site meetings, Summer 1999

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

Sample Block Report

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

SIZE:

Total acreage of the matrix site: **49,738**

Core acreage of the matrix site: **39,015**

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

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

INTERNAL LAND BLOCKS OVER 5k: 42 %

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

Internal Land Block Size Distribution:

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

MANAGED AREAS: 7 %

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

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

15 Largest managed area parcels within site

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

LANDCOVER SUMMARY:

Natural Cover: 96 %

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

Non-Natural Cover: 4 %

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

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

ROADS, ETC.:

Miles / 1k acres: **2**

Internal Transportation Linework

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

Boundary Linework

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

RESULTS FOR MATRIX-FORMING ECOSYSTEMS*

Modifications to Standard Method

Disturbance Scaling in CBY

The disturbance scaling approach proved more challenging in the Chesapeake Bay Lowlands ecoregion than elsewhere, because studies examining climatic and other large-scale catastrophic disturbances to native vegetation in CBY are almost totally lacking. What little information exists suggests that *large-scale disturbances in the coastal plain of the Mid-Atlantic are extremely rare*.

Hurricanes

Remarkably, Delaware, Maryland and Virginia are less likely to be struck by hurricanes than almost all other states along the East Coast, from Massachusetts to Florida, in spite of having a considerable amount of land area in the Coastal Plain. Between 1898 and 1992, only a single storm of hurricane strength (> 74 mph) passed through Maryland, Hurricane Hazel (Category 2) in 1954 (Neumann et al. 1993). In that same hundred-year period, no hurricanes struck Delaware, and only four hurricanes (two unnamed storms, Category 2 in 1933, and Cat. 3 in 1944, Connie, Cat. 1 in 1955, and Charley, Cat. 1 in 1986) took paths that crossed into Virginia (Neumann et al. 1993). New York and Connecticut are actually more likely to be struck by hurricane-strength storms than are Delaware and Maryland; from 1898 to 1992, 9 hurricanes hit New York and 8 struck Connecticut. For states south of Virginia, of course, hurricanes are common; from 1898 to 1992, North Carolina was hit by 24 hurricanes, and South Carolina by 15 (Neumann et al. 1993). The reason for this pattern was not investigated for this document, but would appear to reflect a complex meteorological interaction between hemispheric circulation patterns, oceanic currents, prevailing winds and the geometry of the U.S. coastline.

Considerable information is available describing the impact of hurricanes on coastal plain forests in the southeastern U.S., with many studies evaluating the impact of Hurricane Hugo (Category 4) on coastal forests in South Carolina in 1989 (USDA 1997). Incredibly, an area of 4.5 million acres was significantly impacted by this storm, with damage to many trees in a large portion of this area, including parts of Congaree National Forest. Many of the forest areas affected, however, were dominated by even-aged stands of relatively young (< 40 years old) loblolly pines on lands used primarily for timber/pulpwood harvest. Because large stands of even-aged loblolly pine plantations also characterize extensive areas of CBY, a large hurricane striking the region might be expected to cause damage similar to that seen from Hurricane Hugo. At the same time, this pattern of damage is unlikely to resemble what would have been typical for undisturbed, mature upland (i.e., long-leaf pine dominated) and lowland (mixed hardwoods) forests on the southern coastal plain in pre-colonial periods. So this event provides little, if any, guidance for assessing either historical patterns of hurricane damage to Mid-Atlantic coastal plain forests, or patterns likely to characterize contemporary hurricane damage to natural forest stands in the region.

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* Anderson, M.G. and S.L. Bernstein (editors). 2003. Results for matrix-forming ecosystems. Based on Samson, D.A. 2002. Chesapeake Bay Lowlands Ecoregional Plan; First Iteration. The Nature Conservancy, Conservation Science Support, Northeast & Caribbean Division, Boston, MA.

Tornadoes

Tornadoes are uncommon but not rare in the Chesapeake Bay Lowlands ecoregion. Between 1950 and 1995 there were 55 recorded in Delaware, 103 in Maryland (CBY counties only) and 59 in Virginia (CBY counties only) (Tornado Project 2002), or an average of almost five per year for the ecoregion. Of those 217 tornadoes, 28% (60) were categorized as F0 (Weak; winds 40-72 mph), 56% (121) as F1 (Moderate; winds 73-112 mph), and 15% (32) as F2 (Strong; winds 113-157 mph). Only 4 tornadoes recorded from 1950 to 1995 were categorized as F3 (Severe; winds 158-206 mph), and no storms in any of the three states during that time period have ever reached the two highest categories on the Fujita scale, F4 (Devastating; winds 207-260 mph) and F5 (Incredible; winds 261-318 mph).

Ranked by total number of tornadoes between 1950 and 1994, Virginia placed 29th, Maryland 34th, and Delaware 44th among all states in the U.S. (NOAA website, 2002). Standardizing the ranks by taking size differences among states into account, however, Delaware ranked an amazing 6th among all states (ranks of Maryland and Virginia not available; NOAA website, 2002).

Data on path widths and lengths for tornadoes that have occurred in the service area of the Baltimore/Washington National Weather Service Forecast Office are available on-line (NOAA website, 2002). For 50 tornadoes recorded between 1926 and 1996 in four counties on Maryland's western shore, the average length was 1.9 miles, and average width was 85 yards (lengths ranged from 0.1 to 17.8 miles, and widths from 15 to 500 yards, and there was no obvious correlation between F-scale and length or width). The "severe" impact area from an average tornado in this area, then, would be only about 59 acres (and in a long, narrow line), with the degree of impact depending on the specific intensity (F-scale) of the event. (*Note: The discussion and calculations here should be viewed as a "back-of the-envelope" exercise, rather than a scientifically rigorous analysis. There are a number of qualifications related to the analysis of this data that will not be discussed further here*).

There are no published articles available describing tornado damage to large forested tracts in CBY, or even to natural areas more generally in the ecoregion (versus extensive records of damage to homes, businesses, utility lines, developed areas, etc.). Tornado damage effects to forests have been described at other sites around the U.S. Above threshold wind speeds, areas of complete blowdown can occur, but at lower storm intensities, the nature and scope of the damage varies among species, tree ages/sizes, and community types (e.g., upland versus floodplain) as a function of wind speed and direction, storm velocity, and other factors. Forest recovery from tornado damage, however, may more typically resemble gap vegetation dynamics, given the linear geometry and limited scale of the typical disturbance. At the same time, some tornadoes are spawned by hurricanes and accompanied by flooding rains, and others produce hailstorms, so additional disturbance impacts to natural areas may be associated with certain storm events.

Taking all of this frequency, intensity, and impact-area-size information into account, it appears that tornadoes are likely to be only a minor disturbance event affecting forests in CBY, both currently and in pre-colonial times.

Downbursts, Floods, Ice Storms, Insect/Disease Outbreaks

Studies describing the scale and frequency of downbursts, floods, ice storms and insect outbreaks in the Mid-Atlantic coastal plain, or the ecological effects of such disturbances on native forests in the region, are lacking. Speculating in the absence of data, floods in the Chesapeake Bay Lowlands would be unlikely to function as major disturbance events for matrix forest communities; impacts would be confined to floodplains (where vegetation is adapted to flooding) or adjacent edges in higher elevations of the ecoregion (i.e., western shore of MD), while on the Delmarva Peninsula high infiltration rates and low, flat topography would minimize the destructive force of floodwater flows. Even the excessive regional flooding that resulted from Tropical Storm Agnes in 1972, caused little measurable destruction of forested communities in the ecoregion.

Ice storms are not infrequent in the Mid-Atlantic, but most of the evaluation of the impacts of these events focuses on damage to private property, utility lines, and commercial development, rather than natural areas. Again, speculating in the absence of scientific research, the argument could be made that pre-colonial forests in the region were unlikely to have been significantly affected by ice storms; most of the damage from these events is caused by excess weight that develops on horizontal or angled tree limbs, a growth form that is typically lacking in trees growing in dense forest stands.

Individual tree species and entire forest stands have certainly been devastated by insect and disease outbreaks – e.g., chestnut blight, gypsy moths, southern pine bark beetle - in the CBY region in the past. But most of these well-known known cases are the result of the introduction of exotic pests by humans, or have largely impacted “artificial” forest stands (i.e., pine plantations established for tree farming). The pre-European impact of native insects and disease organisms on coastal plain forest stands is unknown, and probably unknowable.

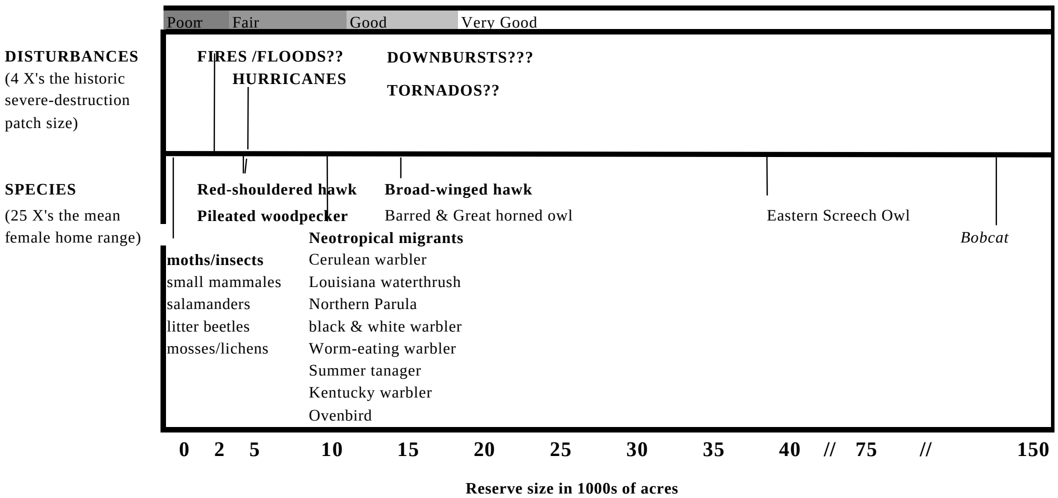
Fires

The fire history of the Mid-Atlantic region has received far less scientific attention than other areas of the U.S., presumably because in a landscape characterized by moist temperate climate and extensive cover of mesic deciduous forests, fire is unlikely to have been a major disturbance factor in structuring vegetation patterns. Currently, we are not aware of a single article or publication that attempts to reconstruct the natural fire history of forests in the Mid-Atlantic coastal plain region prior to European colonization. Authors who have written about fire use by Native Americans inhabiting the ecoregion generally describe fire as being used only locally and at low-intensity to clear forest understory for settlements and garden areas (e.g., Rountree and Davidson 1999). While wildfires undoubtedly occurred in CBY forests prior to 1500, except for periods of extended drought, the scale and frequency of canopy-level, catastrophic wildfires was likely to have been low.

Scaling Criteria in CBY

Using Figure 3, we set our minimum size criteria for matrix forest occurrences in CBY at 10,000 acres. At this point in time, 10,000 acres is a *minimum* threshold; that is, it is not necessarily large enough for the reserve to fully function as a coarse filter for common species in the ecoregion over time. The actual size needed for each reserve to remain functional depends on what happens to the entire landscape of the ecoregion over the next two centuries. Ten thousand acres *is* intended to define a reserve size below which matrix forest conservation will likely not succeed, or will become increasingly expensive and labor intensive to maintain.

Figure 3. Scaling factors and minimum reserve size for matrix forest occurrences in the Chesapeake Bay Lowlands ecoregion.



Locating, Selecting, and Prioritizing Matrix Forest Areas in CBY

The ELU analysis and block-group selection process proceeded somewhat differently in CBY, for several reasons. First, given the low elevation and the lack of relief in the coastal plain, the total number of ELU types in CBY was significantly less, and the geographic extent of each type was far greater, than in other ecoregions in the eastern U.S. (Map 2 and Map 13). Six ELU groupings were identified by the cluster analysis, which combined with the small number (20) of draft matrix blocks mapped for the ecoregion, meant that only 2-4 blocks per ELU group were present in CBY. This result, together with the spatial arrangement of the blocks in the ecoregion, vis a vis the number per group and number per state, was such that selecting a subset of only the highest rated blocks per group was deemed to be unnecessary. At the second meetings held state-by-state, the ELU block groupings were confirmed as reasonable, the condition, characteristics and boundaries of the blocks were reviewed, and 10 Year Action blocks were chosen by each state. All 20 blocks are considered to be in the CBY portfolio.

Numerical Goals for Matrix Forest Examples in CBY

Numerical goals, per se, were not set for matrix forest occurrences in CBY, except to include at least one example of each ELU-group, as noted above. Given the geologic and topographic homogeneity of the CBY ecoregion, and the fact that several of Bailey's sectional boundaries extend beyond the ecoregion (due to the Conservancy's subdivision of Bailey's original, much larger Coastal Plain ecoregion), no attempt was made to stratify matrix forest occurrences across sections in the ecoregion.

Results: Locations and Characteristics of Matrix Forest Blocks

Twenty matrix forest blocks totaling almost 1 million acres were included in the Chesapeake Bay Lowlands ecoregional portfolio (Map 2, Table m1). Four blocks occur in Delaware, with three of those overlapping into Maryland. Thirteen blocks fall entirely in Maryland, five on the Eastern

Shore and eight on the western side of the Chesapeake Bay. Three matrix forest blocks occur in Virginia, two of which share a portion of a common boundary formed by a large highway (Map 2).

The CBY matrix forest blocks range considerably in size, from just over 10,000 acres (Calvert Cliffs and McIntosh in southern Maryland) to as much as 225,000 acres (Dragon Run in Virginia; Table m1). The Virginia blocks, except for Nassawango on Maryland’s Lower Eastern Shore, are the largest in the ecoregion. The average size of the matrix blocks in CBY is just over 48,000 acres, or almost five times the minimum size for a single viable matrix forest occurrence (above).

As expected, forest cover is quite high (average of 71%) for the majority of the blocks, and more than half the blocks exceed 80% total natural vegetative cover (Table m1). The three blocks with forest cover values below 50% (Aberdeen, Upper Rappahannock, Lower Pocomoke) have more than 20% of the area within the block in emergent marsh and/or open water, so the total natural cover values remain above 70% for two of the three. Although several blocks approach 90% total natural cover, only A.P. Hill exceeds that value.

The proportion of the land area in agriculture within CBY matrix forest blocks averages 18.5%, considerably less than the value (33%) for the ecoregion as a whole (Introduction, above). However, agricultural land use is 25% or higher for four blocks, and two of those (Blackbird-Millington and Upper Rappahannock) have more than a third of their total acreage in agricultural use (Table m1). Developed land cover is less than 1% for almost half the blocks, but it is 4% or higher for four blocks. However, only Aberdeen has a developed land cover value that exceeds the overall average (7.7%) for the ecoregion. Among blocks, there is no discernable correlation (positive or negative) between developed land cover and forest cover, agricultural land, or total natural cover.

Road density values vary less than developed land cover, and here, too, variation among blocks follows no apparent pattern. For example, the two highest values (7.7 mi. per 1000 acres) occur in a block with high agricultural land cover (Redden-Ellendale) and a block with very low agricultural land cover but high forest cover (A.P. Hill), while the next two highest values occur in blocks with average forest cover and agricultural land cover (Calvert Cliffs and Nassawango; Table m1). At the same time, the five blocks with the lowest road densities (about a mile of roads per 1000 acres) vary quite a bit in their forest cover, and/or agricultural land cover, and/or developed land cover. Stream density shows relatively little variation among blocks, suggesting that surface water drainages are more or less homogeneously distributed across the landscape in the ecoregion.

Managed Area Lands in Matrix Forest Blocks

The amounts, proportions and types of managed area lands in the CBY matrix forest blocks varies considerably among sites (compare Maps 2 and 9, Table m1). Two blocks, Aberdeen (MD) and A.P. Hill (VA) consist almost entirely of military lands owned by the Defense Department and used for training by the Army. Federal land also makes up over 70% of the area of the Patuxent WRC block, but here it is a wildlife research center owned and managed by the U.S Fish & Wildlife Service (Dept. of the Interior). On the other hand, the only other block with more than half of its land in managed area is the Great Cypress Swamp block (in DE and MD), where a private conservation organization (Delaware Wildlands) owns about 12,000 acres. Most of the managed area land within the other 16 matrix forest blocks in the CBY ecoregion consists of state forests, parks, and wildlife management areas in the three states. The only major exception would be the Blackwater and Transchic blocks in Maryland, which include several thousand acres of federal national wildlife refuge lands (Blackwater NWR).

At the other end of the scale, four blocks—including one of the smallest (McIntosh in southern Maryland) and the largest in the ecoregion (Dragon Run in Virginia)—have little or no managed area (Table m1). Three other blocks have less than 10% of their total acreage in managed area, while six have between 10 and 20% in managed area. Ignoring the Great Cypress Swamp and the three blocks dominated by federal lands, only two blocks—Redden-Ellendale and Elk Neck—have more than 20% of their acreage in managed area. The former block, however, has the third highest percentage of agricultural land cover in the ecoregion (Table m1).

The Nature Conservancy owns land within only five matrix forest blocks in CBY, and the overall percentage of Conservancy-owned matrix forest land is extremely low. Even the 3,700 acres of Conservancy land within the Nassawango Creek block (MD), accounts for barely 3% of the land area of that block. The proportional representation of Conservancy lands in matrix forest blocks in CBY is probably between 0.5 and 1.0% (i.e., 4,800-9,600 acres) or about the same as the Conservancy's proportional ownership of land for the ecoregion as a whole (see Portfolio Overview).

Table m1. Characteristics of the twenty portfolio matrix forest blocks in CBY (10 Year Action sites in bold).

Name (State)	Size (ac)	%MA[1]	%For[2]	%Wetld[3]	%Ag[4]	%Devel[5]	TotNat[6]	Streams[7]	Roads[8]
Aberdeen (MD)	26,202	95.5	49.6	24.9	13.7	11.6	74.7	2.4	1.9
Blackbird-Millington (DE/MD)	52,280	11.2	52.4	1.8	44.3	0.8	54.9	1.0	2.8
Patuxent WRC (MD)	15,041	71.6	82.8	1.9	10.1	4.8	85.1	3.9	1.9
Redden-Ellendale (DE)	46,206	23.9	69.1	1.0	28.1	1.5	70.4	2.6	7.7
Nanticoke (MD/DE)	47,041	13.8	67.2	9.6	18.4	0.4	81.2	2.5	3.3
Mattawoman (MD)	15,485	19.6	85.3	0.7	10.1	4.0	86.0	3.3	1.2
Calvert Cliffs (MD)	10,461	5.7	76.9	2.8	14.0	6.2	79.8	2.1	5.7
Nanjemoy (MD)	44,983	8.1	82.4	3.9	9.9	2.2	88.0	2.0	4.1
Zekiah (MD)	21,554	0.5	71.7	0.4	25.0	2.9	72.1	3.2	1.3
Transchic (MD)	39,329	10.8	64.6	20.2	15.1	0.1	84.8	1.3	1.2
Great Cypress Swamp (DE/MD)	19,434	63.5	79.5	1.3	18.4	0.6	81.0	0.9	2.6
Blackwater (MD)	48,131	15.6	75.1	13.0	11.0	0.9	88.1	1.3	2.1
McIntosh (MD)	10,480	0	81.1	0.5	17.3	1.1	81.6	2.3	0.9
Nassawango (MD)	122,326	6.3	75.0	1.6	19.9	0.4	79.7	1.3	5.8
St. Mary's (MD)	17,699	12.0	79.3	1.9	16.4	2.4	81.3	2.3	1.2
A.P. Hill (VA)	76,678	94.2	88.6	2.1	4.6	0.7	94.7	2.3	7.7
Upper Rappahannock (VA)	85,028	0.5	42.2	20.7	34.8	2.1	63.1	2.3	1.8
Lower Pocomoke (MD/VA)	20,924	13.1	49.4	25.9	23.9	0.6	75.4	1.0	3.6
Dragon Run (VA)	225,169	0	76.5	4.7	17.3	0.7	82.1	2.6	3.0
Elk Neck (MD)	21,568	26.7	76.4	3.4	17.7	2.5	79.9	1.7	2.9
CBY Average	48,301	24.6	71.3	7.1	18.5	2.3	79.2	2.1	3.1

[1]Managed Area
[2]Forest cover, including forested wetlands
[3]Emergent herbaceous + open water cover
[4]Agricultural land cover (all types)
[5]Residential, commercial, industrial development
[6]Total natural cover = sum of all forest types, wetland types, open water, transitional barrens, bare rock/sand
[7]Miles of streams per 1,000 ac
[8]Miles of roads (primary, secondary, major, minor) per 1,000 ac

Potential Forest Communities

An analysis of the Ecological Land Unit (ELU) composition of the 20 matrix blocks suggested that the blocks could be partitioned into the following ecologically consistent groups (Map 2 and Appendix m2).

First the blocks were divided into A) those that exhibited sideslopes, coves, low hills and extensive dry flats, and B) those that lacked those features but contained peatlands, tidal marshes and estuarine features

Within Group A, the Virginia blocks (group A1): A.P Hill, Dragon Run, Upper Rappahannock plus the Nanjemoy block across the Potomac, were largely flat landscapes characterized by silts, clays or fine floodplain soils, and few freshwater wet lands. Elk Neck Run block was later added to this group, based on its high proportion of wetlands and other similar features on silt/clay sediments.

The other blocks on Maryland's Western Shore (Group A2 – Mattawoman, Zekiah, Pautuxent)) also were characterized by upland forests, with large proportions of flats, toeslopes and slower sideslopes on alluvial coarse soils as well as similar moderate terrain features on clays and silts.

More distinct were the strongly upland (90-92%) Maryland blocks with many moderate relief features on loamy soils (group A3 – St. Marys, Calvert Cliffs, MacIntosh). Last, two Delaware blocks (Group A-4 – Redden and Blackbird Creek) were on loamy soil settings and comprised entirely of flats and freshwater wetlands.

Among the more estuarine blocks, the three blocks on the Delmarva Peninsula, (Group B1 – Blackwater, Transchic, and Lower Pocomoke) - were characterized by large proportions of tidal wetland systems, extremely flat terrain, and organic or coarse estuarine soils. The Aberdeen block, near the head of the Bay on Maryland's Western Shore, was grouped with this set of blocks but was somewhat anomalous in its composition. It was composed of low relief and considerable tidal wetlands (though much fresher than the southern, Eastern Shore blocks) .

Also on the Peninsula, the Nanticoke, Nassawango and Great Cypress Swamp blocks (Group B2) grouped together, with generally flat terrain, extensive peatlands and forested wetlands with the Nassawango block being further distinct in having 45% of its extent on eolian sands. The Kiptopeke block was similarly distinct in having a large proportion of features on Marine loams. It was later rejected as a matrix forest block and is not shown on any maps.

10-Year Action Sites

Thirteen of the 20 blocks in the portfolio have been selected as 10-year Action Sites by the Conservancy, including all of the blocks in both Delaware and Virginia, and seven of the fourteen blocks in Maryland (Map 2, Table m1). In Virginia, the Dragon Run block overlaps geographically with the Chesapeake Rivers Project Area, a landscape-scale, community-based conservation initiative led by the Virginia Chapter. At the A.P. Hill and Upper Rappahannock blocks, the Conservancy is assisting public and private partners who are actively pursuing conservation initiatives at those sites.

In Maryland and Delaware, four blocks (Blackwater, Transchic, Nanticoke, and Redden-Ellendale) fall within the Nanticoke River Project Area, formerly a Conservancy bioreserve and now a cross-border, landscape-scale, community-based conservation initiative. Still within Maryland, the Calvert Cliffs and Zekiah blocks represent priority areas for conservation by the Department of Natural Resources, with the Conservancy as a major partner at the former but not the latter site. The last two 10-Year Action blocks in Maryland, Nanjemoy and Nassawango, capture two watersheds that have been major focus areas for conservation by the Chapter since its inception in 1977. In Delaware, the Conservancy is partnering with the Department of Forestry in the Blackbird-Millington block and with Delaware Wildlands at the Great Cypress Swamp block.

CHESAPEAKE BAY MATRIX BLOCK ASSESSMENT			01/21/01																			
		Matrix-landscape group	**A4**		**A3**			**A2**			**A1**				**B2**				**B1**			
UP/Wet	Surficial / total	Topography	Redden - Ellendale	Black Bird Creek / Mil	St. Marys	Calvert Cliffs	MacIntosh	Patuxent WRC	Zekiah	Mattawoman	A. P. Hill	Dragon Run	Nanjemoy	Upper Rappahannock	Kiptopeke*	Nanticoke	Great Cypress Swamp	Nassawango	Transchic	Blackwater	Lower Pocomoke	Aberdeen
UPLAND TOPOGRAPHY SUMMARY																						
Upland	Totals	Flat summit/ridge Total	-	-	-	0	-	-	-	-	0	0	-	0	-	-	-	-	-	-	-	-
Upland	Totals	Steep slope Total	-	-	-	0	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-
Upland	Totals	low hill Total	-	0	0	2	1	1	1	1	2	1	1	1	0	0	-	0	-	-	-	0
Upland	Totals	low rounded summit Total	-	0	0	9	4	3	4	3	5	2	2	3	0	0	-	0	-	-	-	-
Upland	Totals	lower sideslope Total	-	0	1	21	7	4	9	8	11	3	3	5	0	0	-	0	-	-	0	-
Upland	Totals	upper sideslope Total	-	0	0	9	2	1	2	1	2	1	1	2	0	-	-	0	-	-	-	-
Upland	Totals	valley flat Total	-	0	0	2	1	1	1	1	1	1	0	0	0	0	-	0	-	-	-	-
Upland	Totals	Cove, draw Total	-	0	0	8	1	0	1	1	2	1	0	1	0	-	-	-	-	-	-	-
Upland	Totals	drawbottom Total	-	0	0	8	3	2	3	3	4	2	1	2	0	0	-	0	-	-	0	0
Upland	Totals	toeslope/swale Total	0	3	24	23	37	35	23	28	41	26	29	22	5	2	0	1	0	-	0	1
Upland	Totals	Flat Total	77	78	66	9	34	30	30	34	26	51	51	36	74	56	13	75	37	25	33	53
		UPLAND TOTAL	**77**	**82**	**91**	**92**	**90**	**76**	**74**	**80**	**93**	**87**	**89**	**72**	**79**	**58**	**13**	**76**	**37**	**25**	**33**	**54**
WETLAND TOPOGRAPHY SUMMARY																						
Wetland	Totals	stream Total	3	2	3	2	4	2	3	4	3	3	2	2	1	2	1	1	0	1	1	1
Wetland	Totals	fresh wetland Total	20	16	5	4	7	22	24	16	4	7	6	8	3	24	68	21	37	45	30	11
Wetland	Totals	lake/pond Total	0	0	1	-	-	0	-	0	0	0	-	0	1	0	-	0	1	1	0	0
Wetland	Totals	saline wetland Total	-	0	-	2	-	-	0	-	-	1	3	3	4	2	-	-	21	27	19	14
Wetland	Totals	estuary/river Total	-	-	-	-	-	-	-	-	-	1	0	15	12	4	-	1	0	2	4	6
Wetland	Totals	water Total	-	-	-	-	-	-	-	-	-	0	-	0	0	0	-	-	0	-	0	46
Wetland	Totals	peatland Total	-	-	-	-	-	-	-	-	-	-	-	-	-	9	18	1	4	-	13	-
		WETLAND TOTAL	**23**	**18**	**9**	**8**	**10**	**24**	**26**	**20**	**7**	**13**	**11**	**28**	**21**	**41**	**87**	**24**	**63**	**75**	**67**	**79**
SURFICIAL GEOLOGY SUMMARY																						
	Alluvial coarse Total		11	0	1	0	5	18	19	22	0	8	0	0	0	31	0	7	0	0	0	0
	Loam Total		66	82	70	58	57	7	25	27	0	0	23	0	12	19	1	0	0	0	0	0
	Silt/clay Total		0	0	20	34	28	51	30	29	92	55	0	30	0	0	0	0	0	0	0	0
	Estuarine fine Total		0	0	0	0	0	0	0	1	1	24	63	39	0	0	0	0	0	0	0	0
	Marine Loam Total		0	0	0	0	0	0	0	0	0	0	0	0	54	1	11	18	0	0	0	0
	Eolian sand Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	46	0	0	0	0
	Estuarine coarse Total		0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	5	29	15	28	0
	Peat/Saline/Marsh Total		0	0	0	0	0	0	0	1	0	1	3	2	13	0	0	0	8	9	5	54
		SURFICIAL TOTAL	**77**	**82**	**91**	**92**	**90**	**76**	**74**	**80**	**93**	**87**	**89**	**72**	**79**	**58**	**13**	**76**	**37**	**25**	**33**	**54**
ELU DETAILS -UPLANDS																						

Table m2. Chesapeake Bay Lowlands Matrix Block Assessment

CHESAPEAKE BAY MATRIX BLOCK ASSESSMENT		01/21/01																				
		Matrix-landscape group	**A4**		**A3**			**A2**			**A1**				**B2**				**B1**			
UP/Wet	Surficial / total	Topography	Redden - Ellendale	Black Bird Creek / Mil	St. Marys	Calvert Cliffs	MacIntosh	Patuxent WRC	Zekiah	Mattawoman	A. P. Hill	Dragon Run	Nanjemoy	Upper Rappahannock	Kiptopeke*	Nanticoke	Great Cypress Swamp	Nassawango	Transchic	Blackwater	Lower Pocomoke	Aberdeen
Upland	Alluvial coarse	Steep slope	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Alluvial coarse	Flat summit/ridge	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Alluvial coarse	low hill	-	-	-	-	0	0	0	0	-	0	-	-	-	0	-	0	-	-	-	-
Upland	Alluvial coarse	low rounded summit	-	-	0	-	0	1	1	1	-	0	-	-	-	0	-	0	-	-	-	-
Upland	Alluvial coarse	upper sideslope	-	-	0	-	0	0	0	0	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Alluvial coarse	Flat	11	-	1	-	1	10	10	11	-	4	-	-	-	30	-	7	-	-	-	-
Upland	Alluvial coarse	toeslope/swale	0	-	0	-	2	6	4	7	-	2	-	-	-	1	-	0	-	-	-	-
Upland	Alluvial coarse	lower sideslope	-	-	0	-	1	1	2	2	-	0	-	-	-	0	-	-	-	-	-	-
Upland	Alluvial coarse	valley flat	-	-	-	-	0	0	0	0	-	0	-	-	-	-	-	0	-	-	-	-
Upland	Alluvial coarse	drawbottom	-	-	0	-	0	0	1	0	-	0	-	-	-	0	-	0	-	-	-	-
Upland	Alluvial coarse	Cove, draw	-	-	-	-	0	0	0	0	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Loam	Flat summit/ridge	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upland	Loam	low hill	-	0	0	2	1	0	0	0	-	-	0	-	-	-	-	-	-	-	-	-
Upland	Loam	low rounded summit	-	0	0	5	2	0	1	0	-	-	0	-	0	0	-	-	-	-	-	-
Upland	Loam	upper sideslope	-	0	0	4	1	0	1	0	-	-	0	-	-	-	-	-	-	-	-	-
Upland	Loam	Flat	66	78	55	7	23	2	11	16	-	-	12	-	11	19	1	-	-	-	-	-
Upland	Loam	toeslope/swale	0	3	15	16	23	3	7	9	-	-	9	-	1	0	-	-	-	-	-	-
Upland	Loam	lower sideslope	-	0	0	12	4	1	2	1	-	-	1	-	0	-	-	-	-	-	-	-
Upland	Loam	valley flat	-	0	0	1	1	0	0	0	-	-	0	-	0	0	-	-	-	-	-	-
Upland	Loam	drawbottom	-	0	0	6	2	0	1	1	-	-	0	-	0	0	-	-	-	-	-	-
Upland	Loam	Cove, draw	-	0	0	4	1	0	0	0	-	-	0	-	-	-	-	-	-	-	-	-
Upland	Silt/clay	Steep slope	-	-	-	0	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-
Upland	Silt/clay	Flat summit/ridge	-	-	-	0	-	-	-	-	0	-	-	0	-	-	-	-	-	-	-	-
Upland	Silt/clay	low hill	-	-	0	1	0	1	1	1	2	0	-	1	-	-	-	-	-	-	-	-
Upland	Silt/clay	low rounded summit	-	-	0	4	1	2	2	2	5	1	-	2	-	-	-	-	-	-	-	-
Upland	Silt/clay	upper sideslope	-	-	0	5	0	0	1	1	2	1	-	1	-	-	-	-	-	-	-	-
Upland	Silt/clay	Flat	-	-	10	2	10	18	8	7	25	32	-	8	-	-	-	-	-	-	-	-
Upland	Silt/clay	toeslope/swale	-	-	9	7	13	26	11	11	41	17	-	12	-	-	-	-	-	-	-	-
Upland	Silt/clay	lower sideslope	-	-	0	9	2	2	5	5	11	2	-	3	-	-	-	-	-	-	-	-
Upland	Silt/clay	valley flat	-	-	0	1	0	0	0	0	1	0	-	0	-	-	-	-	-	-	-	-
Upland	Silt/clay	drawbottom	-	-	0	3	1	1	2	1	4	1	-	1	-	-	-	-	-	-	-	-
Upland	Silt/clay	Cove, draw	-	-	0	3	0	0	1	1	2	1	-	1	-	-	-	-	-	-	-	-
Upland	Estuarine fine	Steep slope	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-

CHESAPEAKE BAY MATRIX BLOCK ASSESSMENT		01/21/01																				
		Matrix-landscape group	A4		A3			A2			A1				B2				B1			
UP/Wet	Surficial / total	Topography	Redden - Ellendale	Black Bird Creek / Mil	St. Marys	Calvert Cliffs	MacIntosh	Patuxent WRC	Zekiah	Mattawoman	A. P. Hill	Dragon Run	Nanjemoy	Upper Rappahannock	Kiptopeke*	Nanticoke	Great Cypress Swamp	Nassawango	Transchic	Blackwater	Lower Pocomoke	Aberdeen
Upland	Estuarine fine	Flat summit/ridge	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Upland	Estuarine fine	low hill	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-	-	-	-	-	-
Upland	Estuarine fine	low rounded summit	-	-	-	-	-	-	-	0	0	1	1	1	-	-	-	-	-	-	-	-
Upland	Estuarine fine	upper sideslope	-	-	-	-	-	-	-	0	0	0	0	0	-	-	-	-	-	-	-	-
Upland	Estuarine fine	Flat	-	-	-	-	-	-	-	1	1	14	38	27	-	-	-	-	-	-	-	-
Upland	Estuarine fine	toeslope/swale	-	-	-	-	-	-	-	0	0	7	20	9	-	-	-	-	-	-	-	-
Upland	Estuarine fine	lower sideslope	-	-	-	-	-	-	-	0	0	1	2	1	-	-	-	-	-	-	-	-
Upland	Estuarine fine	valley flat	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
Upland	Estuarine fine	drawbottom	-	-	-	-	-	-	-	0	0	0	1	0	-	-	-	-	-	-	-	-
Upland	Estuarine fine	Cove, draw	-	-	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-
Upland	Marine Loam	low hill	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	0	-	-	-	-
Upland	Marine Loam	low rounded summit	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	0	-	-	-	-
Upland	Marine Loam	upper sideslope	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Marine Loam	Flat	0	-	-	-	-	-	-	-	-	0	-	-	51	1	11	18	-	-	-	-
Upland	Marine Loam	toeslope/swale	-	-	-	-	-	-	-	-	-	0	-	-	3	0	0	0	-	-	-	-
Upland	Marine Loam	lower sideslope	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-	-	-	-
Upland	Marine Loam	valley flat	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-	-	-	-
Upland	Marine Loam	drawbottom	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-	-	-	-	-
Upland	Marine Loam	Cove, draw	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Upland	Eolian sand	low hill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Upland	Eolian sand	low rounded summit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Upland	Eolian sand	upper sideslope	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Upland	Eolian sand	Flat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	45	-	-	-	-
Upland	Eolian sand	toeslope/swale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Upland	Eolian sand	lower sideslope	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Upland	Eolian sand	drawbottom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Upland	Estuarine coarse	Flat	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	5	29	15	28	-
Upland	Estuarine coarse	toeslope/swale	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0	-	0	-
Upland	Estuarine coarse	lower sideslope	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Upland	Estuarine coarse	drawbottom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
Upland	Peat/Saline/Marsl	low hill	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	0
Upland	Peat/Saline/Marsl	low rounded summit	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-
Upland	Peat/Saline/Marsl	upper sideslope	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-

Table m2. Chesapeake Bay Lowlands Matrix Block Assessment

CHESAPEAKE BAY MATRIX BLOCK ASSESSMENT		01/21/01																				
		Matrix-landscape group	A4		A3			A2			A1				B2				B1			
UP/Wet	Surficial / total	Topography	Redden - Ellendale	Black Bird Creek / Mil	St. Marys	Calvert Cliffs	MacIntosh	Patuxent WRC	Zekiah	Mattawoman	A. P. Hill	Dragon Run	Nanjemoy	Upper Rappahannock	Kiptopeke*	Nanticoke	Great Cypress Swamp	Nassawango	Transchic	Blackwater	Lower Pocomoke	Aberdeen
Upland	Peat/Saline/Marsh	Flat	-	-	-	-	-	-	-	0	-	0	2	1	12	-	-	-	8	9	5	53
Upland	Peat/Saline/Marsh	toeslope/swale	-	-	-	-	-	-	-	0	-	0	1	1	1	-	-	-	0	-	0	1
Upland	Peat/Saline/Marsh	lower sideslope	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-
Upland	Peat/Saline/Marsh	valley flat	-	-	-	-	-	-	-	0	-	0	0	0	-	-	-	-	-	-	-	-
Upland	Peat/Saline/Marsh	drawbottom	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	0
Upland	Peat/Saline/Marsh	Cove, draw	-	-	-	-	-	-	-	0	-	0	0	0	0	-	-	-	-	-	-	-
ELU DETAILS -WETLANDS+B53																						
Wetland	Alluvial coarse	stream	0	-	0	-	0	1	1	2	-	0	-	-	-	1	-	0	-	-	-	-
Wetland	Alluvial coarse	lake/pond	-	-	-	-	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	-
Wetland	Alluvial coarse	estuary/river	-	-	-	-	-	-	-	-	-	0	-	-	-	1	-	0	-	-	-	-
Wetland	Alluvial coarse	saline wetland	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-	-	-	-	-	-
Wetland	Alluvial coarse	fresh wetland	2	-	0	-	0	16	14	12	-	2	-	-	-	7	-	2	-	-	-	-
Wetland	Loam	stream	2	2	2	1	2	0	1	1	-	-	1	-	0	1	0	-	-	-	-	-
Wetland	Loam	lake/pond	0	0	0	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-
Wetland	Loam	estuary/river	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	-	-	-	-	-
Wetland	Loam	water	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
Wetland	Loam	saline wetland	-	0	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-
Wetland	Loam	fresh wetland	18	16	3	1	3	1	2	0	-	-	1	-	1	3	4	-	-	-	-	-
Wetland	Silt/clay	stream	-	-	1	1	1	1	1	1	3	2	-	1	-	-	-	-	-	-	-	-
Wetland	Silt/clay	lake/pond	-	-	1	-	-	0	-	-	0	0	-	0	-	-	-	-	-	-	-	-
Wetland	Silt/clay	estuary/river	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-
Wetland	Silt/clay	water	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Wetland	Silt/clay	saline wetland	-	-	-	2	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-
Wetland	Silt/clay	fresh wetland	-	-	2	3	4	5	9	3	3	2	-	1	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	stream	-	-	-	-	-	-	-	0	0	1	2	1	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	lake/pond	-	-	-	-	-	-	-	0	0	0	-	0	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	estuary/river	-	-	-	-	-	-	-	-	-	0	0	3	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	water	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	saline wetland	-	-	-	-	-	-	-	-	-	1	2	2	-	-	-	-	-	-	-	-
Wetland	Estuarine fine	fresh wetland	-	-	-	-	-	-	-	0	0	3	4	5	-	-	-	-	-	-	-	-
Wetland	Marine Loam	stream	0	-	-	-	-	-	-	-	-	0	-	-	0	0	0	0	-	-	-	-
Wetland	Marine Loam	lake/pond	0	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
Wetland	Marine Loam	estuary/river	-	-	-	-	-	-	-	-	-	-	-	-	6	0	-	-	-	-	-	-

Table m2. Chesapeake Bay Lowlands Matrix Block Assessment

CHESAPEAKE BAY MATRIX BLOCK ASSESSMENT		01/21/01																				
		Matrix-landscape group	A4		A3			A2			A1				B2				B1			
UP/Wet	Surficial / total	Topography	Redden - Ellendale	Black Bird Creek / Mil	St. Marys	Calvert Cliffs	MacIntosh	Patuxent WRC	Zekiah	Mattawoman	A. P. Hill	Dragon Run	Nanjemoy	Upper Rappahannock	Kiptopeke*	Nanticoke	Great Cypress Swamp	Nassawango	Transchic	Blackwater	Lower Pocomoke	Aberdeen
Wetland	Marine Loam	water	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-
Wetland	Marine Loam	saline wetland	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
Wetland	Marine Loam	fresh wetland	0	-	-	-	-	-	-	-	-	0	-	-	2	2	13	3	-	-	-	-
Wetland	Eolian sand	stream	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Wetland	Eolian sand	lake/pond	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Wetland	Eolian sand	estuary/river	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-
Wetland	Eolian sand	fresh wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	12	-	-	-	-
Wetland	Estuarine coarse	stream	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0	0	0	-
Wetland	Estuarine coarse	lake/pond	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	1	0	-	-
Wetland	Estuarine coarse	estuary/river	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0	0	1	-
Wetland	Estuarine coarse	water	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0	-	-	-
Wetland	Estuarine coarse	saline wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	8	12	4	-
Wetland	Estuarine coarse	fresh wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	24	18	6	1
Wetland	Peat/Saline/Marsl	stream	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0
Wetland	Peat/Saline/Marsl	lake/pond	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	0	1	0	0	6
Wetland	Peat/Saline/Marsl	estuary/river	-	-	-	-	-	-	-	-	-	1	0	12	6	3	-	0	0	1	3	14
Wetland	Peat/Saline/Marsl	water	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0	-	0	14
Wetland	Peat/Saline/Marsl	saline wetland	-	-	-	-	-	-	-	-	-	0	1	1	1	2	-	-	13	16	15	11
Wetland	Peat/Saline/Marsl	fresh wetland	-	-	-	-	-	-	-	-	-	0	0	2	0	8	49	3	12	27	24	-
Wetland	Peat/Saline/Marsl	peatland	-	-	-	-	-	-	-	-	-	-	-	-	-	9	18	1	4	-	13	

* Kiptopeke was later dropped. The Elk Neck Run block was added later.

PLANNING METHODS FOR ECOREGIONAL TARGETS: ESTUARINE, COASTAL AND MARINE*

Target Selection

The identification of estuarine, coastal and marine conservation targets in the Chesapeake Bay Lowlands ecoregion, and Significant Conservation Areas (SCA's) that collectively captured the conservation targets, was influenced by four factors: 1) the size and scope of the area covered by tidal waters; 2) the goal of including representative occurrences of all of the estuarine, coastal and marine biodiversity characteristic of the ecoregion; 3) the significance of the region for migratory land birds, water birds, and waterfowl, as well as for spawning populations of fish; 4) a general absence of *rare* estuarine, coastal and marine species or communities in the ecoregion.

Tidal waters cover about 20% of the CBY ecoregion, and the ecological diversity within these marine and estuarine systems is impressive. The Chesapeake Bay mainstem spans about 200 miles from the mouth of the Susquehanna River to its connection with the Atlantic Ocean, making it the largest estuary in North America. The Bay also has the largest drainage basin on the eastern seaboard, receiving freshwater flow from over 64,000 square miles of land. On average the Chesapeake Bay holds more than 15 trillion gallons of water (EPA Chesapeake Bay Program 2000). A dozen major rivers empty into the mainstem Bay, along with hundreds of smaller rivers and creeks. Thousands of embayments, ranging from a few acres to tens of thousands of acres, line the shores of the Bay and its tributaries, producing a total length of Bay shoreline that has been estimated to be 11,684 miles (EPA Chesapeake Bay Program 2000). Moreover, the ecoregion also encompasses the entire Atlantic coastline of the Delmarva Peninsula, from the mouth of Delaware Bay on the north, to the confluence of the Bay and the Atlantic to the south. This 175-mile stretch of barrier islands, back bays and coastal saltmarsh systems contributes numerous marine-influenced species and habitats to the ecoregion, which is otherwise dominated by the estuarine systems found in and along the mainstem of the Chesapeake Bay.

The Chesapeake Bay has been widely recognized as the home of abundant blue crabs, oysters, and rockfish, and for its large expanses of tidal wetlands. The region is also known for its extensive coastal habitats (beaches, tidal flats, etc.) rich in food resources important to migrating birds in the Atlantic Flyway (e.g., Watts 1999). In addition, millions of ducks, geese, swans and other birds overwinter on the temperate shores of the Bay and the Atlantic Ocean (Watt 1999, Funderburk et al. 1992). The Chesapeake's tidal tributaries also provide important spawning and nursery sites for several species of fish, such as white perch, striped bass, herring and shad (MD Dept. Natural Resources 2000; Olney 1991; EPA 2000). Finally, an important source of primary productivity in the Bay, and a source of both food and physical habitat for many animal species - vertebrate or invertebrate, resident or migratory - is submerged aquatic vegetation (SAV), found in beds of a few acres to several thousand acres in shallow waters along the Bay's edge.

Our conservation planning approach for estuarine, coastal and marine biodiversity in the Chesapeake Bay Lowlands ecoregion was deliberately modeled on, and informed by, the ecoregional plan done by Mike Beck (Dir., Coastal Waters Program) for the Northern Gulf of Mexico (Beck 2000, Beck and Odaya 2001). Following this earlier lead, we first focused on

* Jasinski, P. 2002. Planning methods for ecoregional targets: Estuarine, Coastal and Marine. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA

estuarine/marine "habitats" as conservation targets (Table 1), under the presumption that conservation of a good representation of these habitat types in the Bay and coastal bays would adequately protect the diversity of species found in tidal waters in the ecoregion. As Beck (2000) points out, estuarine/marine habitats are generally classified more coarsely than terrestrial vegetation communities, and may be defined by either dominant vegetation (e.g., SAV beds) or animal species (e.g., oyster reefs). Using estuarine/marine habitats as conservation targets, then, should result in the inclusion of a much larger number of similar but distinct natural community types, in addition to all of their associated species. This approach is completely analogous to using matrix forest blocks to capture common species and functional occurrences of widespread natural community types on land.

Table ecm1. Estuarine, Coastal & Marine Conservation Targets

Habitats: Tidal wetlands (all salinity zones)
Submerged aquatic vegetation
Sandy beaches and bars
Tidal flats
Species: Eastern oyster (*Crassostrea virginica*)
Blue crab (*Callinectes sapidus*)
Hard clam (*Mercenaria mercenaria*)
Soft clam (*Mya arenaria*)
Striped bass or Rockfish (*Morone saxatilis*)
Shad and River Herrings:
American shad (*Alosa sapidissima*)
Hickory shad (*Alosa mediocris*)
Alewife (*Alosa pseudoharengus*)
Blueback herring (*Alosa aestivalis*)
Yellow perch (*Perca flavescens*)
Atlantic loggerhead sea turtle (*Caretta c. Caretta*)
Colonial nesting waterbirds (e.g., great blue heron, snowy egret, great egret, little blue heron, green-backed heron, and black-crowned night heron)
Waterfowl aggregations (e.g., canvasback, pintail, scoters, ruddy ducks, tundra swans, and wood ducks)

Note that tidal marshes, swamps and other wetlands were combined for analysis into one "habitat" type, as opposed to separating out fresh and saltwater systems as was done in the Northern Gulf of Mexico plan (Beck 2000). Given the salinity gradient present in the Bay and most of its tributaries, and a significant seasonal migration of salinity zones up and down the Bay that varies with freshwater flow (**(ref?)**), defining particular wetlands as fresh, brackish or saline, and drawing boundary lines between them, is problematic (a constraint that was evident in some of the available tidal wetlands data layers). By stratifying SCA's along the north-south axis of the mainstem Bay (below), and including areas along the Atlantic back bays, we captured tidal marshes and swamps representative of the full range of variation (fresh, brackish, saline) present in the ecoregion

Our designation of species conservation targets in CBY (Table ecm1) differed somewhat from the Northern Gulf of Mexico work, for a couple of reasons. First, there are very few rare estuarine/ marine animal species in the CBY ecoregion, and those that do occur either occur on land and are geographically restricted (e.g., piping plovers and sea turtles on Atlantic beaches only) or lack sufficient occurrence records (e.g., sturgeon) to be useful for site selection analyses. (Note: good element occurrence data exists for most of the estuarine and coastal rare plant species in the ecoregion, so these targets were covered in the Species Target portion of the plan.) Second, the abundance of distribution data that was available for some of the more common and characteristic species in the Bay allowed us to add that information to the data on habitats, and do a more comprehensive analysis.

With considerable input and feedback from experts (see below) we settled on ten species or species categories that represent: a) species that are critical to the functioning of Bay ecosystems (e.g., oysters & clams); b) keystone species for important Bay ecosystems (e.g., blue crabs as significant benthic predators); c) species whose life history includes activity in multiple ecosystems, and which therefore provide indirect assessments of the state of those systems and the connectivity between (e.g., anadromous fish, waterbirds, waterfowl). Individually and together, many of the targets are "indicator" species whose presence and abundance indicates good water quality, intact and functional ecological processes, and appropriate trophic structure. Note that most of the targets are both commercially and recreationally harvested in the Bay and coastal bays, which explains why occurrence and/or distribution data were available for many of them. The targets are also some of the best known, most "characteristic" species in the Bay, for the same reason. Detailed descriptions of all of the estuarine, coastal and marine conservation targets are presented in Appendix ECM1.

The list of CBY estuarine, coastal and marine conservation targets was modified during the planning process, as a result of feedback from experts, and constraints imposed by data availability. Several targets initially considered were not included on the final list because: 1) there was a scarcity of geospatial or other data; 2) they were covered in the Aquatic Communities (i.e., freshwater systems) portion of the planning process, or; 3) they were covered through the Species Target portion of the plan (i.e., there were Element Occurrences in state BCD's). For example, the diamondback terrapin (G4) was initially considered as a conservation target, as the species is state-listed in Maryland. But the only data available for terrapins comes from one river system in Maryland, and using that limited information would have provided a biased and inaccurate picture of the distribution of the animal in the ecoregion. However, we are fairly confident that diamondback terrapins were still captured in the portfolio, since their preferred habitats of sandy beaches (for nesting) and wetlands (for feeding) were identified as conservation targets.

Horseshoe crabs, found throughout the Bay and coastal region, were also initially considered as a conservation target. But there is almost no data on important nesting grounds within the ecoregion, and experts had very little information on what represented preferred foraging habitat for horseshoe crabs. Some of the Significant Conservation Areas identified here likely provide both nesting and feeding habitat for horseshoe crabs, but additional field work would be necessary to confirm that assumption. Atlantic and shortnose sturgeon were also offered as conservation targets by several experts, since they were once abundant in the Bay. But neither species has rebounded from overfishing earlier in this century, and beyond some recent, fairly limited restocking programs, both are mostly absent from the Bay. Experts provided information on bottom types and historical spawning grounds that were important to this species and could provide restoration opportunities. This information was evaluated in the identification of SCAs, so that if a site was already under consideration for other reasons it was given additional weight as potential sturgeon habitat.

Another species that was considered as a target is menhaden (*Brevoortia tyrannus*). This fish is one of the most ecologically important fishery species in the Bay. Menhaden have been a key component in the diets of striped bass, birds of prey, and waterfowl. Although, while menhaden populations in Chesapeake Bay were once legendary, today they are almost non-existent due to extensive over-fishing. No other Chesapeake Bay fish can take its place in the ecosystem (Franklin 2001). As filter feeding fish, schools of menhaden consume large quantities of phytoplankton, or algae. This helps control outbreaks of harmful algal blooms. The menhaden catch in 2000 was the second lowest catch in 60 years (Franklin 2001). Schools of menhaden move based on food availability, therefore mapping preferred habitat is difficult. Therefore it was excluded as a target species. However, even though menhaden are not anadromous fish, the juveniles tend to use the same brackish upstream nursery areas as young shads and herrings (Lippson and Lippson 1984). For that reason we feel confident that our SCAs capture areas that are also important to this valuable species.

Data Assembly and Viability Analysis

In order to identify a network of "significant conservation areas" (SCA's) that, taken together, would capture a representative and sufficient sample of the conservation targets, data (generally, spatially referenced polygons in GIS) on the distribution of conservation targets were collected from a variety of sources (Table ecm2) and mapped for the ecoregion (Map 16). The Chesapeake Bay is one of the best-studied estuaries in the world, with a wealth of available data. There are numerous state, federal, and research agencies currently doing research and restoration work within the ecoregion. State agencies within Maryland and Virginia supplied a substantial amount of data for this project, most of which is publicly available. Specifically, Maryland Department of Natural Resources (DNR) and the Virginia Institute of Marine Science (VIMS) provided much of the information on Chesapeake Bay targets. The Environmental Protection Agency (EPA), its Chesapeake Bay Program Office (CBPO), the US Geological Survey (USGS) and the National Oceanographic and Atmospheric Administration (NOAA) through its Chesapeake Bay Office provided several region-wide databases.

The Geographic Information System (GIS) software utilized for this project was ArcView 3.1, along with various extensions. Spatial Analyst v 1.1 was also used to develop spatial relationships among the various targets and to ensure spatial variability among SCAs.

Table ecm2. Sources for estuarine, coastal & marine target data in CBY

Data Type	Data Source	Contact info or URL
Maryland wetlands	MD Dept. Natural Resources Quarter quads on CD-ROM, updated on a rolling schedule (roughly 1990-	Bill Burgess, (410) 260-8755

	1998)	
Virginia tidal wetlands	Virginia Inst. Marine Science Survey done by county, rolling updates (roughly 1985-1999)	Marcia Berman, (804) 684-7188
National Wetlands Inventory	US Fish and Wildlife Service	http://www.fws.gov/nwi
Maryland natural oyster beds	MD Dept. Natural Resources	Bill Burgess, (410) 260-8755
Maryland Artificial Reefs	MD Dept. Natural Resources	Bill Burgess, (410) 260-8755
Virginia Oyster Reefs	Virginia Marine Resources Commission (VMRC)	Jerry Showalter (VMRC), (757) 247-2225 or Jim Wesson, (757) 247-2121.
Virginia Leased Bottom	Virginia Inst. Marine Science, and Virginia Marine Resources Commission	Marcia Berman, (804) 684-7188 or Jerry Showalter (VMRC), (757) 247-2225
Maryland waterfowl	MD Dept. Natural Resources, Component of the Sensitive Species Project Review Areas (SSPRA) coverage	Anne Williams and Lynn Davidson (410) 260-8700
Virginia Waterfowl	Surveys provided by Barry Truitt, John Porter (Uva), and VA DGIF	Barry Truitt, Va. Coast Reserve(757) 442-3049 John Porter, (757) 331-4323
Water quality-Potomac	ICPRB- Summary paper Expert input on localized Potomac resources	Claire Buchanan, ICPRB (301) 984-1908
Bay wide water quality	EPA Chesapeake Bay Prog.	David Jasinski, (410) 267-5700
Chesapeake Bay interpolator (1m x 1m grid)	EPA Chesapeake Bay Program	David Jasinski, (410) 267-5700
Multi-resolution Land Cover	EPA, Region III	http://www.epa.gov
1995 National Shellfish Register	NOAA	Distributed on CD-ROM, visit http://state_of_coast.noaa.gov
Rivers, counties, states	ESRI	http://www.esri.com
RF3 Stream coverage	EPA	http://www.epa.gov
Submerged aquatic vegetation Restoration Goals (Tiers I-III)	EPA, Chesapeake Bay Prog.	Brian Burch, (410) 267-5700
Submerged aquatic vegetation (SAV)- Annual coverages 1973-2000	Virginia Inst. Marine Science	http://www.vims.edu Dave Wilcox, (804) 684-7088
Blue crab distributions Settlement SAV beds Migration corridor Overwintering areas Male/female distributions	Virginia Inst. Marine Science, expert consultation based on biological and physical parameters	Rom Lipcius, (804) 684-7330
Fish passage/blockage database	Chesapeake Bay Program	Howard Weinberg (410) 267-5700
Environmental Sensitivity Index (ESI), shoreline composition and species distribution for Chesapeake Bay and Delaware Bay	NOAA	http://www.noaa.gov

Sensitive Areas	EPA, Region III	http://www.epa.gov Steve Jarvela, (814) 566-3259
Poultry houses in the Chesapeake Bay watershed	USGS, West Virginia	http://www.usgs.gov
Distribution of spawning and nursery habitat for migratory fishes in Maryland	Maryland DNR	Jim Mauer or Drew Koslow, (410) 260-8635
Legally defined striped bass spawning areas	DNR	Jim Mauer or Drew Koslow, (410) 260-8635
Distribution of spawning fish habitat in Virginia	VIMS, trawl survey	Herb Austin (804) 684-7000

Identification and mapping of SCA's in the Bay and coastal bays for this Plan was accomplished through three interdependent approaches: 1) spatial analysis of overlays of distributional data for all conservation targets (Map 16); 2) a "condition analysis" using water quality data to assess the "viability" (habitat quality) of SCA's; 3) expert opinion feedback, using both individual interviews and group workshops. Each of these approaches is discussed in more detail below.

Spatial Analysis

Once available data layers for conservation targets had been assembled and mapped, draft SCA's were designated using one or more of three criteria: 1) areas of high target diversity; 2) areas of unique diversity; 3) stratification along the dominant gradient in the Bay, from freshwater in the north to brackish/saline water in the south, and between the western and eastern shores (especially for widely distributed targets). Stratification accomplishes at least three objectives: 1) it maximizes the likelihood of capturing all of the targets; 2) it increases the representation of genetic variation within species captured at geographically distinct portfolio sites; 3) it increases the likelihood of retaining viable occurrences in the portfolio over time, since local catastrophes are expected to eliminate local populations of one or more targets, but replicate occurrences elsewhere will survive. These criteria were evaluated qualitatively rather than quantitatively for the most part, using maps primarily at 1:24,000 scale, and initial SCA boundaries were approximate. The identification and mapping process was iterative over several months, as new target data layers were obtained and included, as the results of the condition analysis (below) were incorporated into the selection process, and as information came in from experts familiar with the targets and the sites.

Condition Analysis

We performed a condition analysis of the Chesapeake Bay as a way of filtering poor-quality occurrences from the collection of potential conservation areas. All else equal, an area encompassing a good diversity of conservation targets and with high water quality, would be chosen for the portfolio over an equally diverse area with poor water quality. To do the condition analysis, we used the US EPA Chesapeake Bay Program monitoring segments. This monitoring scheme segments the Chesapeake Bay and its tributaries into 82 different segments (Map 17), although the Chesapeake Bay Program only routinely sponsors monitoring at 162 stations within 72 of these segments (Map 17). Thirty-three of these segments were classified as mesohaline, 18 as oligohaline, 7 as polyhaline, and 14 as tidal fresh. The Chesapeake Bay Program developed this segmentation scheme to divide the Bay and its tributaries by salinity regime, and therefore similar hydrodynamic characteristics.

Salinity was chosen as a stratifier because salt content plays such a large role in determining community structure and processes within the estuary. The segmentation scheme is also a well-established standard used by many cooperating estuarine researchers throughout the Bay system. The Chesapeake Bay ranges from polyhaline (~35 ppt) near its mouth to tidal fresh in the upper reaches of most tributaries and near the mouth of the Susquehanna. The Atlantic coastline is largely polyhaline, while most of the coastal bays and inlets generally have slightly lower salinities (25 ppt and above). However, due to the lack of available water quality monitoring data for the Atlantic coastal region within CBY, the condition analysis did not include the Atlantic coastal bays and shoreline.

The condition analysis examined the status and trends for the following eight parameters: total suspended solids (TSS), Secchi depth, percent light at leaf (PLL), dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), chlorophyll a, bottom dissolved oxygen, and surface dissolved oxygen. The Chesapeake Bay Program has developed a number of water quality criteria, based on these parameters, to assess the status of estuarine habitat. For example, levels of bottom dissolved oxygen (DO) along the Bay's bottom are critical to many benthic and pelagic species (e.g., oysters, striped bass, and blue crabs; EPA Chesapeake Bay Program 1999). The Chesapeake Bay Program has established a limit of 3.0 mg/L as the minimum acceptable level for bottom waters during the summer months (Funderburk et al. 1992). Although bottom levels of DO tend to be the lowest, water column levels of DO are important to most estuarine species of plants and animals. Many of the Bay's important fishery species (yellow perch, alewife, shad, blueback herring, striped bass) require at least 5.0 mg/L of DO in the water column or they will become stressed (Funderburk et al. 1992).

Levels of the nutrients nitrogen and phosphorus are very important to overall water quality. These nutrients enter the Bay and Atlantic coastal region from the air, land, and Atlantic Ocean. Excess amounts of these nutrients can cause rapid and uncontrollable algal blooms. These blooms cloud water and deprive underwater grasses of sunlight. Additionally, when the algae die they settle out to the bottom. Their decomposition there uses up oxygen needed by other plants and animals, often leading to critically low dissolved oxygen levels.(EPA Chesapeake Bay Program 1999).

Each of the eight water quality parameters is associated with "critical" months, those months when the target level of the parameter is most important to living resources. For most of these parameters, the critical months are between May and September, when most Bay region living resources are active and breeding. Additionally, as water temperatures increase during these months, dissolved oxygen levels in the water column decrease. The condition analysis was run using data only from the critical time periods. To get a better idea of water quality trends, we looked at 3 distinct time periods for comparison purposes. The analysis looked at monitoring results within the 72 segments for 1997 (the latest available data), 1991, and again for 1984-1997 (the entire time period with available data). Experts generally agreed that certain parameters should carry more weight than others, therefore PLL and bottom dissolved oxygen were given additional weight within the ranking analysis (Funderburk et al. 1992, Marcia Olson and Dave Jasinski, pers. comm.). The analysis of these three time periods resulted in a ranking of segments based on how well they met the established thresholds for each parameter. The rankings were also stratified by salinity, so we could analyze which segments in each salinity zone consistently met the criteria.

What resulted were a few segments within each salinity regime that consistently had excellent water quality (Map 17). Although the initial SCA identification was done separately and independently, many of the same areas of the Bay were highlighted by both approaches. This demonstrates the important relationship between water quality and healthy living resources.

The condition analysis was spatially and technically informative, and the results suggested that the information was best incorporated into discussions at each of the expert workshops. In the end however, limitations in the data prevented us from using the analysis either to select conservation areas, or to remove areas from consideration. First, because all water quality parameters were provided by segment, the process could not provide reliable information on systems smaller than a segment. For example, some smaller creeks and rivers may have good water quality, but because they are aggregated with larger tributaries of poorer quality, they may not appear to meet water quality standards. Second, and similarly, some SCA's fell into two different Bay segments, and determining the appropriate parameters to use was unclear. Third, comparable data were not available for the coastal bays along the Atlantic, because the Chesapeake Bay Program doesn't sample there. One could argue that, being different systems, the coastal bays cannot meaningfully be compared to Bay segments, even if water quality data were available.

Expert Opinion

Expert opinion on conservation targets and SCA's were solicited in two ways during the planning process; personal interviews and group workshops. Academic and agency experts were contacted individually (by phone and email) throughout the plan's development for information and feedback regarding conservation targets. Two expert panels were also held to address the selection of conservation targets and Significant Conservation Areas in the Bay and coastal bays. The first was held in Annapolis, Maryland on March 2, 2001 to primarily evaluate areas within Maryland and Delaware waters. On March 15, another meeting was held in Gloucester Point, Virginia (VIMS) to address targets and conservation areas within Virginia waters. A great deal of effort was put into ensuring that experts in all of the appropriate disciplines were represented at these meetings. There were 25-30 experts at each meeting, from various state and federal agencies, academic research laboratories and regional environmental groups (Appendix ECM2, appended to this section). We also met more informally, prior to the expert workshops, with a small group of Chesapeake Bay Foundation scientists to discuss an early draft of our conservation target list and mapped conservation areas.

The experts were asked to evaluate the choice of conservation targets and the data and assumptions being used to select SCA's. In many cases, experts provided valuable feedback on specific site conditions and features, and helped to qualify existing data. For instance, a regional GIS coverage for restored oyster reefs showed the highest density of reefs along the western shore of the Bay in Maryland. Benthic ecologists working in Maryland, however, indicated that none of those projects have been successful. The same experts were able to identify other areas that represented healthier reef systems.

Workshop attendees confirmed the significance of most of the draft SCA's, and also offered justification for additional conservation areas not originally identified. For example, one such area is at the Bay's mouth. This deepwater conservation area was suggested for several reasons. The area is important for over-wintering female blue crabs, it is the primary migration corridor for several species, it is valuable habitat for spawning fish and feeding waterfowl, and it connects with a recently designated Natural Resources Defense Council Priority Ocean Area for Protection (NRDC 2001). The experts also endorsed the idea of having two levels of SCA designations, labeled "Tier 1" and "Tier 2." Tier 1 areas are the best representations of targets and healthy ecosystems. The Tier 2 designation was developed for conservation areas that might already be better represented by a Tier 1 area, but which also provide significant target coverage. The boundaries of a number of draft SCA's were also modified as a result of input from experts at the workshops.

Mike Beck, Director of the Conservancy's Coastal Waters Program, provided considerable insight, advice, information and assistance for the estuarine, coastal and marine portion of the CBY plan. Mike met with working group members several times and consulted periodically via phone and email. He provided relevant literature and expert contact information, as well as many of the slides we used in the introductory presentation made to the experts workshops. He also critically reviewed both early draft and final results of our work.

Finally, a draft version of this section of the ecoregional plan, and the Summary Results (above) was provided to all of the experts who had provided input on estuarine, coastal and marine targets and SCA's during the planning process. Comments, clarifications and suggestions made by experts who reviewed the draft report have been incorporated into the current document.

Conservation Goals

Setting ecoregional conservation goals for species and communities in terrestrial systems (i.e., numbers of populations, or areal extent of a habitat type) remains an emerging discipline. Similarly, the rationale for setting conservation goals for estuarine/marine species and communities is poorly developed (Beck and Odaya 2001). Again following the lead of the Northern Gulf of Mexico plan, we set the conservation goal for Significant Conservation Areas in CBY that they collectively contain at least 20% of the current distribution of each community and species target for the ecoregion (Beck 2000). Studies of marine reserves in fisheries management have suggested that 20% of the area of concern is the minimum necessary to preventing overfishing of the stock, to increase yields, to buffer against population fluctuations, and to provide some connectivity among reserves (NOAA Plan Development Team 1990, National Research Council 1999, Roberts and Hawkins 2000, Chesapeake Bay Commission 2001). Several other studies, on the other hand, have suggested that at least 30% or 40% of the system may need to be included in reserves in order to ensure that all native species or taxa are protected (Turpie et al. 2000, Ward et al. 1999).

As Beck and Odaya (2001) point out, conservation goals would ideally be assessed against historical rather than current distributions of target species and communities. But historical data rarely exist, or are available only in a form (e.g., a paper map) of indeterminable accuracy. Even in the absence of current data, however, historical information is sufficient to tell us that many estuarine, coastal and marine species and communities are far less abundant and widespread today compared to their historical distributions and numbers. Where current distributions are half or less of historical distributions, the 20% goal is an absolute minimum, and much higher coverages should be considered (Groves et al. 2000).

Unfortunately, several CBY targets are far less common now than they once were. Most notably, Eastern oyster (*Crassostrea virginica*) populations within Chesapeake Bay have declined 98% from historical levels (EPA 1999a, Chesapeake Bay Foundation 2000). Once legendary, most

Chesapeake Bay oyster reefs are now the result of ongoing restoration programs. Oyster populations have suffered from over-harvesting, disease, and increased sedimentation within the Bay. Almost as dramatic has been the loss of the Bay region's submerged aquatic vegetation (SAV), which now covers only about 12% of its historical extent (Chesapeake Bay Foundation 2000, EPA Chesapeake Bay Program 1999a). These losses have been largely due to increased nutrient and sediment runoff, including the devastating effects of Tropical Storm Agnes in 1972, which not only flushed many years worth of chemicals and sediment into the Bay, but also significantly reduced salinities for an extended period of time, due to the massive pulse of freshwater that entered the Bay (e.g., EPA Chesapeake Bay Program 1993, other refs).

The loss of SAV beds, as well as fishing pressures and other disturbances, have also recently caused blue crab (*Callinectes sapidus*) populations to drop below 50% of their historical numbers (EPA 1999a, Chesapeake Bay Foundation 2000, Chesapeake Bay Commission 2001). Additionally, anadromous fish species have been significantly affected by overfishing, habitat losses and blockages, and water quality degradation. Their concentrated upstream spawning areas make them easy targets for fishing, and/or subject to the impacts of runoff from farm fields and development. Those stresses, along with the presence of physical blockages (dams, culverts, etc.) on many tributaries that prevent migration to upstream spawning grounds, has resulted in dramatic reductions in most of the region's migratory fish species, such as shad, river herring, and sturgeon.

APPENDIX ECM2: EXPERTS ON ESTUARINE, COASTAL AND MARINE HABITATS AND SPECIES, AND SIGNIFICANT CONSERVATION AREAS, IN THE CBY ECOREGION

Expert	Affiliation
Herb Austin	College of William and Mary Virginia Institute of Marine Science
Mike Beck	Coastal Waters Program The Nature Conservancy
Peter Bergstrom	US Fish and Wildlife Service Chesapeake Bay Field Office
Donald Boesch	University of Maryland – CEES Horn Point Environmental Lab
Dave Brinker	Wildlife and Heritage Division ,MD Dept. of Natural Resources
Gene Burreson	College of William and Mary Virginia Institute of Marine Science
Tom Fisher	Horn Point Lab Univ. of Maryland Center for Environmental Science
Doug Forsell	US Fish and Wildlife Service Chesapeake Bay Field Office
Charles S. Frentz	Oyster Recovery Partnership
Greg Garman	Dept. of Biology Virginia Commonwealth University
Bill Goldsborough	Chesapeake Bay Foundation
Bill Harvey	Wildlife and Heritage Division MD Dept. of Natural Resources
Carl Hershner	College of William and Mary Virginia Institute of Marine Science
Tuck Hines	Smithsonian Environm. Res. Center
Steve Jordan	Fisheries Service MD Dept. Natural Resources
Romuald Lipcius	College of William and Mary Virginia Institute of Marine Science
Mark Luckenbach	Virginia Institute of Marine Science Eastern Shore lab
Maurice Lynch	College of William and Mary Virginia Institute of Marine Science

Roger Mann	College of William and Mary Virginia Institute of Marine Science
Jim McCann	Wildlife and Heritage Division MD Dept. of Natural Resources
Steve McInish	Virginia Commonwealth University
Ken Moore	College of William and Mary Virginia Institute of Marine Science
Bob Murphy	University of Maryland Chesapeake Biological Laboratory
Mike Naylor	Resource Assessment Service MD Dept. of Natural Resources
Roger Newell	Horn Point Lab Univ. of Maryland Center for Environmental Science
John Olney	College of William and Mary Virginia Institute of Marine Science
Robert Orth	College of William and Mary Virginia Institute of Marine Science
Richard Osman	Academy of Natural Sciences
Dave Secor	University of Maryland Chesapeake Biological Laboratory
Albert Spells	U.S. Fish and Wildlife Service
Bill Street	Chesapeake Bay Foundation
Barry Truitt	The Nature Conservancy Virginia Coast Reserve
Bryan Watts	College of William and Mary Center for Conservation Biology

RESULTS FOR ESTUARINE, COASTAL AND MARINE CONSERVATION TARGETS*

Portfolio Occurrences

In CBY, we identified 18 Significant Conservation Areas (SCA's) that captured the 14 estuarine, coastal and marine targets (Map 4). The SCA's range in size from 1300 to 262,000 acres (1,276,986 ac total), and occur throughout the salinity gradient in the ecoregion, from freshwater (i.e., Susquehanna) to saline (e.g., Cape Henlopen, Lower Bay, Lower Eastern Shore; Map 4). Eleven SCA's fall all or in part in Virginia (including Nanjemoy and Blackwater/ Bay Islands), while nine occur in Maryland and one occurs in Delaware.

Expert opinion informed and refined the identification of a group of 14 Tier 1, or highest-quality Significant Conservation Areas and a group of four Tier 2, or good-but-lower-ranked SCA's (Map 4, Table ecm3 at end of chapter). The Tier 1 areas, which range in size from 1,300 ac to 262,000 ac (average = 83,000 ac) include 11 within the Chesapeake Bay and three along the Atlantic Coast (Table ecm3, Map 4). These SCA's are well-distributed along both the western and eastern shores of the Bay, in the mouths of major rivers (e.g., 1, 9, 11), in upstream, brackish, tidal water sections of major rivers (e.g., 2, 3, 6, 7), as well as open-water portions of the mainstem Bay (e.g., 8, 10). Individual Tier 1 areas extend into as many as five of the Bay segments identified by the Chesapeake Bay Program, and all of the SCA's together occur in 38 of the 80-odd segments defined for the Bay. Descriptions of each SCA, with maps and lists of the ecoregional targets present, and a brief discussion of major stresses affecting each, are presented below.

The estuarine, coastal and marine habitat targets are abundant in many of the SCA's, but their acreages vary significant among sites (Table ecm3). Among Tier 1 areas, two contain more than 10,000 acres of SAV beds, while seven contain less than 100 ac and four have none. Similarly, tidal marsh cover varies from less than 1,000 acres in five SCA's, to as much as 69,000 ac in the Lower Eastern Shore SCA. Sandy beaches, too, are very abundant in several SCA's but absent from four others. Significant Conservation Areas that captured moderate or high acreages of most of the habitat targets include Nanjemoy Creek and Mid-Potomac River, Blackwater and Bay Islands, and Assateague and Chincoteague. Areas with only low or moderate acreages of two or more of the habitat targets include Dragon Run, the Upper York Complex, Chickahominy River and the Nanticoke River. Note, however, that these latter SCA's are some of the smallest of the entire group (acreages of habitat targets were not standardized for variation in SCA size). Not surprisingly, the Lower Open Bay SCA contains none of the habitat targets, and the Cape Henlopen SCA captures only beach habitat (Table ecm3).

Target habitat acreages among the four Tier 2 SCA's were generally less for SAV and tidal marshes than in Tier 1 sites, but beach habitat was somewhat more abundant in Tier 2 than Tier 1 areas (Table ecm3). The Tier 2 SCA's, though, were only a third the size of the Tier 1 SCA's, on average.

Many of the estuarine, coastal and marine species targets were captured at Medium or High levels in most of the Significant Conservation Areas, both Tier 1 and 2 (Table ecm2). Thirteen of

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* Jasinski, P. 2002. Results for Estuarine, Coastal and Marine Conservation Targets. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA.

the Tier 1 areas contain populations of at least six of the ten species targets, and four SCA's (Lower York Complex, Nanticoke, Choptank, and Lower Eastern Shore) each captured 8 targets. Two other areas – Upper York Complex and Nanjemoy Creek – contain 7 targets each, and in the latter SCA, five of those are at High abundance. The Blackwater and Bay Islands SCA captured only 5 of the ten targets, but shad and herring spawning grounds would not occur in this part of the Bay, and this was is the only SCA in which all of the occurrences are ranked "High." Among Tier 2 SCA's, three of the four contained six of the species targets, and two (Upper Chester and Mattawoman) had four of those occurrences ranked "High" (Table ecm3).

Ignoring oysters and loggerhead turtles, each of the species targets occurred in at least seven SCA's across all Tier 1 sites, and four targets – blue crabs, rockfish, waterfowl aggregations and waterbirds – were captured in 12 or more Tier 1 SCA's (Table ecm3). Across Tier 2 SCA's, six of the ten species targets were found in at least 3 of the four sites.

Descriptions of Significant Conservation Areas

This section provides a description of each Significant Conservation Area identified in the plan, along with the approximate acreage and the habitat and species targets present in that area. In addition, we list and briefly discuss some of the most significant stresses and threats known for each area; this assessment is necessarily qualitative and cursory, and is not meant to be a comprehensive. The information here is based on qualitative evaluation of the data layers for target distributions, as well as expert input and literature reviews (where cited).

Tier 1 Areas

Susquehanna Flats (29,900 acres)

Targets present: Tidal freshwater marshes, freshwater SAV (native and non-native), tidal flats, coarse sand beaches, upstream spawning habitat for shad and herring, striped bass, and yellow perch, waterfowl, and colonial nesting waterbirds.

Major Stresses: Direct losses, sedimentation, eutrophication, exotic species

The Susquehanna Flats region is a wide, shallow region at the mouth of the Susquehanna River. The majority of this area is less than 10 feet deep, while channels from the Northeast and Susquehanna Rivers reach close to 20 feet. SAV beds have increased in size and density over the last several years. In fact, SAV beds present in this region account for over 70% of the SAV in the upper Bay and about 10% of the total Bay (Orth et al. 2000). SAV and tidal wetland plant species present are comprised of species characteristic of the tidal fresh environment. While some exotic species of SAV are present, the size and perseverance of these beds cannot be overlooked. However, exotic species, like Eurasian watermilfoil (*Myriophyllum spicatum*) and Hydrilla (*Hydrilla verticillata*), continue to displace native grasses like Redhead grass (*Potomageton perfoliatus*) and Wild celery (*Vallisneria americana*) (Orth et al. 2000, Carter and Rybicki 1986).

Many anadromous fish species (shad, herring, striped bass, etc) pass through the Susquehanna Flats on their way to northern spawning grounds. The SAV beds found here are active nursery areas for those and other fish and shellfish species. Male blue crabs migrate to this area during the warmer summer months. Coarse sand beaches and wide tidal flats border the area, making it important foraging grounds for fish and birds. A major concern for this area is the high level of both nutrients and sediments washing down the Susquehanna River. Much of this input stems from the high level of agriculture within the Susquehanna watershed. Fortunately, however some of the inputs are countered by the fact that over 60% of the watershed is currently forested (MRLC 1991-1993).

Nanjemoy Creek and Mid-Potomac River (56,100 acres)

Targets present: Tidal freshwater marshes; tidal salt/brackish marshes; tidal flats; SAV; Eastern oyster habitat; blue crabs; shad, herring, yellow perch and striped bass spawning reaches; waterfowl, and colonial nesting waterbirds.

Major Stresses: Toxics, exotics, direct losses

The Nanjemoy Creek watershed per se is largely forested (70%; MRLC, 1991-1993), as is a much larger area along the Potomac River to the west, south and east, helping to control the amount of sediments and nutrients washed into the creek and adjacent river. The upstream portions of Nanjemoy Creek provided historical spawning grounds for alewives, perch, shad, herring, and striped bass. Because unique hard bottom areas are present within this stretch of the Potomac River, sturgeon sightings have been reported from this area; few other areas within the Chesapeake Bay region provide the hard bottom type preferred by sturgeon. Tidal freshwater wetlands and forested shoreline reaches provide good habitat for great blue heron and other waterbirds. The tidal mouth of Nanjemoy Creek has a strong and diverse population of SAV, although some exotic species are present as well. The SAV beds and tidal flats are good feeding grounds for fish and waterbirds. Both male and female blue crabs use this section of the Potomac River during summer months.

The portion of the Potomac River included within this area has recently seen increased numbers of menhaden and other fish. These increases are thought to be associated with improving water quality and healthier communities of phytoplankton and zooplankton. Wastewater treatment plant upgrades, better land use management practices, and increases in SAV within the upstream reaches of the Potomac are likely the reasons for improved water quality.

Blossom Point Proving Grounds is located on the southeastern side of Nanjemoy Creek. It has been associated with high levels of some toxic chemicals within adjacent waters. Another source of concern for this area has been the encroaching development from Waldorf and La Plata.

Upper Rappahannock River (19,000 acres)

Targets present: Tidal brackish marshes, tidal freshwater marshes, tidal flats, blue crabs, spawning reaches for striped bass, shads and herrings, and yellow perches, waterfowl, and colonial nesting waterbirds.

Major Stresses: Direct losses, sedimentation

Consistently high numbers of spawning fish have been recorded in the upper Rappahannock River in recent years, even when numbers were decreasing in other rivers. Striped bass, yellow perch, herring, and shad all spawn within this area. The river is edged with wetlands, both brackish and freshwater, providing habitat, nursery, and feeding grounds to finfish, waterfowl, and colonial nesting waterbirds. During summer months, blue crabs (primarily males) migrate into this area looking for food and refuge. Tidal flats within the area are also home to healthy benthic communities. More than 40 pairs of breeding bald eagles have been reported within this area. The upper Rappahannock provided refuge to bald eagles when populations elsewhere were depressed or extirpated. Although this portion of the river does not have extensive SAV beds, those that are present have increased over the last several years.

Dragon Run (1,300 acres)

Targets present: Tidal freshwater marsh, juvenile and adult striped bass habitat, colonial waterbird aggregations, and waterfowl.

Major Stresses: Eutrophication, sedimentation

The upper portion of the Piankatank River is commonly referred to as Dragon Run. Most of this area is a tidal fresh, forested wetland. The surrounding landscape is relatively undeveloped, with most of the land in the watershed in forest (65%) and agricultural (19%) use. The nature of the landscape attracts colonial nesting waterbirds and many species of waterfowl. Plant and animal communities are very diverse within the area. In summer months, high densities of male blue crabs are often found within this region.

Lower York Complex (Mobjack Bay, Chisman Creek, and Poquoson River) (65,300 acres)

Targets present: salt marshes, SAV, tidal flats, fine grain beaches and bars, blue crabs, oysters, blue crabs, striped bass, hard clam, soft clam, loggerhead sea turtles, waterfowl aggregations, colonial nesting waterbirds.

Major Stresses: Eutrophication, over-harvesting,

The Lower York complex encompasses areas to the north and south of the York River's mouth. The area to the north is referred to as Mobjack Bay and is a polyhaline embayment of the Chesapeake Bay. Several smaller tributaries feed into Mobjack Bay, which is a very productive area. To the south are Chisman Creek and Poquoson River, also polyhaline environments. The entire Lower York complex is home to healthy populations of SAV and tidal wetlands. Because of the extent of SAV beds and location, this area is very important for juvenile blue crab settlement. As blue crab zooea come back into the Bay from the Atlantic, SAV beds provide good nursery habitat and shelter from predators. The beds within this area are in close proximity to the Bay's mouth, and therefore are well utilized by small blue crabs. Male and female blue crabs can be found in this area year-round. The beaches and bars are also very productive feeding and nesting grounds for colonial nesting waterbirds. Despite being well-within disease range, there are several oyster reef restoration projects here. Oysters continue to settle and grow, although most still succumb to disease before reaching commercial size. Oysters, blue crabs, hard and soft clams, and many species of finfish are commercially caught within the Lower York complex. Although there are no reported nests for loggerhead sea turtles within this area, adults can be found here during the summer.

Upper York Complex (Mattaponi and Pamunkey Rivers) (25,800 acres)

Targets present: Tidal freshwater and brackish marshes, tidal flats, blue crabs, spawning reaches for striped bass, yellow perch, and shads and herrings, soft clams, waterfowl and waterbird aggregations.

Major Stresses: Eutrophication, sedimentation, sea level rise

The Upper York complex is a tidal freshwater to oligohaline environment. It is a very productive area for migratory fish, such as striped bass, and shad. Adults and juveniles of these fish species are found in high numbers here. These fish also use these areas as spawning reaches. Both the Mattaponi and Pamunkey Indian Reservations have been very instrumental in shad restoration programs within this area. Tidal freshwater and brackish wetlands are extensive throughout the Upper York complex and provide nursery areas for several species of finfish, blue crabs, and other animals. Primarily male blue crabs are found in this SCA, and they are found here only during summer months. The plant communities within this area are also very diverse, especially within the tidal freshwater marshes. Colonial nesting waterbirds and waterfowl feed within the marshes and along the tidal flats found here.

Chickahominy River (11,200 acres)

Targets present: Tidal freshwater and brackish marshes, blue crabs, spawning reaches for striped bass, shad, herring, and yellow perch, congregations of waterfowl and colonial nesting waterbirds.

Major Stresses: Direct losses, eutrophication, sedimentation

The Chickahominy River watershed is largely forested. The river itself is fringed with tidal freshwater wetlands. The dominant wetland communities include arrow arum and pickerelweed, yellow pond lily, and very diverse freshwater mixed plant communities. The Chickahominy system is important for migratory fish, such as striped bass, shad, herring, and yellow perch. Adjacent tidal wetlands attract and provide home for many species of waterfowl and migratory songbirds. Male blue crabs are found here during the warmer summer months.

The proximity of Richmond, Virginia to this area has led to increasing development pressures on the system. Development within the watershed has also increased sediment and nutrient loadings to the river.

Lower Open Bay (179,400 acres)

Targets present: Blue crabs, striped bass, hard clam, loggerhead sea turtles.

Major Stresses: Over-harvesting, sedimentation, eutrophication

This area is important to the life cycle of blue crabs, as well as other Bay species, both target and non-target. It is used as a migration corridor for blue crabs as they re-enter the Bay as zoeae. It includes important over-wintering grounds for female crabs, which also migrate into this area to spawn. Because it is well-known that female blue crabs over-winter here, the area is targeted for winter dredging operations. These efforts have greatly reduced the numbers of female blue crabs left for spawning. This area is also important for sea turtles migrating up and down the Atlantic coast, which enter the Chesapeake through this area. Menhaden, croaker, spot, weakfish, and summer flounder also use this area as spawning grounds (Natural Resources Defense Council 2001). Hard clams can be found within this SCA.

Nanticoke River (17,700 acres)

Targets present: Tidal brackish and freshwater marshes, tidal flats, coarse sand beaches, blue crabs, oysters, hard clam, soft clam, spawning reaches for striped bass, yellow perch, and shads and herrings, waterfowl aggregations and colonial nesting waterbirds.

Major Stresses: Eutrophication, sedimentation, over-harvesting, direct losses

The upstream portions of the Nanticoke River are important spawning and nursery grounds for many species of migratory fish. The river is also year-round home to blue crabs, male and female. Although the river has almost no SAV, it still provides productive feeding and habitat grounds for waterfowl, fish, and shellfish. Hard and soft clams are found within the Nanticoke River. The coarse sandy beaches also provide nesting and feeding habitat for waterbirds. Waterfowl are found within this SCA feeding on small fish and clams.

The Nanticoke River watershed is about 43% agricultural land. Sediment, fertilizers and pesticides drain from agricultural lands into the Nanticoke River causing eutrophication, decreased water clarity, and other problems for its estuarine plant and animal communities. Much of the Eastern Shore is currently experiencing rapid development due to sprawl from Western Shore urban centers, such as Annapolis and Baltimore. The Nanticoke watershed in Delaware is under increasing development pressure, especially on agricultural and forested lands.

Blackwater and Bay Islands (135,700 acres)

Targets present: Tidal salt marsh, tidal brackish wetlands, SAV, tidal flats, beaches and bars, oysters, hard clam, waterfowl, colonial nesting waterbirds.

Major Stresses: Sea level rise, over-harvesting, sedimentation

The vast expanses of tidal marshes in lower Dorchester County, Maryland, as well as the string of bay islands to the south (which are fringed by brackish marshes), are rapidly eroding. The marshes and islands are eroding due to a combination of natural geologic processes (esp., land subsidence), sea level rise, and altered sediment regimes imposed by man-made structures. The tidal marshes have also been severely impacted by nutria, an exotic herbivore introduced to the area about xx years ago. Nutria feeding on marsh vegetation may be accelerating the marsh loss caused by physical processes. At current rates, many coastal geologist estimate that these marshes and islands may be lost within the next 50 years. Most of these islands are sparsely developed, if at all, and lack large predators that would prey upon nesting birds. Thus, they provide sanctuary and abundant habitat for waterfowl and colonial nesting waterbirds. The surrounding waters are also rich with shellfish, both clams and oysters. Male and female blue crabs are found in large numbers throughout this SCA, during both summer and winter months. fringe many islands, although erosion and sedimentation are causing decreases in these wetlands.

Choptank River (96,600 acres)

Targets present: Tidal salt and freshwater marshes, SAV, tidal flats, beaches and bars, oysters, blue crabs, soft clams, yellow perch, striped bass, shad, and herring spawning reaches.

Major Stresses: Over-harvesting, sedimentation, eutrophication, exotics

The Choptank River provides important spawning and nursery grounds for finfish. All major anadromous fish species known in the Chesapeake Bay region use the upstream portions for spawning. There are also several oyster reef restoration projects within the Choptank River. Although the river usually has lower levels of oyster spat recruitment than more southern areas, it has higher than average survival rates of oysters. The river is largely outside of the oyster disease range and represents good opportunities for oyster recovery programs. Soft clams can also be found along the Choptank's bottom, often in high densities (Funderburk et al. 1992). Large populations of blue crabs are found throughout the Choptank. Both male and female blue crabs use this area during the summer, although males predominate. Additionally, male blue crabs over-winter within the lower Choptank River (Funderburk et al. 1992). One reason for the large populations of macro-benthics and waterfowl aggregations is the diversity of native SAV species, including widgeon grass (*Ruppia maritima*), sago pondweed (*Potomageton pectinatus*), and horned pondweed (*Zannichellia palustris*) (Orth et al. 2000). The SAV beds draw in large populations of waterfowl. However, over the last two years of monitoring, SAV beds have decreased substantially within the Choptank. This may be due to increased sedimentation and decreased water clarity from agricultural runoff, or coastal development.

Cape Henlopen (19,400 acres)

Targets present: Salt marshes, beaches and bars, tidal flats, striped bass, blue crabs, hard clam, waterfowl, colonial nesting waterbirds.

Major Stresses: **[sea level rise? horsecrab harvesting? overfishing?]**

Beaches, bars, and tidal flats here support diverse populations of shorebirds and waterfowl, and extensive intertidal habitats provide rich feeding grounds for both birds and finfish.. Horseshoe crabs lay eggs throughout Delaware Bay, and millions of migratory waterbirds come to these beaches to feed on that abundant food source. Blue crabs are also found within this SCA, and adult striped bass use the area as a foraging ground.

Assateague and Chincoteague (241,700 acres)

Targets present: Salt marshes, SAV, tidal flats, beaches and bars, oysters, blue crabs, hard clams, waterbirds, loggerhead sea turtles, waterfowl aggregations.

Major Stresses: Eutrophication (from groundwater discharge), over-harvesting, sand starvation

This area captures vast expanses of tidal marshes, shallow coastal bay waters, and barrier island habitats along the Maryland and Virginia eastern shores bordering the Atlantic Ocean. Much of the area is in federal ownership, managed by the US National Park Service. Due to extensive SAV beds throughout the inlets and back bays, fish and loggerhead turtles use the area both for refuge and as foraging grounds. Piping plover and other migratory shorebirds and waterfowl use these beaches as stopovers and nesting areas. Small populations of horseshoe crabs nest on back bay beaches. The bays and inlets also support large populations of blue crabs, which face high fishing pressure. These areas tend to warm up earlier than the Chesapeake Bay itself. Therefore, blue crabs are often active earlier in the season that in the Bay. Hard clams are also found along the sandy bottoms within this SCA.

Ocean City, Maryland is directly to the north of this area. This urban center maintains a jetty that starves the Assateague and Chincoteague beaches of southward migrating sand. This has led to increased rates of beach erosion.

Lower Eastern Shore (262,300 acres)

Targets present: Tidal salt and brackish marsh, tidal flats, beaches and bars, SAV, oysters, blue crabs, hard clams, soft clams, striped bass, waterfowl, colonial nesting waterbirds, hard clams, waterfowl, colonial nesting waterbirds.

Major Stresses: Eutrophication, over-harvesting, sedimentation

Also characterized by vast expanses of coastal bay and barrier island habitats, this area along the Lower Eastern Shore is home to large and diverse colonies of waterbirds, waterfowl, and shellfish. This stretch of Atlantic beach provides stop-over and/or over-wintering grounds for millions of migratory birds. This area has the highest known concentration of piping plover nests in the region (Truitt, pers. comm.). Healthy populations of hard clams, oysters, and blue crabs are also found here, especially within the bays and inlets. Additionally, large concentrations of young loggerhead sea turtles feed and find shelter within the bays and inlets.

Tier 2 Areas

Aberdeen (15,200 acres)

Targets present: Tidal brackish and freshwater marshes, SAV, tidal flats, beach, blue crabs, striped bass, yellow perch, shads and herrings, waterfowl, colonial nesting waterbirds.

Major Stresses: Sedimentation, eutrophication

The Aberdeen area is adjacent to the Aberdeen Proving Grounds property. The shoreline is comprised mainly of tidal brackish-freshwater wetlands and consistently supports high concentrations of waterfowl. Male and female blue crabs are found within this SCA, especially during summer months. Adults and juvenile migratory finfish also use the nearshore habitat within this SCA for foraging and shelter. The area is affected by nutrient and sediment runoff from adjacent land areas.

Upper Chester River (7,600 acres)

Targets present: Tidal freshwater and brackish marshes, SAV, beaches, tidal flats, blue crabs, soft clams, spawning reach for striped bass, yellow perch, shad, herring, and waterfowl.

Major Stresses: Direct losses, sedimentation, eutrophication

The upper Chester provides a year-round home to male blue crabs and is an important spawning river for migratory fish. Large concentrations of waterfowl visit the area to feed within the SAV beds and tidal wetlands. This area represents the northern extent of soft clams and oysters. Both male and female blue crabs are found throughout the Upper Chester. This SCA also represents a probable juvenile and nursery area for menhaden, an ecologically important fish (Funderburk et al. 1992). Although almost 60% of its watershed is used for agricultural purposes, the water quality remains fairly good. However, the area is threatened by increasing development of agricultural and forested lands.

Mattawoman Creek (2,000 acres)

Targets present: Tidal freshwater wetlands, SAV, tidal flats, blue crabs, spawning reaches for striped bass, shads and herrings, and yellow perch, waterfowl, and colonial nesting waterbirds.

Major Stresses: Direct losses, eutrophication, sedimentation, exotics

Mattawoman Creek is a very diverse, tidal freshwater environment. Although being encroached upon by development, it is still productive nursery and habitat for several water-dependent species, including waterfowl, fish, reptiles and mammals. More than 60% of the Mattawoman's watershed is still forested, including many forested wetlands and riparian forest buffers. This SCA represents a refuge to many species of waterfowl and colonial nesting waterbirds. The upstream area is also an active spawning reach for striped bass, shads and herrings, and yellow perch. The major stresses are related to urbanization taking place within the watershed, including sprawl around Waldorf, Maryland.

Pocomoke Sound (90,500 acres)

Targets present: Salt marsh, SAV, tidal flats, beaches/bars, blue crabs, oysters, hard clams, soft clams, waterfowl, colonial nesting waterbird aggregations.

Major Stresses: Eutrophication

Blue crabs congregate within Pocomoke Sound; both sexes and all life stages can be found year-round within this area. Hard and soft clams are also found within this SCA, with soft clams being particularly abundant along the northern border of the area (Funderburk et al. 1992). The shoreline is fringed with abundant SAV and wetlands, attracting water-dependent avian species. About 20% of the watershed area is in agricultural use, which is low for the Eastern Shore, but there are a large number of poultry houses in the watershed. This leads to high levels of nutrients, both nitrogen and phosphorus, entering the river and tidal waters downstream. Many scientists believe that extreme eutrophication in this system led to the *Pfiesteria piscida* outbreaks of 1998. This microorganism causes lethal lesions in finfish, and has numerous effects on humans that come into contact with it in certain life stages.

Progress Towards Goals

The conservation goals (20%) were met or exceeded for all of the habitat conservation targets (Table ecm3). For species targets, our qualitative analysis (Table ecm4) suggest that a considerable proportion of the ecoregional distribution of each species was captured in the 14 Tier 1 sites. Although we cannot assign quantitative values to target species occurrences in SCA's, every Tier 1 area captured at least three species targets, 10 captured Medium or High occurrences of at least four targets, and 11 captured six or more species targets (Low, Medium or High; Table ecm2). Notably, the Tier 2 Significant Conservation Areas also captured at least five species targets each, and several of these areas (e.g., Upper Chester River, Mattawomen Creek) had High abundances of four of the targets (Table ecm3).

Table ECM4: Success towards meeting conservation goals for habitat targets.

Habitats	Baywide Totals	% of Baywide total, all SCA's			20% Goal Met?
		Tier 1 Sites	Tier 2 Sites	Tier 1 and 2 Sites	
SAV	64,689 ac	79%	8%	85%	Yes
Tidal Marsh*	327,365 m^2	34%	2%	36%	Yes
Tidal Flats	Unknown				Assumed
Beach/bar	2,441,369 m^2	17%	6%	23%	Yes
Reefs	33	36%	0	36%	Yes

*Includes tidal salt, brackish, and fresh marshes

Table ecm3. Occurrences of habitat and species targets in Significant Conservation Areas.

Significant Conservation Area (SCA)[1]	Area[2] (acres)	CBP Segments[3]	SAV[4] (acres)	Tidal Wetlands[5] (acres, type)	Tidal Flats[6] (ac)	Beach[7] (m)	Oyster reefs[8] (size)	Blue Crabs	Striped Bass	Shad & herrings	Yellow perch	Hard clams	Soft clams	Logger-head	Water fowl aggreg.	Water birds
Tier 1																
Susquehanna Flats	29,900	CB1 NORTF	5,918	732 tf		68,000	-	Low[9]	Low	Med[9]	Med				High[9]	Med
Nanjemoy Creek and mid-Potomac River	56,100	POTOH POTMH	5,186	2,230 sm, pf		115,000	-	Med	Med	High	High		High		High	High
Upper Rappahannock River	19,000	RPPTF RPPOH	35	121 tf		70,000	-	Low	High	High	High				Med	High
Dragon Run	1,300	PIAMH	0	475 tf, pf	0	171	-		Low						Low	High
Lower York Complex	65,200	YRKPH MOBPH	9,033	980 sm		38,000	1 reef >1,000 yds^3	High	Low			High	Med	Low	Med	Med
Upper York Complex	25,900	YRKMH PMKOH PMKTF MPNOH MPNTF	0	2,500 sm/tf		5370	-	Med	High	High	High		Low		Low	Med
Chickahominy River	11,200	CHKOH JMSOH	96	1,225 tf, pf		0	-	Low	High	High	High				Med	High
Lower Open Bay	179,400	CB8PH CB6PH CB7PH Atlantic	0	0	0	0	-	High	Low			Med		Med	Low	Low
Nanticoke River	17,700	NANMH NANOH	0	6,800 sm, pf		0	-	High	High	High	High	Med	High		High	High
Blackwater and Bay Islands	135,700[10]	TANMH HNGMH	11,216	11,231 sm, pf		52,900	-	High				High	High		High	High
Choptank	96,600	CHOMH1 CHOMH2 CHOOH CHOTF CB4MH	3,045	11,800 sm/tf/pf		43,780	10 reefs >6,000 yds^3	High	High	High	High		High		Med	High
Cape Henlopen	19,400	Atlantic	-	N/A		32,187	-		Low			Low			High	
Assateague and Chincoteague	241,700[10]	Atlantic	16,900	5,355 sm		125,000	-	High	Low			Low		Med	High	High
Lower Eastern Shore	262,300[10]	CB7PH Atlantic	50	68,810 sm/pf		156,700	1 reef >5,000 yds^3	High	Med			High	Med	Med	High	High
Tier 1 Totals	**1,161,400**	**30 segments + Atlantic**	**51,479**	**112,259**		**415,937**	**12 reefs**									
Tier 2																
Aberdeen	15,238	CB2OH GUNOH	1	1,154 sm	0	64,300	-	Low	Low	Low	Med				High	Low
Upper Chester	7,559	CHSOH	29	2800	0	33,000	-	Low	High	High	High				High	Med

		CHSTF		sm/tf/pf												
Mattawoman	2,011	MATTF	356	420 tf/pf		13,000	-	Low	High	High	High				Med	High
Pocomoke Sound	90,533	POCMH CB7PH TANMH	4691	1866 sm/pf		27,700	-	High				Med	High		Low	Low
Tier 2 Totals	**115,341**	**8 segments**	**5,077**	**6,240**		**138,000**	**0**									
Tier 1 + 2 TOTALS	**1,276,986**	**38 segments +Atlantic**	**56,556**	**118,499**	*****	**553,937**	**12 reefs** >12,000 yds[3]									

Sources and Notes:
[1]Areas are listed in counter-clockwise order, starting at the head of the Bay.
[2]Estimates based on polygon size in GIS; digitized boundaries are approximate, especially along shorelines
[3]Chesapeake Bay Program, 1997 Segmentation Scheme. This segmentation scheme does not include the Atlantic coastline so the Atlantic segment was added for the purposes of our analysis.
[4]Submerged aquatic vegetation numbers based on 1999 aerial monitoring survey, Orth et al. 2000.
[5]sm = salt marsh, tf = tidal fresh, pf = palustrine forested; tidal wetlands acreages were developed using USFWS, NWI, data for MD and the Virginia Tidal Marsh Inventory for VA.
[6]Tidal flat information will be determined from NWI
[7]Beach data derived from the NOAA ESI, 1994
[8]Baywide oyster reef data maintained by the US EPA Chesapeake Bay Program
[9]Qualitative assessment of abundance in the SCA, relative to the average occurrence across all appropriate habitats in the ecoregion
[10]Acreages include upland areas above high-tide level within polygon; these are estimated to make up no more than XX% of the total area of the SCA

APPENDIX ECM1: DESCRIPTIONS OF ESTUARINE, COASTAL AND MARINE HABITAT AND SPECIES TARGETS*

Habitats

Tidal Wetlands.

A wide diversity of tidal wetlands, stratified by salinity, including coastal salt marshes, brackish marshes and tidal fresh marshes, swamps and other wetlands, occur within the Chesapeake Bay Lowlands ecoregion. Tidal wetlands provide a large number of ecological functions. Both salt and freshwater wetlands provide nursery areas for juvenile fish, stabilize shorelines, and provide food and shelter to a variety of coastal wildlife. Salt marshes and brackish marshes are largely dominated by one or a few species of grasses, while tidal freshwater marshes have more structural and species diversity, often including shrubs, trees, and tall grasses. A classification of tidal wetlands, and detailed descriptions of their structure, composition and functioning, is provided by Cowardin et al. (1979). The US Fish and Wildlife National Wetlands Inventory provided the basis for Maryland's wetlands acreages and classification. Virginia performs its own regularly updated survey of tidal wetlands, the Tidal Marsh Inventory (VIMS). Because the Tidal Marsh Inventory was more recent and was subjected to extensive ground-truthing, it was used to identify tidal wetlands acreages and classifications for Virginia.

Submerged Aquatic Vegetation (SAV).

Several species of "underwater grasses" (actually, both monocots and dicots) are commonly found in the CBY ecoregion, they are collectively referred to as submerged aquatic vegetation (Table AECM1). Being vascular plants, their distribution is primarily controlled by water depth (2 m or shallower), which determines light penetration. The species composition of SAV beds varies primarily as a function of salinity, and beds may consist of one or several species (Orth et al. 2000). Hydrilla (*Hydrilla verticillata*) is an introduced exotic that is now cosmopolitan throughout tidal reaches of the Chesapeake Bay (get recent refs, in addition to Carter and Rybicki, 1986).

Submerged aquatic vegetation is a significant source of primary productivity in the Chesapeake Bay, and in the back bays along the Atlantic coast. They also remove sediments from the water, protect shorelines from waves and erosion, and add oxygen to the water. They provide food and shelter for many species of estuarine and coastal species, including fish, crabs and invertebrates. Many animal species preferentially use SAV beds versus other non-vegetated bottom habitats. For example, juvenile blue crabs are found in much higher densities in SAV beds than in adjacent non-vegetated areas. Additionally, several species of waterfowl depend on SAV for a large part of their diet. There are several ongoing restoration programs (e.g., EPA Chesapeake Bay Program, Alliance for Chesapeake Bay, Chesapeake Bay Foundation) to increase native SAV distribution throughout the Chesapeake Bay and Atlantic coastline.

The rangewide distribution of SAV species common to the Bay and coastal bays includes species that extend north along the Atlantic coast into New England (Hurley 1992) as well as southern species that can be found in estuarine waters throughout the Carolinas, Georgia, Florida, and the Gulf of Mexico (e.g., widgeon grass and wild celery) (Hurley 1992, Beck and Odaya 2000).

* Jasinski, P. 2002. Description of Estuarine, Coastal and Marine Habitat and Species Targets. Appendix ECM1 of the Chesapeake Bay Lowlands Ecoregional Plan. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA.

Table AECM1. Typical Species of Submerged Aquatic Vegetation found in the CBY Ecoregion

(Orth and Dennison in EPA Chesapeake Bay Program 1993, Hurley 1992)

Species by Salinity Regime	Common Name
Polyhaline	
Zostera marina	Eelgrass
Ruppia martima	Widgeon grass
Zannichellia palustris	Horned pondweed
Mesohaline	
Zostera marina	Eelgrass
Ruppia martima	Widgeon grass
Zannichellia palustris	Horned pondweed
Stuckenia pectinata	Sago pondweed
Potomageton perfoliatus	Redhead grass
Myriophyllum spicatum	Water milfoil
Vallisneria americana	Wild celery
Oligohaline/Fresh	
Ruppia maritima	Widgeon grass
Potamogeton pectinatus	Sago pondweed
Potomageton perfoliatus	Redhead grass
Myriophyllum spicatum	Water milfoil
Vallisneria americana	Wild celery
Heteranthera dubia	Water stargrass
Hydrilla verticillata	Hydrilla
Elodea canadensis	Common Elodea
Ceratophyllum demersum	Coontail
Najas guadalupensis	Southern naiad
Zannichellia palustris	Horned pondweed

Historically abundant throughout the region, the Bay-wide acreage of SAV has declined significantly over the past few decades. According to a 1999 survey, SAV acreage in the Bay was about 12% of historic levels (Orth et al. 2000, Chesapeake Bay Foundation 2000). **[Remove previous sentence, or reconcile with Mike Naylor's argument that real value is closer to 25%]** The dramatic baywide decline of all SAV species was first noted in the late 1960's and 1970's (Orth and Moore 1983) and was correlated with increasing nutrient and sediment inputs from development of the surrounding watershed (Kemp et al. 1983), greatly exacerbated by the historic flooding from Tropical Storm Agnes in 1972 (e.g., Orth and Moore 1983). The strong link between water quality and SAV distribution and abundance (Batiuk et al.1992) supports the concept that SAV is a good barometer of Chesapeake Bay health (Orth and Moore 1988).

Sandy Beaches and Bars.

Sandy beaches and bars are typically unvegetated, or sparsely vegetated, environments. Within the Chesapeake Bay Lowlands ecoregion, the broadest sandy beaches are found mostly in the lower Bay and along the Atlantic coastline. These beaches and bars provide feeding grounds for the abundant waterfowl and shorebirds. A number of common species also use these habitats for nesting areas, such as horseshoe crabs, terrapins, and some shorebirds. Atlantic beaches provide important nesting habitat for two globally rare animal species that are conservation targets in CBY, piping plover (*Charadrius melodus*) and the loggerhead sea turtle (*Caretta caretta*). In addition, two globally rare plant species that are CBY conservation targets grow on Atlantic beaches; seabeach amaranth (*Amaranthus pumilus*) and sea-beach knotweed (*Polygonum glaucum*). The former species, which is federally Threatened, had largely disappeared from its known locations on Atlantic beaches in Delaware, Maryland and Virginia until recently, when several small populations were recorded by Natural Heritage Program botanists and others. National Park Service and MD Wildlife and Heritage Division staff have initiated a reintroduction project in an attempt to reestablish viable populations of seabeach amaranth on Assateague Island (Chris Lea, pers. Comm.).

As is the case with all barrier islands along the entire Atlantic coast, beach and dune habitats in CBY are highly dynamic systems, constantly shaped and reshaped by winds, storms and ocean currents. Prevailing winds and nearshore currents cause Atlantic barrier islands to migrate slowly southward, with sand lost from the north end often transported to build new beaches and dunes at the south end. Hurricanes and nor'easters also move tremendous quantities of sand, both onshore and offshore, as well as along the main axis of the islands. Breaches or blowouts of the beach-dune systems can occur during major storms, creating new channels for flow between the ocean and back bays, and further altering the dynamics of these island systems.

Smaller sandy beaches border Bay islands and sections of shoreline in the lower Bay, and along the western shore of the Bay in Maryland, especially in Calvert County. Many of these beach habitats in Virginia and Maryland support populations of the Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), which is federally Threatened and a CBY conservation target. Although not included as a conservation target here, sizable cliffs (up to 100' high) coincide with many of the beaches in Calvert County, and provide excellent habitat for the Puritan tiger beetle (*Cicindela puritana*), a federally Threatened species and CBY conservation target.

Tidal Flats.

Tidal flats (also known as, intertidal or mud flats) are muddy-to-hard bottom areas exposed only at low tides. The type of substrate present determines the biotic community within the flat. Soft-bottom flats are comprised mainly by silt and clay particles, whereas hard-bottom flats have a higher percentage of sand particles. Marine animals are sensitive to the size of sediment particles; consequently, certain animals common to soft muds are never found in sandy-mud, and vice versa. However, the composition of mud flats in the Chesapeake Bay is quite variable, and many estuarine and coastal organisms have adapted to a wide range of sediment types (Lippson and Lippson 1984).

Seaweeds often grow or float among the shells, rocks, and other structures present in the intertidal areas. Sea lettuce (*Ulva lactuca*), seaweed (*Enteromorpha* spp), and horned pondweed (*Zannichellia palustris*) are often found along tidal flats. The algae and bacteria that grow here provide additional food for fish, shellfish, and other animals using this habitat. Typical tidal flats visitors include shorebirds, hard and soft clams, fiddler crabs, blue crabs, mussels, worms, mantis and marsh shrimp, and snails. These areas are rich feeding grounds for waterfowl and shorebirds.

Species

Eastern (American) Oyster

The Eastern, or American, oyster (*Crassostrea virginica*) is the characteristic bay oyster. Oysters are prized for their commercial value, but they also play (or once played) a significant ecological role in the Bay and region. Once the mainstay of the Bay's fishing industry, declines due to over-harvesting, disease, and loss of habitat have made them a scarce commodity. In fact, commercial harvests in 1998 were about 2% of those seen in the 1950's, when 30-40 million pounds were taken annually from the Chesapeake Bay (EPA 1999a, Chesapeake Bay Foundation 2000, NOAA 1999). Newell (1988) has estimated that standing stocks of the Eastern oyster within the Bay were as high as 188 x 10^6 kg dry tissue weight prior to the major harvests of the late 19^{th} Century. Due to continued overfishing and disease, however, the current population is estimated to be only about 1.9 x 10^6 kg dry tissue weight (Newell 1988). Bay region oyster populations are subject to two diseases, MSX and Dermo. MSX kills oysters while still in the spat stage, while Dermo can kill adult oysters long before they are big enough to reproduce or harvest. However, MSX is more lethal in waters between 15-30 ppt, which partially accounts for the difference in oyster stocks between Maryland and Virginia. In 2000, Virginia watermen harvested only about 10% as many oysters as watermen working in Maryland.

Oysters can grow on a variety of bottom types, although they require firm substrate to form substantial populations. The oyster is a true estuarine species, able to tolerate salinities from 5-30 ppt (Galtstoff 1964) and can be found at water depths between 8-25 feet (Lippson 1989). They are ecologically important for the habitat oyster reefs provide to other animals, and for their filtering abilities. It has been suggested that oysters were once so plentiful here that they could filter the entire volume of Bay water in 3-6 days; because of the drastic declines in oyster populations, however, the same process would now take about 325 days (Newell 1988). The Chesapeake Bay Foundation and numerous other public agencies, environmental groups and community associations conduct oyster restoration programs within the region, primarily by working to establish artificial and restored reefs.

Oyster reefs or bars are underwater, three-dimensional structures created when dense colonies of oysters cluster together. Once established, they maintain themselves because oyster larvae settle and grow on other oyster shells. The oyster bar community serves as a productive, characteristic habitat of the Bay and coastal region. The hard shells of the oysters allow many sessile organisms to attach and grow, while providing shelter to small fish, crabs, and other marine organisms. Associated animals include: sea anemones, barnacles, mussels, sea squirts, mud crabs, and oyster toadfish. Within oyster reefs, both the density and diversity of species is much higher than on adjacent soft bottom areas (Newell and Breitburg 1993).

Maryland oyster harvests accounted for about 90% of the Bay's oyster harvest in 2000. The dockside value for oyster landings in Maryland and Virginia in 2000 was about $5.5 million. This accounts for only about 10% of the nation-wide harvests (NOAA/NMFS Chesapeake Bay Office 2001).

Blue Crab.

Blue crabs (*Callinectes sapidus*) are one of the most commercially important species in the Chesapeake Bay region. In recent years, they have been the most valued commercial species in the Bay. In 2000, approximately 47 million pounds of Bay crabs were commercially harvested, carrying a dockside value of about $50 million (NOAA/NMFS 2001). This represents about 20% of the nation-wide catch for this species. But humans are not the only species that likes to feed on blue crabs, making them ecologically important as a food source for shorebirds, rays, turtles, and fish. Their biology, however, makes them a particularly difficult species to manage. Blue crabs begin their lives near the Bay's mouth, where female crabs release larvae (zoea). The currents carry the zoea out into the Atlantic ocean where they develop into shrimp-like megalopae and drift back into the Bay on wind-driven currents. Here they shed their shells and become juvenile blue crabs. They preferentially settle on SAV beds, which provide shelter and food (e.g., Heck and Orth 1980). After a year of growth, young blue crabs migrate throughout the Bay, but gender plays a large role in determining their annual migration patterns. Male crabs roam throughout the Bay searching for food, while females migrate towards the lower Bay in spring and fall to spawn. Females also overwinter in the deeper waters of the lower Bay (e.g., Schaffner and Diaz 1988). This migration pattern has led to a largely male harvest in Maryland, while the Virginia fishery largely depends on females (Chesapeake Bay Commission 2001).

Submerged aquatic vegetation beds and tidal wetlands are important to blue crab survival. Immediately after molting, crabs are more vulnerable to predators and often hide in the vegetation of wetlands or SAV beds for protection. Young crabs use these areas as nurseries, and all crabs forage within them. Studies have indicated that up to ten times more crabs can be found within grass beds than in adjacent unvegetated areas (Orth and van Montfrans 1987, Thomas et al. 1990).

With declines in other commercial species, fishing pressures on blue crabs has increased over the last several years. Researchers believe that populations naturally fluctuate, but habitat losses and increased harvest efforts have destabilized the Bay's blue crab population. The lowest recorded level of blue crab spawning stock was in 1968. Stock measurements in 1999 and 2000 hovered just above that level (Chesapeake Bay Commission 2001). The highest rates of fishing mortality, when harvesting pressures on crab stocks led experts to suggest the fishery might be in danger of collapsing, occurred in the 1970s and again in the 1990s (Chesapeake Bay Commission 2001). Maryland and Virginia are currently working together on a Bi-State Blue Crab Advisory Committee to develop a comprehensive plan to manage crabs more effectively, including possibly designating a spawning crab sanctuary in the lower Bay in Virginia (Rom Lipcius, personal comm., Chesapeake Bay Commission 2001). The long-term management of this species will also depend on the establishment of better harvest targets and continued restoration of underwater grasses.

The original natural distribution of blue crabs was from Nova Scotia to northern Argentina, but the species has been introduced to Europe and the Mediterranean Sea and has been reported in Japan (Van Heukelem 1992, Williams 1984). They are an important commercial fishery from the Carolinas to Florida, and in the Gulf of Mexico (NOAA/NMFS Chesapeake Bay Office 2001). In 2000, Maryland and Virginia waters produced about one quarter of the nation-wide blue crab harvests (NOAA/NMFS Chesapeake Bay Office 2001).

Hard Clam.

Hard clams (*Mercenaria mercenaria*) are found along the eastern coast of North America from the Gulf of St. Lawrence to Texas. They are a hardy species with few known diseases affecting wild hard clam populations. Hard clams prefer sandy areas of moderate salinity or higher (above 20 ppt) within the Bay and along the Atlantic coastline. In the Bay, this species ranges from the intertidal zone to depths greater than 6 feet (Funderburk et al. 1992). They are filter feeders and have become increasingly important to watermen as the oyster fishery has declined. In 2000, Maryland reported a dockside value of over $13,000 for hard clams (NOAA/NMFS Chesapeake Bay Office 2001). Virginia supports a large commercial fishery of hard clams, based primary on aquaculture management and harvest. Annual landings for hard clams in Virginia probably exceed $10 million. Hard clams are important food sources for blue crabs, horseshoe crabs, large fish, and gulls.

Soft Clam.

Soft clams (*Mya arenaria*) prefer relatively shallow, sandy, mesohaline areas of the upper Bay and Atlantic coastline. They occur mostly in Maryland waters, but are found in some areas of Virginia. Their distribution is restricted by several variables, particularly salinity, sediment type, anoxia, and predation. Predation is thought to be the most important source of mortality for this species, although disease and toxics are also a factor. They are an important benthic filter feeder, removing microscopic algae from the water column. Crabs, eels, rays, fish, shrimp, and waterfowl all feed on soft clams. In 2000, Maryland reported almost $1 million in dockside value from soft clam commercial harvests, representing about one-twelfth the nation-wide harvest (NOAA/NMFS Chesapeake Bay Office 2001).

Striped Bass.

Striped bass (*Morone saxatilis*), also known as rockfish, is a large, anadromous fish found along the entire eastern coast of North America (Funderburk et al. 1991). It is also found along the west coast in many bays and estuaries (Setzler-Hamilton et al. 1988). Striped bass spend most of their lives in the Bay or Atlantic ocean but throughout the late winter and spring migrate to the tidal freshwater portions of tributaries to spawn. Juveniles sometimes remain in these freshwater areas for up to two years. They can live up to 30 years and females do not reach spawning age until they are around seven years old.

The rockfish population in Chesapeake Bay represents a remarkable success story for fisheries management. In the mid-late 1970’s scientists became aware that the species was in trouble along the East Coast. Maryland issued a total moratorium on the fishery in 1985, although Virginia did not follow suit until 1989. The fishery re-opened for a limited 1990-91 season. By 1995, the Atlantic States Marine Fisheries Commission declared the species restored. Striped bass are voracious predators, mostly on fish and blue crabs. In their early life stages they are important prey for other species. There is increasing concern that low dissolved oxygen (DO) in deeper waters has reduced much of the summer habitat of adult and sub-adult striped bass (Setzler-Hamilton and Hall, Jr. 1991). Contaminants have also been associated with larval mortality in Chesapeake Bay tributaries (Mehrle et al. 1986, Setzler-Hamilton and Hall, Jr. 1991).

Striped bass landings in the Bay represent over 50% of the nation-wide totals. In 2000, over 3.5 million pounds of striped bass were commercially harvested in Maryland and Virginia waters. The dockside value of this harvest was about $5.5 million (NOAA/NMFS Chesapeake Bay Office 2001).

Shad and River Herrings.

Each spring shad and river herring come into freshwater reaches of the Chesapeake Bay to spawn. Shad and herring are anadromous, meaning they begin their lives in freshwater reaches but spend most of their adult lives in the Atlantic Ocean. Shad and herring are believed to return to their natal streams to spawn (Lippson and Lippson 1984). There are four anadromous species of shads and herrings in the Bay, each with a number of common names. American shad or white shad (*Alosa sapidissima*) and hickory shad (*Alosa mediocris*) are the largest of this group. Two species of river herrings are commonly found in the Bay, the alewife or big-eye herring (*Alosa pseudoharengus*) and the blueback herring, also occasionally called alewife, (*Alosa aestivalis*) (Lippson and Lippson 1984).

Anadromous species are more vulnerable to both overfishing and habitat losses than other fish species. Their concentrated runs make them easy targets for harvesting, and much of their spawning habitat has been blocked (especially by dams) or degraded by human disturbances and developments. Formerly some of the most abundant and valuable fisheries in the Bay, stocks of shad and herring stocks are currently depleted. Current restoration efforts focus on restocking and the removal of obstructions, or creating fish passages. Fish passages are ladders or lifts that allow migratory fish to get past large dams. Shad and herring are important food sources for a variety of animals, including osprey, green heron, striped bass, large-mouth bass, and perch.

Shad range along the Atlantic coastline from Canada to Florida. Herrings are found along the Atlantic coast, from Canada to South Carolina (EPA Chesapeake Bay Program 1989, Rulifson et al. 1982). Due to their wide range, these species represent an important ecological component of freshwater, estuarine, and marine communities for most of the East Coast. Commercial harvests of river herrings in the 1980s were 80-90% lower than during the previous decade (EPA Chesapeake Bay Program 1989). Shad have experienced similar population declines over the last several decades. There is currently no viable commercial fishery of shad within the Bay. Both shad and river herrings have suffered from the effects of pollution and over-fishing throughout their ranges.

Yellow Perch.

Yellow perch (*Perca flavescens*) are freshwater fish that are also common in the brackish waters of upper estuaries. They spawn in freshwater areas in the late winter, making them the traditional first catch for many fishermen each year. Populations of yellow perch in the Bay have declined since the mid-1960's (Piavis 1991). Increased sedimentation, eutrophication from excessive nutrient loadings, acid rain, and blockages to spawning habitat have all likely contributed to these declines. In addition, with recent declines in other major sport and commercial fish species (e.g., striped bass, shad, and herring), many fishermen have targeted more harvest effort on yellow perch (Piavis 1991). Recommendations for the restoration of this species include better land use practices (to decrease sedimentation, nutrient run-off, and toxic inputs), removing stream blockages to spawning grounds, and more restrictions on the fishery (Klauda 1989, Auld 1974, Hayward and Margraf 1987).

The range of yellow perch stretches from South Carolina north to Nova Scotia, west through the southern Hudson Bay region and Saskatchewan, and south to the northern half of the Mississippi drainage (Richkus and Stroup 1987). Although widespread along the Atlantic Coast, yellow perch suffer from habitat degradation, stream blockages, and fishing pressure throughout their distribution.

Atlantic Loggerhead Turtles.

Of all sea turtles, the Atlantic loggerhead (*Caretta c. caretta*) is the most abundant within the Chesapeake Bay region. Although this area is not an important nesting ground for the Atlantic population, loggerhead nesting has been recorded in Virginia on the barrier islands of the Eastern Shore, and on the Western Shore near the Bay's mouth (Musick 1988). The turtles usually enter the Bay in large numbers in the late spring/early summer to feed. Individuals establish home ranges of only a few miles in area, usually at the edges of channels where they move with the tide and search for food. The SAV beds here provide rich foraging grounds for them. Loggerhead turtles prey on the abundant shellfish found here, especially horseshoe crabs and blue crabs. Their diet also includes jellyfish, shrimp, fish, and sea grass. Each year, there are between 250-300 sea turtle strandings within the Bay. Most of these occur as the turtles are entering the region. Reasons for most strandings are unclear but likely involve entanglement in fishing nets, boating accidents, or illness. Loggerheads cannot overwinter in this area because the low water temperatures would be fatal.

Colonial nesting waterbirds and waterfowl aggregations.

The Chesapeake Bay region's extensive wetlands, riparian forest buffers, and beaches attract and support a large diversity and tremendous number of birds that use estuarine and coastal habitats. Over 180 species of birds regularly breed within the Mid-Atlantic region, many of which are associated with coastal habitats. Many of the waterbirds and waterfowl are identified in a recent regional report (Watts, 1999) as being conservation priorities. These species include Piping Plover, Salt Marsh Sharp-tailed Sparrow, Roseate Tern, American Oystercatcher, Seaside Sparrows, Wilson's Plover, and Clapper Rail.

Dozens of bird species migrating along the Atlantic Flyway find temporary food and shelter within the Chesapeake Bay region. Nearly a million waterfowl over-winter in the region each year. For example, tundra swans, Canada geese, and a large number of waterfowl, including canvasbacks, pintails, scoters, eiders, and ruddy ducks all spend their winters here. Large populations of bald eagles and osprey nest along the shores. Worldwide populations of these birds are dependent on available Chesapeake nesting and over-wintering habitat, as well as abundant food resources.

Among the colonial nesting waterbirds within the region are the great blue heron, great egret, snowy egret, cattle egret, little blue heron, green heron, black-crowned night heron, American bittern, and glossy ibis. These birds wade along the shorelines to forage within wetlands and tidal flats for food. Fortunately, populations of most wading birds have remained constant or increased in recent decades, as in the case of the great blue heron.

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THREATS ANALYSIS*

Ecoregional Perspective

Any discussion of threats to native species and natural communities in the eastern United States must start by acknowledging a fundamental reality and conundrum; significant natural areas occur where they do in large part because they have escaped (or survived) major impacts from human development in the past. These areas, then, are – relatively speaking – the least threatened places in the ecoregion. Conversely, important natural area sites (especially those harboring rare, threatened or endangered species and/or unique natural communities) are largely absent from the portions of the region massively disturbed by human development over the last 350 years; they have been eliminated by development or degraded to the point where they lack conservation value. In CBY, such areas include most of the central and northern portions of the western shore of Maryland (i.e., the Washington-Baltimore-Annapolis corridors and environs), suburban lands around major urban centers in Virginia (e.g., Richmond) and Delaware (e.g., Wilmington), and much of the upland landscape of the Delmarva Peninsula, which has been continuously farmed for over 300 years.

The majority of the natural areas of traditional conservation interest in CBY, then, occur in places that historically have been unavailable, unattractive or uneconomical for development or farming. Not surprisingly in this coastal plain ecoregion, many of these places occur in rural areas and are wet. Thus, much of the habitat for rare native species and high-quality natural communities in the ecoregion (as also discussed in the Portfolio - Species section, above) is provided by creeks, streams and rivers that have not been dammed or diverted, as well as swamps and marshes and other herbaceous and forested wetlands that have not been drained or filled, built on or plowed (or which have recovered from such impacts in the past).

Most of these wetland and aquatic sites in CBY remain unsuitable for other uses, under existing construction and engineering techniques, and given current federal, state and county environmental protection regulations, which recognize the value of the ecosystem services provided by such areas and their contributions to open space and buffer area needs. Thus, many sites are unlikely to be directly damaged or converted to other uses – that is, reduced in size - in the foreseeable future.

At the same time, the current viability of many of these sites may be poor due to past and ongoing impacts that degrade the condition of the occurrence, its landscape context, or both. In addition, future land cover/land use changes may further degrade either or both of these viability criteria, threatening the long-term health of many sites. These threats fall into three general categories: 1) alterations in water (and/or habitat) quality; 2) alterations in water quantity; 3) alterations in regional processes.

Alterations in Water/Habitat Quality

Many of the rivers, creeks, and streams in the Chesapeake Bay Lowlands ecoregion – as well as in the eastern United States more generally – are in poor or fair condition. In Maryland, only xx% of the 1,000 streams and rivers sampled from 1996 to 2000 were judged to be in good condition, while many – including those in the Nanticoke, Pocomoke and Choptank watersheds

* Samson, D.A., M.G. Anderson et al. 2003. Chesapeake Bay Lowlands Ecoregional Conservation Plan; First Iteration, Edited. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA

in CBY – were judged to be in poor condition, based on measurements of both water quality and diversity and abundance of macroinvertebrates (Maryland Biological Stream Survey, 2001). On Maryland's Eastern Shore, and in western shore rural areas dominated by agriculture, the primary cause of poor water quality is nonpoint runoff of excess nitrogen, phosphorus and sediments from crop land (MBSS, 2001). These patterns also likely characterize similar regions of Delaware and Virginia.

On the one hand, no-till techniques and other conservation, best-management farming practices have become common in recent years, reducing sediment and nutrient runoff from farm lands. At the same time, though, runoff from hundreds of poultry houses and thousands of tons of poultry manure applied to farm fields (as fertilizer) remains a significant source of excess nutrients in creeks and rivers in the region. In addition, many waterways in the ecoregion—including thousands of miles of drainage ditches and channelized streams on Delmarva—continue to lack vegetated riparian buffers along their banks, so filtering of surface and groundwater runoff is minimal (MBSS, 2001).

Although quantitative research is lacking, excess nutrients and sediments in surface waters of the ecoregion are presumably also impacting tens of thousands of acres of vegetated floodplain swamp and marsh habitats (nontidal and tidal) associated with flowing waters. Excess sediments may particularly affect tidal marsh communities, because significant differences in species composition and abundance are associated with small differences in substrate elevation (relative to tidal range). But nutrient enrichment, too, might lead to altered marsh and swamp communities, since competitive interactions among co-occurring plant species often depend on resource availability and species-specific absorption rates. Since many rare plant species grow in, and many rare animal species are associated with, these wetland and aquatic habitats in CBY, degradation of site condition potentially affects numerous ecoregional conservation targets at dozens of portfolio sites.

Water quality impacts to isolated, ground-water dominated wetlands (e.g., vernal ponds, coastal plain ponds, wet flatwoods) have been poorly studied, especially on the Delmarva Peninsula, where they are most abundant. Research at coastal plain sites – which are dominated by porous, sandy soils - has confirmed that nutrients and other agricultural chemicals are transported into seasonal wetlands from adjacent farm land through groundwater. Further, the rate of those transport processes is such that it takes decades for nutrients applied to a field to show up in a wetland a few hundred meters away. Thus, the condition of some (many?) rural sites will continue to be affected by threats present long ago, even as the threat of similar impacts in the future diminishes as best-management practices improve and/or land use changes. Again, however, the degree to which the condition of these wetlands has been, and continues to be, degraded by alterations in ground water quality remains largely unknown.

Since new farm land is generally not being developed in the ecoregion, and numerous conservation incentive (e.g., CREP – Conservation Reserve Enhancement Program) and regulatory approaches (e.g., for poultry manure storage and field application) are likely to further reduce nutrient and sediment runoff in the future, this major historical threat to a large number of portfolio conservation areas will likely decline over time. Simultaneously, however, a small but steady proportion of farm land is being converted to other uses every year, over an area totaling tens of thousands of acres in the ecoregion. Most of this conversion involves farm fields being developed as residential communities, often single-family homes on small (1/4 to 5 acres) lots.

Unfortunately, research documenting changes in water quality in streams and rivers following significant conversion of land from agriculture to residential development in watersheds is lacking. Intuitively, we would expect that the net effect – improved water quality versus further degradation – would depend specifically on the amount, type and pattern of development constructed on the site. For example, if we start with a typical 60 acre farm field used to grow corn or soybeans every year, and transform that field into, say, 120 single-family houses, each with a well-manicured lawn and paved driveway, accessed by multiple paved lanes, and lacking much in the way of a stormwater management system, the nutrient runoff (from lawn and garden fertilizers) into the local stream might easily increase, and the runoff of new and different chemicals (weed killers, pesticides, car oil, household solvents, etc.) will likely increase dramatically, especially given the increased impervious surface area. In addition, since such rural developments typically use individual septic systems, rather than municipal wastewater treatment, nutrients and other chemicals will continue to infiltrate into the local water table aquifer, potentially enriching nearby wetlands and waterways for decades to come.

On the other hand, the same farm field developed as 10 five-acre house lots, with 10 acres of community open space, lots of replanting of trees and shrubs, and a state-of-the-art stormwater management system might produce a significant reduction in nutrient and chemical runoff into local waterways. Average application rates (per acre) of fertilizer would be much lower and absorption by vegetation would be higher in the development versus the farm field. Soil erosion and sediment runoff to local waterways is also likely to be lower for any type of residential development versus that from cultivated farm land, in spite of the greater cover of impervious surfaces. If woody cover (trees, shrubs, patches of woods) increases significantly over time under the low-density development scenario, that 60 acres would also provide improved habitat for common, generalist animal species (vertebrate and invertebrate), compared to the minimal habitat available from cropland, or high-density residential development.

Statistics are unavailable, but personal experience suggests that a typical new residential development built on converted farmland on the Delmarva Peninsula most resembles the first scenario, at a smaller scale. That is, lots sizes are usually ½ ac or less, but the acreage typically developed is lower (10-20 acres) and some portion of the converted land is left undeveloped. Thus, both the amount and the scale of the impact on local wetlands and waterways would be lower. Where farm land is being converted to residential development on the western shores of both Maryland and Virginia, lot sizes are generally larger (1/2 – 2 acres), houses are much larger, and the scale of the average development is probably larger (e.g., 50-100 acres). At the same time, these “suburban” developments are probably much more likely – due to county regulations - to tie into municipal wastewater treatment systems, set aside land as community open space, and use state-of-the art stormwater treatment systems.

Larger house lots (e.g., 3-5 acres) in new developments on either side of the Chesapeake Bay are more typical on properties that are currently forested. Alterations in water quality (esp., increased nutrients and chemicals) in nearby wetlands and waterways following forest conversion to this kind of residential development are likely to be extremely localized, and significant cumulative impacts might only occur (and/or be measurable) where several hundred new homes are constructed in one small watershed. Again, research documenting changes in water quality (i.e., site condition) of local streams and rivers due to conversion of nearby farm land or forest land to housing developments, is sadly lacking.

If determining the net effects of current and future land use changes on site condition (water and/or habitat quality) seems difficult, determining the net effects of those changes on the other measure of site viability - landscape context – is nearly impossible. We can be absolutely certain that any time forested or vegetated land adjacent to a wetland or aquatic conservation area is developed (for farm land, housing, or commercial or industrial development, and associated infrastructure), the landscape context will be degraded either directly (i.e., loss of habitat and connectivity) or indirectly (increased invasives, edge effects, incidental take, etc.). Beyond that, is landscape context better or worse if the adjacent land is farmed or developed for housing? How does the pattern and scale of development affect landscape context? Are there thresholds for impact related to type and scale of development? If so, are they related to the type and scale of the site? What if site condition is improved, but landscape context is degraded by land use changes around conservation sites? The answers to many of these questions, and many more like them, are unknown, and probably undeterminable.

Alterations in Water Quantity

Surface Waters

In general, most creeks, streams and rivers in the Chesapeake Bay Lowlands ecoregion probably experience larger peak flows, of higher velocity but shorter duration, than in pre-Colonial periods (supporting refs?). On the western shore this result is due to impervious surface cover, which reduces infiltration, and transportation and stormwater management infrastructure, which concentrates and speeds up runoff. On the Delmarva Peninsula the same result is due to the thousands of miles of drainage ditches and channelized streams - built over many decades in the past - that are engineered to remove excess surface and groundwater from agricultural land (which covers 46% of the landscape).

On the other hand, the low-elevation, low-gradient topography in CBY has kept the ecoregion largely free of dams, which are a major threat to aquatic systems in many other ecoregions. Dozens (hundreds?) of low-head dams exist in CBY, but these have minimal impacts on the hydrological dynamics of coastal plain streams and rivers, and they are generally not considered to be serious threats to conservation areas. Ironically, at a number of sites in CBY where old millpond dams have been blown out by past storms or have collapsed over time, the remnant wetland upstream of the former dam provides high-quality habitat for rare plants and animals (pers. obs.).

Generally speaking, new dams and drainage ditches are not being constructed in the ecoregion, so the threat of significant alteration in surface water flows in the future from these sources is small. Further, although few projects have been done to date, we expect that federal, state and local agencies, as well as private organizations, will be doing more and more habitat management projects in the future that involve dam removal, ditch filling, and channelized stream restoration.

Groundwater

The greatest threat to water "quantity" in the Chesapeake Bay Lowlands ecoregion – for both human and natural communities – may be diminished groundwater aquifers. Surface aquifers have been already been significantly depleted/lowered by withdrawals for large municipal wells around major towns on Delmarva in recent decades. In addition, massive and long-term withdrawals for urban/suburban centers on the western shore of the Bay are not only depleting local aquifers, but are also depleting deep aquifers under the Delmarva Peninsula, since the western shore serves as a recharge area for those deep aquifers. Municipal and domestic wells around the region are running dry, and new wells are having to be drilled much deeper in order to find water.

At the same time, a considerable amount of groundwater is being withdrawn from surface and deep aquifers on the Delmarva Peninsula for agricultural irrigation. Data on total numbers of systems (generally, center pivot spray), locations, and the amounts and timing of withdrawals are hard to come by, and obviously vary significantly among seasons and years, depending on weather. Beyond that, assessments of the magnitude, scope and cumulative effects of agricultural irrigation on surface and groundwater hydrology – and thus wetland and aquatic ecosystems - on the Peninsula are lacking, making it difficult to draw even general conclusions about the degree of threat. For example, where numerous irrigation systems in close proximity are drawing large volumes of water from the surface (water table) aquifer in hot summer months – with most of the irrigation water then lost to evaporation and evapotranspiration – local groundwater will be depleted and surface water flows will likely diminish significantly. Alternatively, where a number of nearby irrigation systems are drawing water from a deep aquifer and applying it to fields under moderate weather conditions, local groundwater levels and surface water flows might actually be enhanced, or at least prolonged over time relative to conditions that would have occurred without infusion of deep water into the surface system. Wetland and aquatic natural areas adjacent to irrigated farm land would obviously fare very differently under these two scenarios.

Regional changes in weather patterns may compound the threat of overuse of groundwater resources in CBY (and possibly the entire eastern US). The Mid-Atlantic is currently (April, 2002) experiencing one of the worst and most prolonged drought periods in the last 100 years. This episode follows a severe regional drought in 1999, when water conservation measures were necessary in order to ensure adequate supplies for homes and businesses. Whether or not these recent droughts are indicative of a longer-term change in precipitation patterns in the Mid-Atlantic region is unknown. Global climate change models predict that this portion of North America will warm slightly, with minimum – nighttime – temperatures increasing much more than maximum – daytime – temperatures, and that annual precipitation will increase slightly, on average. But the resolution of the models is too poor to characterize expected effects within CBY, per se, and the confidence intervals around the model predictions are large relative to normal interannual variation in climate, making it nearly impossible to attribute short-term trends to global climate change, even where they fit predicted patterns.

Alterations in Regional Processes: Sea Level Rise

Aside from significant climate change, the single greatest future threat to both human and natural communities in the Chesapeake Bay Lowlands ecoregion is sea level rise. Current models predict an increase of from 12 to 24 inches over the next 100 years in the Mid-Atlantic region. In some areas of CBY, especially on the western shore of the Bay, sea level rise in this range over the next several decades may not produce significant impacts on human communities and developments, which are generally located a meter or more above mean high tide. Sea level around the Bay has already increased xx inches on average since 1900 (a combination of regional sea level rise and local land subsidence; refs), and shoreline topographic relief is such that measurable flooding of new ground is likely to be minimal in many areas.

On the other hand, a significant portion of the land area of the Delmarva Peninsula is less than 1 m above sea level, and a number of the major rivers on the western shore of both Maryland (e.g., Patuxent, Zekiah Swamp Run/Wicomico, Mattawoman) and Virginia (e.g., Rappahannock, Mattaponi, Pamunkey, Chickahominy) have extensive floodplains at very low elevations (Map 1). Clearly, the effects of sea level rise in such low-lying areas will depend on the exact magnitude and rate of rise. If the actual change is near or below the lower end of the predicted range and/or occurs slowly, impacts on farm land, residential communities, commercial developments and transportation infrastructure in CBY may be relatively minor, and/or will be minimized by mitigation measures engineered over the coming decades.

Impacts on tidal and nontidal aquatic and wetland natural communities, however, are likely to be significant, although many of the effects may be much more subtle, indirect and complex than simple flooding of low-lying lands. Tidal reaches will expand upstream, altering tidal ranges and periodicity in tens of thousands of acres of floodplain swamps and marshes. Even above tidal reaches, flows of rivers and creeks will be slowed and raised, altering the hydrology of thousands of additional acres of freshwater swamps and marshes. Salinity levels in the expanded tidal areas will increase, further affecting the composition and abundance of native plant species in low-lying wetland and aquatic communities, and altering both the composition and distribution of aquatic animal communities, with unpredictable effects on existing vertebrate and invertebrate species. Ocean, bay and river water average temperatures are expected to rise, with similarly complex and unpredictable results on aquatic plant and animal communities. Groundwater levels in lowlands in the downstream portion of watersheds will likely rise and/or remain higher during longer periods of the year, and/or be affected by salt water intrusion, altering both human uses of that land (e.g., for farming, pulpwood harvest) and the composition and functioning of local wetlands dominated by groundwater hydrology. Streambank erosion rates will likely increase, adding sediment loads to waterways and creating new channels and drainage patterns in floodplains. Increased inundation and/or salinity levels may lead to high mortality of one or more tree species in tidal and nontidal swamps, leading to dramatic changes in swamp forest composition and functioning, with subsequent impacts on native animal communities inhabiting these wetlands.

Threats to the Chesapeake Bay and Coastal Bays

The Chesapeake Bay Watershed

The Chesapeake Bay, the largest estuary in North America and the dominate natural feature of the ecoregion, drains 83% of the land area of CBY. At the same time, the ecoregion makes up only 16% of the total 64,000 square mile land area of the Bay watershed, and lies at the “bottom” or downstream end of all of the major rivers feeding the Bay. Thus, human activities and natural events throughout the Bay watershed are highly relevant to, and may directly or indirectly affect, most of the ecoregional conservation targets and sites in CBY. Any assessment of environmental conditions in the entire Bay watershed, however, may or may not accurately characterize patterns and trends present in the smaller CBY area. Conversely, assessments of past, current and future conditions and threats in the ecoregion per se (even just for the portion within the Bay watershed), likely misrepresents the typical situation in other subregions of the larger watershed, given notable differences in both human and the natural landscapes between the coastal plain ecoregion and the Appalachian and Piedmont areas that form the upstream Bay watershed.

A comprehensive discussion of threats to the Chesapeake Bay and its component systems is beyond the scope of this ecoregional plan. Only a brief summary, drawn primarily from Environmental Protection Agency reports and the annual *State of the Bay* reports issued by the Chesapeake Bay Foundation, will be presented here. Stresses and sources affecting the estuarine, coastal and marine conservation targets identified in this plan are discussed above and in Appendix ECM1. Considerable information on the health and condition of the Chesapeake Bay, component species and ecological communities, and the Bay watershed, is available from the Chesapeake Bay Program (website link here), the Chesapeake Bay Foundation (web link), and numerous other federal, state and local agencies and private organizations that work on conservation of the Bay, and/or parts of the Bay watershed.

State of the Bay

Since 1983, the Chesapeake Bay Foundation (CBF) has tracked the status of about a dozen factors that measure or reflect the health of the Bay. The factors fall into three categories - habitat, fisheries, and pollution – and each September CBF issues an annual report that presents the ranks of each factor and a overall score for the "state" of the Chesapeake Bay. The ranks are based on assessments made by CBF staff using the best available scientific data and information, and range from "0" (absolute worst condition) to "100", which represents the presumed "pristine" condition present at the time of John Smith's exploration of the Bay in 1607.

According to the Foundation, the health of the Bay declined throughout the 20th century until 1983, when it reached a low point – an overall score of 23 – and began to improve (Table t1). The pace of improvement (or at least no further overall deterioration) since 1983 had been slow but steady until last year, when for the first time the overall score declined from the previous year. That decline occurred in spite of improvement in Forest Buffers, because both Resource Lands and Crabs declined significantly from the year before (Table t1). New estimates of the annual rate of loss of open land to development are higher than the figures CBF had been using previously, so that factor was reduced (CBF, 2001). For Crabs, continued low harvests, in spite of intensive fishing pressure, suggests that that fishery is in serious trouble.

Scores for most of the factors tracked in CBF's State of the Bay reports have changed little in recent years. Decimation of the oyster and shad fisheries, relative to historic levels, keep those values close to zero, although the shad population has begun to make a slow recovery (Table t1). Three of the Pollution factors (Water Clarity, Dissolved Oxygen, and Nitrogen/ Phosphorus) and Underwater Grasses rank consistently low, and are interdependent; poor water quality suppresses growth of submerged aquatic vegetation (SAV), while the absence of SAV means that nutrient absorption and generation of oxygen is low. But the lack of recovery in the oyster population in the Bay is thought to be a major impediment to better water quality, since the millions of oysters that once carpeted the Bay are estimated to have been able to filter the entire water volume of the Bay every three days.

Table t1. Summary of Chesapeake Bay Foundation's "State of the Bay" scores for 1998-2001.

		Ranks		
Factor	**1998**	**1999**	**2000**	**2001**
Habitat				
Wetlands	43	42	42	42

Forest Buffers	53	52	52	54
Underwater Grasses	12	12	12	12
Resource Lands	33	33	33	30
Fisheries				
Rockfish	70	75	75	75
Crabs	50	48	46	42
Shad	2	3	5	6
Oysters	1	2	2	2
Pollution				
Toxics	30	30	30	30
Water Clarity	15	16	15	15
Dissolved Oxygen	15	15	15	15
Nitrogen/Phosphorus	15	16	15	15
Overall Score	**27**	**28**	**28**	**27**

The Chesapeake Bay Program has also recently assessed the state of the Chesapeake Bay (CBP, 1999). Their report confirms the extremely poor condition of the oyster and shad fisheries, although they point to the continued elimination of fish blockages (or construction of fish passages) as a hopeful sign for rebound of shad and herring populations. Among living resources, major success stories include regional recovery of rockfish and bald eagle populations, and abundant/healthy or increasing populations of seven fish species and 13 waterfowl species characteristic of the Bay region. At the same time, 11 other native fish species are described as low (or decreasing in) abundance, or overfished, and populations of seven native species of waterfowl have declined 22 to 60 percent since the mid-1970's (CBP, 1999). In addition, populations of four waterfowl species (snow goose, resident mallards, resident Canada goose, and mute swans) considered to be pest or invasive species have increased dramatically, eliminating foraging and nesting habitat for native species.

According to the Chesapeake Bay Program, nitrogen levels in non-tidal portions of most of the major rivers draining into the Bay, and tidal portions of the rivers on the western shore of the Bay, have declined or remained stable between the 1980's and 1997, with improvements largely due to reduced discharges from point sources (CBP, 1999). Levels of nitrogen in tidal portions of major rivers and adjacent areas of the Bay on the eastern shore (i.e., Delmarva Peninsula), however, have increased during the same time period, reflecting the effect of nonpoint runoff from thousands of acres of farm fields. Phosphorus levels in the same segments of nontidal and tidal rivers have generally decreased over time, with only a few watersheds showing higher levels (again reflecting nonpoint runoff from agricultural land). As of 1999, the goal of reducing nutrient inputs to the Bay by 40% by the year 2000, established by the first *Chesapeake Bay Agreement* in 1987 (with subsequent amendments), appeared to be achievable for phosphorus but not nitrogen (CBP, 1999).

Unfortunately, sediment concentrations in major rivers flowing into the Bay have not shown a consistent pattern of decline since the mid-1980's, and water clarity has worsened over time at almost all locations sampled in the mainstem Bay and tidal tributaries (CBP, 1999). This situation appears to be due to a increased frequency of much higher-than-average annual flows of freshwater into the Bay since 1972, when Tropical Storm Agnes flooded the Bay with an unprecedented flush of freshwater, nutrients, sediments, man-made chemicals, and artificial and natural debris. Particularly during short-term, regional storm events, excess precipitation washes over hundreds of thousands of acres of developed and farmed lands in the watershed, carrying an enormous volume of dissolved chemicals and particulate matter – as well as the water itself - into an estuary that is no longer well-equipped to absorb it. The largest annual freshwater flow into the Bay on record – almost twice the long-term average - occurred in 1996. Ironically, regional droughts are generally good for the Bay; runoff of nutrients, sediments and other toxic materials decreases significantly, and brackish water areas move upstream, providing expanded habitat for marine species.

Future of the Bay

The Chesapeake Bay Foundation has set the goal of having the overall score in their annual *State of the Bay* report reach 40 by 2010, and they believe it may be possible to have the score reach 70 by 2050. *Chesapeake 2000*, the revised Chesapeake Bay Agreement, was signed by Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the US Environmental Protection Agency two years ago, and sets dozens of objectives under five major new goals that the parties to the Agreement commit to achieving by 2010 or earlier (see Agreement on CBP website for full details). Both the Foundation and the members of the Bay Program consortium continue to invest significant resources in carrying out numerous scientific research projects, community outreach and education programs, and on-the-ground restoration projects (e.g., building oysters reefs, planting SAV beds, restoring riparian vegetation) that have proved successful in the past.

But major challenges to improving the health of the Chesapeake Bay and its watershed in the future remain. Much of the progress in the last 15 years has been due to specific, measurable changes that have been relatively easy to implement – removing phosphate from laundry detergent, controlling nutrient and chemical discharges from point sources (commercial and industrial facilities, municipal wastewater treatment plants, etc.), installing fish passages (or removing blockages), and others. But further progress on reducing some impacts will be much harder, take longer, and be much more expensive. For example, research has shown that 66% of the phosphorus and 57% of the nitrogen entering the Bay comes from nonpoint sources (especially farmland), making control of these nutrient streams much more difficult. Further, 9% of the phosphorus and an astounding 21% of the nitrogen entering the Bay and its tributaries comes through atmospheric deposition (indirectly on watershed land and directly into the water); reducing these inputs will require dramatic improvements in controlling emissions from power plants and factories in the mid-west, as well as from vehicle tailpipes in a Chesapeake Bay "airshed" that stretches from Canada to Indiana to South Carolina (CBP, 1999).

More importantly, a tidal wave of increased human development in the region and the watershed threatens to overwhelm the modest improvements in Bay health that have occurred over the last 20 years. While regional population growth over the next 10-15 years will be slower than the pace from 1970 to 1997, it is estimated that 3 million additional people will live in or near the Bay by 2020 (CBP, 1999). More notably, patterns of suburban development and modern work and lifestyles are such that vehicle miles driven increases at about four times the rate of population growth (a rate that is clearly unsustainable over the long term). Although the Bay watershed is still 59% forested, a steady increase in forest cover in the region after the end of the

Civil War reversed in the mid-1970's (CBP, 1999). For example, tree (and/or forest) cover in the Washington metropolitan area decreased by xx% between 1973 and 1998 (American Forests, 19xx).

Currently, about 35,000 acres of farms, wetlands and forests are converted to development each year in the Bay region. The Chesapeake 2000 Agreement commits to a goal of having 20% of the land area of the watershed protected by 2010. The Mid-Atlantic Division of The Nature Conservancy has recently committed to developing a new conservation initiative for the Chesapeake Bay; working to help achieve the 20% land protection goal may be the best contribution that the Conservancy can make to the future of the Bay.

Coastal Bays

The coastal bays of the Delmarva Peninsula - Rehobeth and Indian River in Delaware, Little Assawoman, Assawoman, Isle of Wight, Sinepatuxent and Chicoteague in Maryland, and Chincoteague and Hog Island in Virginia – are a major landscape feature of the ecoregion, stretching almost 140 miles from Cape Henlopen in Delaware to Cape Charles in Virginia and encompassing over 380,000 acres of shallow water and salt marsh ecosystems. But with the Chesapeake Bay to the west, Delaware Bay to the north and the Atlantic Ocean to the east, the coastal bays were long treated as the "poor sister" of the region, receiving far less scientific, regulatory and media attention than the larger water bodies around them. Commenting on this imbalance, one recent description of the coastal bays likened them to "...a little sliver of meat between...two thick pieces of bread" (Kutz et al., 1999). Similarly, an earlier conference on coastal bays in Maryland was entitled "Focus on Maryland's Forgotten Bays" (Report, 1990).

Our understanding of the environmental health and ecological functioning of the coastal bays has improved significantly in the last decade, however, due to new scientific research and extensive field monitoring programs carried out by federal and state agencies (Kutz et al. 1999). Much of this work was catalyzed by local citizens groups, community associations, and coastal county governments, who saw a clear linkage between land use changes, rampant coastal development and increasing degradation of "their" coastal bay ecosystems, especially in Delaware and Maryland (Report, 1990, EPA, 1996).

As with the Chesapeake Bay, however, a comprehensive review of the environmental health of the coastal bays is beyond the scope of this Plan. Major threats and trends will be summarized below, with details available elsewhere (Kutz et al. 1999, Maryland Coastal Bays Program website, Delaware Center for the Inland Bays website).

The major threats to the coastal bays include excess nutrients from agricultural runoff (from both cropland and poultry operations), toxic chemical and nutrient (sewage and septic) inputs and habitat loss (esp. wetlands, forest) from development, and overfishing (both commercial and recreational) of finfish and shellfish populations. These are the same major threats that affect the Chesapeake Bay, but the consequences of the impacts are somewhat different in the coastal bays. They also vary significantly from north to south, reflecting gradients in landform, watershed size, land use, mixing rates (with Atlantic waters), development pressure and living resources that extend down the coastline, and which are interrelated.

Compared to the 200 mile-wide, 450 mile-long Chesapeake Bay watershed, which is 16 times the size of the Bay itself, the coastal bays receive freshwater from creeks that extend barely ten miles inland in the north and less than five miles in the south, draining a total "watershed" area of only about 400,000 acres. Also unlike the Bay, the northern bays (Rehobeth, Indian River, Little Assawoman, Assawoman, Isle of Wight, Sinepatuxent) have limited openings to the Atlantic (Indian River and Ocean City inlets only), especially relative to their size, which dramatically restricts the rate at which bay water is "flushed" to the ocean. In the southern bays in Virginia, by contrast, barrier islands are lacking, and bay and ocean water mixes freely, flowing around and through extensive salt marsh complexes.

Unfortunately, runoff from more than half of all of the cropland in the combined coastal bay watersheds flows into the northern bays (especially Rehobeth, Indian River, Little Assawoman, Assawoman, and Isle of Wight), and the bulk of the coastal development in the ecoregion is also concentrated around those bays. Dense commercial and residential development stretches 25 miles, on both the ocean and bay shorelines, from Rehobeth Beach, Delaware to Ocean City, Maryland, broken only by two relatively undeveloped state parks. With more than 10 million visitors coming to the coast each year for recreation, bay waters and living resources are directly impacted by tens of thousands of people boating, jet-skiing, crabbing, clamming and fishing every day. And these recreational harvests come on top of commercial fisheries for hard clams, blue crabs, sea trout, and several other species of fish (Kutz et al., 1999).

Not surprisingly, then, recent studies have shown that water quality is poor and benthic communities are most severely degraded in Indian River Bay, while conditions in Rehobeth Bay, Assawoman Bay, and Sinepatuxent Bay are progressively less degraded, in that order (Kutz). Chincoteague Bay was the least impacted of the major bays. But new sampling further south in Virginia's bays, where agricultural and development impacts are lowest, and flushing rates are highest, showed moderate levels of degradation, a result that is currently unexplained (Kutz).

In northern bays, too, chemical contamination in sediments is high, including levels of persistent pesticides no longer commercially available (e.g., DDT, chlordane, dieldrin) that clearly entered the system in years past but have not been flushed to the Atlantic or broken down by decomposers (Kutz). Fish community composition in Maryland bays is good, but has shifted towards stress-tolerant, generalist species in Delaware bays, a pattern that parallels the observed differences in water quality and other living resources (e.g., SAV cover, benthic communities) between these water bodies (Kutz).

Toxic algal blooms and declining horseshoe crab populations have garnered considerable media attention over the last several years as major potential threats to the coastal bays, as well as both Chesapeake Bay and Delaware Bay. But good scientific data to support patterns and trends for these organisms are lacking. Pfisteria outbreaks, which kill massive numbers of fish and cause significant human health problems, have been largely absent from the mid-Atlantic since 199x, when a number of the Bay's tributaries were severely affected. Red tides kill fish but are not a major threat to human health, while brown tides render shallow waters murky, reducing light levels and causing SAV die-off. Sampling in 1998 and 1999 revealed the presence of the organism responsible for brown tides in Maryland's but not Delaware's coastal bays.

Horseshoe crabs spawn by the millions in early summer on the shores of Delaware Bay and at other sandy beaches along the Atlantic shoreline and in the lower Chesapeake. Their eggs serve as a vital food source for millions of migrating shorebirds, which stop to feed on Delmarva beaches to replenish their depleted reserves before continuing north to their summer breeding grounds. With the crab fishery in decline, many commercial fisherman have turned to harvesting eel and conch, which are traditionally caught with traps baited with horseshoe crabs. While some evidence suggests that regional populations of the horseshoe crab are in decline, other assessments argue that such trends cannot be documented.

Last, but certainly not least, coastal bays along the Delmarva Peninsula are severely threatened by sea level rise and global climate change. As discussed above, direct ecological impacts of a 12-18 inch increase over the next 50-100 years in the Mid-Atlantic region would include massive loss of marsh and floodplain habitat, upstream extensions of tidal reaches, increased shoreline and streambank erosion, and alterations in stream and river hydrology. Coupled with the expected increased air and water temperatures, increased precipitation (and therefore freshwater flows and runoffs) and the likelihood of larger and more frequent Atlantic storms, however, the indirect effects – cascading through multiple interdependent plant and animal communities and trophic layers - may exceed the direct impacts, and yet are far more difficult to predict.

Faced with these known threats to the health of the coastal bays, predictions of significant population growth in bay watersheds in the near future (with all of the attendant impacts on lands, waters and environmental quality), and mindful of the estimated $3 billion annual economic impact from commercial and recreational activities associated with the coastal bays, both Delaware and Maryland have launched new coastal bay initiatives in recent years. Maryland developed a Maryland Coastal Bays Program in 1996, as a partnership among the towns of Berlin and Ocean City, Worcester County, the state Department of Natural Resources, Dept. of Agriculture, Dept. of the Environment, and Office of Planning, the National Park Service and the US Environmental Protection Agency. In 1999, the MD Coastal Bays Program produced a comprehensive conservation and management plan for Maryland’s coastal bays, containing four Action Plans for the long-term restoration and protection of the bays: 1) water quality; 2) fish and wildlife; 3) recreation and navigation, and; 4) community and economic development. Planning is not as far along in Delaware, but the Delaware Center for the Inland Bays was recently developed to lead the state’s work on the coastal bays.

Threats to Upland Natural Communities

In the eastern United States, one of the most significant and ubiquitous threats to native species and natural communities in terrestrial, upland habitats is human development, with all of its associated impacts. Residential, commercial and industrial development and the necessary accessory infrastructure – roads, utility corridors, impervious surfaces, stormwater management structures, and so on – cause considerable habitat destruction and fragmentation (of both uplands and wetlands), altered surface and groundwater hydrology, and degraded water quality in streams and rivers. Urban/suburban development also causes a host of more subtle direct and indirect effects; degraded environmental conditions along edges of natural areas, facilitation of overabundant (e.g., white-tailed deer) and invasive species (dozens of weed species), and direct killing of plants (e.g., ROW mowing and spraying, park trails, direct harvest) and animals (e.g., by pet cats, automobiles, boys with BB-guns, insecticide spraying).

Matrix Forest Blocks

Not surprisingly, and as was the case for many of the aquatic and wetland conservation sites in CBY, the matrix forest blocks are primarily located in the most rural portions of the ecoregion, or in areas where large tracts of seasonally wet woods predominate, precluding development or restricting it to local areas of high ground. In Maryland, six of the 13 blocks occur in “southern” Maryland (i.e., Charles, St. Mary’s and Calvert counties on the western shore), which until recently was rolling farm and forest country, beyond the acceptable commuting distance to

Washington or Annapolis. On Maryland's eastern shore, five other blocks fall in the extensive "low country" around the Blackwater and Nanticoke rivers in Dorchester County, or in the wet woods landscape around the lower Pocomoke River and its tributaries. In south-central Delaware, the Redden-Ellendale block captures extensive forest wetland acreage along and among multiple headwater streams of the Nanticoke River. Further south on the Maryland-Delaware border, the Great Cypress Swamp matrix forest block encompasses one of the largest nontidal wetlands along the East Coast, and then extends south to capture a large wetland complex along the headwaters of the Pocomoke River. Similarly in Virginia, the Upper Rappahannock and Dragon Run matrix blocks encompass large areas of floodplain habitat along rivers in a very rural portion of the state. Even the Blackbird-Millington block, which straddles the MD-DE line in the north-central Delmarva Peninsula, is centered on an extensive series of coastal plain ponds (Delmarva bays) and interconnecting wet woods.

Only four of the 20 matrix forest blocks identified in CBY don't fit this pattern of rural location and/or high proportion of wetland acreage; two of these are military bases (Aberdeen in Maryland and Fort A.P. Hill in Virginia) and one is a federal wildlife research center (Patuxent) that doubled in size in the early 1990's when more than 7,000 ac of mostly undeveloped land at the adjacent Fort Meade was transferred to Patuxent. Elk Neck, at the head of the Bay in Maryland, is the only non-federal matrix forest block in CBY that consists primarily of upland habitats and is located relatively close to major urban/suburban centers.

The CBY matrix forest blocks that occur in rural areas and are dominated by floodplains, nontidal wetlands and low, wet woods – perhaps a third of the total - are probably minimally threatened by new anthropogenic impacts, at least in the near future. The most significant past and current threats include logging, farming and fragmentation from rural roads. Logging for pulpwood and/or timber has probably occurred in large areas of every one of these blocks over the last few decades, with impacts that would include construction of roads (generally dirt) and drainage ditches, and replanting of clear cuts in loblolly pine plantations. Farming in upland areas of these blocks generally makes up 10-20% of the land use, with all of the attendant impacts on streams and wetlands discussed in detail above.

Forested stands and other upland and wetland natural communities on the two military bases and in the Patuxent matrix forest block are probably also relatively safe from major new stresses in the near future, baring significant alterations in the mission and/or operations of these federal facilities. Private lands within the draft block boundaries, however, are likely to be developed, and edges of forested areas on federal land will continue to be affected by adjacent urban/suburban developments and infrastructure.

In addition to Elk Neck, the CBY matrix forest blocks most threatened by current and future human development are those in southern Maryland. With state highway improvements reducing commuting times in recent years, northern Charles and Calvert counties have become bedroom communities for Washington and Annapolis. Soaring residential development rates, along with associated commercial and infrastructure development, threaten both the Mattawoman and Calvert Cliffs blocks. Further south, a significant expansion in personnel and operations at the Patuxent Naval Air Test Center (as a result of Congressionally mandated base closings/realignment) is fueling a similar upsurge in suburban sprawl in southern Calvert and St. Mary's counties, threatening the St Mary's and McIntosh matrix forest blocks. Finally, although a large portion of the core corridor of the Zekiah block is forested floodplain swamp that will never be developed, residential and commercial development threatens upland buffer areas, especially in the headwaters area of northern Charles County.

Upland areas beyond the extensive floodplain swamps and marshes in the Upper Rappahannock and Dragon Run matrix blocks in Virginia are also vulnerable to new development (or growth in existing communities), but these blocks are sufficiently distant from major population centers that significant suburban sprawl is not likely in the near future.

Other Upland Natural Communities and Terrestrial Species Conservation Targets

As discussed above, very few of the species conservation targets in CBY are associated with terrestrial, upland habitats, and only a small fraction of the natural community targets belong to that category. Proportionally, therefore, the number of portfolio sites in CBY that support viable occurrences of upland targets is relatively small.

Assessing regional threats to a diverse collection of upland species and natural community targets is difficult, and in some cases natural and anthropogenic processes and activities that threaten one species or community may be beneficial to others. For example, frosted elfin butterflies (*Callophrys irus*), Cream-flowered tick-trefoil (*Desmodium ochroleucum*) and Box huckleberry (*Gaylussacia brachycera*) all require open or sparse woodland habitats, the kind that would have been created after wildfires burned through dry, oak-pine forests on sandy ridges on the Delmarva Peninsula in pre-Colonial times. Species like the Delmarva fox squirrel (*Sciurus niger cinereus*), Sweet pinesap (*Monotropsis odorata*) and Virginia least trillium (*Trillium pusillum* var. *virginianum*), on the other hand, require large stands of mature forest habitat. Threats (past, current and future) to the former species – and their characteristic natural habitats - on the Delmarva Peninsula include fire suppression, pulpwood production and residential development (Bowman, 2000). Logging and development also threaten forested tracts that harbor the latter species, perhaps rendering irrelevant the differences between the two groups in the natural processes necessary to maintain them.

Numerous portfolio occurrences of upland species and habitats in CBY fall within one or more matrix forest blocks, so threats to the larger sites would also apply to the specific embedded sites. In addition, quite a few of the species and natural community targets in CBY occur on barrier islands along the Atlantic Coast, where the classification of the target as “aquatic/wetland” or “upland” is blurred. Viable occurrences of these latter targets only occur where the landscape has already been protected from intensive coastal development (e.g., Delaware Seashore State Park, Assateague Island National Seashore, Chincoteague National Wildlife Refuge), so anthropogenic threats come mostly from recreational uses of public lands. Sea level rise and global climate change – with the possibility of more frequent and powerful Atlantic storms (hurricanes and nor’easters) – pose the most significant threats to these coastal natural areas in the near future.

DATA, INFORMATION AND FIELD SURVEY GAPS AND NEEDS*

Science versus "Best Available Knowledge" in Ecoregional Planning

The Nature Conservancy has long described itself as a "science-based" organization. By this we mean that our conservation work is informed by a thorough understanding of the numerous scientific disciplines - ecology, geology, climatology/meteorology and so on - relevant to protecting and managing natural areas. It means we apply our knowledge of disturbance processes, life history, population and meta-population dynamics, intraspecific and interspecific interactions (social behaviors, predation, competition, parasitism, pollination biology, etc.), vegetative succession, landscape ecology, conservation biology and other disciplines - all of which are based on the fundamental framework of evolution through natural selection and adaptation - to our conservation work. It also means that we use scientific thinking and methods to assess and monitor the status (rarity, viability, population trends, etc.) of populations of native species, as well as the condition (composition, functioning, etc.) of natural communities in the field. Scientific knowledge and principles also underlie the methods we use for managing species and ecological systems on protected lands, and for restoring native species and ecological systems in natural areas previously degraded by human activities.

The Nature Conservancy also carries out many basic and applied ecological research studies, funds others to do such studies (e.g., through federal grants, the D.H. Smith and Mellon Ecosystem programs, chapter small grants programs, etc.), and gives academic and public agency scientists permission to conduct ecological research on Conservancy-owned lands across the country. These types of projects fit the strict definition of "science" in that they involve: 1) hypothesis testing; 2) field and laboratory experiments, with appropriate controls; 3) peer-review and publication of the research results in scientific journals. Studies of some of the rarest species and most sensitive natural communities, though, are uncommon, since even the slight impacts of field research may further imperil an already-vulnerable population or habitat.

The state of our scientific knowledge about the natural world is far greater now than at an previous time in human history. Tens of thousands of naturalists, botanists, zoologists and ecologists working worldwide during the last three centuries have amassed a body of field observations, physiological, behavioral and ecological data, and experimental research results that taken together would fill many libraries. Dozens of scientific journals covering every natural history discipline publish thousands of new studies of individuals, populations, species, and ecosystems every month. Monographs on individual species or genera running hundreds of pages each are published every year. University professors now have a selection of texts on conservation biology to choose from, where barely ten years ago there were none.

Most significantly, because of the work of thousands of Natural Heritage Program biologists over the last twenty five years, the state of our knowledge about the "last of the least" – rare, threatened and endangered species and natural communities (esp. in North America) – is far greater now than it would have been, had the Natural Heritage Program network never been developed by The Nature Conservancy. NatureServe, the "online encyclopedia of life" now contains information on the conservation status, distribution, ecology and life history and management of over 50,000 plant and animal species, subspecies and ecological communities

* Samson, D.A., M.G. Anderson et al. 2003. Chesapeake Bay Lowlands Ecoregional Conservation Plan; First Iteration, Edited. The Nature Conservancy, Mid-Atlantic Division, Charlottesville, VA

(28,000 plants, 7,300 vertebrates, 14,000 invertebrates, and 4,600 ecological communities) in the US and Canada (NatureServe website, 4/16/02). Included in this database is information on more than 6,600 plant and animal species considered to be globally rare (Stein et al. 2000), as well as for thousands of "common" species (i.e., that are rare in only one or a few states, or are globally secure – ranked G5 – throughout their range).

As impressive as the depth and breadth of this mountain of knowledge may be, it is dwarfed by the phenomenal diversity and complexity of natural systems, in both time and space. Thus, we continue to have an extremely limited understanding of even basic facts about the biology, ecology and life history of the vast majority of species – much less all of the interactions and processes occurring at the multi-species, community or ecosystem levels of biological diversity. As paltry as the sum total of our knowledge may be, though, *no single individual* is capable of learning and understanding all that *is* currently known about the thousands of plants and animals (vertebrates, invertebrates, microorganisms) that inhabit every conservation site, much less the tens of thousands native to each state or ecoregion. Ironically, then, conservation decision-making is simultaneously constrained and confounded by two forms of ignorance – the absence of knowledge and a limited capacity to process overabundant information.

In addition, because billions of dollars have been spent (especially in the US) studying the effects of anthropogenic waste and by-products (nutrients, chemicals, invasives, etc.) on natural systems - often undertaken as a means to the end of understanding potential threats to human health and economic livelihood - we often know more about what's *bad* for native species and natural communities than we do about what's *good* for them. At the same time, science can tell us relatively little about how human development patterns will change and grow (usually) over time in and around conservation sites, and what the consequences of those activities might be for plants, animals and ecological processes in those natural areas. We can study county zoning plans, population trends, economic data, the real estate market, and so on, to get a broad sense of likely future change in the human landscape of a local area. But thousands of individual actors (landowners, businesses, corporations, public agencies, federal, state and local governments, etc.) making individual decisions based on idiosyncratic objectives and self-interests – all within a dynamic socioeconomic environment – is not a situation amenable to predictive science. Yet it is these patterns of human development and their consequences that pose the greatest threats to most conservation sites.

Our profound ignorance about how nature really works—in part or in whole, and both in the presence and absence of human disturbance—means that most of the time we are using not science, but "professional judgement", "expert opinion", or "best-available knowledge" to do our conservation work. Day to day in the field—that is, at the chapter or field office level—we set conservation priorities, develop and implement conservation strategies, and measure conservation success not by using science—a regression line on an X-Y plot, or the P value of a statistical test, or even the number of plants we count in a square meter of habitat—but based on our *best understanding* of how ecological systems work generally, and what processes and interactions appear to be important at each particular site. We make these informed but ultimately subjective judgements and decisions in this manner, often committing sizable amounts of staff time and financial resources in the process, because there is simply no "science" to turn to for answers.

Furthermore, in many states the "best available knowledge" doesn't even reside within the heads of chapter Conservancy staff. It lies with Natural Heritage Program biologists and ecologists, many of whom have many years of experience working with native species and natural communities in their state, and often spend hundreds of hours in the field at conservation sites every year. In many states in the eastern U.S., Natural Heritage Program biologists are critical, irreplaceable colleagues and partners, whose experience, advice and recommendations are fundamental to setting conservation priorities, identifying and implementing conservation strategies, and measuring conservation success. Sadly, the significance of this critical dependency appears to be unappreciated by senior managers within the Conservancy in recent years, as the organization works to distance itself – both nationally and at state chapter levels - from a phenomenally successful undertaking, one that represents perhaps the most innovative and significant advance in organizing biological knowledge since Linnaeus.

Like our day-to-day conservation work, ecoregional planning as carried out to date by the Conservancy has also rested heavily on "best available knowledge" rather than true science. Reliance on professional judgement and expert opinion suffuses the entire planning process, from identifying Primary vs. Secondary species targets, to assigning rangewide distribution categories for species and natural communities, to assessing viability and setting conservation goals for target occurrences (species, natural communities, and aquatic ecosystems), to setting thresholds for minimum land area and amount of vegetative cover for matrix forest blocks, to determining appropriate boundary locations for blocks based on fragmenting features, to identifying significant conservation areas for estuarine/coastal/marine targets, and many others.

Ironically, the Conservancy's heavy reliance on best available knowledge to develop our ecoregional portfolios is a direct consequence of our deep commitment to using ecological concepts and principles in the planning process. That is, using a coarse filter/fine filter and multi-scale framework, and identifying a minimum number of high-quality occurrences of specific conservation targets to ensure viability into the future, to achieve the goal of capturing *all* native biodiversity in each ecoregion, derives directly from sound ecological/ conservation thinking. But this approach requires that we target real populations and specific habitats on the ground, in spite of a frustrating dearth of site-specific data and information. Given the paucity of knowledge and information, assessing target occurrence viability using criteria (e.g., size condition, landscape context) that are still in development and which vary significantly among conservation targets (within and among target groups), and determining quantitative conservation goals for multiple categories of targets, are science-based, but not scientific, exercises.

Other large-scale (i.e., statewide, multi-state, regional) conservation planning efforts face the same constraints on available data, and all such efforts incorporate "best available knowledge" directly or indirectly. These other approaches typically rely more heavily on quantitative, landscape-level information (especially remote-sensed vegetation and land-cover/land-use data), and usually lack a fine filter component. That is, they have the goal of identifying large areas of existing or potential natural habitat that could be conserved as a coarse filter for native biodiversity, but without the requirement to demonstrate that common or rare species or natural communities do indeed occur in the target areas. For example, regional GAP Analysis plans produced with support from the US Fish and Wildlife Service overlay species rangewide distribution maps (for all vertebrates and select invertebrates) with managed area data layers to identify both existing habitat and gaps in natural area coverage for native species. Similarly, the Maryland Greenprints project used land cover/land use, hydrology, and other data layers to produce a statewide map of natural area "hubs" and corridors that – if substantially protected - would act as a coarse filter to conserve native biodiversity in the state.

While recognizing the clear necessity of using best available knowledge and expert opinion to accomplish conservation planning, the tradeoff implicit in such an approach is diminished scientific rigor, given the absence of a purely scientific method. Results do not address a testable hypothesis, and biases may enter the process, due to the specific sources of best available knowledge used (i.e., who was or was not consulted, group dynamics at expert workshops, the degree of subjectivity or confidence in an expert's opinion, etc.). The most important consequence here is that the results may or may not meet the test of repeatability; another person or group might come up with a different "answer" to the same question, even if they use similar data and analytical methods.

Using a best-available-knowledge approach for conservation planning doesn't remove the obligation to: 1) compare the results to other similar "studies" and; 2) subject the work to scientific peer review. Comparing a Conservancy ecoregional plan to other regional conservation plans for the same geographic area would illuminate the degree to which the results were or were not dependent on the specific data/information sources used, and the methods (analyses, criteria, etc.) that were applied. Good spatial correspondence between independently developed plans for the location of important conservation areas would provide important "repeatability" and reinforce the appropriateness of using best available knowledge, raising the level of confidence in the results.

If anything, peer review is even more important for plans heavily dependent on best available knowledge, compared to plans produced by applying purely objective analytical techniques to quantitative data sets and data layers. Peer review can: 1) provide external perspective on objectives, concepts and approaches; 2) provide objective feedback on specific methods by which expert opinion is incorporated into the planning process; 3) illuminate potential biases resulting from the use of best available knowledge; 4) provide references to additional sources of relevant information that might have been missed. For these and other reasons, the Conservancy's ecoregional plans would benefit greatly by being subjected to at least a minimal level of "scientific" peer review.

Unfortunately, a detailed comparison of the CBY ecoregional Plan to other conservation plans covering a similar geographic region is beyond the scope of this project. Several of the most appropriate alternative plans (e.g., the MD-DE-NJ GAP Analysis project, Maryland Greenprints) have themselves been in development during the same time period as the CBY Plan, and final reports are not yet available. Submitting the CBY Plan to a scientific journal or magazine as an original article remains a possibility for the future, but taking that action prior to the completion of a final document for internal Conservancy use is neither feasible nor desirable.

Data Gaps and Information Needs by Target Group

There are data gaps and information needs that are universal to every Conservancy ecoregional plan (or at least those covering ecoregions in the eastern US), and others that are specific to the Chesapeake Bay Lowlands Plan, per se. Major gaps and needs in both categories are presented below in bulleted form, separately for each major conservation target group.

Matrix Forest Blocks

Universal Gaps and Needs

- Better understanding of scale and frequency of regional disturbance processes

- Better understanding of magnitude and scope of effects of each disturbance event on native plant and animal communities, and differences in effects among disturbance types (e.g., fire versus tornadoes vs. hurricanes)
- Better understanding of interaction effects among disturbance processes, across multiple scales
- Better understanding of numbers and types of interior forest area-sensitive species by region/ecoregion
- Better understanding of area requirements and minimum population sizes of interior forest dwelling species
- Better understanding of relationships between type and size of fragmenting features (roads, utility corridors, development) and landscape ecology impacts (edge effects, connectivity, plant and animal dispersal dynamics, predation rates, invasibility, etc.)
- Better understanding of relationships between forest composition and age versus function as coarse filter for native species, common and rare
- Better understanding of response dynamics of eastern forests to loss of dominant component species (e.g., American chestnut)
- Better understanding of response dynamics of eastern forests to acid precipitation, air pollution, regional/global climate change

<u>CBY Gaps and Needs</u>

- Data on scale and frequency of major meteorological disturbance events (hurricanes, tornadoes, wind and ice-storms, etc.) in the coastal plain
- Data on composition and structure of pre-colonial coastal plain forests in Mid-Atlantic
- Identification of interior forest area-sensitive species other than birds, and their habitat requirements (forest type, age, area)
- Better understanding of interactive effects of extirpation and/or recovery of populations of regional keystone vertebrate predators, herbivores and granivores (e.g., extinction of passenger pigeon, extirpation of wolves, cougars, woodland bison, elk, black bear, near-extirpation of beaver and white-tailed deer, with overabundant recovery of latter) on forest composition, condition, and function
- Quantitative assessment of role of timber harvest lands (esp. loblolly pine plantations, or stands dominated by loblolly pine) in supporting populations of native species

Aquatic Ecosystems

<u>Universal Gaps and Needs</u>

- Data (much, much more) on vertebrate and invertebrate communities/assemblages associated with different system types, and analysis of the relationship between the two
- Better understanding of relationship between aquatic community composition, structure and functioning, and all categories of anthropogenic impacts: biological (invasive and non-native species), chemical (nutrients, toxins) and physical (changes in water temperature, riparian vegetative cover, dams and other alterations in hydrology, etc.)
- Better understanding of the relationship between cumulative and/or interactive effects of sub-watershed condition and the "health" of stream segments downstream
- Progress on theoretical/conceptual justification for setting conservation goals (i.e., numbers, sizes, stratification, etc., of occurrences in portfolio) for system types within and among ecoregions

- Development of conceptual underpinnings that support, and objective metrics for assessing, the viability status of aquatic ecosystem occurrences

<u>CBY Gaps and Needs</u>

- Clearer understanding of the extent and geographic location of historic "blackwater" systems on the Delmarva peninsula
- More data and/or expert opinion on quality/viability of small nontidal streams on VA portion of Delmarva Peninsula
- Progress on standardizing the expert-selection process for tidal river segments, and the criteria used to assess viability of these segments

Estuarine/Coastal/Marine Targets and Significant Conservation Areas

<u>Universal Gaps and Needs</u>

- Distribution and abundance data for many estuarine/marine species, especially those not harvested commercially
- Progress on theoretical/conceptual justification for setting conservation goals (i.e., numbers, sizes, stratification, etc., of occurrences in portfolio) for species and habitat targets
- Development of conceptual underpinnings that support, and objective metrics for assessing, the viability status of estuarine/coastal/marine target occurrences

<u>CBY Gaps and Needs</u>

- Standardized habitat (e.g. tidal wetlands) classifications, sampling protocols and monitoring programs across states
- Better or more accessible data/information on the rangewide distribution of target species and habitat types

Natural Communities

<u>Universal Gaps and Needs</u>

- Greater investment in reconciliation of state classifications with each other and with NVC
- Progress on standardizing EO Specs/ranks among states; refinement of (and develop conceptual justification for) "condition" assessment process, including criteria for assigning status ranks
- Progress on refining, and developing the conceptual justification for, the GIS-based "landscape context" assessment approach, including criteria for assigning ranks (by patch type and ecoregion)
- More data/information to document both ecoregional and rangewide distributions of types
- Progress on theoretical/conceptual justification for assigning patch type to community types
- Progress on theoretical/conceptual justification for setting conservation goals (i.e., numbers, sizes, stratification, etc., of occurrences in portfolio) for types, within and among patch size and rangewide distribution categories

<u>CBY Gaps and Needs</u>

- Completion of a full community classification in Maryland; documentation of occurrences of many rare and common types in the Natural Heritage Program database
- Documentation of many additional EO's, in all 3 states, especially for common community types

Species

Universal Gaps and Needs

- Element Occurrence Specifications ("EO Specs") for all species, standardized across states and ecoregions.
- Standardized EO Specs applied consistently among state Natural Heritage Programs, so that EO Ranks are consistent and complete
- Consistent database tracking decisions for G3-ranked species
- Consistent standards for defining meta-populations and aggregating field records accordingly
- Reasonably frequent (e.g., every 5 years) field verification of presence/absence and EO Rank of EO's

CBY Gaps and Needs

- More field collections of, and taxonomic work on, poorly known invertebrate groups (e.g., amphipods, beetles, moths)
- New/additional field surveys for Primary target species with few or no known viable occurrences in CBY
- Verification of rangewide status and portfolio capture success of Primary targets in adjacent ecoregions (i.e., North Atlantic Coast, Mid-Atlantic Coastal Plain), with subsequent reassessment of conservation goals where appropriate

Glossary

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Conservation Target: see Target.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Goal: see Conservation Goal.

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

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

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

Herptile: A term encompassing reptiles and amphibians.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Mosaic : An interconnected patchwork of distinct vegetation types.

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

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

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

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

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

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

Portfolio Occurrence: see Occurrence.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Review of current portfolio for CBY for communities- status in relation to goals- 113001-REZ- cbyncgoals1203.xls

A= accepting into the portfolio		M= Matrix communituy	W= Widespread	
R= rejected-not in portfolio		LP= Large Patch	P= Peripheral	
C= currently believed to be in subsection		SP= Small Patch	L= In CBY and one other ecoregion	*= only believed to occur in a limited number of subsections, need to adjst goals to natural distribution
P= believed to probably be in the subsection		L = Linear Patch	R= Found only in CBY	blank subsection cell= nvc type not known in that subsection

				Three Subregions								Goals		Status			
NVC #	**NVC Name**	**Patch size**	**Global distribution**	**232Ad**		**232Bt**	**232Bz**	**232Bx**	**232Br**		**232Ch**	**Strat Level**	**Total goal**	**Number in portfolio**	**Number rejected**	**Strat goal met**	**Number still needed**
Group 1- Dry- Mesic Oak Forests																	
6336	Quercus (alba, rubra, velutina) / Cornus florida / Viburnum acerifolium Forest	LP	W	C		C		P	C			1	4	0	0	no	4
6269	Quercus (falcata, alba, velutina) / Gaylussacia baccata - Vaccinium pallidum Forest	M?/LP	W	P		C	P	P	C			1	4	0	0	no	4
6374	Quercus velutina - Quercus coccinea - Quercus prinus / Kalmia latifolia Forest	LP/SP	W	P		P			C		**1A**	1	4	1	0	yes	3
7232	**Quercus alba-Carya ovata/ Cercis canadensis Forest**	LP?	?					P	**1A**		P	1?	4?	1	0	yes?	3
6282	**Quercus prinus - Quercus (rubra, velutina) / Gaylussacia baccata Forest**	LP?	?	**1R**								1?	4?	0	1	no	4
	Untagged, but in group													0	0		
Group 2- Mesic Hardwood Forests																	
7181	Fagus grandifolia - Acer barbatum - (Quercus muehlenbergii) / Rich Herbs Calcareous Ravine Forest	SP	R						**1A**		P	3	15	1	0	no	14
6075	Fagus grandifolia - Quercus alba - Liriodendron tulipifera - Carya spp. Forest	M	W	**1A/1R**		**3A/1R**	**1A/3R**	P	**4R**		**1A**	1	4	6	9	yes	**MET GOALS**
6390	Quercus falcata - Quercus phellos / Ilex opaca Forest	SP	R?/L			C	P	C				2	8	0	0	no	8
7748	Quercus muehlenbergii - Acer barbatum / Verbesina virginica var. virginica Forest	SP	R						**1A/1R**		**3A**	3	15	4	1	no*	11

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
8465	**Fagus grandifolia - Quercus rubra/Cornus florida/ Polystichum acrostoides - Hexastylis virginiana Forest**	LP?	W?				P		**2R**		**1A**	1	4	1	2	yes	3
7184		?	?								**1A**	1	4	1	0	yes	3
	untagged, but in group								**1A**		**1A**			2	0		

Group 3- Evergreen or Mixed Coastal Plain Forests

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6169	Pinus taeda - Quercus falcata / Gaylussacia frondosa Forest	M	L?			C	**2A/2R**	C	**1R**			1	4	2	3	yes	2
6040	Pinus taeda / Myrica cerifera / Vitis rotundifolia Forest	SP	L				**5A**	P				2	10	5	0	no*	5
6354	Pinus virginiana - Quercus falcata - Carya pallida Forest	?	?			**1A**			**3A**			2	10	4	0	no*	6
6600	Tsuga canadensis / Corylus americana / Asarum canadense Forest	SP	?	**1R**		**1R**					C	3	15	0	2	no	15
4766	**Pinus taeda - Quercus (alba, falcata, stellata) Forest**	?	?			**1A**								1	0		
6621		?	?			**1A**								1	0		
	Untagged but in group					**15A/2R**	**1R**	**6A**						21	3		

Group 4- Alluvial Forests and Shrublands

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6602	Liquidambar styraciflua - Quercus palustris / Carpinus caroliniana / Carex intumescens Forest	SP	R?	C-?								3	15	0	0	no	15
6603	Platanus occidentalis - (Liquidambar styraciflua, Liriodendron tulipifera) / Asimina triloba Forest	SP	R?	C					C			3	15	0	0	no	15
6604	Pinus taeda - Quercus (michauxii, falcata) - Liquidambar styraciflua / Ilex opaca Temporarily Flooded Forest	SP?	R?	C								3	15	0	0	no	15
6605	Quercus (palustris, phellos) - Acer rubrum / Cinna arundinacea Forest	SP?	L	C					C		**1A**	2	10	1	0	no	9
4457	**Cephalanthus occidentalis / Limnobium spongia - Salvinia minima Shrubland**	SP?	?					**1A**				?	?	1	0	no*	?
6414	Cornus amomum - Alnus serrulata Shrubland	SP?	L?	C								2	10	0	0	no	10
	Untagged, but in group													0	0		

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
Group 5- Cypress- Gum Swamps																	
7847	Nyssa biflora - (Liquidambar styraciflua) / Itea virginica / Saururus cernuus Forest	SP?	P						P		P	1	5	0	0	no	5
6214	Taxodium distichum - Nyssa biflora Chesapeake Bay Forest	SP/L	R	C		**2A/2R**	P	C	C			3	15	2	2	no	13
	Untagged, but in group					**2R**								0	2		
Group 6- Non Alluvial Wetland Forests																	
6606	Acer rubrum - Fraxinus pennsylvanica / Saururus cernuus Forest	SP	R	C					C			3	15	0	0	no	15
6238	Acer rubrum - Nyssa sylvatica - Magnolia virginiana Forest	LP?/SP?	W	**1A/3R**			**1A/1R**		**5A/3R**		C	1	4	7	7	yes	**GOALS MET**
6413	Acer rubrum - Fraxinus pennsylvanica / Myrica cerifera / Calthat palustris Forest	LP?/SP?	R?	P					**3A**			3	15	3	0	no	12
6090	Chamaecyparis thyoides - Acer rubrum / Magnolia virginiana / Alnus maritima Forest	LP/SP	R	C		**10A/5R**	**2A**	C				3	15	12	5	no	3
6137	Pinus taeda / Myrica cerifera / Osmunda regalis var. spectabilis Forest	SP	L				**1R**	P				2	10	0	1	no	10
6607	Quercus phellos - Quercus michauxii Forest	SP	R?	P		P	P	P				3	15	0	0	no	15
6110	Liquidambar styraciflua - Acer rubrum - Quercus phellos / Leucothoe racemosa Forest	LP/SP	W			C	P		**2R**		**1R**	1	4	0	3	no	4
6188	**Chamaecyparis thyoides - Ilex glabra Forest**	LP?/SP?	L			**1A**						2	10	1	0	no*	9
7449	**Quercus michauxii - Quercus pagoda/Clethra alnifolia - Leucothoe axillaris Forest**	LP?	R?								**1A**	3	12	1	0	no*	11
6307	**Chamaecyparis /Alnus maritima**	SP?	R			**1A**						3	15	1	0	no*	14
	Untagged, but in group					**2R**								0	2		
Group 7- Woody Vegetation of Coastal Plain Ponds																	
6221	Cephalanthus occidentalis / Carex striata Shrubland	SP	R			**1A/1R**		**1R**				3	15	1	2	no*	14

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6242	Cephalanthus occidentalis / Polygonum hydropiperoides - Panicum verrucosum Shrubland	SP	L/W?			**5A/2R**		P	**4A/3R**		**1R**	2	10	9	6	no	1
6223	Liquidambar styraciflua - Acer rubrum - Nyssa biflora / Carex joorii Forest	SP	R			**6A/1R**		**1A/1R**	**4A/1R**			3	15	11	3	no*	4
4644	Quercus phellos / Carex striata var. brevis Forest	SP	R				C					3	15	0	0	no	15
	Untagged, but in group													0	0		
Group 8- Herbaceous Coastal Plain Ponds																	
4120	Carex striata var. brevis Herbaceous Vegetation	SP	W	**1R**		**7A**	P				C	1	5	7	1	yes	**GOALS MET**
6332	Cladium mariscoides - Coelorachis rugosa Herbaceous Vegetation	SP	R?/L?			**1A**	**1A**					3	15	2	0	no*	13
6608	Eragrostis hypnoides - Ludwigia sphaerocarpa - Polygonum hydropiperoides Herbaceous Vegetation	SP	R			C		**1R**	**1R**		**1R**	3	15	0	3	no	15
6610	Juncus repens - Boltonia asteroides Herbaceous Vegetation	SP	R			**1A**	**1A**	P				3	15	2	0	no*	13
6086	Nymphaea odorata - Eleocharis robbinsii Herbaceous Vegetation	SP	W			C		C				1	5	0	0	no	5
6338	Panicum hemitomon - Panicum verrucosum Herbaceous Vegetation	SP	L			**5A**		**1A**				2	10	6	0	no*	4
6264	Rhexia virginica - Panicum verrucosum Herbaceous Vegetation	SP	W			**2A**						1	5	2	0	no*	3
6609	Saccharum giganteum - (Dichanthelium spretum, Panicum verrucosum) Herbaceous Vegetation	SP	R			**1A/1R**		**1A**				3	15	2	1	no*	13
4475	Woodwardia virginica / Sphagnum cuspidatum Herbaceous Vegetation	SP	W			C					C	1	5	0	0	no	5
6415	Dulichium arundinaceum - Juncus canadensis Herbaceous Vegetation	SP	W			C			C			1	5	0	0	no	5
	untagged, but in group			**1R**		**1R**	**1A**	**1R**	**1R**		**1R**			1	5		
Group 9- Sea-level Fen																	
6310	Cladium mariscoides - Drosera intermedia - Eleocharis rostellata Herbaceous Vegetation	SP	L				**7A/1R**	**1A**				2	10	8	1	no*	2
	Untagged, but in group													0	0		

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
Group 10- Freshwater Non Tidal Marshes																	
4112	Juncus effusus Seasonally Flooded Herbaceous Vegetation	SP?	W	P		P	P	P	P		P	1	5	0	0	no	5
2386	Nuphar lutea ssp. advena - Nymphaea odorata Herbaceous Vegetation	L	W	P		C	P	P	C		P	1	4	0	0	no	
6349	Scirpus cyperinus Seasonally Flooded Herbaceous Vegetation	SP?	P	P		P	C	P	P		P	1	5	0	0	no	5
4291	Pontederia cordata - Peltandra virginica Semipermanently Flooded Herbaceous Vegetation	L	W	P		C			C			1	4	0	0	no	4
6153	Typha (angustifolia, latifolia) - (Scirpus spp.) Eastern Herbaceous Vegetation	LP/SP	W	C		C	C	C	C		C	1	5	0	0	no	5
	Untagged, but in group			**1R**		**2A/1R**	**1A/1R**							3	3		
Group 11- Tidal Swamp Forests																	
6287	Acer rubrum - Fraxinus pennsylvanica - (Nyssa biflora, Nyssa sylvatica) / Polygonum arifolium Woodland	L	R			**2A/1R**		C	C		**1R**	3	12	2	2	no	10
4651	Pinus taeda - Nyssa biflora - Taxodium distichum / Myrica cerifera / Osmunda regalis var. spectabilis Forest	L	R					C	**3A**		C	3	12	3	0	no	9
	Untagged, but in group													0	0		
	Group 12- Tidal Shrublands																
6337	Alnus (incana ssp. rugosa, serrulata) - Cornus amomum Shrubland	L	W	?		C	C	P	C			1	4	0	0	no	4
3921	Baccharis halimifolia - Iva frutescens ssp. oraria / Spartina patens Shrubland	L	W	P			C	C	C		**1A/1R**	1	4	1	1	yes	3
	Untagged, but in group													0	0		
Group 13- Tidal Marshes																	
6080	Amaranthus cannabinus Tidal Herbaceous Vegetation	SP/L	W			C						1	5	0	0	no	5
6611	Eleocharis rostellata - Spartina patens Herbaceous Vegetation	SP	R				**1A/1R**	P	**1A**			3	15	2	1	no	13
6352	Eriocaulon parkeri - Polygonum punctatum Herbaceous Vegetation	L	R/L?			C						3	12	0	0	no	12

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6058	Isoetes riparia Tidal Sparse Vegetation	SP	W									1	5	0	0	no	5
4186	Juncus roemerianus Herbaceous Vegetation	SP	W	C			C	**1A**	**1R**		**1R**	1	5	1	2	yes	4
4472	Nuphar lutea ssp. advena Tidal Herbaceous Vegetation	LP/L	W	P		C	C	C	**1A/1R**		**1A**	1	5	2	1	yes	3
6150	Panicum virgatum - Carex silicea Herbaceous Vegetation	SP?	?	C			C	C				1	5	0	0	no	5
4706	Peltandra virginica - Pontederia cordata Tidal Herbaceous Vegetation	LP?/SP?	L	**1A**		**1A/1R**	C	C	**7A/4R**			1	5	9	5	yes	**GOALS MET**
4306	Plantago maritima var. juncoides Herbaceous Vegetation	SP	W?				C					1	5	0	0	no	5
4308	Sarcocornia perennis - Salicornia spp. - Spartina alterniflora Dwarf-shrubland	SP/L	W				**1A/2R**	C				1	5	1	2	yes	4
4192	Spartina alterniflora / (Ascophyllum nodosum) Acadian/Virginian Zone Herbaceous Vegetation	M/LP	W	P		P	**1A**	**1A**	**2A**		**1R**	1	4	4	1	yes	**GOALS MET**
6416	Spartina alterniflora - Scirpus robustus Herbaceous Vegetation	L	R?				P	P	C		P	3	12	0	0	no	12
6417	Spartina alterniflora - Amaranthus cannabinus Herbaceous Vegetation	SP/L	**R**			C		C				3	15	0	0	no	15
6418	Spartina alterniflora - Ptilimnium capillaceum - Polygonum punctatum Herbaceous Vegetation	SP	R?			C		P				3	15	0	0	no	15
4195	Spartina cynosuroides Herbaceous Vegetation	LP?/SP	W	C		**2A**	C	C	**4A/1R**		**1A**	1	5	7	1	yes	**GOALS MET**
4197	Spartina patens - Distichlis spicata - Borrichia frutescens Herbaceous Vegetation	LP	W				**1A**	C	**1A/1R**		**2R**	1	4	2	3	yes	2
6612	Scirpus americanus - Spartina patens - Herbaceous Vegetation	SP	L				C	C			**1A**	2	10	1	0	no	9
4201	Typha angustifolia - Hibiscus moscheutos Herbaceous Vegetation	LP?/SP?	W	P		**1A**	**1R**	C	**4A**		**1A**	1	5	6	1	yes	**GOALS MET**
4202	Zizania aquatica Tidal Herbaceous Vegetation	LP?/SP?	W?	**1R**		**2A**	C	C	**2A**		**1A**	1	5	5	1	yes	**GOALS MET**
4705	Zizaniopsis miliacea Tidal Herbaceous Vegetation	LP?/SP?	P?						**1A**			1	5	1	0	yes	4
4473	Sagittaria subulata - Limosella australis Tidal Herbaceous Vegetation	L	W			C						1	4	0	0	no	4
4187	**Phragmites australis tidal herbaceous vegetation**	LP/SP	W	P		P	P	P	P		**C**	1	5	0	0	no	5
6837	**Eleocharis fallax/ E. rostellata**	SP?	?	C		C		C					?	0	0		
6833	**"Acorus"**	LP?	?										?	0	0		
6834	**Peltandra/ Impatiens/ Typha**	LP?	?	**C**		**C**		**C**					?	0	0		

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6835	**Scirpus americanus/ Spartina patens**	SP?	?	**C**		**C**		**C**					?	0	0		
6836	**Spartina patens/ Distichlis spicata**	SP?	?										?	0	0		
	Untagged, but in group			**1A**										1	0		

Group 14- Submerged Saline Tidal

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6027	Potamogeton pectinatus - Zannichellia palustris - (Ruppia maritima) Permanently Flooded - Tidal Herbaceous Vegetation	SP?/L?	W	P		P	P	P	P		P	2	10	0	0	no	10
6167	Ruppia maritima Acadian/Virginian Zone Temperate Herbaceous Vegetation	SP?	W	P		P	P	P	P		P	2	10	0	0	no	10
4336	Zostera marina Herbaceous Vegetation	LP?/SP?	W	P		P	P	P	P		P	1	5	0	0	no	5
	Untagged, but in group													0	0		

Group 15- Maritime Shrub

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
3950	Hudsonia tomentosa / Panicum amarum Dwarf-shrubland	SP	L				**1A**					2	10	1	0	no	9
3809	Myrica cerifera - Baccharis halimifolia / Spartina patens Shrubland	LP?/SP	W				C					1	5	0	0	no	5
3840	Myrica cerifera / Hydrocotyle spp. Shrubland	LP	R				**1A**	P				3	12	1	0	no	11
3881	Myrica pensylvanica / Diodia teres Shrubland	SP	L				**1A**				P	2	10	1	0	no	9
6319	Prunus serotina / Myrica cerifera / Smilax rotundifolia Shrubland	SP	R				**1A**				**C- eor**	3	15	1	0	no	14
3886	Smilax glauca - Toxicodendron radicans Vine-Shrubland	SP/L	W			P	C				P	1	5	0	0	no	5
3833	Quercus virginiana - (Ilex vomitoria) Shrubland	SP?	L				P					2	10	0	0	no	10
	Untagged, but in group						**1R**							0	1		

Group 16- Interdunal Wetlands

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
6350	Bacopa monnieri - Eleocharis albida Seasonally Flooded Herbaceous Vegetation	SP	R				**2A**					3	15	2	0	no*	13

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
4117	Fimbristylis (castanea, caroliniana) - Scirpus pungens Herbaceous Vegetation	SP	R				**5A**					3	15	5	0	no*	10
4111	Juncus dichotomus - Drosera intermedia Herbaceous Vegetation	SP?	L				**10A/2R**					2	10	10	2	no*	**GOALS MET***
3906	Myrica (cerifera, pensylvanica) - Vaccinium formosum Shrubland	SP?	L				C					2	10	0	0	no	10
4129	Panicum virgatum - Spartina patens Herbaceous Vegetation	SP?	W			**1A**	**1A**					1	5	2	0	yes	3
6342	Spartina patens - Eleocharis parvula Herbaceous Vegetation	SP?	W				**2A**					1	5	2	0	yes	3
6141	Vaccinium macrocarpon - Myrica pensylvanica Dwarf-shrubland	SP?	W				**2A**					1	5	2	0	yes	3
6348	Salix nigra Seasonally Flooded Woodland	SP/L	R				C					3	12	0	0	no	12
4103	**Carex torta herbaceous vegetation**	L	W			**1A**			P			1	5	1	0	no*	4
	Untagged, but in group						**7A/1R**							7	1		
Group 17- Dune/Grassland/Beaches																	
4043	Ammophila breviligulata - Panicum amarum Herbaceous Vegetation	LP/SP/L	W				**3A/1R**				**1R**	1	4	3	1	yes	1
4400	Cakile edentula ssp. edentula - Salsola caroliniana Sparse Vegetation	SP?/L	W				**1A**				P	1	4	1	0	yes	3
4240	Myrica pensylvanica / Schizachyrium scoparium ssp. littorale - Eupatorium hyssopifolium Shrub Herbaceous Vegetation	SP	L				C					3	15	0	0	no	15
4097	Spartina patens - Scirpus pungens - Solidago sempervirens Herbaceous Vegetation	SP	L				C					2	10	0	0	no	10
	Untagged, but in group						**3A**	**1R**	**1A**					4	1		
Group 18- Dune Woodlands																	
6212	Juniperus virginiana var. virginiana / Myrica pensylvanica Woodland	SP	L				**1A**					2	10	1	0	no	9
6117	Pinus rigida / Hudsonia tomentosa Woodland	LP?/SP	L				C					2	10	0	0	no	10
6172	Pinus taeda - Quercus nigra / Gelsemium sempervirens Forest	SP	L				C				C	2	10	0	0	no	10
6052	Pinus taeda / Hudsonia tomentosa Woodland	LP	R				**5A/1R**				**1R**	3	12	5	2	no	7

NVC #	NVC Name	Patch size	Global distribution	232Ad		232Bt	232Bz	232Bx	232Br		232Ch	Strat Level	Total goal	Number in portfolio	Number rejected	Strat goal met	Number still needed
	Untagged, but in group			3R		1A	1R		2A/2R					3	6		
	Table assembled 11/30/2001, REZaremba, laptop file name: cbyncgoals1130.xls																
	update 1203																

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SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	EOR IN PORTFOLIO	PORTFOLIO STATUS	Comments
ANTIPOISON NECK			Y	Y	Site name should be Antipoison Neck
AREA T-17 RAVINES	AREA T-17 RAVINES	FORT BELVOIR MILITARY RESERVATION	Y	Y	
ASSATEAGUE ISLAND MEGASITE		CHINCOTEAGUE NATIONAL WILDLIFE REFUGE	Y	PL	
ASSAWOMAN CREEK FEN	ASSAWOMAN CREEK FEN		Y	PL	
BETHEL BEACH MACROSITE	BETHEL BEACH NORTH		Y	PL	INTERIM PARENT EOR (9 SubEO's)
BIG BETHEL FLATWOODS			Y	Y	
BIG MARSH POINT	CHICAHOMINY RIVER - BIG MARSH POINT		Y	Y	GName & GCOMName should be TIDAL FRESHWATER MARSH
BRENT MARSH	BRENT MARSH		Y	10Yr	
BROWNSVILLE FARM		VIRGINIA COAST RESERVE	Y	10Yr	
CALEDON STATE NATURAL AREA	CALEDON STATE NATURAL AREA	CALEDON NATURAL AREA	Y	PL	
CAPE CHARLES SOUTH	VIRGINIA EASTERN SHORE - CAPE CHARLES HARBOR SOUTH	CAPE CHARLES COASTAL HABITAT NATURAL AREA PRESERVE	Y	PL	INTERIM PARENT EOR for Cape Charles/ Pickett Harbor site (5 SubEO's)
CARTERS CORNER MACROSITE	BETTYS BOTTOM	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
CATTLET CREEK - TURKEY TRACK CREEK MACROSITE	FORT A.P. HILL - CATTLET CREEK	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
CEDAR GROVE FARM	CEDAR GROVE FARM		Y	PL	
CEDAR ISLAND	VIRGINIA BARRIER ISLANDS - CEDAR ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	PARENT EOR
CHEATHAM ANNEX		CHEATHAM ANNEX MANAGEMENT AREA	Y	PL	
CHOPTANK NATURAL AREA PRESERVE	CEDAR GROVE FARM		Y	PL	Site name is Chotank Natural Area preserve. GName should be TIDAL OLIGOHALINE MARSH
CHURCH NECK	CHURCH NECK		Y	Y	INTERIM PARENT EOR (2 SubEO's)
CLAM MARSHES	FRANCE CREEK BEACH		Y	Y	INTERIM PARENT EOR (9 SubEO's)
COARDS BRANCH POND	COARDS BRANCH POND		Y	PL	
COBB ISLAND	COBB ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	PARENT EOR
COLEMAN'S MILL BOG	COLEMAN'S MILL BOG		Y	PL	Heritage and TNC to work together with Dominion Power
CROWS NEST			Y	PL	Partners are USFWS and TPL
CUMBERLAND MARSH - CHAMBERLAYNE POINT	LILLY POINT MARSH		Y	?	GName & GCOMName should be TIDAL FRESHWATER MARSH
DIASCUND CREEK NATURAL AREA	WILCOX NECK, DIASCUND CREEK, BIG MARSH POINT, WILC		Y	Y	Site name should be Diascund Creek Natural Area
DRAGON RUN	DRAGON SWAMP		Y	10Yr	GName should be TIDAL OLIGOHALINE MARSH
DRAKES MARSH	RAPPAHANNOCK RIVER - DRAKES MARSH		Y	10Yr	
ELKO WEST	CHICKAHOMINY RIVER - ELKO WEST		Y	PL	
FEENY ROAD BOTTOMLAND	FEENY ROAD BOTTOMLAND	AFETA CAMP PEARY	Y	Y	
FISHERMANS ISLAND		FISHERMANS ISLAND NATIONAL WILDLIFE REFUGE	Y	PL	
GARNETTS CREEK	GARNETTS CREEK		Y	10Yr	GName & GCOMName should be TIDAL FRESHWATER MARSH
GORDON CREEK	CHICKAHOMINY RIVER - GORDON RIVER		Y	Y	GName & GCOMName should be TIDAL FRESHWATER MARSH
GRAFTON PONDS	POND N105-1	GRAFTON PONDS NATURAL AREA PRESERVE	Y	PL	Partners are City of Newport News and DCR
GRANDVIEW BEACH	GRANDVIEW BEACH	GRANDVIEW NATURE PRESERVE	Y	PL	PARENT EOR (no SubEO's)
GROVE CREEK	GROVE CREEK		Y	Y	
GUM MARSH	MATTAPONI RIVER - SANDY POINT		Y	10Yr	
HACKS NECK	HACKS NECK		Y	Y	INTERIM PARENT EOR for Hacks Neck/ Hyslop Marsh site (4 SubEO's)
HARROD LANE POND	HARROD LANE POND	BATTLE PARK	Y	Y	
HICKORY FORK SEEPS	HICKORY FORK SEEPS	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	

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HICKORY HOLLOW	HICKORY HOLLOW	HICKORY HOLLOW NATURAL AREA PRESERVE	Y	PL	partner is DCR
HOG ISLAND	HOG ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	
HOG NECK CREEK HABITAT ZONE	HOG CREEK		Y	Y	
HUGHLETT POINT NATURAL AREA PRESERVE	DAMERON MARSH	DAMERON MARSH NATURAL AREA PRESERVE	Y	PL	INTERIM PARENT EOR for Harveys Neck/ Dameron Marsh site (6 SubEO's)
KITTEWAN CREEK	KITTEWAN CREEK	KITTEWAN WILDLIFE MANAGEMENT AREA	Y	10Yr	
LEE MARSH	PAMUNKEY RIVER - LEE MARSH		Y	PL	Partners are VIMS and DU. GName should be TIDAL OLIGOHALINE MARSH
LITTLE MOSQUITO CREEK	LITTLE MOSQUITO CREEK	WALLOPS FLIGHT FACILITY	Y	Y	GName should be TIDAL OLIGOHALINE MARSH
LOWER CHICKAHOMINY MACROSITE		NEW KENT FORESTRY CENTER	Y	10Yr	
LOWER MATTAPONI RIVER MARSHES	MATTAPONI RIVER - MELROSE LANDING		Y	10Yr	
LOWER QUEEN CREEK		COLONIAL NATIONAL HISTORICAL PARK	Y	PL	
LOWER SKIMIN CREEK		AFETA CAMP PEARY	Y	Y	
MARACOSSIC CREEK TRIBUTARY	MARACOSSIC CREEK TRIBUTARY	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
MARTINS CORNER SEEP	FORT A.P. HILL - MARTINS CORNER SEEP	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
MASHBOX RUN SEEP	MASHBOX RUN SEEP	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
MATTAPONI SPRINGS			Y	Y	
MATTAWOMAN CREEK HEADWATERS	ROADSIDE PARK W OF REEDTOWN		Y	Y	
MEADOW CREEK	MEADOW CREEK - MEADOW CREEK POND	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
METOMPKIN ISLAND	VIRGINIA BARRIER ISLANDS - METOMKIN ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	PARENT EOR
MOSQUITO POINT	MOSQUITO POINT		Y	Y	INTERIM PARENT EOR for Rappahannock River North site (6 SubEO's)
MOUNT CREEK SLOPES	LOWER MOUNT CREEK	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
MOUNT PLEASANT CHURCH	MOUNT PLEASANT CHURCH SITE - MILL CREEK HEADWATERS		Y	Y	
MUTTON HUNK FEN	MUTTON HUNK FEN		Y	10Yr	GName should be TIDAL OLIGOHALINE MARSH
MYRTLE ISLAND	MYRTLE ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	
NANCES SHOP BOG	CHICKAHOMINY RIVER - NANCE'S SHOP BOG -EDNA'S MILL		Y	PL	Partners is DCR and Dominion
NEW POINT COMFORT	NEW POINT COMFORT ISLAND SOUTH	NEW POINT COMFORT ISLAND	Y	10Yr	INTERIM PARENT EOR (2 SubEO's)
NORTH ASSAWOMAN: SOUTH WALLOPS ISLAND	NORTH ASSAWOMAN-SOUTH WALLOPS ISLAND	CHINCOTEAGUE NATIONAL WILDLIFE REFUGE	Y	PL	PARENT EOR; Partners are USFWS and NASA; Note managed area is incorrect
NORTH WALLOPS ISLAND	WALLOPS ISLAND NORTH	WALLOPS ISLAND NATIONAL WILDLIFE REFUGE	Y	PL	
OCCOHANNOCK NECK	SPARROW POINT		Y	Y	INTERIM PARENT EOR (2 SubEO's)
OCCUPACIA MARSHES	RAPPAHANNOCK RIVER - OCCUPACIA MARSHES		Y	10Yr	
OLD NECK CREEK	CHICKAHOMINY RIVER MEGASITE- OLD NECK CREEK		Y	Y	
PARKERS MARSH	PARKERS MARSH MIDDLE AND WARE	PARKERS MARSH NATURAL AREA PRESERVE	Y	PL	INTERIM PARENT EOR for Parkers Island/ Parkers Marsh site (6 SubEO's)
PARRAMORE ISLAND	PARRAMORE ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	
PENLA SEEPS	PENLA SEEPS		Y	Y	
PEUMANSEND CREEK HEADWATERS	PEUMANSEND CREEK HEADWATERS	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
PICKETTS HARBOR	VIRGINIA EASTERN SHORE - PICKETT'S HARBOR	WILLIAM B. TROWER BAYSHORE NATURAL AREA PRESERVE	Y	PL	

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PIPSICO FOREST	PIPSICO BOY SCOUT RESERVATION	PIPSICO BOYSCOUT RESERVATION	Y	Y	
POHICK/ACCOTINK WETLANDS	ACCOTINK WETLANDS	FORT BELVOIR MILITARY RESERVATION	Y	PL	partner is DCR and DOD
POWHATAN CREEK NATURAL AREA	CHISEL RUN		Y	Y	
RAGGED POINT	CHINCOTEAGUE NWR - CHERRYTREE HILL	CHINCOTEAGUE NATIONAL WILDLIFE REFUGE	Y	10Yr	Partner USFWS
REEDY CREEK SEEPS	REEDY CREEK BOG		Y	PL	Partners are DCR and Dominion
REEDY MILL WOODLAND	REEDY MILL WOODLAND		Y	10Yr	
ROLLINS FORK RAVINES	ROLLINS FORK RAVINES	FORT A.P. HILL MILITARY RESERVATION	Y	10Yr	
SALEM RUN	CHICKAHOMINY RIVER - SALEM RUN BOG		Y	PL	Partners are DCR and Dominion
SAVAGE NECK DUNES	VIRGINIA EASTERN SHORE - SAVAGE NECK DUNES	SAVAGE NECK NATURAL AREA PRESERVE	Y	PL	
SAVAGE NECK DUNES	VIRGINIA EASTERN SHORE - SAVAGE NECK SPIT	SAVAGE NECK NATURAL AREA PRESERVE	Y	PL	INTERIM PARENT EOR (2 SubEO's)
SAXIS ISLAND	SAXIS ISLAND		Y	Y	PARENT EOR (no SubEO's)
SCARBOROUGH NECK	SCARBOROUGH NECK		Y	Y	PARENT EOR (no SubEO's)
SHIP SHOAL ISLAND	SHIP SHOAL ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	PARENT EOR
SMITH ISLAND	SMITH ISLAND	VIRGINIA COAST RESERVE	Y	10Yr	
SMITH POINT	SMITH POINT NORTH		Y	Y	INTERIM PARENT EOR (22 SubEO's)
STOVE POINT NECK	STOVEPOINT NECK NORTHEAST		Y	Y	INTERIM PARENT EOR for Stingray Point/ Piankatank River site (13 SubEO's)
SWEET HALL MARSH	PAMUNKEY RIVER - SWEET HALL MARSH	SWEET HALL MARSH NATIONAL ESTUARINE RESEARCH RESER	Y	10Yr	
THE HOOK	CHINCOTEAGUE NWR - THE HOOK	CHINCOTEAGUE NATIONAL WILDLIFE REFUGE	Y	10Yr	
TURKEY ISLAND MARSHES	TURKEY ISLAND MARSHES	PRESQUILE NATIONAL WILDLIFE REFUGE	Y	PL	Partner is USFWS
UPPER CRAB NECK HABITAT ZONE	SEAFORD		Y	Y	
WALLOPS ISLAND SEEPS	LUCKY BOY FEN		Y	10Yr	
WARE CREEK	WARE CREEK		Y	Y	GName should be TIDAL OLIGOHALINE MARSH
WARRENEYE NATURE TRAIL HABITAT ZONE	WARRENEYE NATURE TRAIL		Y	Y	
WHITE HILLS	CHINCOTEAGUE NWR	CHINCOTEAGUE NATIONAL WILDLIFE REFUGE	Y	10Yr	
WILCOX NECK	CHICKAHOMINY RIVER - LANEXA		Y	Y	
WORMLEY POND		COLONIAL NATIONAL HISTORICAL PARK	Y	PL	
WRECK ISLAND	WRECK ISLAND	WRECK AND BONE ISLAND NATURAL AREA PRESERVE	Y	PL	PARENT EOR; Partner is DCR
YARMOUTH CREEK	YARMOUTH ISLAND		Y	Y	GName & GCOMName should be TIDAL FRESHWATER MARSH
103 sites					

Chesapeake Bay Lowlands Ecoregion (Revised 11/9/01 by D. Samson)

Delaware Draft Portfolio Site Selection Spreadsheet

SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	TARGET	EOR IN PORTFOLIO	PORTFOLIO STATUS	Comments
ANGOLA NECK MACROSITE	ANGOLA NECK/DELAWARE WILD LANDS		P	Y	PL	partner is DE Wildlands
ASSAWOMAN PONDS COMPLEX	ASSAWOMAN POND	ASSAWOMAN WILDLIFE AREA	P	Y	PL	partner is DE Fish & Wildlife
BEACH PLUM ISLAND	BEACH PLUM ISLAND		P	Y	10Yr	Part of Great Marsh & DE Bayshores Bioreserve; partner is State Parks
BEAVERDAM CREEK	BEAVERDAM BRANCH		P	Y	10Yr	
BLACKBIRD CREEK	BLACKBIRD STATE FOREST-TYABOUT CAROLINA BAY	BLACKBIRD STATE FOREST	P	Y	PL	Located in large protected forest block; probably should have been ranked Y? Partner is State Forest
BROAD CREEK	BROAD CREEK NANTICOKE	NANTICOKE WILDLIFE AREA	P	Y	10Yr	partner is DE Fish & Wildlife
BROADKILL RIVER	ROUND POLE BRANCH		P	Y	Y	
CAPE HENLOPEN MACROSITE	CAPE HENLOPEN PINELANDS	CAPE HENLOPEN STATE PARK	P	Y	PL	partner is State Park
CEDAR CREEK NATURAL AREA	CEDAR CREEK (W OF HWY 1)		P	Y	PL	State Easement
CHAPEL BRANCH	CHAPEL BRANCH		P	Y	Y	
CHERRY WALK	CHERRY WALK CREEK FENS		P	Y	PL	partner is DE Wildlands
CHOPTANK RIVER	SANDTOWN POND EAST		P	Y	Y	
CHRISTINA RIVER MACROSITE	BANNING MARSH		P	Y	PL	partner is DE Fish & Wildlife; restoration needed
CHURCH BRANCH	CHURCH BRANCH		P	Y	Y	
COLDWELL CORNERS	COLDWELL CORNERS		P	Y	Y	
COUNTY LINE POND	COUNTY LINE PONDS	BLACKBIRD STATE FOREST	P	Y	10Yr	partner is State Forest
CUBBAGE POND	CEDAR CREEK-CLENDANIEL POND		P	Y	Y	
CYPRESS BRANCH	CYPRESS BRANCH	BLACKBIRD STATE FOREST	P	Y	PL	partner is State Forest
DEEP COWBRIDGE BRANCH	MILLSBORO CEDAR SWAMP		P	Y	Y	
DEEP CREEK	RIVER'S END ESTATES MARSH		P	Y	10Yr	
DELAWARE BAYSHORES BIORESERVE	RED MILL POND WOODS		P	Y	10Yr	Part of Great Marsh & DE Bayshores Bioreserve
DOUBLE PONDS	DOUBLE PONDS		P	Y	10Yr	ponds are intact & undisturbed; saying pop is non-viable is difficult because of life history
GREAT CYPRESS SWAMP MACROSITE	GREAT CYPRESS SWAMP	GREAT CYPRESS SWAMP	P	Y	PL	partner is DE Wildlands
GREAT MARSH	GREAT MARSH-OYSTER ROCKS		P	Y	10Yr	Part of Great Marsh & DE Bayshores Bioreserve
HOLLAND NECK	HOLLAND NECK WOODS		P	Y	PL	partner is State Park
HUDSON POND SITE	CEDAR CREEK BELOW SWIGGETTS POND		P	Y	PL	partner is State Forest
INGRAM BRANCH	INGRAM BRANCH WEST		P	Y	10Yr	
INLAND BAYS ISLANDS	DELAWARE SEASHORE STATE PARK	DELAWARE SEASHORE STATE PARK	P	Y	PL	partner is State Park
JAMES BRANCH	JAMES BRANCH		P	Y	PL	partner is State Park
LEIPSIC RIVER	CHESWOLD NORTHEAST-ALSTON BRANCH		P	Y	10Yr	
MARSHYHOPE CREEK MACROSITE	MARSHYHOPE CREEK		P	Y	10Yr	
MIDDLEFORD NORTH	MIDDLEFORD NORTH		P	Y	10Yr	
MIDDLEFORD SOUTH	DEEP CREEK		P	Y	Y	pop partially impacted by house, but overall is doing fine
MISPILLION RIVER	BLAIRS POND	BLAIRS POND AND ACCESS SITE	P	Y	Y	
MUDSTONE BRANCH	MUDSTONE BRANCH OLD GROWTH		P	Y	10Yr	
MURDERKILL RIVER MACROSITE	BROWNS BRANCH		P	Y	PL	partner is State Park & County
NANTICOKE RIVER MEGASITE	NANTICOKE WILDLIFE AREA (SOUTH)		P	Y	10Yr	partner is DE Fish & Wildlife
PEMBERTON BRANCH	BRITTINGHAM BRANCH	TNC PEMBERTON BRANCH PRESERVE	P	Y	10Yr	
PHILLIPS BRANCH	PHILLIPS BRANCH		P	Y	Y	
PIKE CREEK	OLD COACH BRIDGE MARSH		P	Y	PL	partner is State Park
PRIME HOOK	PRIME HOOK NATIONAL WILDLIFE REFUGE	PRIME HOOK NATIONAL WILDLIFE REFUGE	P	Y	Y	USFWS
RED HOUSE LANDING AREA	NANTICOKE WILDLIFE AREA NORTH	NANTICOKE WILDLIFE AREA	P	Y	10Yr	partner is DE Fish & Wildlife
ROBBINS	JENNINGS TRACT	MAPLE BRANCH	P		Y	Robbins tract has a good EOR seed bank that responds to clearing; EOR's disappeared when canopy closed; Potential management as open wet meadow if easements are acquired by State.
SOWBRIDGE BRANCH MACROSITE	INGRAM BRANCH SWALE		P	Y	Y	
ST JONES RIVER	WARREN-WOODSIDE WOODS		P	Y	PL	National Estuarine Research Reserve;

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Chesapeake Bay Lowlands Ecoregion (Revised 11/9/01 by D. Samson)
Delaware Draft Portfolio Site Selection Spreadsheet

SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	TARGET	EOR IN PORTFOLIO	PORTFOLIO STATUS	Comments
STILL POND	STILL POND		P	Y	10Yr	
SWAN CREEK	SWAN CREEK		P	Y	Y	
TRAP POND	TRAP POND	TRAP POND STATE PARK	P	Y	PL	partner is State Park
TUBBS BRANCH	TUBBS BRANCH		P	Y	10Yr	
VANDYKE	VANDYKE TRACT-TEARDROP POND	BLACKBIRD STATE FOREST	P	Y	PL	partner is State Forest
WATCH TOWER BOG	FENWICK ISLAND STATE PARK	ASSAWOMAN WILDLIFE AREA	P	Y	PL	partner is State Park
WELCHES POND	WELCHES POND		P	Y	Y	
WHITE CLAY CREEK MACROSITE	DUPONT KOPPERS MARSH SITE		P	Y	PL	partner is DE Fish & Wildlife
WOLFE GLADE BOG	WOLFE NECK WOODS		P	Y	PL	partner is State Park
54 sites						

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Chesapeake Bay Lowlands Ecoregion

(created 1/3/02 by D. Samson)

Maryland Draft Portfolio Final Sites List

SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	TARGET	EOR IN PORTFOLIO	PORTFOLIO STATUS
ADKINS VI BOGS	BOG #1	NASSAWANGO CREEK BALD CYPRESS SWAMP SANCTUARY	P	Y	10Yr
ANDOVER FLATWOODS			P	Y	PL
ASSATEAGUE ISLAND MACROSITE		ASSATEAGUE ISLAND NATIONAL SEASHORE - MD PORTION	P	Y	PL
ASSATEAGUE ISLAND NORTH		ASSATEAGUE ISLAND NATIONAL SEASHORE - MD PORTION	P	Y	PL
BALTIMORE CORNER	POND A	BALTIMORE CORNER PRESERVE	P	Y	10Yr
BIG MARSH			P	Y	Y
BLACK BOTTOM PONDS	POND D		P	Y	PL
BLACKWATER ROADSIDE			P	Y	10yr
BOARMAN WOODS			P	Y	Y
BRANDYWINE RECEIVING STATION SITE		BRANDYWINE RECEIVING STATION	P	Y	PL
BRIDGETOWN PONDS		BRIDGETOWN PONDS	P	Y	PL
BROOKVIEW PONDS	POND C	CHESAPEAKE FOREST	P	Y	PL
BRYAN POINT		PISCATAWAY PARK	P	Y	PL
CALVERT CLIFFS		CALVERT CLIFFS STATE PARK	P	Y	PL
CARSON CORNERS POND			P	Y	Y
CEDAR ISLAND		CEDAR ISLAND WILDLIFE MANAGEMENT AREA	P	Y	PL
CHICONE WOODS		CHICONE WOODS	P	Y	PL
CHOPTANK WETLANDS		CHOPTANK WETLANDS PRESERVE	P	Y	Y
COVE POINT		COVE POINT MARSH NATURAL HERITAGE AREA	P	Y	10Yr
DELAWARE WILDLANDS		DELAWARE WILDLANDS	P	Y	Y
DIVIDING CREEK PONDS		POCOMOKE STATE FOREST	P	Y	PL
DORCHESTER POND	DORCHESTER POND ENTRANCE ROAD	DORCHESTER POND PRESERVE	P	Y	10Yr
DUNCANS CROSSING WOODS			P	Y	Y
EAST BETTERTON			P	Y	10Yr
EAST MELVILLE POND			P	Y	Y
EDEN SWAMP AND POWERLINE			P	Y	Y
FLAG PONDS		FLAG PONDS NATURE PARK	P	Y	PL
FREETOWN SWAMP			P	Y	Y
GOLTS PONDS	POND A		P	Y	PL
GRAHAM CREEK MARSH			P	Y	Y (ask WT)
GREER'S POND			P	Y	Y
GROVE NECK			P	Y	10Yr
GROVE POINT			P	Y	10Yr
GUM SWAMP		BLACKWATER NATIONAL WILDLIFE REFUGE	P	Y	10yr
HANCOCK CREEK SWAMP			P	Y	10Yr
HOLLINGSWORTH PONDS	BIG POND		P	Y	10Yr
HOWELL POINT CLIFF			P	Y	10Yr
JACKSON LANE SITE	CROSS POND		P	Y	10Yr
JANES ISLAND BEACH		JANES ISLAND STATE PARK	P	Y	PL
KANE CROSSROADS POND			P	Y	10Yr
LITTLE COVE POINT			P	Y	10Yr
LITTLE MILL RUN			P	Y	Y
MAGRUDER FERRY SEEP	SHORELINE MARSH	PATUXENT RIVER PARK	P	Y	PL
MARSHYHOPE SEASONAL POND		CHESAPEAKE FOREST	P	Y	PL
MATTAPONI		POCOMOKE RIVER STATE PARK (MILBURN LANDING AREA)	P	Y	PL
MCINTOSH RUN			P	Y	10Yr
MESSICK POND			P	Y	10Yr
MILL CREEK		MILL CREEK NATURAL HERITAGE AREA	P	Y	Y
MILL CREEK WILDLIFE SANCTUARY		MILL CREEK WILDLIFE SANCTUARY	P	Y	PL
MILLINGTON WMA PONDS		MILLINGTON WILDLIFE MANAGEMENT AREA	P	Y	PL
MOUNT ZION SOUTH POND			P	Y	Y

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Chesapeake Bay Lowlands Ecoregion

(created 1/3/02 by D. Samson)

Maryland Draft Portfolio Final Sites List

SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	TARGET	EOR IN PORTFOLIO	PORTFOLIO STATUS
NANJEMOY CREEK		NANJEMOY CREEK GREAT BLUE HERON SANCTUARY	P	Y	10Yr
NASSAWANGO CREEK MEGASITE		NASSAWANGO CREEK BALD CYPRESS SWAMP SANCTUARY	P	Y	10Yr
NEW BRIDGE			P	Y	10Yr
NORTH BRICE POWERLINE BOG			P	Y	10Yr
NORWICH CREEK			P	Y	Y
NUTTERS NECK	HIDDEN POND	NANTICOKE WILDLIFE MANAGEMENT AREA	P	Y	PL
PATUXENT WILDLIFE RESEARCH CENTER SITE	MABBOTT POND	PATUXENT WILDLIFE RESEARCH CENTER	P	Y	PL
PAWPAW CREEK			P	Y	Y
PERSIMMON PRESERVE SITE	POND A		P	Y	10Yr
PIKES CREEK			P	Y	10Yr
PINEY BRANCH POWERLINE BOG			P	Y	Y
PLUM POINT			P	Y	10Yr
POWELL CREEK			P	Y	10Yr
PRICES CHAPEL PONDS			P	Y	Y
PRINCESS ANNE MARSHES	TAYLOR BRANCH		P	Y	10Yr
PRISTINE PINES	POND B	PRISTINE PINES PRESERVE	P	Y	10Yr
R AND M BAY			P	Y	Y
RANDLE CLIFF BEACH		RANDLE CLIFF BEACH NATURAL HERITAGE AREA	P	Y	10Yr
SCARBORO CREEK WOODS		E. A. VAUGHN WILDLIFE MANAGEMENT AREA	P	Y	PL
SCHUYLER ROAD POND			P	Y	Y
SCIENTISTS CLIFFS		PARKERS CREEK	P	Y	10yr
SETH FOREST	SETH VERNAL POOL #1 (TYPE LOCALITY)	SETH DEMONSTRATION STATE FOREST	P	Y	PL
SHORTS CREEK MARSH			P	Y	10Yr
SHREWSBURY NECK CLIFF			P	Y	10 Yr
SKIMMER ISLAND			P	Y	PL
SNETHEN CHURCH ROAD POWERLINE			P	Y	10Yr
STEELS NECK WOODS		LECOMPTE WILDLIFE MANAGEMENT AREA	P	Y	PL
STILL POND NECK			P	Y	10Yr
STONY RUN		BALTIMORE-WASHINGTON INTERNATIONAL AIRPORT	P	Y	PL
STUMP NECK BEAVER MARSH		INDIAN HEAD NAVAL SURFACE WARFARE CENTER	P	Y	PL
STUMP POINT MARSHES			P	Y	10Yr
TANHOUSE CREEK			P	Y	Y
TEMPLEVILLE PONDS			P	Y	Y
THIRD HAVEN WOODS		THIRD HAVEN WOODS PRESERVE	P	Y	10Yr
TURNER CREEK NECK EAST		SASSAFRAS RIVER NATURAL RESOURCES MANAGEMENT AREA	P	Y	PL
TURNER CREEK NECK WEST		SASSAFRAS RIVER NATURAL RESOURCES MANAGEMENT AREA	P	Y	PL
UPPER BLACKWATER RIVER		UPPER BLACKWATER RIVER NATURAL HERITAGE AREA	P	Y	10Yr
WADE'S SAVANNA			P	Y	10Yr
WANGO PINES			P	Y	10Yr
WEST GOVERNOR RUN WATERSHED		SOUTH GRAVATT TRACT - ACLT	P	Y	10yr
WESTERN SHORES			P	Y	10Yr
WETIPQUIN POND		WETIPQUIN POND PRESERVE	P	Y	10Yr
WYE ISLAND WOODS		WYE ISLAND NATURAL RESOURCES MANAGEMENT AREA	P	Y	PL
			P	Y	10yr
		BLACKWATER NATIONAL WILDLIFE REFUGE	P	Y	10yr

Chesapeake Bay Lowlands Ecoregion

(created 1/3/02 by D. Samson)

Maryland Draft Portfolio Final Sites List

SITENAME	SURVEY SITE NAME	MANAGED AREA NAME	TARGET	EOR IN PORTFOLIO	PORTFOLIO STATUS
		BLACKWATER NATIONAL WILDLIFE REFUGE	P	Y	PL
			P	Y	10Yr
			P	Y	PL
			P	Y	PL
		EASTERN NECK NATIONAL WILDLIFE REFUGE	P	Y	PL
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
			P	Y	Y
		REMINGTON FARMS	P	Y	Y
			P	Y	Y
			P	Y	Y
117 sites					

CBY Ecoregion

(Revised 11/18/01 by D. Samson)

Delaware Target Species Occurrence Summary

EOCODE	GNAME (Global Name)	GCOMNAME (Global Common Name)	GRANK	SRANK	STATE	Total	Y	N	?
PDAMA040Z0*006*DE	AMARANTHUS PUMILUS	SEABEACH AMARANTH	G2	S1.1	**DE**	6	6	0	0
IILEPE2140*002*DE	CALLOPHRYS HESSELI	HESSEL'S HAIRSTREAK	G3G4	S1	**DE**	4	3	1	0
IILEPE2220*004*DE	CALLOPHRYS IRUS	FROSTED ELFIN	G3	S1	**DE**	2	2	0	0
PMCYP037T0*005*DE	CAREX LUPULIFORMIS	FALSE HOP SEDGE	G4	S1	**DE**	5	4	1	0
ABNNB03070*006*DE	CHARADRIUS MELODUS	PIPING PLOVER	G3	S1B	**DE**	6	2	4	0
ARAAD02040*002*DE	CLEMMYS MUHLENBERGII	BOG TURTLE	G3	S1	**DE**	4	1	3	0
PDAST2L0T0*004*DE	COREOPSIS ROSEA	ROSE COREOPSIS	G3	S1	**DE**	2	2	0	0
IIODO29090*001*DE	EPITHECA SPINOSA	ROBUST BASKETTAIL	G4	S1	**DE**	2	2	0	0
PDEUP0Q1T0*001*DE	EUPHORBIA PURPUREA	GLADE SPURGE	G3	S1.1	**DE**	1	1	0	0
PMCYP0B0F0*006*DE	FIMBRISTYLIS PERPUSILLA	HARPER'S FIMBRISTYLIS	G2	S1	**DE**	5	5	0	0
PDERI0G020*001*DE	GAYLUSSACIA BRACHYCERA	BOX HUCKLEBERRY	G3	S1	**DE**	5	5	0	0
PMLIL10010*025*DE	HELONIAS BULLATA	SWAMP-PINK	G3	S2	**DE**	27	22	5	0
PDCLU03010*006*DE	HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S2	**DE**	6	3	3	0
PMORC1F010*001*DE	ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	G2	S1.1	**DE**	1	0	1	0
PMPOA4K150*001*DE	PANICUM HIRSTII	HIRSTS' PANIC GRASS	G1	S1.1	**DE**	1	1	0	0
IICOL5Y020*007*DE	PHOTURIS BETHANIENSIS	A LAMPYRID FIREFLY	G1?	S1	**DE**	7	7	0	0
PDPGN0L120*001*DE	POLYGONUM GLAUCUM	SEABEACH KNOTWEED	G3	S1.1	**DE**	1	1	0	0
PDLAM1N0G0*002*DE	PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	G2	S1	**DE**	2	0	2	0
PDMLS0H020*006*DE	RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S1	**DE**	7	2	5	0
PMCYP0N170*002*DE	RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S1	**DE**	4	2	2	0
IILEPD4090*001*DE	SATYRIUM KINGI	KING'S HAIRSTREAK	G3G4	S1	**DE**	1	1	0	0
PPSCH03040*001*DE	SCHIZAEA PUSILLA	CURLY-GRASS FERN	G3	S1.1	**DE**	1	1	0	0
PMCYP0Q0L0*002*DE	SCIRPUS ETUBERCULATUS	CANBY BULRUSH	G3G4	S1	**DE**	3	2	1	0
AMAFB07042*002*DE	SCIURUS NIGER CINEREUS	DELMARVA FOX SQUIRREL	G5T3	S1	**DE**	2	2	0	0
IIODO32190*002*DE	SOMATOCHLORA PROVOCANS	TREETOP EMERALD	G4	S1	**DE**	2	2	0	0
TOTALS						**107**	**79**	**28**	**0**

CBY Ecoregion
(Revised 11/28/01 by D. Samson)

Virginia Target Species Occurrence Summary

EOCODE	GNAME (Global Name)	GCOMNAME (Global Common Name)	GRANK	SRANK	STATE	Total	Y	N	?
PDFAB04080*006*VA	AESCHYNOMENE VIRGINICA	SENSITIVE JOINT-VETCH	G2	S2	**VA**	17	10	7	0
ABPBX91050*004*VA	AIMOPHILA AESTIVALIS	BACHMAN'S SPARROW	G3	S1	**VA**	1	1	0	0
IILEPE2220*001*VA	CALLOPHRYS IRUS	FROSTED ELFIN	G3	S2	**VA**	1	0	1	0
ARAAA01010*002*VA	CARETTA CARETTA	LOGGERHEAD	G3	S1B,SZN	**VA**	2	2	0	0
PMCYP037T0*003*VA	CAREX LUPULIFORMIS	FALSE HOP SEDGE	G4	S1	**VA**	2	0	2	0
ABNNB03070*024*VA	CHARADRIUS MELODUS	PIPING PLOVER	G3	S2	**VA**	15	10	5	0
PDSCR0F010*029*VA	CHELONE CUTHBERTII	CUTHBERT TURTLEHEAD	G3	S2	**VA**	5	2	3	0
IICOL02011*069*VA	CICINDELA DORSALIS DORS	TIGER BEETLE	G4T2	S2	**VA**	20	17	3	0
PMORC0Q0F0*002*VA	CYPRIPEDIUM KENTUCKIENS	SOUTHERN LADY'S-SLIPPER	G3	S1	**VA**	1	1	0	0
IIODO29090*005*VA	EPITHECA SPINOSA	ROBUST BASKETTAIL	G4	S2	**VA**	1	0	1	0
PMCYP0B0F0*002*VA	FIMBRISTYLIS PERPUSILLA	HARPER'S FIMBRISTYLIS	G2	S1	**VA**	11	11	0	0
PMLIL10010*039*VA	HELONIAS BULLATA	SWAMP-PINK	G3	S2S3	**VA**	18	12	6	0
PMORC1F010*024*VA	ISOTRIA MEDEOLOIDES	SMALL WHORLED POGONIA	G2	S2	**VA**	12	2	10	0
PMJUN010K0*025*VA	JUNCUS CAESARIENSIS	NEW JERSEY RUSH	G2	S2	**VA**	17	8	9	0
PDLAU08010*001*VA	LITSEA AESTIVALIS	PONDSPICE	G3	S1	**VA**	1	0	1	0
PDMON04020*001*VA	MONOTROPSIS ODORATA	SWEET PINESAP	G3	S2S3	**VA**	2	1	1	0
PDNYM04016*003*VA	NUPHAR LUTEA SSP SAGITT	CAPE FEAR SPATTERDOCK	G5T2	S1	**VA**	5	3	2	0
PDPGN0L120*008*VA	POLYGONUM GLAUCUM	SEABEACH KNOTWEED	G3	S1S2	**VA**	9	4	5	0
IILEP71020*001*VA	PROBLEMA BULENTA	RARE SKIPPER	G2G3	S1	**VA**	1	1	0	0
AMAFB07042*001*VA	SCIURUS NIGER CINEREUS	DELMARVA FOX SQUIRREL	G5T3	S1	**VA**	2	2	0	0
IIODO32190*003*VA	SOMATOCHLORA PROVOCANS	TREETOP EMERALD	G4	S2	**VA**	1	0	1	0
ICMAL05290*013*VA	STYGOBROMUS ARAEUS	AMPHIPOD	G2G3	S2	**VA**	8	2	6	0
ICMAL05240*007*VA	STYGOBROMUS INDENTATUS	TIDEWATER AMPHIPOD	G3	S2	**VA**	2	2	0	0
ICMAL05250*003*VA	STYGOBROMUS PHREATICUS	AMPHIPOD	G1	S1	**VA**	1	1	0	0
PMLIL200Q3*035*VA	TRILLIUM PUSILLUM VAR V	VIRGINIA LEAST TRILLIUM	G3T2	S2	**VA**	9	4	5	0
TOTALS						**164**	**96**	**68**	**0**

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Prepared 11/18/2001 by D. Samson
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CBY Ecoregion

(Revised 11/18/01 by D. Samson)

Maryland Target Species Occurrence Summary

EOCODE	GNAME (Global Name)	GCOMNAME (Global Common Name)	GRANK	SRANK	STATE	Total	Y	N	?
AFCAA01010*004*MD	ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3	S1	MD	3	0	3	0
AFCAA01040*001*MD	ACIPENSER OXYRINCHUS	ATLANTIC STURGEON	G3	S1	MD	1	0	1	0
PDFAB04080*008*MD	AESCHYNOMENE VIRGINICA	SENSITIVE JOINT-VETCH	G2	S1	MD	6	5	1	0
IIODO14110*001*MD	AESHNA MUTATA	SPATTERDOCK DARNER	G3G4	S1	MD	1	1	0	0
PDSCR01010*003*MD	AGALINIS ACUTA	SANDPLAIN GERARDIA	G1	S1	MD	1	0	1	0
PDSCR01130*003*MD	AGALINIS AURICULATA	EARLEAF FOXGLOVE	G3	S1	MD	1	1	0	0
PDSCR010T0*002*MD	AGALINIS SKINNERIANA	PALE FALSE FOXGLOVE	G3	S1	MD	2	2	0	0
IMBIV02030*002*MD	ALASMIDONTA HETERODON	DWARF WEDGEMUSSEL	G1G2	S1	MD	5	3	2	0
PDAMA040Z0*001*MD	AMARANTHUS PUMILUS	SEABEACH AMARANTH	G2	S1	MD	1	1	0	0
IILEPE2220*003*MD	CALLOPHRYS IRUS	FROSTED ELFIN	G3	S1	MD	4	2	2	0
ARAAA01010*002*MD	CARETTA CARETTA	LOGGERHEAD	G3	S1B,S1N	MD	2	2	0	0
PMCYP037T0*004*MD	CAREX LUPULIFORMIS	FALSE HOP SEDGE	G4	S1?	MD	6	1	5	0
PDFAB47051*002*MD	CHAMAECRISTA FASCICULAT		G5T3	S1	MD	2	2	0	0
ABNNB03070*001*MD	CHARADRIUS MELODUS	PIPING PLOVER	G3	S1B,SAN	MD	1	1	0	0
IICOL02011*009*MD	CICINDELA DORSALIS DORS	TIGER BEETLE	G4T2	S1	MD	13	6	7	0
IICOL02030*007*MD	CICINDELA PURITANA	PURITAN TIGER BEETLE	G1G2	S1	MD	16	14	2	0
PDAST2L0T0*004*MD	COREOPSIS ROSEA	ROSE COREOPSIS	G3	S1	MD	1	1	0	0
PDFAB1D100*004*MD	DESMODIUM OCHROLEUCUM	TREFOIL	G2G3	S1	MD	1	1	0	0
PMCYP0B0F0*004*MD	FIMBRISTYLIS PERPUSILLA	HARPER'S FIMBRISTYLIS	G2	S2	MD	18	18	0	0
PDERI0G020*001*MD	GAYLUSSACIA BRACHYCERA	BOX HUCKLEBERRY	G3	S1	MD	1	0	1	0
PMLIL10010*010*MD	HELONIAS BULLATA	SWAMP-PINK	G3	S2	MD	6	2	4	0
IICOL6Z010*001*MD	HYDROCHUS SP 1	SCAVENGER BEETLE	G1	S1	MD	1	1	0	0
PDCLU03010*008*MD	HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S1	MD	8	7	1	0
PMJUN010K0*002*MD	JUNCUS CAESARIENSIS	NEW JERSEY RUSH	G2	S1	MD	3	2	1	0
PDLAU08010*001*MD	LITSEA AESTIVALIS	PONDSPICE	G3	S1	MD	1	1	0	0
PDMON04020*012*MD	MONOTROPSIS ODORATA	SWEET PINESAP	G3	S1	MD	2	1	1	0
PMPOA481U0*001*MD	MUHLENBERGIA TORREYANA	TORREY'S DROPSEED	G3	S1	MD	1	1	0	0
PDAPI1L010*001*MD	OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	MD	1	1	0	0
IILEP73011*001*MD	POANES MASSASOIT CHERMO	WING	G4T1	S1	MD	1	1	0	0
PDPGN0L120*002*MD	POLYGONUM GLAUCUM	SEABEACH KNOTWEED	G3	S1	MD	5	3	2	0
IILEP71020*002*MD	PROBLEMA BULENTA	RARE SKIPPER	G2G3	S1	MD	4	4	0	0
PDLAM1N0G0*011*MD	PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT	G2	S1	MD	2	1	1	0
PMCYP0N170*003*MD	RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S1	MD	3	3	0	0
IILEPD4090*001*MD	SATYRIUM KINGI	KING'S HAIRSTREAK	G3G4	S1	MD	4	3	1	0
PMCYP0Q0L0*001*MD	SCIRPUS ETUBERCULATUS	CANBY BULRUSH	G3G4	S1	MD	1	1	0	0
AMAFB07042*027*MD	SCIURUS NIGER CINEREUS	DELMARVA FOX SQUIRREL	G5T3	S1	MD	26	26	0	0
IIODO32190*001*MD	SOMATOCHLORA PROVOCANS	TREETOP EMERALD	G4	S1	MD	1	1	0	0
ICMAL05240*001*MD	STYGOBROMUS INDENTATUS	TIDEWATER AMPHIPOD	G3	S1	MD	1	0	1	0
PMLIL200Q3*009*MD	TRILLIUM PUSILLUM VAR V	VIRGINIA LEAST TRILLIUM	G3T2	S2	MD	9	8	1	0
TOTALS						**166**	**128**	**38**	**0**

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