The Neotropical Migratory Songbird Coastal Corridor Study

Special Virginia Edition

Cover Illustrations

Vegetation from top to bottom: Loblolly Pine, White Oak, Red Maple, American Holly

Birds clockwise from top: Scarlet Tanager, Black-throated Blue Warbler and Common Yellowthroat

THE NEOTROPICAL MIGRATORY SONGBIRD COASTAL CORRIDOR STUDY
VIRGINIA SPECIAL EDITION

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WITH

A PRELIMINARY NATURAL AREAS SURVEY OF NORTHAMPTON AND ACCOMACK COUNTIES, VIRGINIA

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I. ACKNOWLEDGEMENTS

The Neotropical Migratory Songbird Coastal Corridor study was funded jointly by the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management, The Nature Conservancy, the National Fish and Wildlife Foundation, the U.S. Fish and Wildlife Service, the Phillip Reed Foundation and the Mary Flagler Cary Charitable Trust. Support from NOAA was provided by grant monies through Section 309 of the Coastal Zone Management Act of 1972 as amended in 1986. The authors wish to extend special thanks to NOAA's Office of Ocean and Coastal Resource Management for making the initial investment in this project and David Kaiser and Bill Millhouser, in particular, for recognizing the importance of protecting coastal habitat for migrating songbirds. Special thanks also to Michael Lipford, Laura McKay, Chris Pague, and Larry Master for conceiving of this project and securing grant funds. Special thanks for securing grant funds also go to Bruce Runnels, John Hall, and Wayne Klockner of The Nature Conservancy.

We have received technical support from Natural Heritage and Nongame state agency staff and Nature Conservancy offices across the region. Larry Master, Laura McKay, and Robert Unnasch provided invaluable help in the creation of this document through their comments and hard work. Jim McCann and Richard Trout are credited with the arduous task of data handling and analysis. Gil Allen facilitated data tabulation conducted by Advanced Systems, Inc. Megan Rollins provided advice on graphics. Shepard Moon contributed extensively to our policy recommendations. Sharon Paul composed maps, produced graphics, and designed layout for the final draft of this report.

The complexity and regional nature of the study necessitated a cooperative effort, involving a team of people with diverse backgrounds and affiliations. The study team included biologists and land use policy advisors from various state and federal conservation agencies, academia, and nonprofit conservation groups. State conservation agencies and non-governmental organizations in each of the four states coordinated and implemented the study (Appendix A). In addition, hundreds of skilled birdwatchers volunteered their expertise as field observers.

II. EXECUTIVE SUMMARY

Repeated accounts of population declines for many neotropical migratory songbird species are awakening widespread concern and sparking national and international conservation initiatives. To date the majority of research and protection efforts have focused on the fragmentation and loss of breeding and wintering habitat. Migratory stopover habitats, however, are in need of comparable attention particularly in such important concentration regions as the mid-Atlantic and the Gulf coasts. Migration is a physiologically stressful time when all resources, including food and shelter, take on added significance. From the human perspective, migration is an aesthetically spectacular event that has inspired awe for thousands of years. The existing and potential economic value of protecting migratory habitat is significant for the tourism-based and rural communities of the Cape May and Delmarva peninsulas.

In the fall of 1991, following preliminary observations that landbird migrants concentrate in a relatively narrow strip of shrubby and wooded habitat along the coasts and near the tips of the Cape May and Delmarva peninsulas, the Neotropical Migratory Songbird Coastal Corridor Study (NMSCC) examined the distribution and habitat associations of fall migrating landbirds within the coastal region of the four state area. This regional approach addressed the fundamental nature of *migrating* birds; they are mobile, paying no heed to political boundaries. The NMSCC has been a cooperative project involving governmental agencies, non-governmental organizations, academicians, and many individual landowners and volunteers in New Jersey, Delaware, Maryland, and Virginia.

The study results establish that neotropical migrants are not randomly or evenly distributed over the Cape May and Delmarva peninsulas during stop-over; rather the birds are concentrated in particular geographic areas within the region. Four clear distribution patterns are evident:

- Migrants are more abundant in areas close to all coastlines (within 0-0.9 mi) than they are in equivalent areas farther away from the coast (0.9-1.9 mi).

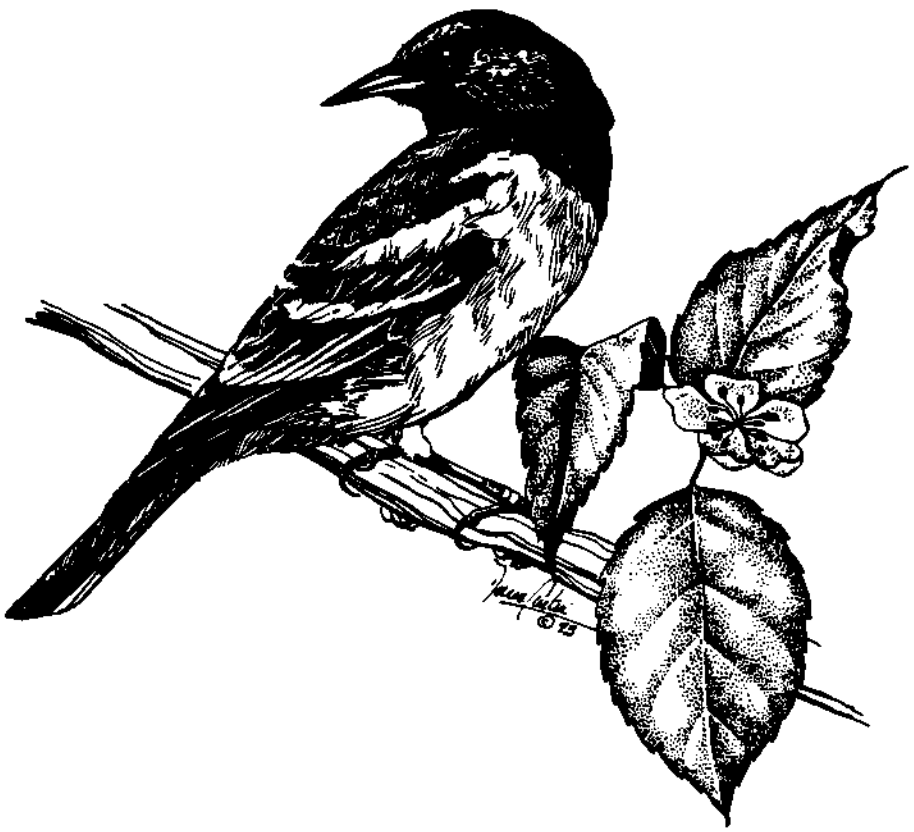
- Bay coastal zones have higher densities of migrants than seaside coastal zones or interior regions.

- Migratory songbirds are more abundant on barrier islands than the coastal mainland.

- Migrants are associated with particular habitats on a species-specific basis.

Based on these results we recommend that the protection of migratory landbird habitat become an objective of conservation measures currently acting within the coastal regions of the Delmarva and Cape May peninsulas.

Inventories of the best remaining natural areas within the coastal zones of the four state region were also sponsored by the NMSCC. Copies of these inventory reports are available from each state's Natural Heritage program.



III. INTRODUCTION

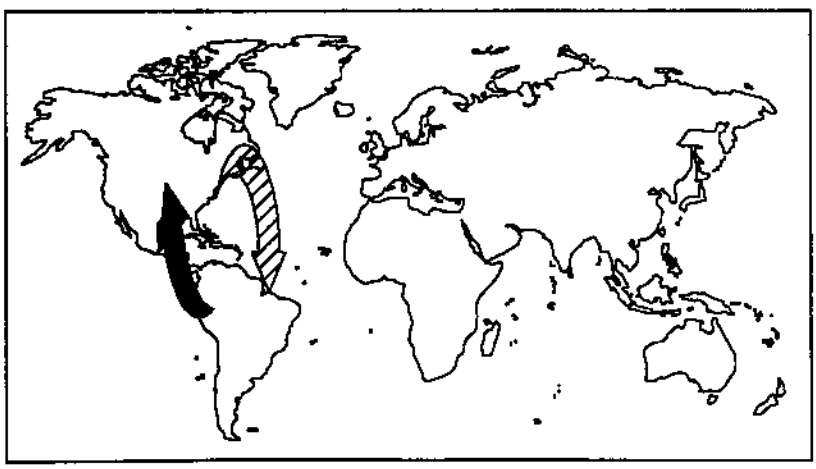
As a group, neotropical migrants make up 60-80% of all breeding birds in forests across eastern North America.

Neotropical migratory songbirds are a group of species that breed in North America and spend the rest of the year in the tropical and sub-tropical Americas. In all, nearly two hundred species of birds have adopted this remarkable lifestyle including some of North America's best loved birds: warblers, hummingbirds, swallows, orioles, tanagers, vireos, thrushes, flycatchers, sparrows, cuckoos, and nighthawks. As a group, neotropical migrants make up 60-80 percent of all breeding birds in forests across eastern North America.

Although there remains a tremendous diversity of behaviors and specific life styles among the species of neotropical migrants, long-distance migration gives unifying definition to the annual cycle of all neotropical migrants. The generalized life history that follows serves as a brief introduction to the ecology of neotropical migratory songbirds and emphasizes migration. The summary of threats to neotropical migrant populations also treats this diverse group stereotypically.

LIFE HISTORY OF NEOTROPICAL MIGRATORY SONGBIRDS

From a North American perspective, neotropical migrants arrive in the spring, mate and raise their young throughout the summer, and then depart to winter in warmer climes. This series of events is repeated year after year during the average four to six years of a migrant's life. A simplified picture of migration routes illustrates the extraordinary demands of this life style (Map 1). From the bird's perspective, each year is a continuous struggle to survive and reproduce with no clear beginning or end; the arrows depicting migration pathways quite likely point to a small, familiar clump of trees or shrubs at both ends of the journey. It is the birds' perspective that most clearly explains the pressures they face during the course of their lives.



Map 1. Migration Routes

Neotropical migratory songbirds leave their winter residences in the early spring and move north to establish their breeding territories and to find a mate. The majority of species and individuals continue traveling to the forests of the northeast United States and Canada. Males usually arrive first with the females arriving less than a week later. Individuals of most species are extremely site-faithful, often returning to the same breeding territory every year.

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Once the pair bond is formed, the couple begins their first nesting attempt in late April or early May. Most neotropical migrants are open-cup nesters, and many build nests on or close to the ground. Although sites for cup-nesters are abundant, their unprotected nature leaves the parents and young quite vulnerable to predation. It also affords Brown-headed Cowbirds, a nest parasite, the opportunity to lay their eggs in the migrants' nest where the young cowbirds will mature at the expense of the hosts' own chicks.

The nesting period may take between 17 - 24 days from laying to fledging (Bent 1963). If the nest is destroyed early, the pair will probably try until they have raised a brood or until it is too late to fledge young. Once the young fledge, they remain in the care of the parents for several weeks as they learn to fly and to forage on their own. Under the best circumstances, a pair may raise young to independence in about six weeks. If it is still early summer after raising their first brood, they can repeat the whole procedure. If not, they will begin to prepare for the long trip south by gaining weight and molting their feathers. The molt is important; it supplies the birds with the best equipment for flying, and provides males of many species with less conspicuous plumage. Sometime between late July and mid-August young birds disperse and adults abandon their breeding territories. Southbound migration commences between late July and mid-September for most species. With the addition of a new generation, the population is considerably larger at this time than it was in May. Inexperience and a migratory lifestyle, however, dictate that many of the birds in this new generation will not survive their first year.

A migration of several thousand miles demands tremendous energy from birds that weigh only one third to two ounces. Although there is evidence that some neotropical migrants fly non-stop from Canada to the Caribbean in a few days (Emlen 1975), most migrants take several weeks. Traveling long distances at night in unpredictable weather can lead to exhaustion and death by starvation (Moore and Kerlinger 1987). Yet, most migrants endure, demonstrating their dependence on stopover and staging areas where food and shelter must be readily attainable.

...most migrants endure [migration], demonstrating their dependence on stopover and staging areas where food and shelter must be readily attainable.

Between September and early November, neotropical migrants (re)establish themselves in their southern residences. From the vast continent of North America, millions of migratory songbirds pack into the relatively small land mass found in Central America, the Caribbean, and northern South America (Lovejoy 1983). In contrast to their presence in

northern South America (Lovejoy 1983). In contrast to their presence in North American forests, neotropical migrants constitute only 20-50 percent of all birds (Greenberg 1990a) during the non-breeding season. Despite the potential for competition, the mild, consistent climate and the variety of food provide sufficient compensation for the rigors of migration.

New neighbors are only part of what makes the southern home so different. The climate and plant communities are also vastly dissimilar from those into which they were born. As a result, during the five to seven months spent in the south, different behaviors are often more effective for fulfilling life's requirements. Birds, like the White-eyed Vireo and the Eastern Kingbird, that were eating insects just weeks before turn to fruit. Others, like the Tennessee Warbler, find a taste for nectar. Some species join large foraging flocks with tropical residents, while others maintain individual territories. There is growing evidence that some wintering migrants display site-fidelity similar to that of the breeding season (Keast and Morton 1980, Hagan and Johnston 1992).

By late March it is time to build up fat reserves and replace the dull winter feathers with breeding colors, once again in preparation for another extensive trip. Migratory songbirds move swiftly towards their breeding territories where competition for food, space, and mates will be intense.

STOPOVER AND EN ROUTE ECOLOGY

Migration is a complex process. Individual birds rely on innate ecological, geographical, meteorological, and social cues to travel thousands of miles. Navigating by the stars, the earth's magnetism and other cues, migratory songbirds fly at night and may adjust their course at dawn (Emlen 1975, Gauthreaux 1978, Morse 1989). The geographic distribution of migrants in passage is influenced primarily by prevailing weather patterns, major land forms, and the birds' internal orientation mechanisms. Prevailing weather patterns (wind direction and strength, temperature shifts, storms) change dramatically on a temporal scale, never offering the same conditions for migration from one year or season to the next. The geographic distribution of migrating songbirds changes predictably between fall and spring, however. During fall, a majority of neotropical migrants follow the Atlantic flyway fairly close to the coast. Concentration areas are found along the Mid-Atlantic and Gulf coasts. Spring migration is more diffuse and follows a broad front through the central and eastern regions of the continent with concentrations at the Gulf coast, the shores of the Great Lakes and, to a lesser extent, the Atlantic coast (Gauthreaux 1982). Regardless of the direction of movement, when bad weather or large bodies of water are encountered, migratory birds display a tendency to delay migratory flight.

Two major challenges face migrating birds: maintaining fat stores and avoiding predation.

Beyond the geographic and atmospheric considerations, two major challenges face migrating birds. First, they must maintain sufficient

fat stores. Second, they must avoid predation. Most neotropical migrants make a series of short night flights, stopping during the day to rest and re-fuel (Moore et al. *in press*). This is the most energy-efficient approach to the difficulty of traveling thousands of miles, although weather conditions and species-specific differences add variability to the system. During these short periods, birds conserve and add to their energy stores by resting and eating. Migratory songbirds can increase their weight by more than 5 percent in a single day (Moore and Kerlinger 1987). When conditions become favorable (e.g., the weather changes and/or the birds have gathered sufficient energy), the migrants move on. Stopping, however, increases the risk of predation. It is clear then, that migrants must find the best place to re-fuel safely.

Migratory songbirds can increase their weight by more than 5% in a single day.

Along the migration route, migrating birds are confronted with a diversity of habitats. Their dispersion within a geographic location is biased by the spatial and temporal availability of suitable habitat -- the places where they can rest and forage. Habitat that adequately provides for neotropical migrants must be defined not only by resource availability but by the immediate needs of individual birds, the amount of competition for resources, and the risk of predation. Weather plays an important role on this level too. Prevailing weather patterns can control the availability of food items (insects and fruit) and the loss (in fall) or emergence (in spring) of vegetative cover (Moore et al. *in press*). Human activities affect the availability of suitable habitat through alteration of the landscape. Both factors have some bearing on the relative number of predators and the potential for dispersing high densities of competing migrants.

Locating appropriate habitat is critical for migrating birds. A major movement, called morning flight, occurs close to dawn when birds redistribute themselves according to their assessment of suitable habitat (Moore et al. 1990, Wiedner et al. 1992). The Cape May and lower Delmarva peninsulas are areas where large and highly visible morning flights occur during the fall (Wiedner et al. 1992, Watts and Mabey unpubl. data). These birds are likely making constant decisions to stay in a patch of habitat or to move on in hopes of finding something better. Lean birds are more likely than fatter birds to stay in sub-optimal habitat (Moore and Kerlinger 1987) and all birds are likely to stay wherever they land if weather is inhospitable (Moore et al. *in press*). Researchers have also found that certain species are strongly associated with particular habitats during the spring and fall migrations (Moore et al. 1990, Winker et al. 1992).

The Cape May and lower Delmarva peninsulas are areas where large and highly visible morning flights occur during the fall.

The number of factors influencing migration and the en-route distribution of neotropical migrants illustrate the intricacies of this phenomenon on both the population and individual level. Each of these factors intensifies the vulnerability of songbirds during migration while confounding conservation efforts on their behalf.

THREATS TO NEOTROPICAL MIGRATORY SONGBIRD POPULATIONS

In the past decade, evidence suggesting that populations of many neotropical migratory songbird species are dwindling has mounted. Researchers studying birds during migration began reporting declines in the numbers of birds caught at banding stations. The strongest information, however, comes from long term monitoring studies of breeding birds. The most widely cited of these is the Breeding Bird Survey (BBS) that has conducted standardized surveys for 27 years. Analysis of the data from the late 1970's and 1980's indicates consistent annual population declines of 0.2-3.0 percent over two decades in many species (Robbins et al. 1989).

Long-term studies at many sites have detected even more precipitous declines in migrant populations (Askins et al. 1990). In most of these cases the study sites have undergone noticeable, if not dramatic, changes in internal habitat (e.g., ageing of forests that can lead to changes in bird species composition) or external factors (e.g., fragmentation and isolation) (Askins et al. 1990). The declines may be related to these changes, particularly fragmentation of surrounding forests and the isolation of the study areas.

Most researchers agree that the repeated detection of declines is cause for concern (Hagan and Johnston 1992, Askins et al. 1990) and several credible hypotheses have been proposed to explain the declines. They all fall under the general umbrellas of habitat loss and degradation. In North America, the birds' northern homeland, forest fragmentation and suburban sprawl result in an increase of predation and nest parasitism. In the migrants' southern homeland, tropical deforestation is rapidly changing the landscape, limiting available space and resources.

...due to the extreme stresses and demands of migration, this period is particularly critical to the maintenance of migratory populations.

The vulnerability of neotropical migratory songbirds during migration has been largely ignored by major professional reviews (Askins et al. 1990) and initiatives on the problem of population declines. However, the generalized life history of neotropical migrants reveals that vulnerabilities exist during all life phases. In fact, due to the extreme stresses and demands of migration, this period is particularly critical to the maintenance of viable populations. When combined with statistics on rapid human population growth and concomitant development in coastal regions critical to migrants, a compelling case can be made for integrated protection measures on behalf of neotropical migratory songbirds. Research in migration ecology is gaining attention (Hagan and Johnston 1992, Moore et al. *in press*). The Neotropical Migratory Songbird Coastal Corridor Study takes an important step in determining the regional distribution of fall migrants on the Cape May and Delmarva peninsulas.

IV. THE NEOTROPICAL MIGRATORY SONGBIRD COASTAL CORRIDOR STUDY

STUDY JUSTIFICATION

The Atlantic migratory flyway covers the entire Atlantic coast. The most significant stopover area for landbirds in this flyway is coastal habitat from Cape May, New Jersey to Cape Charles, Virginia. Although the Delaware and Chesapeake bays are best known for large concentrations of waterfowl and shorebirds, these areas are also critical to eastern neotropical migratory landbirds. The Cape May and Delmarva peninsulas consolidate southbound migrants that are reluctant to cross large bodies of water unless weather conditions are advantageous. A combination of factors related to geography, the direction of prevailing wind, and innate behavior are likely responsible for such a phenomenon (Dunne et al. 1989).

The most significant stopover area for landbirds in [the Atlantic] flyway is coastal habitat from Cape May, NJ to Cape Charles, VA.

Preliminary observations suggest that landbird migrants rest, feed, and seek cover in a narrow strip of shrubby and wooded habitat along the coasts and near the peninsula tips. These habitats, not yet adequately defined or delineated, are facing intense development pressures, especially on waterfront properties. The loss and fragmentation of habitats where large numbers of birds concentrate in small areas could have serious repercussions on population viability. Piecemeal and uninformed approaches to protection of habitats within the migratory corridor will not address the conservation needs of neotropical migrants. This study identifies the breadth, extent, and components of a migratory landbird corridor on the Cape May and Delmarva peninsulas (Map 2).

STUDY GOALS

The goal of the study was to identify coastal areas on the Delmarva and Cape May peninsulas that support the greatest abundance and species number of migrating songbirds. Five questions were addressed:

1. ***Are migrant abundance and species richness (the number of migrant species) greater along the mainland coast than farther inland? (I.e., is there a coastal effect?)***

Although the coast of the mid-Atlantic region has long been considered an important concentration area for southbound migrating songbirds, descriptions of fall migration within the region lack scientific rigor. In order to quantify coastal concentrations across the region, we compared songbird numbers near the coast (0 - 0.9 mi from the coastline) with inland areas (0.9 - 1.9 mi from the coastline).

2. ***Are there differences in migrant abundance and species richness between the bay coast, ocean coast, and mainland interior?***

The nature of populations of migrating birds is highly dynamic. Migrants must respond to a variety of physical and biological pressures. The distribution of birds during stopover is a manifestation of birds responding to the needs of eating, resting, hiding, and moving on. Movements thought to be associated with these responses include morning flight, reorientation, and general dispersal.

On the Cape May and Delmarva peninsulas a north- and northwestward morning flight has been observed (Wiedner et al. 1992, H. Armistead, pers. comm.) Birds reluctant to cross large bodies of water in daylight may follow the coast around the tips of peninsulas and then northward up the bay coasts in search of a narrower over-water crossing point (USFWS 1984, Moore and Kerlinger 1992). At the same time, some birds disperse inland, in search of habitats where there are fewer avian predators and competition for food and cover is reduced (Wiedner et al. 1992). To determine the overall effects of these movements on the distribution of migrants within the region, the Chesapeake and Delaware Bay coasts, the four-state Atlantic coast, and mainland interior areas were compared for migrant abundance and species richness.

3. ***Do migrants concentrate near the tips of peninsulas?***

Observations of fall migration at two well-known bird research stations (Cape May Bird Observatory and Kiptopeke Bird Banding Station) have documented that as diurnal migrants (e.g., raptors) move south along the coast, they tend to become funneled towards the southern points of peninsulas (USFWS 1984, VA Heritage 1988). Consequently, they become concentrated at these narrow tips of land, reluctant to cross open water during the day. Radar studies suggest this also occurs with nocturnally migrating songbirds. We examined this possible concentration effect by comparing migrant abundance among coastal areas located 0 - 6.2 mi (0 - 10 km), 6.2-18.6 mi (10-30 km), and 18.6 - 31 mi (30 - 50 km) from the southern tips of the Cape May and Delmarva Peninsulas.

4. ***Are migrant abundance and species number greater on barrier islands than along the adjacent mainland coast?***

Compared to mainland areas, barrier islands are unique, both in terms of their geographic position and vegetation. Barrier islands also represent a significant portion of the coastal landscape. To assess the relative importance of barrier islands as stopover habitat, we compared migrant abundance and species number between barrier islands and the adjacent (seaside) mainland coast.

5. ***Are migrant abundance and species number related to habitat type?***

Individual species of neotropical migrants use specific habitats on both their breeding and wintering grounds (Keast and Morton 1980; Hagan

and Johnston 1992). Specific habitats may also be required by individual species during migration (Moore and Simons 1992, Winker et al. 1992). Habitat associations could confound or augment observed geographic factors if there is a strong bias in the distribution of different habitat types. Bird abundance and species number were compared among four general habitat types (deciduous forest, coniferous forest, mixed deciduous-coniferous forest, and scrub-shrub habitat) and seventeen specific plant communities (Appendix D). Species-specific habitat associations were examined for thirty-two species represented in our data by one hundred or more observations.

STUDY DESIGN

The Neotropical Migratory Songbird Coastal Corridor Study was conducted within the bay and Atlantic coastal regions of Virginia, Maryland, Delaware, and New Jersey, including the islands of Fisherman's (VA), Smith (VA), Parramore (VA), Assateague (VA/MD), and five islands from Sea Isle City to Cape May (NJ) (Map 2). We designated the coastal zone as a 1.9 mi (3.0 km) wide district running parallel to both bay and sea shores. The mean high tide (mht) line defined the zero mi border of the coastal zone. The coastal zone was split into two bands: the near-coast band 0.0 - 0.9 mi (0 - 1.5 km) from mht and the inland band 0.9 - 1.9 mi (1.5 - 3.0 km) from mht; it was then further subdivided latitudinally every 6.2 mi (10 km) to form 1.9 x 6.2 mi (3.0 x 10 km) blocks. We established interior blocks of the same dimensions 6.2 - 14.3 mi (10 - 23 km) from the shoreline in Maryland, Delaware, and New Jersey. Within each block, we randomly selected eight survey sites with fixed radii of 82 ft (25 m) (Fig. 1). Although we were unable to establish blocks of 1.9 x 6.2 mi on all islands included in our study, sites were selected to match a density of 8 sites per 9.98 mi^2.

To maximize uniformity among sites, we randomly selected survey sites as follows: habitat was dominated by woody vegetation greater than 4.0 ft (1.2 m) in height; habitat patches were a minimum of 1 ha in size and no less than 492 ft (150 m) wide; and each site was located at least 164 ft (50 m) from the habitat edge.

Birds were counted at each survey site twice a week from the beginning of August to the end of October 1991. All surveys were conducted between two hours after sunrise and one hour before sunset. We employed a modified point count method to determine the relative density of migratory birds at sites. During each survey, a single observer recorded the species and number of individuals seen within a 10 min period. Individual birds that could not be identified to the species level were grouped into broad categories (e.g., Unidentified Vireo or Unidentified Tanager). Observers played a standardized audio tape of chickadee alarm notes and human pshing and squeaking during the survey period to draw

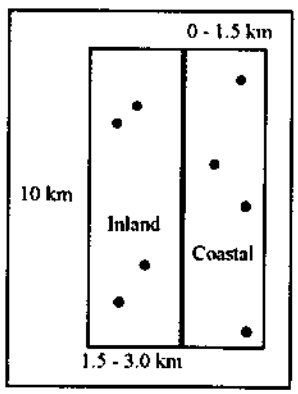


Figure 1. Survey Sites

birds closer and facilitate identification. Observers were rotated among study areas to minimize biases and errors within the data. Surveys were not conducted during heavy rain.

Habitat parameters and plant community types were evaluated at all survey sites. Based on these descriptions, each site was assigned to coniferous forest, deciduous forest, mixed forest, or scrub-shrub habitat types (Map 3) and further classified into one of 17 specific community types (Appendix D). See state technical documents on best remaining natural communities within the study area (Clancy 1992, MDNHP 1992, Windisch 1992, Zebryk and Rawinski 1992)

We established 487 survey sites over the four-state region and conducted more than 12,000 point counts during the migratory period. Over 36,000 birds of 91 species were counted. Although all species recorded have winter ranges that extend south to the tropics or subtropics, a few of them can be found as far north as Virginia or Maryland during the winter (Appendix B).

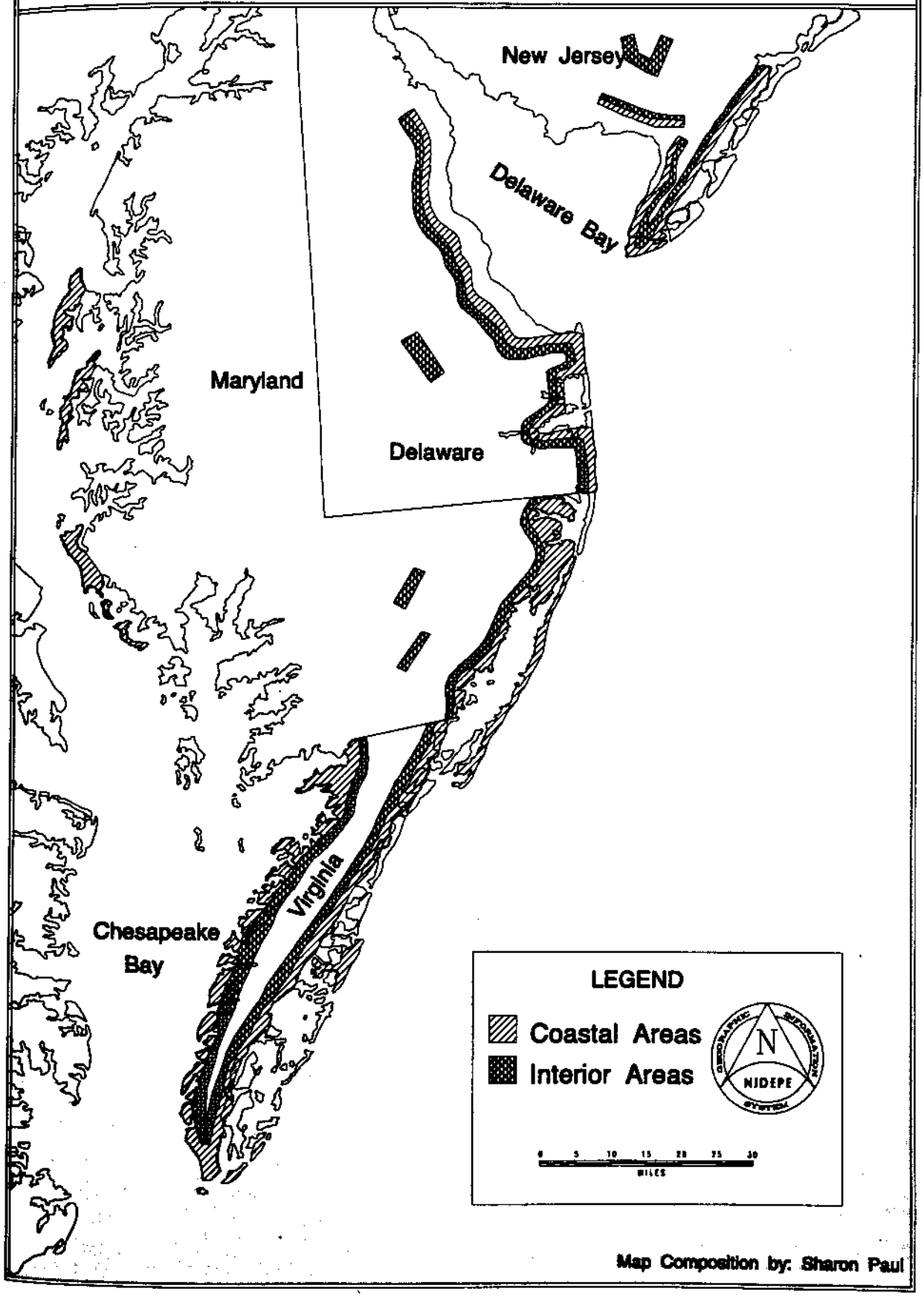
...bird abundance is defined as the mean number of birds per survey excluding raptors.

...species richness is... the mean cumulative number of migrant species (excluding raptors) per survey site.

Analyses of these data focus on two primary variables. The first, bird abundance, is defined as the mean number of birds per survey excluding raptors. The second, species richness, is defined for the purposes of this study as the mean cumulative number of migrant species (excluding raptors) per survey site. The analyses also include an adjusted form of bird abundance that omits all observations of Yellow-rumped Warblers. This species accounted for approximately one third of all observations. The adjusted variable avoids the potential for bias from this single species. We also analyzed all parameters by the abundance of the seven species that were most frequently observed (Yellow-rumped Warbler, Red-eyed Vireo, American Redstart, Pine Warbler, Black-and-white Warbler, Gray Catbird, and Ruby-crowned Kinglet). In addition, we examined habitat associations for thirty-two migrant species for which there were 100 or more sightings. Of these, we highlight those species reported to be experiencing population declines in northeastern North America (Robbins et al. 1989, Askins et al. 1990)

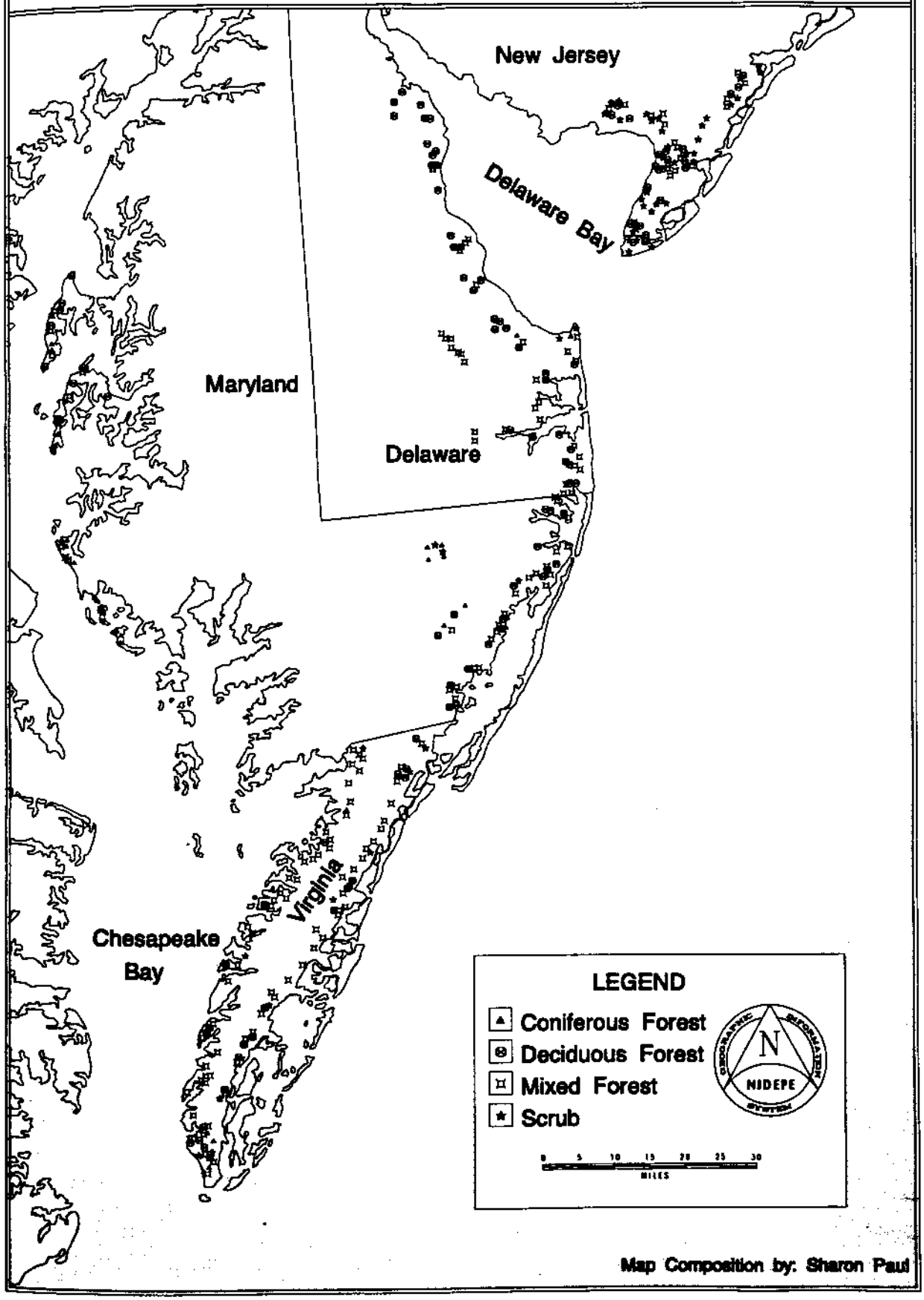
Comparisons of bird abundance and species richness between the independent variables (i.e., geographic areas, habitats) were made using one- or two-way analysis of variance tests (ANOVA SAS). Probability values (P) less than or equal to 0.05 are accepted as denoting a significant difference between variables. Any analyses differing from the above standards are discussed in the Findings section. For more details on the statistical analyses see McCann et al. *in press.*

Neotropical Migratory Songbird
Coastal Corridor Study
Coastal and Interior Study Areas



Map Composition by: Sharon Paul

Neotropical Migratory Songbird
Coastal Corridor Study
Distribution of Habitat Types Over Study Area



Map Composition by: Sharon Paul

V. FINDINGS

• Bird abundance and species richness were greater near the coast than farther inland.

As described above, a 1.9 mi (3 km) coastal zone was delineated and divided into a near-coast sector and an inland sector of equal width (0.9 mi). The results of surveys conducted within the near-coast and the inland sectors were compared to determine if disparities in bird abundance and species richness exist between these areas. Both bird abundance (Fig. 2) and species richness (Fig. 3) are significantly greater in the near-coast sector than the inland sector. In fact, migrants were 17 percent more abundant in the near-coast sector (Table 1)*. Four of the seven species analyzed (Pine Warbler, Ruby-crowned Kinglet, Yellow-rumped Warbler, and Gray Catbird) were significantly more abundant near the coast while only one species (American Redstart) was more abundant inland.

**All tables are located in Appendix C.*

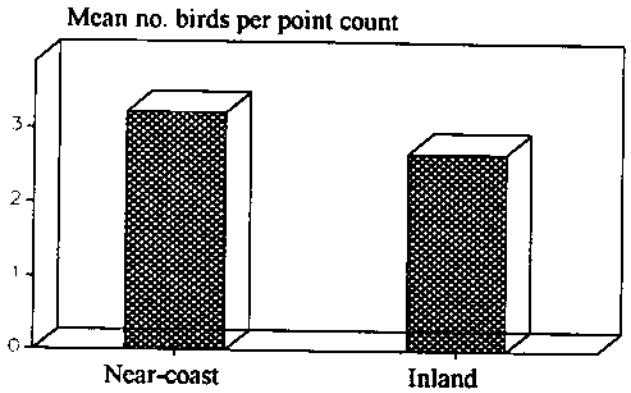


Figure 2. Bird Abundance

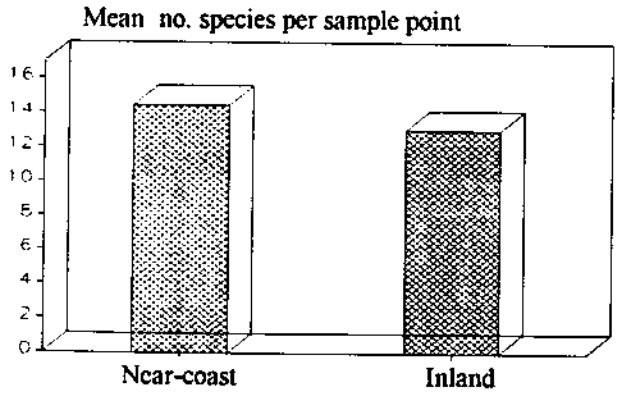


Figure 3. Species Richness

On a regional scale, migratory songbirds were concentrated within 0.9 mi (1.5 km) of the coast on both the bay and sea sides of the peninsulas

during migratory stopovers. It must be noted, however, that the near-coast and inland sectors represent arbitrary delineations. The coastal concentration effect may in fact occur on a much finer geographic scale within the near-coast sector. Regression analysis relating bird abundance/species richness to distance of survey sites from the mean high tide line failed to establish any clear definition of the "natural" boundaries of the concentration area. The number and distribution of the survey sites within the 1.9 mi coastal zone was not appropriate for detecting such a fine scale, local effect. By random chance, our survey sites did not cover the full range of distances from the mht line. A more precise delineation of the concentration area would require a greater density of survey sites distributed evenly throughout the 1.9 mi coastal band or the use of latitudinal transects.

•Migrant abundance and species number are greater on bay coasts than either ocean coasts or peninsula interiors.

Migrant abundance and species number (Figs. 4 & 5) were both significantly greater at sites located on the bayside of the peninsulas than those located on either the Atlantic-side or peninsula interior areas (Table 2). There was no difference between the latter two areas. Among the individual species analyzed Red-eyed Vireo, American Redstart, Black-and-white Warbler, and Gray Catbird had their greatest abundances on the bayside. Both the Pine Warbler and Ruby-crowned Kinglet were observed least on the seaside but neither species clearly favors the bayside. The Yellow-rumped Warbler showed no significant separation between the three areas although average counts on both coasts were nearly three times those for the interior sites.

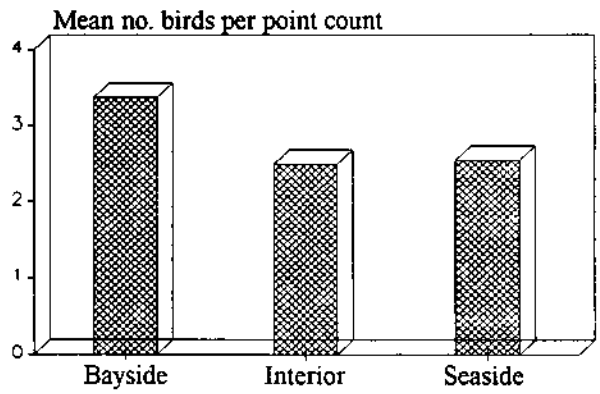


Figure 4. Bird Abundance

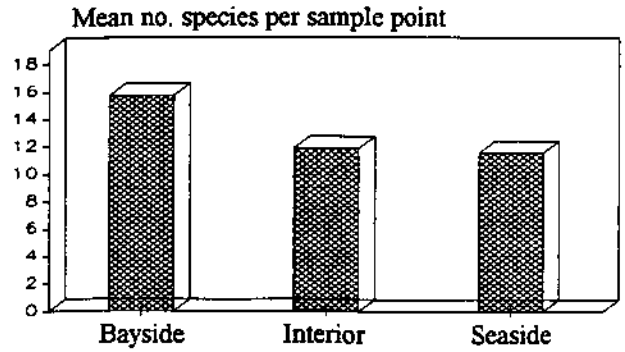


Figure 5. Species Richness

Data from the bay- and seasides were subdivided into near-coast and inland sectors. On both sides of the peninsulas, migrants were most abundant within the near-coast sector. Migrant concentrations were particularly high in the bayside near-coast sector (Figs. 6 & 7).

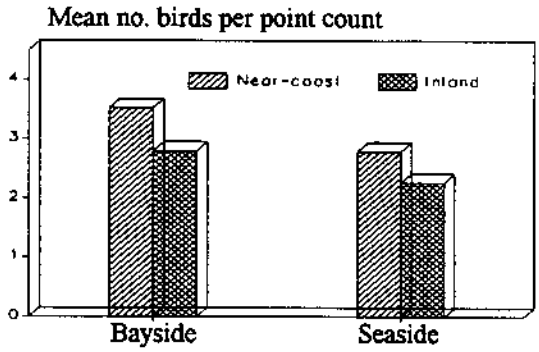


Figure 6. Bird Abundance

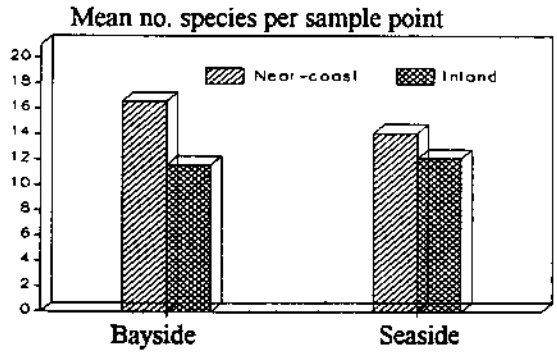


Figure 7. Species Richness

The tendency of migrants to concentrate near the coast, especially along the bay coasts, is probably due to a combination of selective landing ("fallout"), dispersal and reorientation behavior. Fat-depleted, dehy-

drated, or exhausted birds migrating over the mainland and coastal waters may land along the coast rather than continue migratory flight under difficult conditions or during daylight hours (Kerlinger and Moore 1989). Large morning flights appear on days of heavy fallout. During morning flight, birds flow southwestward around the peninsula tips and then disperse northward up the bay coast (Alerstam 1978, Gauthreaux 1978, Wiedner et al. 1992). Adding to coastal concentrations are those birds that have gone off course during the night and must reorient their movement towards the south or southwest. Birds reorienting from somewhere over the Atlantic ocean will arrive on the barrier islands and seaside of the regional study area. Birds that correct their direction over the peninsulas and those birds that continue to move south or southwest will eventually encounter the end of land at the Chesapeake and Delaware Bays (Baird and Nisbet 1960, Drury 1960, Drury and Keith 1962, Drury and Nisbet 1964, Murray 1976, Able 1977). The lack of difference between ocean coasts and interior areas may also be attributed to reorientation flights and/ or birds dispersing inland to more suitable or less contested stopover habitat.

Maryland and Delaware present a unique situation since no major peninsula tips occur within these states. Bird concentration along these sections of the Chesapeake and Delaware Bays is probably due, in part, to large numbers of birds falling out along the coast during early morning hours. Morning flight appears to involve few birds in the Maryland and Delaware sections of the study area. It also seems unlikely that birds engaged in morning flight near the two peninsula tips would disperse as far west as the western shore of the Delaware Bay or as far north as the upper eastern shore of the Chesapeake Bay (e.g., Kent, Tilghman, Taylors, and Hooper Islands).

Similar coast and bayside distribution patterns persist within the four habitat types (Table 3 & 4 and Figs. 8, 9, 10, & 11).

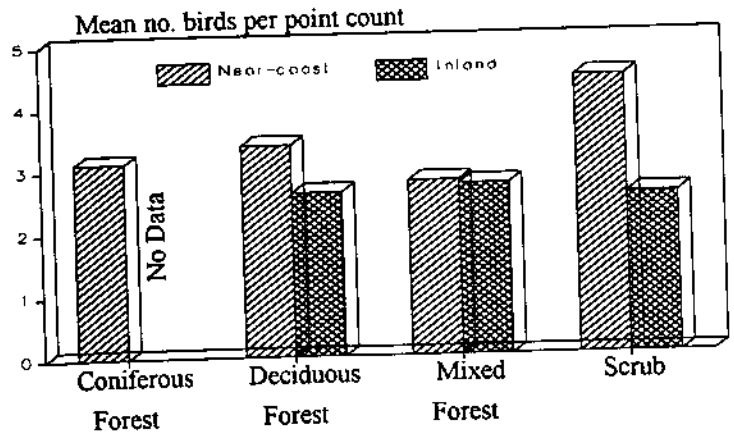


Figure 8. Bird Abundance

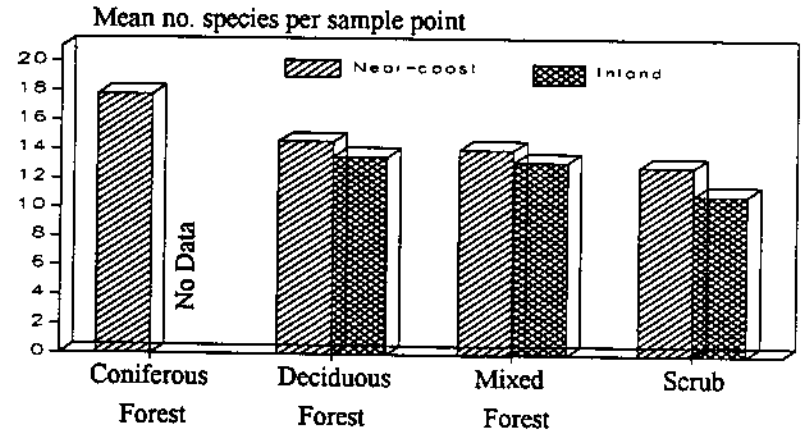


Figure 9. Species Richness

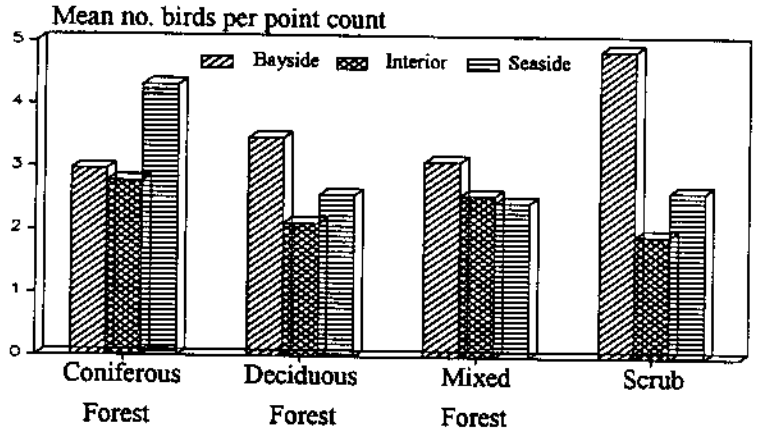


Figure 10. Bird Abundance

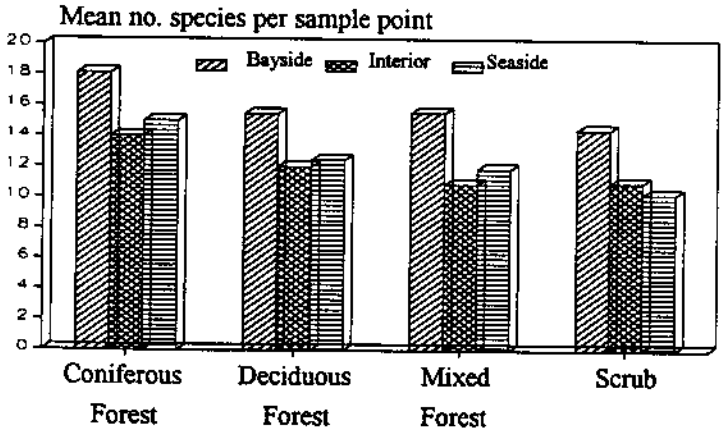


Figure 11. Species Richness

Within a given habitat type, bird abundance and species richness tended to be greatest near the coast and along the bayside of the peninsulas. Although

significant interactions (habitat type by geographic area) were present in analyses of bird abundance, these interactions can be attributed primarily to variation in the magnitude of the difference between geographic areas within habitat types rather than differences in the overall concentration patterns. For example, consider the comparison by habitat type between the near-coast and inland sectors. In this analysis, bird abundance was highest near the coast regardless of habitat type, although differences between the two areas were greatest in scrub-shrub and lowest in mixed forest. These findings indicate that geography strongly influences regional bird abundance and distribution patterns in our study area.

• ***Regional peninsular concentrations were not detected.***

Birds migrating in a southerly direction would be expected to concentrate at any barrier to southerly flight. Such obstacles are well documented for diurnal migrants such as raptors where large stretches of water can increase risks or energy expenditures (Kerlinger 1990, Niles et al. 1992). The Delaware and Chesapeake Bays differ from other major ecological barriers like the Gulf of Mexico. While they do interrupt daytime movement of songbirds, they do not present a barrier to nocturnal migratory flight (Gauthreaux 1978). Peninsular concentrations of migrating songbirds at the mouths of these bays have not been clearly documented.

Regionally, there was no significant difference in the distribution of individuals and species among the three discrete distance categories included in our analysis (Table 5). When the two peninsulas were analyzed separately, no significant pattern was found for abundance or species richness based on distance from the tip of the Cape May peninsula (Figs. 12 & 13). Although there was also no significant difference between species richness values on the Delmarva peninsula, there were significantly fewer birds in the 18.6 - 31 mi region.

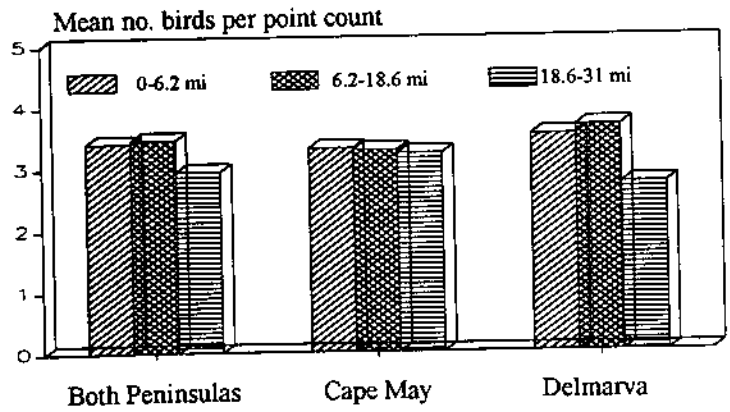


Figure 12. Bird Abundance

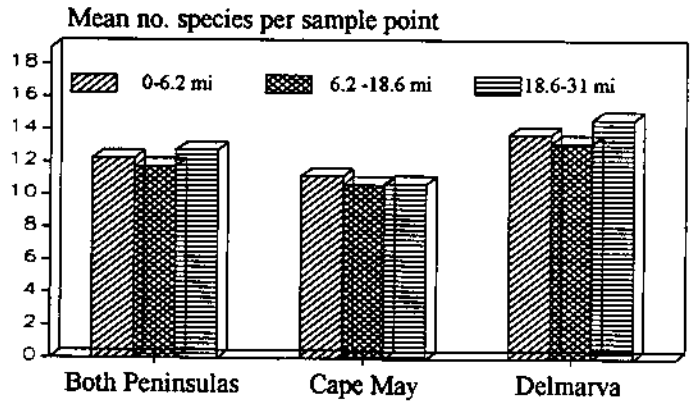


Figure 13. Species Richness

The relationship between bird densities and distance to the tip of the peninsula may be stronger than the data suggest. Sample sites within our study area may have been too diffuse to detect patterns occurring at a more local level. For example, by random chance, few sample points were located within the southernmost 1.9 miles of the Delmarva peninsula in Virginia. However, in an ancillary study, Virginia biologists found nearly twice as many birds within the 1.9 mi as within the next 4.3 mi (Mabey unpubl. data). In fact, published reports and observations substantiate the fact that large numbers of migrants can be found near the tips of both the Cape May and Delmarva peninsulas in the early morning hours (Wiedner et al. 1992, Watts and Mabey unpubl. data). Morning flights, however, allow the birds to redistribute throughout the land mass. This, too, may explain the absence of significant peninsular concentrations.

• Migrant abundance and species number are greater on barrier islands than on adjacent mainland coasts.

Relative migrant abundance is remarkably high on barrier islands. On average, the number of birds per survey was over two times greater on barrier islands than on the adjacent mainland coast (Fig. 14).

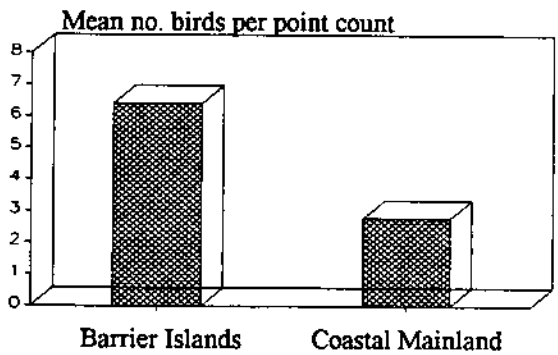


Figure 14. Bird Abundance

Although 54% of the migrants observed on barrier islands were Yellow-rumped Warblers (compared to 26% on the adjacent mainland), analyses without this species still showed greater bird abundance on barrier islands (Table 7). Moreover, barrier islands supported greater abundances of four of the seven most common migrant species (Table 7).

There was no difference in species richness (Fig. 15), and barrier islands and the adjacent mainland coast both supported a nearly complete assemblage of migrant songbird species observed during the study (76 species were observed in both areas). Barrier islands are the first potential landfall for birds attempting to return to the Atlantic coast during the early morning hours (Murray 1976, Wiedner et al. 1992). This placement may in part account for the remarkably high abundance of migrants on barrier islands. Migrant concentrations on barrier islands also may be related to habitat features. Most barrier islands in this study contain extensive, undisturbed areas of dune woodland and interdune scrub vegetation. These habitats offer an abundance of insects and fruit. The extremely dense vegetation provides excellent cover from predators and adverse weather conditions. Such areas support very high densities of migrant scrub-shrub dwellers such as Yellow-rumped Warblers and Gray Catbirds. In fact, these two species are 3 to 5 times more abundant on barrier islands than on the mainland coast (Table 5). Barrier islands also support a greater abundance of American Redstarts and Ruby-crowned Kinglets.

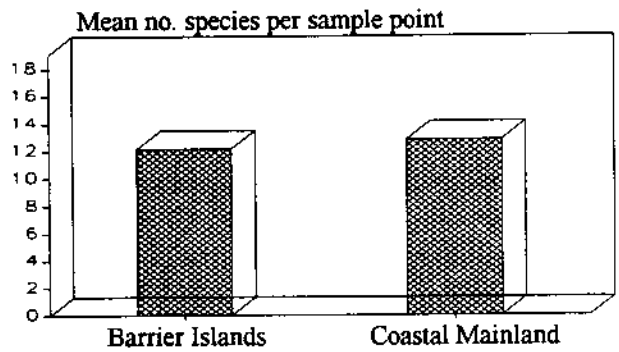


Figure 15. Species Richness

• ***Species occurrence is related to habitat type.***

Several significant differences exist in the associations of migrant species and habitats. Our results fall into two broad classes. First, species number and abundance varies with habitat type and vegetation community; and second, individual species are associated with particular habitats.

The total number of species observed varies among all habitat types. Eighty and eighty-two species were observed in deciduous and mixed forests respectively; slightly fewer species were observed in scrub and coniferous forests (Table 8). However, the picture of species richness

based on the mean number of species per sample point is different. The significant difference in species richness among habitats reflects the gap between coniferous forests (17.06 $\pm$ 4.50) and scrub (12.10 $\pm$ 4.44).

Mean abundance of migrants for the four habitats was strongly affected by the presence of Yellow-rumped Warblers. Including this species in the analysis, there was a significant difference among habitats with scrub-shrub having the highest abundance value. Excluding Yellow-rumped Warblers, however, resulted in a significant yet opposite pattern of all forest types having greater abundances than scrub-shrub. The primary separation of migrant abundance among habitats was between forests and scrub. This dichotomy persists among individual species habitat associations (Table 9).

The same variables were assessed for the sixteen vegetation communities that comprise the survey sites. Several vegetation communities (e.g., Old Field Forest, Coastal Dune Scrub) had relatively high abundance and richness values while other (e.g., Young Pine Scrub, Mesic Mixed Hardwood - coniferous variant) had relatively low values (Appendix C).

No single habitat or vegetation community clearly stands out as attracting the greatest number of species or individuals. This result is not surprising, however, considering that every habitat is significantly associated with at least one migrant species (Table 9).

To examine habitat associations for individual species, we selected 32 species with adequate sample sizes ($n \geq 100$ observations) for analysis. Twenty three of these species exhibit significant ($p < 0.1$) habitat associations (Table 9). As a group, these 23 species show a distinct forest/scrub dichotomy. That is, species are associated with either forest (16 species) or scrub-shrub (7 species). Of the former, six species were most commonly associated with coniferous forests, two were strongly associated with deciduous forest, and one species occurred most frequently in either deciduous or mixed forest. Abundance was similar among the three forest types for the remaining eight forest-associated species. Of the species experiencing population declines, four were significantly associated with forests and one was significantly associated with scrub-shrub (Table 9). Only three species (Ruby-throated Hummingbird, Chestnut-sided Warbler and Magnolia Warbler) were found in roughly equivalent abundances in both scrub and forest habitats. Five of the thirteen warbler species in Table 9 are considered to be undergoing widespread population declines (Robbins et al. 1989). It is noteworthy that all five of these species (Black-throated Blue, Black-throated Green, Prairie, and Black-and-white Warblers; American Redstart) were associated with forested rather than scrub habitats.

Although our data do not address the more complex issue of habitat use, it is important to note that many species requiring forests during the breeding season are also strongly associated with forested habitats during

migration (e.g., Wood Thrush, Black-throated-green Warbler). Likewise, species that nest in young forests and scrub-shrub are also associated with these habitats as migrants (e.g., Gray Catbird, White-eyed Vireo). Most importantly, no single habitat or plant community type can be described as optimum stopover habitat for all migrants or all species. Consequently, as suggested by Sprunt (1975), the best conservation strategy for providing stopover habitat for neotropical migrant songbirds should include a mosaic of native habitats distributed across an entire region. Findings by Winker et al. (1992) suggest a similar strategy. Attention to stopover habitat needs for species showing significant population declines (Table 9) and additional research on the stopover habitat requirements of individual species would refine this strategy.

Conclusion

The results of this study indicate strong geographic distribution patterns for migrating songbirds on the Cape May and Delmarva peninsulas. Both migrant abundance and species richness are weighted toward the near-coast areas, with values for these variables greatest along the bay coasts. Barrier islands within the region are clearly vital to migrating landbirds. In general, these geographic factors override habitat factors, persisting within each habitat type. The one exception to this generalization is that migrant abundance is greater within coniferous forests of the seaside than it is on the bayside. Although forest habitats have greater abundances and species richness than scrub habitats, some individual scrub community types have relatively high values. In addition, we found species-specific habitat associations cover all four habitats and that very few species appear to be equally abundant in both scrub and forest. We can only conclude that, for neotropical migrants as a group, all native habitats are important.

VI. CONSERVATION AND POLICY RECOMMENDATIONS

The study reported here specifically addresses regional patterns but the findings lend support to policy and management recommendations at all levels. Conservation resources must be applied where they will be most effective. However, we stress that with regards to neotropical migrants, it is also essential that the broader picture remain in focus. To that end we present a brief account of current conservation initiatives and propose recommendations for each level of a hierarchical, interactive policy and conservation strategy for neotropical migratory songbirds. Our recommendations are based on the results of this study and current scientific literature from the field of migration ecology. Management and policy initiatives that work together are most effective. The general premises outlined below provide the foundations for our specific recommendations.

1. Wherever special initiatives solely on behalf of migrating songbirds are feasible, they should be established. However, the body of protection for migrants and their habitat will most likely originate from connecting these concerns with existing environmental conservation policies.
2. Coastal areas require special management because of the significant concentrations of migrants found there.
3. A habitat mosaic provides the greatest resources to the greatest number of species and individuals.

CURRENT CONSERVATION OF NEOTROPICAL MIGRATORY SONGBIRDS

Neotropical migratory songbirds require a diversity of habitats throughout the Americas to support their complex lifestyles. Consequently, their protection requires a comprehensive approach. Conservation efforts must be made at all levels from the broad, international scale, to the regional and state domain, down to local jurisdictions and private landowners.

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Many governmental agencies and private, non-profit organizations across the Western Hemisphere are directing energies towards proactive protection of neotropical migrants. Current conservation endeavors on behalf of migratory landbirds are numerous; the descriptions that follow are meant to provide a representative sample of these efforts and are not an exhaustive catalog of all relevant programs.

Two major national/international programs, Partners In Flight and the Smithsonian Institution's Migratory Bird Center, have recently been established to work towards this end. The Partners In Flight program was founded in 1991 as an international partnership initiative to reverse the population declines of migratory songbirds. The program is administered

by the National Fish and Wildlife Foundation and currently has partners in thirteen federal agencies including the U.S. Fish and Wildlife Service, every state government, several Latin American governments, and a host of non-governmental organizations including The Nature Conservancy. They work in five main areas: 1) Population and habitat monitoring; 2) Management; 3) Research; 4) Education, outreach, and communication; and 5) International partnerships. National working groups have been established to pursue action for each of these components. Partners In Flight is a powerful, comprehensive enterprise. The state governmental representatives for Partners In Flight within the Cape May and Delmarva region are: Delaware Division of Fish and Wildlife, Nongame and Endangered Species Program; Maryland Forest, Park and Wildlife Service, Nongame and Urban Wildlife Program; New Jersey Division of Fish, Game and Wildlife, Nongame and Endangered Species Program; and Virginia Department of Game and Inland Fisheries, Nongame and Endangered Species Program.

The Smithsonian Migratory Bird Center was also established in 1991 by an act of the U.S. Congress. Working within the Partners In Flight network, the Center is an important hub of research and policy analysis and development. They have strong international ties and actively train Latin American students in field ecology. The Center is also an excellent resource for educational materials (see Appendix D). Both programs demonstrate the high level of commitment to the conservation of neotropical migratory birds within the United States and beyond.

Many state nongame programs have taken neotropical migratory songbirds as their standard bearers. Working in conjunction with Partners In Flight, they are now expanding monitoring programs (e.g., the Breeding Bird Survey) and sponsoring research initiatives. Public education materials such as the booklets produced in Idaho (Idaho Nongame Wildlife Leaflet #10 1992) and Virginia (Bradshaw 1992) provide educators and private citizens with both a global and local perspective on the plight of neotropical migrants.

Nongovernmental organizations have taken on the roles of educators, policy advocates, researchers, and stewards for neotropical migrants. The National Wildlife Federation has focused its backyard habitat program on teaching private citizens how to enhance the value of their property for migratory birds. The Nature Conservancy's approach of conservation through science-based ecosystem and species protection and their international scope make them well suited for their role as stewards of neotropical migrant habitats across two continents.

Considerations of the importance of en-route habitat requirements and stopover ecology of neotropical migratory songbirds should be more fully incorporated into international conservation initiatives...

Considerations of the importance of en-route habitat requirements and stopover ecology of neotropical migratory songbirds should be more fully incorporated into international conservation initiatives such as Partners In Flight and the efforts of the Smithsonian's Migratory Bird Center. Specifically, this area of migrant ecology and behavior is still in need of detailed, comprehensive research across the Western Hemisphere.

REGIONAL RECOMMENDATIONS

Despite the legal, political, and economic differences from state to state and locality to locality within the Cape May and Delmarva peninsular region, we suggest that neotropical migratory songbirds are best served by complementary actions throughout the region. We recommend the following goals and tools for the protection of neotropical migrants on the regional level:

•Maintain forested and scrub-shrub habitats, particularly large tracts.

These habitats are most crucial as staging and resting areas for migrating landbirds. Large forest blocks, particularly deciduous and mixed forests, provide suitable habitat for the greatest number of species. Thrushes, for example utilize the older interior forest areas while scrub-shrub dwellers like Gray Catbird and Yellow-rumped Warbler are more abundant along forest edges. Large forest blocks also provide nesting habitat for a variety of neotropical migrants during spring and summer. In fact, many of these species (known collectively as Forest Interior Dwelling Birds - FIDS) nest exclusively in large undisturbed forest blocks and are among those species experiencing the most serious population declines in eastern North America. (See Guidance paper No. 1 of the Chesapeake Bay Critical Area Commission and Bushman and Therres (1988) for further information.)

•Maintain natural scrub-shrub habitats such as those occurring along shorelines and dominated by bayberry and high tide bush.

Some species of neotropical migrant, such as Common Yellowthroat, Gray Catbird, and Brown Thrasher, also use these habitats for nesting during the spring and summer.

•Encourage deciduous or mixed tree plantings in areas such as filter strips.

The habitats created by filter strip plantings benefit scrub-shrub dwelling migrant species in early successional stages and, as the trees mature, they will be utilized by forest dwelling migrants. Ideally, these plantings should consist of locally native plant species.

•If wooded habitat must be developed, minimize removal of trees and shrubs to the fullest extent possible.

Encourage replanting with native vegetation.

These general ecological goals can be achieved by incorporating them in the specific existing or potential programs outlined below.

- **Identify boundaries of important habitats as specifically as possible** and make this information available to state and local officials.

- **Include habitat requirements for migrating landbirds in Best Management Practice (BMP) guidelines for Conservation and Watershed districts.**

- **Expand forest stewardship plans** to include migrating songbird habitat needs, especially with respect to habitat diversity and avoidance of monoculture forests.

- **Expand the purview of shoreline stabilization strategies** to consider habitat values, especially the habitat requirements of migrants; establish and implement alternatives to grading shores and replanting with non-native vegetation; where alternative methods are unsuitable, institute mechanisms to protect equivalent inland area with native vegetation.

- **Include considerations for habitat requirements for migrant species in management of U.S. Fish and Wildlife Service lands, national parks, state parks, and state wildlife management areas.**

- **Introduce neotropical migrants and migrating songbird habitats as significant coastal resources into state Coastal Zone Management Program plans as they are revised.**

- **Include habitat considerations for migrant species in governmental and non-governmental land conservation easements**; create standard easement management guidelines for various habitat types.

- **Initiate programs to educate** local and state land planners, field personnel and extension agents from such agencies as Forestry, Soil and Water Conservation, and Agriculture regarding the value of neotropical migratory songbirds and their habitat requirements.

- **Develop property owner education programs** for use by local governments, nongovernmental organizations and realtors detailing options available to private landowners for conservation of migrant habitat.

- **Develop public education programs** for widespread use among schools, civic groups, and the media.

- **Extend the purview of the Chesapeake Bay Program's** Living Resources Subcommittee to consider the need to protect native vegetation within the coastal migration corridor in the Bay area. The subcommittee should include this concern in any updates of the document "Habitat Requirements for Chesapeake Bay Living Resources".

- State wildlife agencies and Natural Heritage programs of the region should **work with power companies to maximize planting of beneficial vegetation within power line right-of-ways** and should **work with state departments of transportation to minimize clearing of vegetation.**

- **State and national forests within the region should join the Sister Forest program** through Partners In Flight to team up with Latin American forests for information, research, and population monitoring exchange.

An integral part of a comprehensive natural area conservation program is creating effective partnerships among the various parties having influence over activities that affect the target resources.

State and federal regulatory programs may afford protection against some of the threats to valuable habitat. More than likely, however, they will not by themselves provide sufficient conservation measures to fully protect a natural area. In order to provide comprehensive natural area conservation, other protection techniques must be used as well. An integral part of a comprehensive natural area conservation program is creating effective partnerships among the various parties having influence over activities that affect the target resources. Landowners, businesses, developers, environmental groups and citizens need to be included in this partnership with local and state government. Below we describe some non-regulatory tools that can be used for building partnerships to conserve stop-over habitat throughout the region.

- **Fee simple acquisition** is one of the oldest and most direct strategies for conserving biologically valuable areas and could be an effective means of protecting the highest priority or most threatened stop-over habitats in the region. Natural areas can be acquired by the federal, state, or local governments, or by private concerns. Funds to acquire these areas can also come from some combination of these groups.

- **Conservation easements** are legally enforceable, recorded agreements between a landowner and a government agency or conservation organization that place restrictions on the present and future use of land. An easement can run for a term of years or could be a perpetual easement to be observed by the present and future owners of the land. Easements are attractive for both the conser-

vation-minded landowner as well as the agency or conservation organization. The restrictive terms of the easement are entirely negotiable between the parties involved. The present and future landowners continue to enjoy many uses of the property while the agency or conservation organization achieves their conservation goals for the site. There are also financial benefits for the donor of the easement such as a possible reduced assessment for real estate purposes, a charitable deduction for state and federal income tax purposes, and reduction of federal estate taxes.

• **A management agreement** is a less formal contract between the landowner of a natural area and an agency or conservation organization to achieve specific conservation objectives. Management agreements are designed to clearly state the desires of the landowner and the conservation group in regard to the conservation intent for the site and the duration of the agreement. These agreements can be used to conserve natural areas on either publicly or privately owned land.

• **Transfer, purchase and lease of development rights** are other mechanisms that hold promise for the future conservation of migratory bird stopover habitat. Where such systems are used, owners of designated open space have been assigned development rights according to a formula based on the amount of land owned in the area where development is to be restricted. Landowners in these designated areas may not develop their land, but may transfer, sell or lease the development rights while keeping the land itself. The development rights can then be used to increase the density of development allowed in less sensitive areas. Once the development rights are gone, the land may be used only for limited purposes such as open space conservation, agriculture or forestry and is taxed accordingly. Laws governing the transfer of development rights vary from state to state.

STATE POLICY AND MANAGEMENT RECOMMENDATIONS

Delaware

DELAWARE

The management of land and water resources in Delaware is shared by various levels of government, and among many separate agencies. The State government assumes the responsibility for the natural resources determined to be worthy of protection through regulation for the general public benefit. There is, however, a strong emphasis from the county and municipal governments for local land use planning efforts.

The data collected under the NMSCC should be incorporated into the efforts undertaken primarily by the Department of Natural Resources

and Environmental Control (DNREC), although other avenues should not be excluded. There are numerous programs currently underway that address many facets of protection of species and habitats statewide. Specific language will need to be incorporated in these on-going efforts to address the need for protection of habitat for songbird species. In some instances, new efforts may need to be undertaken.

Currently three major programs are addressing status and recovery of coastal habitat in Delaware. These are:

- Inland Bays National Estuary Program
- Delaware River and Bay National Estuary Program
- Delaware Coastal Management Program

Each of these deal with specific geographic regions of the state, and are directed at separate and unique activities contained within that region. It is critical that, as these plans are revised, inclusion of the importance of the Delaware coastline as habitat for neotropical migrants be addressed. We recommend that the Comprehensive Coastal Management Plans (CCMP) for the two National Estuary Programs address habitat protection for neotropical migrants and be adopted under the Delaware Coastal Management Program in order to make the measures enforceable. Projects which are funded through these programs may be encouraged to incorporate protection, enhancement, or restoration of habitat for utilization by migratory songbird species. An example may be wetland rehabilitation projects that consider multiple species management actions.

Activities under the Land Protection Act should reflect the importance of certain habitat types for the benefit of migratory songbirds. One of the weighting factors in the rating system may consider the value of the parcel for migratory songbird species as a stand alone category.

There are many efforts statewide that are directed at land protection. Including the importance of the Delmarva as critical habitat for songbird migration should be incorporated into the protection strategy. Efforts such as the Greenway program, and more specifically the Coastal Heritage Greenway, can address the core issue of habitat protection by minimizing habitat fragmentation. The Natural Areas Program may want to incorporate migratory bird habitat in the array of factors addressed with land owners for inclusion in a Natural Area or state recognized Nature Preserve.

As funds become available from the state under the Delaware Land and Water Conservation Trust Fund, efforts may focus on purchasing land specifically for the protection of habitat for migratory bird species.

All State lands, such as Wildlife Management Areas, Forests, and Parks should include, as part of their management plans, actions that would protect habitat for neotropical migrants.

To achieve broad-based success for habitat and species protection, many activities that occur in multiple departments within the State should be encouraged to specify migratory species habitat as a component of their

mission. Increased exposure to habitat protection under the Forestry Stewardship Plans may be warranted within the Department of Agriculture, Division of Forestry. Highway corridors that minimize habitat fragmentation should be considered by the Department of Transportation. Consultations with the Wetland Branch of DNREC should encourage inclusion of songbird habitat into the Wetlands Best Management Practices.

Many avenues for land protection originate at the county level. As each county revises their master plan, language should be added to address the critical importance of these areas within each county. In addition, the county Conservation Districts may consider Best Management Practice guidelines that incorporate protection of habitat for songbird species.

Maryland

MARYLAND

The study demonstrates that forested areas within 0.9 mi of the coastline are of critical importance as stopover habitat for neotropical migrants. Bay coasts and barrier islands are particularly significant. In addition, all four major habitat types (deciduous, coniferous, and mixed forest, scrub-shrub) are important for migrants, although pure coniferous stands had the lowest total number of species during the migration period of 1991.

The general management recommendations set forth at the beginning of this section may be implemented in Maryland through the:

- **Local Chesapeake Bay Critical Area Programs**

Local Critical Area Programs, as required by the Chesapeake Bay Critical Area Act of 1984 (Natural Resources Article, § 8-1801, et seq., Annotated Code of Maryland), focus on land lying within 1,000 feet of the Chesapeake Bay and its tidal tributaries and wetlands. These programs require that a 100 foot natural buffer be maintained adjacent to the tidal waters, wetlands and tributaries of the Chesapeake Bay. The local programs protect habitat areas such as the following:

* nontidal wetlands;
* riparian forested areas; and
* large forested areas (100 acres or greater) utilized as breeding areas by forest interior dwelling birds and other wildlife species.

Local Critical Area Programs also contain provisions to ensure that agricultural activities in the Critical Area do not adversely affect water quality or important plant and wildlife habitats in areas identified as Habitat Protection Areas.

- **Forest Conservation Act** (Natural Resources Article, § 5-1601, et seq., Annotated Code of Maryland)

As of January 1, 1993, persons applying for subdivision, grading, sediment control, or building permits on land parcels greater than 40,000

square feet must submit a forest stand delineation to identify areas for forest conservation. These applicants must identify areas for protection and afforestation. Riparian areas are to be given priority for both forest retention and afforestation.

- **Forestry Programs**

The State of Maryland administers several programs aimed at management and enhancement of forested lands. These programs offer such features as forest planning, financial assistance, and tax incentives. The following management programs are administered by the Maryland Forest Service:

* Green Shores Program;
* Forest Stewardship Program;
* Stewardship Incentive Program;
* Woodland Incentive Program;
* Buffer Incentive Program;
* Forest Conservation and Management Program; and
* Reforestation and Timber Stand Improvement Tax Deduction Program

- **Natural Heritage Program**

This Program is responsible for identifying habitat of rare, threatened or endangered species and encourages voluntary protection of such areas through a landowner contact and education program. Maryland's Natural Heritage Program provides technical assistance to State agencies and local governments working to protect habitat of rare, threatened or endangered species.

- **Maryland Environmental Trust**

This organization was established by the Maryland General Assembly to conserve, improve, and perpetuate the State's natural, scenic, and cultural qualities. The Trust solicits and holds donations of conservation easements on properties of public conservation value. Landowners who donate easements to the Trust are entitled to tax benefits. The Maryland Environmental Trust also supports the development and operation of local land trusts.

- **Program Open Space**

This agency receives funding through a real estate transfer tax collected by the State specifically for the purpose of open space acquisition. The agency coordinates State land acquisition and administers grants to local governments.

Through the Natural Heritage Fund, within Program Open Space, important natural areas identified by Maryland's Natural Heritage Program are acquired for purposes of protection and conservation.

RED MAPLE

Maryland, continued

• **Local Comprehensive Plans and Development Regulations**

Through local comprehensive plans and corresponding development regulations, local governments in Maryland can establish habitat protection measures tailored to the needs and conditions existing in their jurisdictions.

• **Nontidal Wetlands Act** (Natural Resources Article § 8-1201, et seq., Annotated Code of Maryland)

The Nontidal Wetlands Act specifies that impacts of activities on nontidal wetlands are to be avoided and that unavoidable impacts are to be mitigated. The Act also requires a 25 foot buffer around nontidal wetlands. When conditions such as steep slopes or highly erodible soils are present adjacent to a wetland, the buffer may be expanded to as much as 100 feet.

• **Economic Growth, Resource Protection and Planning Act** (amends Article 66B, Zoning and Planning, Annotated Code of Maryland)

As a result of this Act, local governments in Maryland must develop and incorporate into their comprehensive plans, by 1997, sensitive areas protection elements. Local governments must also adopt development regulations necessary to implement the elements. Sensitive area protection elements must, at a minimum, address the following types of sensitive areas: (1) streams and stream buffers; (2) 100-year floodplains; (3) endangered species habitats; and (4) steep slopes. Local governments are encouraged to protect migratory bird habitat through their sensitive area elements.

In addition, the study results reaffirm the high ecological importance of barrier islands such as Assateague Island which is under state (MD Department of Natural Resources, Assateague Island State Park) and federal protection (National Park Service, Assateague Island National Seashore; U.S. Fish and Wildlife Service, Chincoteague National Wildlife Refuge). Scrub-shrub and forested habitats on barrier islands should be maintained and protected to provide appropriate habitat for all migrants.

The Maryland Department of Natural Resources is currently conducting a follow-up investigation of the importance of riparian forests as concentration areas for neotropical migrant landbirds. A final report will be produced in late 1993.

New Jersey

NEW JERSEY

The concentration of migrating passerines adds to the overall significance of the Cape May Peninsula as a critical area for migratory birds. Currently there are major land acquisition and regulatory programs protecting critical habitats for migratory raptors, migratory shorebirds and woodcock on the Cape May Peninsula and the Delaware Bayshore. This includes the Maurice River project, the new Cape May Refuge, expansions to the Higbee WMA, and the new Cape Island WMA. The entire area is

a focus for the North American Waterfowl Plan. Finally, the area lies within the jurisdiction of three strong state regulatory programs protecting significant concentrations of migratory birds within the coastal zone, freshwater wetlands, and the pineland reserve.

The New Jersey coastal zone, however, is one of the fastest growing areas in the state. Both resident and tourist populations have grown dramatically in the last decade spurring a development boom that has only recently slowed from the nationwide recession. Between 1973 and 1986, more than 30% of all available habitat was developed.

Given the extremely high value of both ecological and economic resources in the coastal area, the protection of critical habitats is a source of great conflict between developers and conservation agencies. Under these conditions, we recommend the following:

1. Incorporate the recommendations from this study into guidelines on the protection of migrant species now being developed by the Endangered and Nongame Species Program of the Division of Fish, Game and Wildlife. Much of the area is the same and will increase justification for acquisition or regulatory protection.

2. Develop detailed mapping of the 0.9 mi coastal band and the lower 6.2 mi area of the peninsula, and develop protection guidelines for each of the three land use regulatory programs and the state master plan.

3. Review all current acquisition program plans and readjust acquisition boundaries to include the 0.9 mi band and lower 6.2 mi area. Greatest priority should be given to undeveloped barrier island habitats and upland and freshwater wetland habitats adjacent to both the Atlantic and Delaware Bay marshes.

4. Initiate educational programs aimed at landowners to improve their understanding of the need of migratory passerines. This would include landscaping recommendations based on minimizing impacts to natural habitats and improving habitat conditions for feeding, resting, and roosting migratory birds. The NJ Audubon publication, *Backyard Habitats for Birds*, provides a good technical base for landscaping considerations.

5. Develop guidelines for the management of public lands to provide a diversity of habitats beneficial to passerine migrants without conflicting with the need of other migrants and breeding populations of rare and endangered species. The best approach would be to define a group of species that are most in need of protection and recommend guidelines for protection of that group's primary habitat. The area significant to neotropical migrants is included in the Endangered and Nongame Species Program's Landscape Protection Project and The Nature Conservancy's

New Jersey, continued

Delaware Bay Bioreserve. The Landscape Project will combine information from landuse, soils, and wetlands mapping and will facilitate the use of these data by federal, state, and local land managers, regulators, and planners. The result of this cooperative effort will be more effective protection of rare, threatened and endangered species. The Bioreserve will strive to organize the many protection efforts on the Delaware Bay and target areas for acquisition and protection. Data from the NMSCCS will facilitate action in both projects. More detailed information is necessary for habitat more than 3 km from the coast and further up the Delaware Bay and Atlantic coasts.

6. Data from this project provide a preliminary image of patterns of use in the Cape May area outside the 10 km zone currently protected for migrating raptors. This information requires immediate consideration by CAFRA, Wetlands, and Pinelands regulatory programs outside of the NMSCCS study area. Inventories of the mainland forests in Cape May and Cumberland counties would help to better delineate important areas.

7. Currently, most of the land management practices in this area are for the benefit of game species, or the harvest of timber product. A new management strategy based on corresponding needs of species such as turkey and neotropical migrant interior forest species would help to increase resources available to neotropical migrants and increase the significance of game management projects. These joint projects can provide a strong basis for land management and protection without the need for substantial increases in funding.

Virginia

VIRGINIA

Neotropical migratory songbirds have been recognized as a vital natural resource for the Commonwealth of Virginia. Secretary of Natural Resources, Elizabeth H. Haskell, when referring to the NMSCCS, noted that:

> "Virginia is taking the lead in this conservation issue of international importance... Virginia's Eastern Shore is thought to be one of the most important migratory songbird concentration [stopover] areas in North America. This 15 month study will be the first attempt to document the importance of the mid-Atlantic coastal corridor to scores of bird species. The commitment of nearly 100 Virginia citizen volunteers, whose help has made this study possible, is an inspirational illustration of local action toward global solutions."

With this high level of commitment to migratory bird conservation,

integration of the migrant concentration zone and habitat requirements as established by the NMSCC study into state and local policy should proceed in a timely fashion. In addition to the recommendations outlined for the four-state region, we place added emphasis on local and non-governmental protection mechanisms. The following actions would augment protection of migratory landbirds and their habitat in coastal Virginia.

Virginia, continued

1. Habitats important for migrating songbird conservation should be identified as specifically as possible and mapped at a scale appropriate for land use management efforts.

2. Local governments should use the expanded zoning authority granted by state enabling legislation (HB 861 passed by the General Assembly in 1990) to conserve open space and native vegetation as "environmentally significant" within the 0.9 mi migrant concentration area.

3. State owned lands within the coastal migration corridor should be managed with consideration of migrating songbird needs.

4. The Department of Conservation and Recreation's Shoreline Programs Bureau should consider the needs of migratory songbirds when advising landowners of shoreline stabilization alternatives on lands within the migration corridor.

5. The Virginia Coast Reserve should continue to incorporate the needs of migratory songbirds in their barrier island land management efforts.

Several state laws regulate activities that affect coastal resources. The following laws are currently in place and may help to strengthen conservation efforts on behalf of migratory landbirds.

•**The Chesapeake Bay Preservation Act** (*Virginia Code* §10.1-2100 et seq.), although enacted to protect water quality, has provisions which can help conserve natural heritage resources. The Chesapeake Bay Preservation Area Designation and Management Regulations are administered by the Chesapeake Bay Local Assistance Department and implemented by local governments in the Tidewater region of Virginia. The regulations require local governments to designate tidal and contiguous non-tidal wetlands, tidal shores, and at least a 100 foot buffer as Resource Protection Areas. Development or alteration of these areas is, in most cases, prohibited. Maintaining these buffers in native trees and shrubs will benefit migrating songbirds. Adjacent lands which may affect water quality are designated as Resource Management Areas and land uses in these areas must meet specific water quality protection criteria.

Virginia, continued

◆**The Virginia Environmental Quality Act** (*Virginia Code* §10.1 -1200 et seq.) requires that any state agency or institution proposing to construct facilities costing more that $100,000 must prepare an environmental impact report and submit it to the Department of Environmental Quality. If there is a possibility that natural heritage resources will be affected by a state project, the Division of Natural Heritage is asked to comment. The impacts to natural heritage resources such as migration concentration sites must be described in the environmental impact report along with measures to avoid or minimize these impacts.

◆**Coastal Primary Sand Dune Protection Act** (*Virginia Code* §28.2-1400 et seq.) regulates actions that affect beaches, coastal primary dunes and barrier islands in Virginia. This law is administered in similar fashion to the wetlands law and requires a permit for any dune or beach disturbing activity above the mean high water mark. Beaches below the mean high water mark are regulated by the wetlands law. The Bay coasts and the barrier islands in their entirety are covered by this regulation.

It is important to recognize, however, that the above programs were not designed solely to conserve migratory songbird habitat. It may be necessary in some cases to use other management techniques in addition to the applicable regulations. Several non-regulatory tools are available in Virginia to strengthen habitat protection in areas covered by the above regulations and include the following.

◆**Dedication of Natural Area Preserves**

The Virginia Natural Area Preserves Act authorizes the Department of Conservation and Recreation to accept the dedication of qualified natural areas into the Virginia Natural Area Preserves System, the strongest form of protection that can be afforded a natural area. It involves recording a legally binding agreement which states the conservation purpose of a property owned by any private citizen, state agency, or non-federal public body and grants a conservation interest to the Department. Private landowners may dedicate their property as a natural area preserve and still maintain ownership and all rights to sell or otherwise transfer title to the property. In addition to the satisfaction of preserving important natural resources, the same financial benefits offered the donor of a conservation easement are available to private landowners who dedicate their land as a natural area preserve.

◆**Natural Areas Registry and Management Agreements**

The Virginia Natural Area Preserves Act also authorizes the Department of Conservation and Recreation to maintain a state registry of voluntarily protected natural areas. The Division of Natural Heritage is initiating a registry program for voluntary conservation of publicly and

privately owned natural areas. Natural Area registry agreements are sought on private, state, and federal lands.

Virginia, continued

•Conservation Easements

In Virginia, easements are regulated by the Open Space Land Act (*Virginia Code* § 10.1-1700 et seq.); the Virginia Outdoors Foundation (*Virginia Code* § 10.1-1800 et seq.); and the Virginia Conservation Easement Act (*Virginia Code* § 10.1-1009 et seq.). The Virginia Coast Reserve of The Nature Conservancy has an active easement program on the Eastern Shore of Virginia.

LOCAL GOVERNMENT POLICY AND MANAGEMENT RECOMMENDATIONS

There is a trend towards increased local government involvement in natural resource conservation. An enhanced local role can fill the gaps where federal and state programs are unable to limit habitat loss from land development and other activities which fall under the purview of local programs. Information on the types and location of critical habitat areas for neotropical migratory songbirds can assist localities in planning for community development and implementing local land management programs.

A key principle for a successful local habitat protection program is to integrate conservation into the planning and land management process in a way that considers local circumstances and accommodates community development. There is no single approach for habitat conservation that is suitable for all localities. An appropriate conservation program is determined by local conditions such as population density, anticipated growth, the extent and value of natural areas, public awareness of the issue, and the general vision the community has for its future. Each strategy has advantages and disadvantages in different situations and for different localities. The most effective local programs, however, are likely to consist of a combination of strategies and management techniques. We recommend that localities consider applying the following instruments to migratory landbird habitat protection.

An appropriate conservation program is determined by local conditions such as population density, anticipated growth, the extent and value of natural areas, public awareness of the issue, and the general vision the community has for its future.

1. Incorporating the vision of conserving natural areas for migratory songbirds should be part of the ***comprehensive planning*** process. The need to protect migrant stop-over habitat can help justify a comprehensive open space plan and greenway initiative. In fact, greenways may act as habitat corridors that may be important for harboring migrants while they move locally from patch to patch of protected forest or scrub. Greenways and open space are community assets that can have the added benefit of enhancing local economic development and tourism efforts by protecting prime areas for birdwatching and other environmentally compatible recreational activities.

2. ***Acquisition*** of priority or threatened migrant stopover habitat may at times be the only protection tool available to a local jurisdiction or community. The property could be acquired by the local government, a private environmental group, or a coalition of interests including businesses and private citizens. Funds may be available through a local bond issue or on a competitive basis from state or federal governments and national conservation organizations.

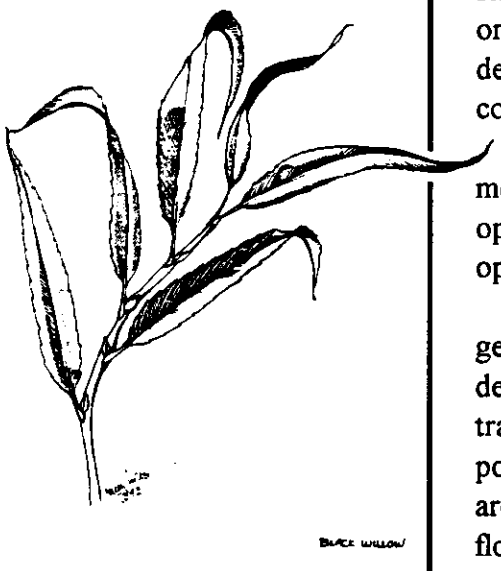
3. Local governments can hold ***conservation easements and land management agreements*** designed to enhance and protect migratory landbird habitat on private lands.

4. ***Tax Incentives*** can be implemented through a program of preferential assessment for lands devoted to agriculture, horticulture, forestry, and open space uses. In localities that adopt this program, properties that meet specified qualifications are assessed according to "use value" rather than fair market value. Such assessments promote the conservation of open space by ameliorating pressures which might otherwise force a property's conversion to more intensive use.

5. ***Zoning*** is one of the most powerful tools for any locality. Different types of zoning may be used for the protection of migratory songbird stop-over habitat with varying degrees of effectiveness.

A. Conventional zoning is the least flexible type of zoning but may be appropriate in some cases where all habitat in the locality should be protected.

B. Overlay zoning creates special districts that are placed "on top of" portions of other conventional zoning districts. The development standards for the overlay zone are then added to the standards of the original zones. Overlay zones can be used to outline natural areas or land designated for open space preservation. Delineation of critical migrant concentration areas could support overlay zoning.



BLACK WILLOW

C. Cluster development encompasses many techniques that allow moderate to high density development in exchange for conservation of open space and natural areas. Clustering is an excellent way to preserve open space by minimizing the amount of land needed for development.

D. Planned unit development (PUD) is a form of clustering, but is generally larger and can include non-residential land uses. Planned unit development regulations set an average development density for large tracts and then permit higher density and cluster development on selected portions of the tract. The more intensely developed areas are off-set by areas with little or no development. Many PUD regulations appear as floating zones which are not designated on a zoning map. This allows more flexibility for the community to reserve judgement on placement of such

large developments until a request is received.

E. Conditional zoning is a procedure that allows localities to accept conditions proffered (voluntarily offered) by an applicant for a rezoning. Under conditional zoning, developers could proffer to leave important natural areas undeveloped and assure the protection and management of these areas.

F. Transferable development rights allow a community to direct the location of development while assuring fair compensation to all landowners. This is an excellent tool for steering incompatible land uses from areas that contain sensitive migratory songbird habitat.

6. ***Other ordinances*** can be passed specifically to protect native vegetation, the mainstay of migrant stop-over habitat. The vegetation ordinance of the Borough of Cape May Point, NJ can serve as a model for other municipalities. The ordinance forbids, with some exceptions, the cutting of trees without a replacement plan. Thus, in this community, songbird migrants will always find trees and shrubs on all building lots.

7. ***Local landowner education programs*** should be developed. Such a program could include educational programs and distribution of an informational brochure to property owners at the time of property transfer.

PRIVATE LANDOWNER RECOMMENDATIONS

Concerned citizens... can ameliorate some of the habitat degradation that has already occured.

Although the best conservation strategy for migrating songbirds is to preserve as much open space and native habitat as possible, development has already usurped the natural habitat at such migratory hotspots as Cape May, NJ, and Chincoteague, VA. Concerned citizens, however, can ameliorate some of the habitat degradation that has already occurred. The following recommendations are for private landowners in the four state coastal region who would like to do their part for the protection of neotropical migratory songbirds.

1. Establish a habitat program in your own backyard.

Several states have backyard habitat programs that instruct homeowners and businesses how to plant their property for wildlife. By incorporating selected native plants (and an occasional beneficial non-native) into the urban/suburban landscape, the landowner can provide food and cover for migrants. If an entire community participates, relatively large numbers of migrants can benefit. This is particularly true in the most sensitive areas identified in this study. Contact your state wildlife agency for specific information. Existing programs in the region include the *Bayscapes*, which was developed by the Alliance for the Chesapeake Bay; a similar program has been developed by the Cape May Bird Observatory (Sutton 1989) and the New Jersey Endangered and Nongame Species Program. Both the Chesapeake Bay and Cape May initiatives include booklets with detailed directions on planning a backyard habitat and lists of plants and the types

of wildlife (including migrating birds) that use those plants (see Appendix D).

2. **Join an Agricultural or Forestal district.**
In states where enabling legislation exists, landowners may declare their intention to maintain their land in agricultural or timber harvesting for a period of five to eight years. Although the primary goal of such declarations is to preserve the economic production aspects of these lands, these districts also serve to "conserve and protect agricultural and forestal lands as valued natural and ecological resources which provide essential open spaces for clean air sheds, watershed protection, wildlife habitat, as well as for aesthetic purposes." In return for entering into a district agreement, landowners receive certain financial incentives and protection from development pressures. Landowners in an agricultural or forestal district are automatically eligible for use-value assessments for property taxes. Limitations are placed on the expenditure of public funds for infrastructure expansion in districts as well as restrictions on the acquisition of land through eminent domain. Local governments rezoning parcels next to agricultural and forestal districts must also consider the existence of these districts in their decision making. (In Virginia, the Agricultural and Forestal Districts Act (*Virginia Code* §15.1-1506 et seq.) allows farm or timberland owners to voluntarily form agricultural or forestal districts.)

3. **Donate a conservation easement or develop a voluntary management plan for your property.**
An easement or management agreement can be held with federal, state, or local agencies or a nongovernmental organization such as The Nature Conservancy. Easements and land management agreements can be designed specifically for migrant habitat needs and tailored to a particular property.

4. **Support local, state, federal, and private efforts to protect and conserve migratory songbird habitat.**

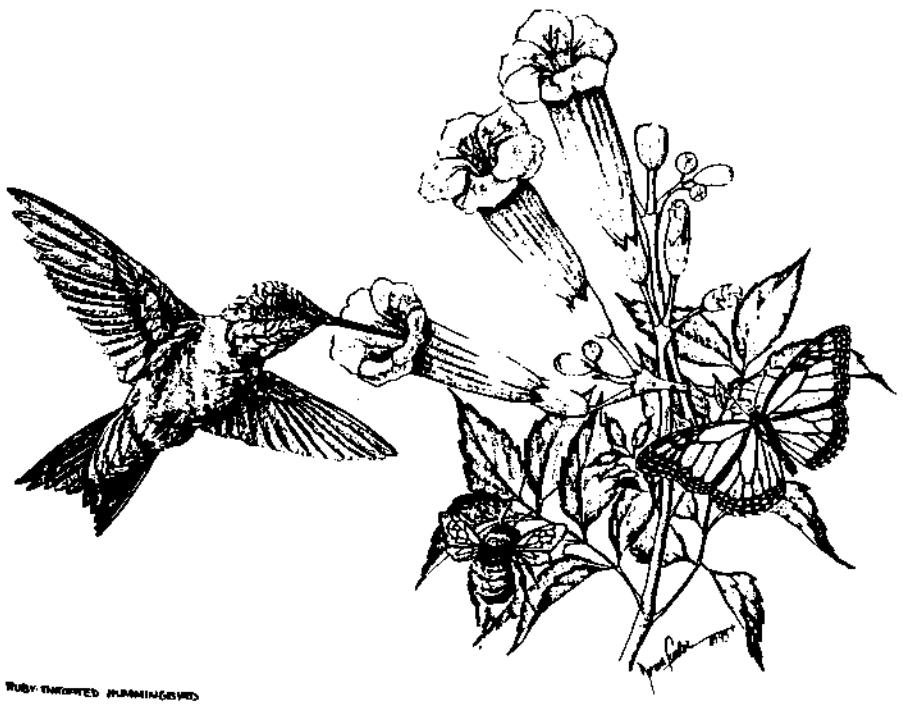
VII. RECOMMENDATIONS FOR FURTHER RESEARCH

The Neotropical Migratory Songbird Coastal Corridor Study has taken an important step towards defining the distributions of southward migrating songbirds stopping-over on the Cape May and Delmarva peninsulas. It was, however, designed to address broad-scale patterns. Many fine-scale issues remain for investigation. Although concentrations of migrants may exist at peninsula tips, our sampling design was unable to detect them. Alternative methodology (including more intensive coverage of the tip areas) that would examine peninsular effects on a finer scale are

recommended.

Details of species-habitat associations and habitat utilization will be critical to our understanding of the relative importance of habitat types. Current research at Cape May, NJ indicates that habitat utilization and association patterns vary within a single day, as well as over longer periods of time (Niles, *in prep.*; Kerlinger *in prep.*).

The relative importance of habitat may also vary according to the overall landscape (i.e., degree of patch isolation, relative abundance of particular habitat types, etc.). Additionally, riparian corridors and inland estuaries are significant landscape features on both the Cape May and Delmarva peninsulas. Migrant use of these coastal extensions must be examined. Research on many of these questions is continuing within the region including an investigation of migrant use of riparian corridors in Maryland (McCann *pers. comm.*); and a study of the geographic, landscape, and vegetation parameters influencing long- and short-distance migratory landbird distributions on the lower Delmarva peninsula (Watts and Mabey *pers. comm.*). Local land use planning and migratory songbird protection efforts will continue to benefit from this increasing understanding of migrating songbirds.



APPENDIX

APPENDIX A. STUDY PARTICIPANTS

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APPENDIX B. BIRD SPECIES INCLUDED IN NMSCC STUDY

	Common Name	Latin Name	Total Study Count
A[1]	Black-billed Cuckoo	*Coccyzus erythropthalmus*	19
A	Yellow-billed Cuckoo	*Coccyzus americanus*	222
A	Ruby-throated Hummingbird	*Archilochus colubris*	322
B[2]	Yellow-bellied Sapsucker	*Sphyrapicus varius*	122
A	Olive-sided Flycatcher	*Contopus borealis*	7
A	Eastern Wood-Pewee	*Contopus virens*	238
A	Yellow-bellied Flycatcher	*Empidonax flaviventris*	21
A	Acadian Flycatcher	*Empidonax virescens*	27
A	Alder Flycatcher	*Empidonax alnorum*	1
A	Willow Flycatcher	*Empidonax traileii*	1
A	Least Flycatcher	*Empidonax minimus*	11
B	Eastern Phoebe	*Sayornis phoebe*	139
A	Eastern Kingbird	*Tyrannus tyrannus*	168
A	Great Crested Flycatcher	*Myiarchus crinitus*	243
A	House Wren	*Troglodytes aedon*	206
B	Ruby-crowned Kinglet	*Regulus calendula*	880
A	Blue-gray Gnatcatcher	*Polioptila caerulea*	241
A	Veery	*Catharus fuscescens*	247
A	Gray-cheeked Thrush	*Catharus minimus*	30
A	Swainson's Thrush	*Catharus ustulatus*	79
B	Hermit Thrush	*Catharus guttatus*	195
A	Wood Thrush	*Hylocichla mustelina*	170
A	Gray Catbird	*Dumetella carolinensis*	1365
	Brown Thrasher	*Toxostoma rufum*	150
A	White-eyed Vireo	*Vireo griseus*	546
A	Solitary Vireo	*Vireo solitarius*	207
A	Yellow-throated Vireo	*Vireo flavifrons*	93

[1]Long-distance migrant with winter range south of U.S. border (Partners In Flight classification)
[2]Short-distance migrant with winter range including southern U.S. (Partners In Flight classification)

A	Warbling Vireo	*Vireo gilvus*	52
A	Philadelphia Vireo	*Vireo philadelphicus*	91
A	Red-eyed Vireo	*Vireo olivaceus*	3181
A	Blue-winged Warbler	*Vermivora pinus*	99
A	Golden-winged Warbler	*Vermivora chrysoptera*	5
A	Tennessee Warbler	*Vermivora peregrina*	29
A	Orange-crowned Warbler	*Vermivora celata*	9
A	Nashville Warbler	*Vermivora ruficapilla*	36
A	Prothonotary Warbler	*Protonotaria citrea*	42
A	Northern Parula	*Parula americana*	532
A	Yellow Warbler	*Dendroica petechia*	93
A	Chestnut-sided Warbler	*Dendroica pensylvanica*	385
A	Magnolia Warbler	*Dendroica magnolia*	358
A	Cape May Warbler	*Dendroica tigrina*	108
A	Black-throated-Blue Warbler	*Dendroica caerulescens*	845
B	Yellow-rumped Warbler	*Dendroica coronata*	9617
A	Black-throated Green Warbler	*Dendroica virens*	177
A	Blackburnian Warbler	*Dendroica fusca*	62
A	Yellow-throated Warbler	*Dendroica dominica*	77
B	Pine Warbler	*Dendroica pinus*	1411
A	Prairie Warbler	*Dendroica discolor*	525
A	Palm Warbler	*Dendroica palmarum*	83
A	Bay-breasted Warbler	*Dendroica castanea*	65
A	Blackpoll Warbler	*Dendroica striata*	63
A	Cerulean Warbler	*Dendroica cerulea*	9
A	Black-and-White Warbler	*Mniotilta varia*	2546
A	American Redstart	*Setophaga ruticilla*	3540
A	Worm-eating Warbler	*Helmitheros vermivorus*	74
A	Swainson's Warbler	*Limnothlypis swaisonii*	8
A	Ovenbird	*Seirus aurocapillus*	410
A	Northern Waterthrush	*Seirus noveboracensis*	41
A	Louisiana Waterthrush	*Seirus motacilla*	7
A	Kentucky Warbler	*Oporornis formosus*	28
A	Connecticut Warbler	*Oporornis agilis*	12

A	Mourning Warbler	*Oporornis philadelphia*	14
A	Common Yellowthroat	*Geothlypis trichas*	539
A	Hooded Warbler	*Wilsonia citrina*	24
A	Wilson's Warbler	*Wilsonia pusilla*	12
A	Canada Warbler	*Wilsonia canadensis*	55
A	Yellow-breasted Chat	*Icteria virens*	43
A	Summer Tanager	*Piranga rubra*	103
A	Scarlet Tanager	*Piranga olivacea*	157
A	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	47
A	Blue Grosbeak	*Guiraca caerulea*	44
A	Indigo Bunting	*Passerina cyanea*	72
A	Dickcissel	*Spiza americana*	2
A	Chipping Sparrow	*Spizella passerina*	38
B	Vesper Sparrow	*Pooecetes gramineus*	3
A	Grasshopper Sparrow	*Ammodramus savannarum*	9
A	Lincoln's Sparrow	*Melospiza lincolnii*	0
A	Bobolink	*Dolichonyx oryzivorus*	16
A	Orchard Oriole	*Icterus spurius*	35
A	Northern Oriole	*Icterus galbula*	657
		Total songbirds counted	**32,440**
	Osprey	*Pandion haliaetus*	70
	Bald Eagle	*Haliaeetus leucocephalus*	5
B	Northern Harrier	*Circus cyaneus*	25
B	Sharp-shinned Hawk	*Accipiter striatus*	200
B	Cooper's Hawk	*Accipiter cooperii*	40
B	Red-shouldered Hawk	*Buteo lineatus*	10
A	Broad-winged Hawk	*Buteo platypterus*	34
B	Red-tailed Hawk	*Buteo jamaicensis*	60
B	American Kestrel	*Falco sparverius*	59
A	Merlin	*Falco columbarius*	17
A	Peregrine Falcon	*Falco peregrinus*	14
	Prairie Falcon	*Falco mexicanus*	0
		Total raptors counted	**534**

APPENDIX C. TABLES

The numbers in these tables represent the average number of birds per 10 minute survey (abundance) or per survey site (species richness). High standard deviations associated with the averages indicate a high degree of variability from survey to survey in the actual number of birds counted and relates to the inherent variability of migration. Note also that each survey represents a very small subset of both time and space. The number of birds counted during a single survey is likewise only a small representative sample of the overall number of migrants moving through the region. All P values ≤ 0.05 indicate a statistically significant difference between given factors.

Table 1. Comparison of neotropical migrant landbird average abundance [a] and average species richness [b] between near-coast and inland areas.

Variables	Near-coast	Inland	P[c]
	#sites = 249	#sites = 174	
Species richness	14.46 ± 5.39	13.03 ± 4.93	0.006
	#surveys = 5787	#surveys = 4132	
Migrant Abundance minus Yellow-rumped Warbler	2.44 ± 4.97	2.20 ± 5.28	0.021
Migrant Abundance	3.21 ± 8.72	2.67 ± 6.38	< 0.001
Most frequently observed species			
Yellow-rumped Warbler	0.82 ± 7.09	0.50 ± 3.54	0.008
Red-eyed Vireo	0.28 ± 0.87	0.28 ± 0.87	0.977
American Redstart	0.27 ± 0.93	0.31 ± 1.04	0.048
Black-and-white Warbler	0.23 ± 0.75	0.21 ± 0.81	0.120
Ruby-crowned Kinglet	0.09 ± 0.60	0.05 ± 0.38	< 0.001
Pine Warbler	0.13 ± 0.73	0.09 ± 0.49	0.002
Gray Catbird	0.11 ± 0.58	0.06 ± 0.39	< 0.001

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on ANOVA

Table 2. Comparison of neotropical migrant landbird average abundance [a] and average species richness [b] among bayside coast, seaside coast, and interior areas.

Variables	Bayside	Interior	Seaside	P[c]
Species richness	#sites = 226 15.66 ± 5.29	#sites = 36 11.50 ± 3.40	#sites = 197 11.83 ± 4.39	< 0.001
	#surveys = 5283	#surveys = 660	#surveys = 4666	
Migrant Abundance minus YRWA	2.76 ± 5.42	2.26 ± 7.61	1.86 ± 4.65	< 0.001
Migrant Abundance	3.37 ± 8.63	2.49 ± 7.76	2.54 ± 6.77	< 0.001
Most frequently observed species				
Yellow-rumped Warbler	0.66 ± 6.52	0.26 ± 1.66	0.72 ± 5.03	0.148
Red-eyed Vireo	0.29 ± 0.89	0.14 ± 0.63	0.27 ± 0.85	< 0.001
American Redstart	0.37 ± 1.16	0.25 ± 0.80	0.20 ± 0.70	< 0.001
Black-and-white Warbler	0.28 ± 0.87	0.12 ± 0.57	0.17 ± 0.63	< 0.001
Ruby-crowned Kinglet	0.11 ± 0.67	0.11 ± 0.47	0.03± 0.25	< 0.001
Pine Warbler	0.12 ± 0.57	0.20 ± 0.68	0.11± 0.71	0.007
Gray Catbird	0.11 ± 0.54	0.07 ± 0.28	0.08 ± 0.47	0.005

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on ANOVA.

Table 3. Comparison of neotropical migrant songbird abundance [a] and species richness [b] among habitats in near-coast (C) and inland (I) areas.

Variables		Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	Habitat X Area Interaction P-value [c]
Species Richness	C [d]	17.77 ± 4.26	14.59 ± 6.00	14.05 ± 5.09	12.94 ± 4.68	0.761
	I [e]	ND	13.56 ± 5.74	13.25 ± 4.56	11.00 ± 4.10	
Migrant Abundance minus YRWA	C	2.78 ± 5.06	2.82 ± 6.03	2.19 ± 4.47	2.12 ± 3.53	< 0.001
	I	ND	2.38 ± 5.92	2.23 ± 5.14	1.72 1 4.68	
Migrant Abundance	C [f]	3.12 ± 6.25	3.39 ± 7.31	2.79 ± 6.40	4.43 ± 17.29	0.111
	I [g]	ND	2.62 ± 6.58	2.73 ± 6.30	2.55 ± 6.44	

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] No coniferous forest habitat was sampled in inland areas. Therefore only 3 levels of habitat factor (deciduous, mixed, scrub) were included in 2-way ANOVA.
[d] Coniferous, # sites = 26; deciduous, # sites = 81; mixed, # sites = 108; scrub, # sites = 34
[e] Deciduous, # sites = 52; mixed, # sites = 98; scrub # sites = 24
[f] Coniferous, # surveys = 657; deciduous, # surveys = 1797; mixed, # surveys = 2484; scrub, # surveys = 709
[g] Deciduous, # surveys = 1212; mixed, # surveys = 2277; scrub, # surveys = 504
ND = No Data

Table 4. Comparison of neotropical migrant songbird abundance [a] and species richness [b] among habitats on the bayside coast (B), seaside coast (S), and interior (I) areas.

Variables		Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	Habitat X Area Interaction P-value [c]
Species richness	B[d]	18.13 ± 4.37	15.46 ± 6.28	15.55 ± 4.71	14.46 ± 4.44	0.985
	I[e]	14.00 ± 4.60	12.00 ± 4.58	10.88 ± 2.93	11.00 ± 1.41	
	S[f]	15.00 ± 1.73	12.45 ± 4.85	11.89 ± 4.30	10.25 ± 3.65	
Migrant Abundance minus YRWA	B	2.62 ± 3.68	3.12 ± 6.64	2.66 ± 5.14	2.38 ± 4.02	0.007
	I	1.74 ± 1.95	1.99 ± 2.55	2.55 ± 9.56	1.83 ± 1.92	
	S	3.98 ± 10.70	2.01 ± 4.93	1.78 ± 4.42	1.60 ± 4.04	
Migrant Abundance	B[g]	2.96 ± 5.34	3.47 ± 7.09	3.10 ± 5.90	4.87 ± 19.32	0.009
	I[h]	2.77 ± 3.86	2.11 ± 2.54	2.56 ± 9.57	1.94 ± 2.00	
	S[i]	4.30 ± 10.82	2.56 ± 6.94	2.45 ± 6.73	2.63 ± 6.37	

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on 2-way ANOVA.
[d] Coniferous, # sites = 23; deciduous, # sites = 77; mixed, # sites = 100; scrub, # sites = 26
[e] Coniferous, # sites = 6; deciduous, # sites = 3; mixed, # sites = 25; scrub # sites = 2
[f] Coniferous, # sites = 3; deciduous, # sites = 56; mixed, # sites = 106; scrub, # sites = 32
[g] Coniferous, # surveys = 579; deciduous, # surveys = 1715; mixed, # surveys = 2314; scrub, # surveys = 551
[h] Coniferous, # surveys = 124; deciduous, # surveys = 65; mixed, # surveys = 406; scrub, # surveys = 36
[i] Coniferous, # surveys = 78; deciduous, # surveys = 1294; mixed, # surveys = 2447; scrub, # surveys = 662

Table 5. Comparison of neotropical migrant landbird abundance[a] and average species richness[b] among coastal areas that are 0-6.2, 6.2-18.6, and 18.6-31 mi from the Cape May and Delmarva peninsula tips.

Variable	0-6.2 mi	6.2-18.6 mi	18.6-31 mi	P[c]
	#sites = 26	#sites = 70	#sites = 51	
Species number	12.23 ± 4.04	11.74 ± 4.62	12.73 ± 5.43	0.543
	#surveys = 832	#surveys = 1506	#surveys = 1149	
Migrant Abundance minus YRWA	2.06 ± 4.46	2.45 ± 6.37	2.32 ± 7.50	0.359
Migrant Abundance	3.41 ± 15.70	3.46 ± 8.92	2.95 ± 8.49	0.450
Most frequently observed species				
Yellow-rumped Warbler	1.46 ± 14.76	1.08 ± 6.24	0.68 ± 4.08	0.130
Red-eyed Vireo	0.19 ± 0.63	0.26 ± 0.87	0.18 ± 0.63	0.011
American Redstart	0.29 ± 1.04	0.35 ± 1.04	0.19 ± 0.65	< 0.001
Black-and-white Warbler	0.23 ± 0.74	0.20 ± 0.78	0.16 ± 0.67	0.132
Ruby-crowned Kinglet	0.05 ± 0.45	0.04 ± 0.25	0.04 ± 0.30	0.642
Pine Warbler	0.05 ± 0.44	0.06 ± 0.36	0.16 ± 1.12	< 0.001
Gray Catbird	0.16 ± 0.65	0.15 ± 0.72	0.12 ± 0.57	0.199

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on ANOVA.

Table 6. Comparison of neotropical migrant landbird abundance[a] and species richness[b] among habitats in coastal areas that are 0 - 6.2, 6.2 - 18.6, and 18.6 - 31 mi from the Cape May And Delmarva peninsula tips.

Variables		Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	Habitat X Area Interaction P-value c
Species richness	0 - 6.2[d]	16.00 ± 0	10.50 ± 4.33	13.43 ± 2.82	12.88 ± 4.39	0.358
	6.2 - 18.6[e]	13.00 ± 0	11.26 ± 4.89	11.94 ± 4.91	11.84 ± 4.17	
	18.6 - 31[f]	ND	14.36 ± 5.70	13.23 ± 5.38	10.50 ± 4.96	
Migrant Abundance minus YRWA	0 - 6.2	6.23 ± 17.69	1.96 ± 3.57	1.98 ± 2.85	2.14 ± 3.48	0.081
	6.2 - 18.6	3.35 ± 4.93	2.29 ± 7.17	2.64 ± 6.28	2.25 ± 5.69	
	18.6 - 31	ND	3.27 ± 10.92	2.19 ± 7.24	1.77 ± 3.08	
Migrant Abundance	0 - 6.2[g]	6.15 ± 17.71	2.35 ± 4.38	3.03 ± 7.69	6.31 ± 33.18	0.20
	6.2 - 18.6[h]	4.04 ± 5.55	2.74 ± 8065	3.42 ± 8.22	4.27 ± 10.39	
	18.6 - 31[i]	ND	4.06 ± 12.43	2.51 ± 7.45	2.89 ± 5.79	

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on 2-way ANOVA.
[d] Coniferous, # sites = 1; deciduous, # sites = 10; mixed, # sites = 7; scrub, # sites = 8
[e] Coniferous, # sites = 1; deciduous, # sites = 19; mixed, # sites = 31; scrub # sites = 19
[f] Deciduous, # sites = 11; mixed, # sites = 26; scrub, # sites = 14
[g] Coniferous, # surveys = 26; deciduous, # surveys = 198; mixed, # surveys = 162; scrub, # surveys = 159
[h] Coniferous, # surveys = 26; deciduous, # surveys = 414; mixed, # surveys = 676; scrub, # surveys = 390
[i] Deciduous, # surveys = 256; mixed, # surveys = 593; scrub, # surveys = 300
ND = No Data

Table 7. Comparison of neotropical migrant landbird abundance [a] and average species richness [b] on barrier islands and the adjacent coastal mainland.

Variable	Barrier Islands	Mainland	P[c]
	#sites = 65	#sites = 93	
Species number	12.15 ± 4.68	12.79 ± 4.98	0.423
	#surveys = 921	#surveys = 2188	
Migrant Abundance minus Yellow-rumped Warbler	3.08 ± 4.70	2.13 ± 6.15	< 0.001
Migrant Abundance	6.40 ± 9.68	2.78 ± 7.80	< 0.001
Most frequently observed species			
Yellow-rumped Warbler	3.45 ± 9.21	0.72 ± 4.90	< 0.001
Red-eyed Vireo	0.27 ± 1.43	0.22 ± 0.64	0.207
American Redstart	0.41 ± 1.20	0.21 ± 0.76	< 0.001
Black-and-white Warbler	0.15 ± 0.59	0.17 ± 0.65	0.388
Ruby-crowned Kinglet	0.06 ± 0.42	0.03 ± 0.29	0.021
Pine Warbler	0.11 ± 0.56	0.10 ± 0.85	0.736
Gray Catbird	0.51 ± 1.03	0.12 ± 0.63	< 0.001

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on ANOVA.

Table 8. Comparison of neotropical migrant landbird abundance [a] and species richness [b] among habitat types on the Delmarva and Cape May Peninsula mainland.

Variable	Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	P-value[c]
No. sites	32	136	231	60	
No. species	68	80	82	75	
Species richness	17.06 ± 4.50	14.14 ± 5.87	13.36 ± 4.76	12.10 ± 4.44	< 0.001
	#birds = 781	#birds = 3074	#birds = 5167	#birds = 1249	
Migrant Abundance minus YRWA	2.62 ± 4.72	2.63 ± 5.94	2.24 ± 5.33	1.95 ± 4.01	< 0.001
Migrant Abundance	3.06 ± 5.93	3.06 ± 6.97	2.75 ± 6.66	3.60 ± 13.69	0.006

[a] Mean (± SD) number of birds per survey
[b] Mean (± SD) number of species observed per site
[c] Significance level based on ANOVA.

Table 9. Migratory stopover habitat associations of neotropical migrant songbirds in the coastal region of the Cape May and Delmarva Peninsulas. Species in bold print are experiencing significant population declines (Robbins et al. 1989).

Species	n[a]	Habitat Association[b]	Mean no. birds per count (X 100)				P[c]
			Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	
No. sites			32	136	231	60	
No. point counts			781	3074	5167	1249	
Yellow-billed Cuckoo **Coccyzus americanus**	213	$Forest_{d,m}$	0.77	2.25	2.65	0.32	****
Ruby-throated Hummingbird Archilochus colubris	301	---	4.35	3.03	2.59	3.20	*
Yellow-bellied Sapsucker Sphyrapicus varius	111	$Forest_a$	1.15	1.46	1.01	0.40	NS
Eastern Wood-peewee Contopus virens	299	$Forest_a$	2.69	4.00	2.69	1.76	***
Eastern Phoebe Sayornis phoebe	129	Scrub	0.90	1.56	0.79	2.64	****
Eastern Kingbird Tyrannus tyrannus	133	Scrub	0.51	1.01	1.12	3.20	*
Great-crested Flycatcher Myiarchus crinitus	222	$Forest_c$	4.99	2.15	2.03	1.25	****
House Wren Troglodytes aedon	143	Scrub	2.56	1.43	0.45	4.48	***

Table 9. Continued

Species	n[a]	Habitat Association[b]	Mean no. birds per count (X 100)				P[c]
			Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	
Ruby-crowned Kinglet *Regulus calendula*	634	$Forest_c$	16.65	7.51	6.25	8.81	****
Blue-gray Gnatcatcher *Polioptila caerulea*	238	$Forest_c$	4.99	2.15	2.25	1.36	***
Veery ***Catharus minimus***	205	$Forest_a$	2.82	2.15	2.11	0.64	*
Hermit Thrush *Catharus guttatus*	183	---	1.92	1.59	2.09	0.88	NS
Wood Thrush ***Hylocichla mustelina***	155	$Forest_a$	1.54	2.12	1.37	0.56	**
Gray Catbird ***Dumetella carolinensis***	895	Scrub	5.51	8.49	3.66	32.19	****
White-eyed Vireo ***Vireo griseus***	449	Scrub	3.2	4.36	2.81	11.61	****
Solitary Vireo *Vireo solitarius*	185	---	2.18	1.98	1.90	0.80	NS
Red-eyed Vireo *Vireo olivaceus*	2800	$Forest_d$	13.70	38.19	27.77	6.73	****

Table 9. Continued

Species	n[a]	Habitat Association[b]	Mean no. birds per count (X 100) Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	P[c]
Northern Parula **Parula americana**	393	---	2.18	7.06	2.98	0.40	NS
Chestnut-sided Warbler **Dendroica pensylvanica**	377	---	0.77	3.48	3.50	6.65	NS
Magnolia Warbler Dendroica magnolia	496	---	5.89	3.58	5.77	3.36	NS
Cape May Warbler Dendroica tigrina	106	---	1.15	0.39	1.59	0.24	NS
Black-throated Blue Warbler Dendroica caerulescens	672	---	5.63	7.97	7.20	0.88	NS
Yellow-rumped Warbler Dendroica coronata	6805	Scrub	50.70	46.32	53.46	177.98	****
Black-throated Green Warbler **Denroica virens**	165	$Forest_a$	2.43	2.51	1.24	0.40	****
Pine Warbler Dendroica pinus	1236	$Forest_c$	26.50	5.17	15.33	6.24	****
Prairie Warbler Dendroica discolor	350	$Forest_c$	13.70	2.60	2.26	3.68	**

Table 9. Continued

Species	n[a]	Habitat Association[b]	Mean no. birds per count (X 100)				P[c]
			Coniferous Forest	Deciduous Forest	Mixed Forest	Scrub	
Black-and-white Warbler *Mniotilta varia*	2260	$Forest_a$	28.81	22.32	24.13	8.17	****
American Redstart *Setophaga ruticilla*	2983	$Forest_a$	34.83	35.13	29.26	9.53	****
Ovenbird *Seirus aurocapillus*	359	Forest[a]	4.10	3.51	3.77	1.92	*
Common Yellowthroat *Geothlypis trichas*	238	Scrub	3.33	2.21	1.47	5.44	****
Scarlet Tanager *Piranga olivaceus*	213	---	2.05	1.82	2.63	0.40	NS
Northern Oriole *Icterus galbula*	649	$Forest_d$	0.90	12.91	4.66	0.32	*

[a] n = total number of individual birds observed
[b] Forest subscripts: c=coniferous, d=deciduous, m=mixed, a=no differences in abundance between forest habitats
[c] P-value based on ANOVA. Means were separated using Tukey's studentized range test.
---No habitat association was detected

APPENDIX D. VEGETATION COMMUNITY TYPES IDENTIFIED WITHIN STUDY AREA

Community 1: Dry Oak Forest - Deciduous Variant

Diagnostic features: well-drained sandy soils; less than 60% of tree cover coniferous; several oaks, including *Quercus stellata, Q. coccinea, Q. falcata, Q. velutina, Q. phellos, Q. prinus* and *Q. alba*; other typical trees and tall shrubs are *Acer rubrum, Carya* spp. *Diospyros virginiana, Cornus florida, Sassafras albidum, Liquidambar styraciflua, Prunus serotina,* and *Vaccinium corymbosum*; *Pinus virginiana* and *Pinus taeda* usually present, except in parts of New Jersey where *Pinus rigida* appears; low ericads such as *Vaccinium pallidum, V. stamineum, Gaylussacia baccata* usually abundant; *Carex pennsylvanica* and other drought tolerant herbs usually present.

Community 2: Mesic Mixed Hardwood/Sweet Pepperbush Forest - Deciduous Variant

Diagnostic features: mesic to wet-mesic sites; organic matter on soil surface tends to be thick, except on some richer soils; less than 60% of tree cover coniferous; *Quercus alba, Pinus taeda, Ilex opaca, Acer rubrum, Nyssa sylvatica, Liriodendron tulipifera, Liquidambar styraciflua, Rhododendron* spp., *Gaylussacia frondosa, Clethra alnifolia* and *Magnolia virginiana* typically present; *Smilax rotundifolia* sometimes abundant; herbaceous layer is usually sparse, with species such as *Monotropa uniflora, Tipularia discolor, Chasmanthium laxum,* and *Mitchella repens* being characteristic; richer soils support an abundance of *Liriodendron* and herbs such as *Podophyllum peltatum*; Northamptom County, VA occurrences frequently support *Persea borbonia.*

Community 3: Mesic Beech/Holly Forest

Diagnostic features: similar to no. 2, but with an abundance of *Fagus grandifolia* and *Ilex opaca*; frequently occurs on steep slopes, less frequently on wet-mesic flats.

Community 4: Red Maple/Sweet Gum Swamp

Diagnostic features: seasonally wet sites; an early succession deciduous swamp forest community dominated by *Acer rubrum* and *Liquidambar styraciflua*; additional species include *Nyssa sylvatica, Quercus phellos, Q. nigra* and *Pinus taeda.*

Community 5: Black Gum Swamp

Diagnostic features: perennially wet sites; rather mature deciduous swamp community with an abundance of water tolerant herbs such as *Saururus cernuus, Osmunda cinnamomea, Anchistea virginica, Cinna arundinacea,* and *Carex* spp.; *Nyssa sylvatica* is dominant.

Community 6: Cape May Lowland Forest

Diagnostic features: a wet-mesic flatwoods similar to no. 4 but characterized by *Quercus michauxii, Q. phellos, Populus heterophylla,* and other hardwoods.

Community 7: Black Willow/Alder Swamp

Diagnostic features: a community of seasonally flooded, mucky stream bottoms encountered very rarely (in VA); characterized by *Salix nigra* and *Alnus serrulata.*

Community 8: Atlantic White Cedar Swamp

Diagnostic features: a community of peaty, oligotrophic lowlands; encountered very rarely (in NJ); characterized by *Chamaecyparis thyoides,* tall ericads, and *Magnolia virginiana.*

Community 9: Pine Plantation Forest

Diagnostic features: obviously planted; usually dominated by *Pinus taeda*; can occur on several different soil types.

Community 10: Old Field Forest

Diagnostic features: a young, early-successional, post-agriculture forest characterized by mixed pines and hardwoods, and a weedy understory, e.g. with much *Loncera japonica, Ailanthus altissima, Toxicodendron radicans, Aralia spinosa*; old fences, rusting farm equipment, and junked cars can be diagnostic.

Community 11: Old Field Scrub

Diagnostic features: an early successional post-agricultural shrub community with plants such as *Juniperus virginiana, Rhus copallinum, Prunus serotina, Tidens flavus* and *Andropogon virginicus, Rubus* spp. and *Lonicera japonica.*

Community 12: Coastal Dune Woodland

Diagnostic features: woodlands situated near the coast and influenced by salt spray; trees usually with gnarled growth forms; *Celtia occidentalis, Sassafras albidum, Pinus taeda* (or *P. rigida* in NJ), *Juniperus virginiana,* and *Prunus serotina* are characteristic; understory usually thick with *Smilax rotundifolia, Toxicodendron radicans, Parthenocissus quinquefolia,* and *Myrica* spp.

Community 13: Salt Marsh Fringe Woodland

Diagnostic features: occurs primarily on the mainland as a narrow fringe bordering salt marshes; characteristic trees are *Pinus taeda, (P. rigida* in NJ), *Juniperus virginiana, Magnolia virginiana, Diospyros virginiana, Ilex opaca, Quercus falcata, Nyssa sylvatica, Liquidambar,* and *Acer rubrum*; frequent in the scrubby understory are *Baccharis halimifolia, Myrica cerifera, Toxicodendron radicans, Panicum virgatum, Poa compressa, Phragmites australis,* etc.

Community 14: Young Pine Scrub

Diagnostic features: usually this community is a young pine plantation occurring with a post-logging coppice of sprout hardwoods; herbs such as *Eupatoriaum capillifolium* and *Andropogon virginicus* usually abundant.

Community 15: Coastal Dune Scrub

Diagnostic features: typical species include *Myrica pensylvancica, Prunus maritima, Diospyros virginiana, Juniperus virginiana, Toxicodendron radicans, Ammophila breviligulata, Rubus spp., Hudsonia tomentosa, Panicum amarulum,* and *Opuntia humifusa.*

Community 16: Dry Oak Forest - Coniferous Variant

Diagnostic features: similar to no. 1, but with greater than 60% of the tree cover coniferous.

Community 17: Mesic Mixed Hardwoods/Sweet Pepperbush Forest - Coniferous Variant

Diagnostic features: similar to no. 2, but with greater than 60% of tree cover coniferous.

Bird Abundance, species number and freqency distribution by state for 17 vegetation community types.

Community type	Mean[1] Bird Abundance	Mean Species Richness	Frequency Distribution by State[2]			
			Delaware	Maryland	New Jersey	Virginia
Dry Oak Forest - Deciduous Variant (n = 1631)	2.58 ± 7.68	1.51 ± 1.93	32	8	37	23
Mesic Mixed Hardwoods - DV (n = 2964)	2.58 ± 5.15	1.58 ±1.90	27	37	9	27
Mesic Beech/Holly* (n = 178)	4.04 ± 6.41	1.96 ± 2.13	29	0	0	71
Red Maple/Sweet Gum Swamp (n = 644)	2.63 ± 8.50	1.32 ± 1.83	3	14	52	31
Black Gum Swamp* (n = 233)	3.79 ± 10.56	1.32 ± 1.73	0	0	0	100
Cape May Lowland Forest* (n = 22)	0.86 ± 1.88	0.68 ± 0.99	0	0	100	0
Black Willow/Alder Swamp* (n = 23)	4.00 ± 4.06	2.61 ± 2.19	0	0	0	100
Atlantic White Cedar Swamp	—	—	—	—	—	—
Pine Plantation Forest (n = 411)	3.28 ± 6.37	1.59 ± 1.61	0	67	0	33
Old Field Forest (n = 1817)	3.67 ± 8.38	1.61 ± 1.87	26	6	5	62
Old Field Scrub (n = 653)	3.72 ± 7.64	1.98 ± 2.02	0	10	90	0
Coastal Dune Woodland* (n = 24)	6.42 ± 6.89	3.04 ± 2.27	100	0	0	0
Salt Marsh Fringe (n = 656)	3.40 ± 6.10	1.78 ± 1.84	18	67	15	0
Young Pine Scrub (n = 636)	2.09 ± 4.33	1.16 ± 1.38	0	12	12	76
Coastal Dune Scrub (n = 580)	7.18 ± 20.12	2.10 ± 1.89	4	48	44	4
Dry Oak Forest - Coniferous Variant (n = 383)	2.88 ± 5.86	1.49 ± 1.75	46	15	0	39
Mesic Mixed Hardwood - CV (n = 633)	2.05 ± 3.28	1.24 ± 1.65	19	58	0	23

[1]Mean ± standard deviation
[2]Percent of community in each state
*Note low sample size and highly skewed distribution

APPENDIX E. ANNOTATED RESOURCE LIST

1. Neotropical Migratory Bird Facts

* Neotropical migrants are those species that breed in North America and winter in the tropical and sub-tropical Americas. They include some of our most beautiful breeding birds: hummingbirds, warblers, swallows, nighthawks, orioles, tanagers, flycatchers, vireos, thrushes, sparrows, and cuckoos.

* 190-200 species of North American breeding birds are considered neotropical migrants. (This is greater than one half of all bird species breeding in North America and accounts for 65-80% of all individual birds in the eastern U.S.)

* During the non-breeding season (our winter), neotropical migrants constitute more than one half of all individual birds in parts of Mexico, Cuba, Jamaica, and Hispaniola. They comprise 20-40% of the birds in the tropical forests of Guatemala and Belize.

* The breeding range for the majority of neotropical migrants consists of over 15 million square miles while the primary wintering grounds are only 2.3 million square miles.

* The average life span of a neotropical migratory songbird (that survives its first critical year) is five years.

* An average warbler pair removes caterpillars from more than a million leaves during the nesting season, reducing the caterpillar numbers by as much as one half. Swallows and Purple Martins feed mosquitoes to their voracious families.

* A migratory songbird can double its mass in preparation for its fall migration. The fat acquired can be burned off with the estimated fuel efficiency of 720,000 miles/gallon (1 g of fat = 150 - 250 km for a songbird).

* A Blackpoll Warbler can fly from New England to Venezuela in 60-80 hours. (A human running six-minute miles for the same amount of time would only make it from Maine to Virginia.) Most migrants, however, take a leisurely 4-8 weeks for their trip south with different peaks of movement for different species.

* Migratory songbirds lead versatile lives. Some species, such as Eastern Kingbirds and White-eyed Vireos rely heavily on fruit for their winter diet, a significant change from their otherwise insectivorous ways. White-eyed Vireos are largely responsible for the dispersal of seeds from the Chacah tree (*Bursera simaruba*) in Mexico. Tennessee Warblers and orioles join the ranks of important tropical pollinators. The ecology, behavior, and population biology of these birds during migration is very poorly documented.

* Although some species of neotropical migrants join flocks in the winter, many are territorial throughout the year, even during their migratory movements. Thus every individual bird has specific spatial requirements.

* In the states of VA, MD, DE, and NJ population declines for 47-74% of neotropical migrant species were observed during the period 1978-1987 (based on analyses of Breeding Bird Survey data). Some species have declined in abundance by as much as 16% per year between 1978 and 1987. At a long-term study site near Washington, D.C., 65-80% of all birds were neotropical migrants in 1940. Today the number is closer to 20 percent. In that area, Red-eyed Vireos have declined by more than 60% and Hooded Warblers have disappeared.

* Tropical forests, winter home of most neotropical migrants, are being lost at an estimated 1-3% a year. In some countries this rate is greatly accelerated. In North America, the fragmentation of our forests exposes neotropical migrants to an abundance of predators that thrive in the human altered landscape. These include raccoons, blue jays, grackles, dogs, cats, and the nest parasite, the Brown-headed Cowbird.

* Hundreds of thousands of Americans enjoy birding as a hobby. Studies have shown that the economic value of birds can be substantial in some communities. An estimated $5.5 million/year is spent by birders in Cape May, NJ, and about $1.7 million U.S./year at Point Pelee, Ontario.

2. Comprehensive Plan: Northampton County, Virginia

While striving for a balance between resource conservation and sustainable economic growth, Northampton County has recognized that there is a potential for conservation to foster economic growth. The first planning goal and objective listed in this 1990 comprehensive plan is to: "Conserve the County's Natural Resources." In outlining the "natural conditions" of the county, the comprehensive plan specifically addresses the importance of migratory birds in a proactive voice.

> Northampton County has one of the great ecological and biological phenomena of the entire east coast of the United States. A peculiarity of geography has caused semi-annual pile-ups of some millions of birds (passerines) in the lower section of the County. Here they pause for rest, cover, and forage in trees and scrub growth along the edge of the Chesapeake Bay... Loss of natural habitat will cause serious declines in the number of birds, and of course eventual elimination. Suitable land use planning and management can preserve this valuable and unique natural asset which if handled correctly can be of great benefit not only to the migrating birds but to the County as a scientific and educational entity. Economic returns would also accrue from the influx of interested scientists and those who enjoy ornithology as an avocation.

3. Borough of Cape May Point Ordinance No. 291-90

This ordinance requires that a Landscaping and Vegetation Plan be submitted the zoning officer for approval if a permit is being sought to increase existing lot coverage by more than 15 %; to construct or convert apartment buildings; or in cases where land use will disrupt or remove more than 50 % of the existing vegetation in less than a five year period. The ordinance provides specific guidelines for retaining trees and replanting if trees are removed. Replanting guidelines are based on the pamphlet: "Backyard Habitat for Birds: A Guide for Landowners and Communities in New Jersey" by P. Sutton. Cape May Bird Observatory/New Jersey Audubon Society. 1989.

4. The Economics of Birding at Cape May, New Jersey. 1991. Kerlinger, P. and D. Wiedner. Pp. 324-334 in Ecotourism and resource conservation: a collection of papers. Second International Symposium: ecotourism and resource conservation, 1991, Miami Beach, FL.

Kerlinger and Wiedner present a study of the economic value of birding in the Cape May Peninsula. The results of their surveys indicate that an excess of $5.5 million enters the local economy directly from birders. This estimate does not include any multipliers. The authors use this information to argue that there is an economic benefit in maintaining open land and a clean environment.

5. Nearctic Avian Migrants in the Neotropics. Rappole, J.H., E.S. Morton, T.E. Lovejoy, III, and J.L. Ruos. U.S. Department of Interior, Fish and Wildlife Service. July 1983.

This reference document provides the most thorough bibliography of literature on neotropical migrants, despite the fact that it is somewhat out-of-date.

6. "Birds over troubled forests." Greenberg, R. Smithsonian Migratory Bird Center. Smithsonian Inst. Press. 1990.

The Smithsonian Migratory Bird Center has created this and other educational materials for a lay audience. Not only do these pamphlets provide a clear and interesting description of migrants and their conservation problems, they offer recommendations for actions easily undertaken by citizens and local governments.

7. Bayscapes. 1993. Alliance for the Chesapeake Bay, Inc. Richmond, VA.

The program focuses on landscaping in the Chesapeake Bay area to reduce the use of fertilizers, pesticides, and water; increase wildlife habitat; and save landowners time and money. This brochure is a guide to creating environmentally sensitive landscapes. It includes information on conservation landscaping, long-term planning, creating diversity, conserving water, using beneficial plants, improving wildlife habitats, and integrated pest management. The brochure packet also contains a Chesapeake Bay resource guide and an annotated plant list (see Appendix F).

NAME	HEIGHT	FEATURES
River Oats *Uniola paniculata*	2-3'	3-season interest; needs sun; tolerates wet soil and drought
Wild Rice *Zizania aquatica*	2.5-3'	favored by migratory birds during migration; WL value; excellent bird food; tolerates wet soils
Switch Grass *Panicum virgatum*	5'	dried flowers, screen; needs sun; tolerates dry soil and drought
Ribbon Grass *Phalaris arundinacea*	18-24"	groundcover; needs sun; tolerates wet soil; not drought-tolerant
Cord Grass (EX) *Spartina pectinata*	4-6'	dried flowers, sand binder; needs sun; tolerates wet soil; not drought-tolerant

• FLOWERING PERENNIALS •

NAME	HEIGHT	FEATURES
Butterfly Weed *Asclepias tuberosa*	2-3'	attracts butterflies, brilliant orange flower; needs sun; tolerates dry soil and drought
Threadleaf Coreopsis *Coreopsis verticillata*	1-2'	airy texture, yellow, star-shaped flower; needs sun; tolerates dry soil and drought
Queen Anne's Lace (EX) *Daucus carota*	2-3'	delicate texture, white bloom; needs sun; tolerates dry soil and drought
Purple Coneflower (EX) *Echinacea purpurea*	2-4'	pastel color, amber center; needs sun; tolerates dry soil and drought
Geum *Geum virginianum*	2-3'	airy habit, colorful; needs sun; tolerates dry soil and drought
Blazing Star *Liatris scariosa*	1-5'	erect, bushy habit, bold color; needs sun; tolerates dry soil and drought
Virginia Blue Bells *Mertensia virginica*	1-2'	light foliage texture, lavender color; needs some sun; tolerates wet soil; not drought-tolerant
Wild Sweet William *Phlox divaricata*	1-2'	small, crowded flowers, color all summer; needs sun; tolerates dry soil and drought
Moss Pink *Phlox subulata*	3-6"	for banks and rock gardens, mass of small pink flowers, edging plant; needs sun; tolerates dry soil and drought
Black-eyed Susan *Rudbeckia hirta var. pulcherrima*	1-3'	yellow, daisy-like flower, upright habit, meadow plant; needs sun, tolerates dry soil and drought
Seaside Goldenrod *Solidago sempervirens*	8'	salt tolerant, background plant for seashore plantings; needs sun; tolerates dry soil and drought

FLOWERING PERENNIALS

Virginia Spiderwort *Tradescantia virginiana*	1-2'	handsome color, low, compact growth habit; needs sun; tolerates wet soil and drought
Culver's Root *Veronica virginica*	3-6'	background planting, upright habit; needs sun; tolerates dry soil and drought
Wild Bergamot *Monarda fistulosa*	3'	lilac to purple flowers; prefers dry soils; excellent perennial herb
Cardinal Flower *Lobelia cardinalis*	2.5-5'	bright scarlet flowers; prefers moist soil, partial shade; erect perennial
Wild Columbine *Aquilegia canadensis*	1.5-2'	excellent garden selection; yellow sepals and red spur; prefers loamy soil, partial shade
Fire Pink *Silene virginica*	6-10"	deep crimson petals; prefers well-drained sandy soil; flowers in loose cluster

This partial list of beneficial plants is comprised of both "exotic" or non-native, introduced species (EX), as well as indigenous, or native species. Native species are those that occur naturally in a region, not having been accidentally or intentionally introduced by man. Most of the plants listed are generally available in the Chesapeake Bay region at large, full-service nurseries and garden centers.

Consult your local nursery for recommendations on many other beneficial plants.

FOR MORE INFORMATION ON BAYSCAPES, CONTACT:

Alliance for the Chesapeake Bay
Post Office Box 1981
Richmond, Virginia 23216
(804) 775-0951

U.S. Fish & Wildlife Service,
Chesapeake Bay Field Office
180 Admiral Cochrane Drive, Suite 535
Annapolis, Maryland 21401

EXHIBIT F. BENEFICIAL PLANTS LIST

FOR THE CHESAPEAKE BAY REGION

• TREES •

EVERGREEN	HEIGHT	FEATURES
American Holly *Ilex opaca*	45'	red berry; WL value; needs moist, acid soil
Loblolly Pine *Pinus taeda*	20-60'	pioneer species; WL value; tolerates sandy soils, salt spray; needles in bundles
White Pine *Pinus strobus*	80-100'	oval; fast growing; WL value; needs well-drained soil; tolerates part shade
Eastern Red Cedar *Juniperus virginiana*	80'	pyramidal; WL value; thick branches, dense foliage; tolerates poor soils
Canadian Hemlock *Tsuga canadensis*	90'	pyramidal; dense habit; WL value; prefers rich, moist soil

LG.DECIDUOUS	HEIGHT	FEATURES
Red Maple *Acer rubrum*	75'	globular; fast-growing, early red blossom; prefers wet but tolerates dry soil
Sugar Maple *Acer saccharum*	75'	oval; beautiful fall color; prefers sandy, loam soil; needs sun
Shagbark Hickory *Carya ovata*	60-80'	oval; narrow habit; nuts; WL value; needs deep, rich soil and sun
Red or Green Ash *Fraxinus pennsylvanica*	60'	oval; fast-growing; prefers rich, well-drained soil
Honey Locust *Gleditsia triacanthos*	80'	globular; fast-growing, fine foliage; tolerates any soil type
Sweet Gum *Liquidambar styraciflua*	50'	pyramidal; rapid growth, pretty fall color, unusual leaf; needs well-drained, wet soil and sun
Tulip Poplar, Tulip Tree *Liriodendron tulipifera*	80-120'	pyramidal; rapid growth, tuliplike flower June; needs deep, rich soil, sun
White Oak *Quercus alba*	60-90'	round-headed, largest of oaks; WL value; tolerates range of soils
Sourwood, Sorrel Tree *Oxydendron arboreum*	40-60'	pyramidal; flower tassels in July, glossy foliage, striking fall color
Sycamore, Buttonwood American Plane Tree *Platanus occidentalis*	120'	oval; white exfoliating bark, attracts insects for birds, WL value; needs sun
Scarlet Oak *Quercus coccinea*	60-80'	oval; medium grower, lustrous foliage, brilliant fall color; WL value; tolerates dry soil; needs sun

(EX) = Exotic Species; WL = Wildlife

• TREES •

Willow Oak *Quercus phellos*	50'	pyramidal; fast growing, fine textured foliage; tolerates wet/dry soil
Black Cherry *Prunus serotina*	55'	abundant black fruit; WL value; white, fragrant flowers
American Ash *Fraxinus americana*	70-90'	fast growing; WL value; prefers well-drained loamy soils; late summer-autumn fruit
American Beech *Fagus grandifolia*	80'	lg. trunk; slow growing; prefers well-drained light soil
Blackgum, Tupelo *Nyssa sylvatica*	75'	horizontal branches; WL value; brilliant fall color; tol. moist soil

SM. DECIDUOUS	HEIGHT	FEATURES
Shad Blow Tree, Downy Serviceberry *Amelanchier arborea or canadensis*	20-30'	oval; light grey bark, early bloom, red fruit summer; WL value
Ironwood *Carpinus caroliniana*	30'	oval; smooth grey bark, zigzag branches, wing fruit; WL value; tolerates moist or dry soil, some sun
Washington Hawthorn *Crataegus phaenopyrum*	30'	oval; brilliant fall color, June flower, bright red berry; WL value; tolerates poor soil, light shade
Hackberry *Celtis occidentalis*	30-40'	round; rapid grower, corky knobs on bark; WL value; tolerates rich moist or dry rocky soil
Redbud, Judas Tree *Cercis canadensis*	40'	globular; flower clusters before leaf April, heart-shaped leaf; needs deep, moist soil; tolerates lte. shade
Fringetree *Chionanthus virginicus*	30'	pyramidal; slow growing fragrant June flower; WL value; needs deep, moist soil; tolerates light shade
Flowering Dogwood *Cornus florida*	30'	oval; May flowers, small red fruits; WL value; needs well-drained, acid soil;tolerates some shade
Cockspur Hawthorn *Crataegus crus-galli*	30'	glossy foliage, dense habit, persistent red fruit; WL value; tolerates poor soil, some shade

• SHRUBS •

EVERGREEN	HEIGHT	FEATURES
Inkberry *Ilex glabra*	3-15'	globular; nectar for bees, open habit, small leaf, black berry; tolerates sandy, peaty, acid soil
Junipers	2-30'	

• SHRUBS •

Creeping Juniper *Juniper horizontalis*	2'	many cultivars, foliage change of color; tolerates any soil type
Mountain Laurel *Kalmia latifolia*	5-30'	whorled leaves, flower June; needs deep, moist, acid soil; tolerates light sun
Bayberry *Myrica pensylvanica*	4-8'	persistent leaves, aromatic; WL value; tolerates dry, sandy soils
Wax Myrtle *Myrica cerifera*	25-30'	persistent leaves; WL value; grayish-waxy fruit, inconspicuous flowers
Rhododendron *Rhododendron catawbiense*	12-15'	majestic bell-shaped, lilac-purple flowers; tolerates poor soil; acid loving
Great Laurel Rosebay Rhododendron *Rhododendron maximum*	15-25'	late June flower, large waxy leaves; needs acid, moist soil

DECIDUOUS	HEIGHT	FEATURES
Red Chokeberry *Aronia arbutifolia*	9'	flowers May-June, smooth pale leaves, red berry; WL value; tolerates wet acid or dry soil
Black Chokeberry *Aronia melanocarpa*	3-6'	oval; black berry; WL value; tolerates wet acid or dry soil
Sweet Pepperbush *Clethra alnifolia*	6'	oval; fragrant flower July-Aug, persistent brown seed; WL value; tolerates acid wet or dry soil and some shade
Gray Dogwood *Cornus racemosa*	8-15'	vase; clustered flower June-July, gray stalk, white berry; WL value; tolerates any soil type
Wahoo *Euonymus atropurpurus*	6'	oval; purple-pink fruit capsule, bright fall color; needs moist, deep fertile soil
Witch-alders *Fothergilla species*	3-6'	oval; brilliant fall color; needs moist, rich soil
Winterberry *Ilex verticillata*	4-9'	oval; small flower May, bright red berry; WL value; tolerates any soil and some shade
Shrubby Cinquefoil (EX) *Potentilla fruticosa*	4'	silver green mounds, summer-long blossoms; tolerates poor soil and light shade
Flame Azalea (EX) *Rhododendron calendulaceum*	9'	oval; May-June flower; tolerates dry, acid soil and light shade
Roseshell, Early	9'	oval; May-June pink flower; blue-

• SHRUBS •

Pink Pinxter Azalea *Rhododendron nudiflorum*	6'	oval; April-May pink flower; needs moist, acid soil; tolerates light sun
Clammy Swamp Azalea *Rhododendron viscosum*	9-15'	oval; needs moist, acid soil; tolerates light sun
Shining Sumac *Rhus copallina*	8-30'	globular; lustrous foliage, flower July-Aug., red fruit; WL value; tolerates dry, sandy soil; needs sun
Staghorn Sumac *Rhus typhina*	6-25'	globular; flower June-July, red fruit WL value; needs dry, well-drained soil and sun
Elderberry *Sambucus canadensis*	6-12'	oval; flat flower cluster June-July; WL value; needs deep, well-drained soil and sun
Coralberry Indian Currant *Symphoricarpos orbiculatus*	3-6'	small pale oval leaves, curving branches; WL value; tolerates poor soil and some shade
Snowberry *Symphoricarpos albus*	3-6'	small terminal spike, flower July, white berry; WL value; tolerates any soil type
Highbush Blueberry *Vaccinium corymbosum*	3-10'	oval; fragrant small flower, brilliant fall color, winter twigs; WL value; tolerates poor soil; needs sun
Highbush Cranberry *Viburnum trilobum (PA)*	12'	globular; flat cluster May; WL value; needs well-drained, acid soil tolerates light shade
Black Haw *Viburnum prunifolium (VA)*	10-25'	attractive flower clusters; WL value bluish-black fruit, oval leaf; tolerates range of soils
Yellow-root *Xanthorhiza simplicissima*	2'	yellow bark and root, small flower tolerates any moist or dry soil

• HARDY GROUND COVERS •

NAME	HEIGHT	FEATURES
Common Bearberry (EX) *Arctostaphylos uva-ursi*	3-6"	creeping habit; needs sun; tolerates dry soil and drought
Lady Fern *Athyrium filix-femina*	2-3'	nice texture; tolerates shade and wet soil; not drought-tolerant
Violet Wood Sorrel *Oxalis violacea*	4-8"	excellent for rock gardens; tolerates some shade, dry soil, and drought
Grass-leaved Blazing Star *Liatris graminifolia*	1-3'	rose-purple flowers, late summer bloom, hairy stem
Bird-Foot Violet *Viola pedata*	2-6"	purple flowers; tolerates some shade, dry

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A PRELIMINARY NATURAL AREAS SURVEY OF NORTHAMPTON AND ACCOMACK COUNTIES, VIRGINIA

The Neotropical Migratory Songbird Coastal Corridor Study

prepared by:

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Virginia Department of Conservation and Recreation
Division of Natural Heritage

June 1992

Zebryk, T. and T. J. Rawinski, 192. A preliminary natural areas survey of Northampton and Accomack Counties, Virginia. Natural Heritage Technical Report 92-22, Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 43pp.

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INTRODUCTION

This report describes the findings of the 1991 natural heritage inventory of Northampton and Accomack Counties, Virginia. The inventory was conducted to accomplish Task 3 of a larger study entitled, A Regional Study of the Coastal Zone Habitat of Critical Importance as Concentration Areas for Neotropical Avian Migrants (NOAA GRANT # NA90AA-H-CZ839). Task 3 stipulated that the best remaining upland (non-saltmarsh) natural communities be identified and described, and that the sites containing them be mapped using Natural Heritage Program methodology.

Past natural heritage inventories in Northampton and Accomack Counties focused on the off-shore barrier beach islands which are now largely protected by The Nature Conservancy and government agencies. The off-shore islands were therefore excluded from the present inventory to allow a more thorough examination of the largely neglected mainland portion of the region.

Community inventory represents a "coarse filter" approach to biological conservation. This approach protects a vast number of cryptic or poorly known species, and at the same time brings needed attention to the aesthetic, scientific, and ecosystem function values of natural communities. A classification is necessary when conducting an inventory, and for this study we selected the classification developed by Rawinski (1992) which is currently used state-wide by the Virginia Division of Natural Heritage (Appendix 1).

This report should be viewed as preliminary. Only those sites actually visited during the 1991 field season and found to contain exemplary communities are described. Additional field work sustained over a several year period is certainly needed here.

Virginia's Division of Natural Heritage

The Virginia Natural Area Preserves Act of 1989 (§10.1-209 et seq. of the Code of Virginia) directs the Department of Conservation and Recreation to "preserve the natural diversity of biological resources of the Commonwealth." The Act further establishes the Virginia Natural Heritage Program (now called the Division of Natural Heritage) and requires the Department to develop a natural heritage plan, produce an inventory of the Commonwealth's natural heritage resources, maintain a natural heritage data bank of inventory data, and provide for the protection and stewardship of natural areas. The Division of Natural Heritage fulfills this mandate as the Commonwealth's principal collector and manager of data on natural heritage resources: "the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest" (§10.1-209 of the Code of Virginia). The Division of Natural Heritage is part of a network of 84 natural heritage data centers established throughout much of the Western Hemisphere.

Natural Heritage Resources

Each natural heritage resource is assigned a rank indicating rarity and status (Table 1). The primary criterion for ranking natural heritage

resources is the number of extant occurrences, i.e. the number of known distinct localities or populations. Other important ranking criteria are the number of individuals at each locality, the total number of individuals statewide, the condition of the occurrences, the number of protected occurrences, and threats to the occurrences. These "S-ranks" apply to Virginia; global ranks, or "G-ranks", reflect species status on a global, or range-wide scale.

Subspecies and varieties are assigned "T-ranks", in addition to their G-rank. Taken together, these ranks give an instant picture of the rarity of the natural heritage resource. Ranks for communities are lacking or provisional because the community classification is not yet developed for the individual plant communities. Rarity ranks used by the Division of Natural Heritage are not legal designations, and they are continuously updated to reflect new information.

The landscape unit that supports a particular natural heritage resource is called an element occurrence. The Division of Natural Heritage has mapped over 5500 element occurrences in the Commonwealth. Information on the location and quality of these element occurrences is computerized within the Division's Biological and Conservation Databases (BCD), and additional information is recorded on maps and in manual files. Each element occurrence is ranked to differentiate large, outstanding occurrences from small, vulnerable ones. Species occurrences are ranked in terms of quality, condition, viability, and defensibility. Community occurrences are ranked by their overall natural condition and size.

Element ranks and element occurrence ranks form the basis for ranking the significance of entire sites. Site biodiversity ranks (B-ranks) are used to prioritize protection efforts among the sites; each B-rank is defined below:

B1 Outstanding Significance: only site known for an element, an excellent occurrence of a G1 species, or the world's best example of a community type.

B2 Very High Significance: one of the best examples of a community type, good occurrence of a G1 species, or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type, good occurrence of a G3 species.

B4 Moderate Significance: good example of a community type, excellent or good occurrence of state-rare species.

B5 General Biodiversity Significance: good or marginal occurrence of a community type, or state-rare species.

Note: Sites supporting rare subspecies or varieties are considered slightly less significant than sites supporting similarly ranked species.

Table 1. Definition of Natural Heritage state rarity ranks (S-ranks). Global ranks (G-ranks) are similar, but are based on range-wide status. Ranks for most community types have not been generated due to on-going community classification efforts. The S and G ranks should not be interpreted as legal designations.

S1	Extremely rare; usually 5 or fewer occurrences in the state; or may have few remaining individuals; often especially vulnerable to extirpation.
S2	Very rare; usually between 5 and 20 occurrences; or with many individuals in fewer occurrences; often susceptible to becoming endangered.
S3	Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
S4	Common; usually >100 occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.
S5	Very common; demonstrably secure under present conditions.
SA	Accidental in the state.
SH	Historically known from the state, but not verified for an extended period, usually >15 years; this rank is used primarily when inventory has been attempted recently.
SN	Regularly occurring migrants or transients species which are non-breeding, seasonal residents. (Note that congregation and staging areas are monitored separately).
SU	Status uncertain, often because of low search effort or cryptic nature of the element.
SX	Apparently extirpated from the state.

NOTE: Sometimes ranks are combined (e.g. S1S2) to indicate intermediate or somewhat unclear status. Elements with uncertain taxonomic validity are denoted by the letter, Q, after the global rank.

STUDY AREA

The Eastern Shore of Virginia, encompassing Northampton and Accomack Counties, is located on the Mid-Atlantic coastal plain at the southern end of the Delmarva Peninsula. To the west lies Chesapeake Bay and to the east lies an interrupted chain of barrier islands and the Atlantic Ocean. Approximately 70 miles long, the Eastern Shore is about 12 miles wide at its widest point near the Maryland border.

Topography is generally flat to undulating, except in the area of Holocene dune ridges and along streams where the underlying marine sediments have been eroded to form small, steep-sided valleys. Both coasts are deeply embayed by tidal creeks with associated peninsulas and necks. "Delmarva bays", shallow elliptical depressions of uncertain geological origin, are rather frequent on the Eastern Shore, though most have been drained for agriculture.

Soils are primarily well-drained to poorly-drained sandy loams and loams. The Bojac-Munden-Molena Series occurs mainly on flatland on the necks along Chesapeake Bay. Sandy loams in this series are characterized by rapid drainage and a seasonally high water table. The Nimmo-Munden-Dragston Series occurs along the eastern region on flats and in depressions. The loams in this series are moderately- to poorly-drained, particularly in depressions, and have a seasonally high water table.

The climate on the Eastern Shore is characterized by mild winters and hot humid summers. The average winter temperature in Painter, Accomack County, is 39.1 F, while the average summer temperature is 75 F. Temperatures in Northampton County average about one degree warmer in winter and summer. The average total annual precipitation 42.7 inches in Accomack County and 40.8 inches in Northampton County. Humidity averages about 60% throughout the region.

Vegetation patterns on the Eastern Shore are complex, varying in response to soil conditions, exposure to salt spray, past disturbances, biogeographic phenomena, and subtle differences in climatic conditions existing from south to north along the peninsula. In both Accomack and Northampton Counties, the Loblolly Pine-Shortleaf Pine forest type encompasses more than 40% of the forest acreage (Thompson 1991). The most common hardwoods include Southern Red oak, White Oak, Water Oak, Sassafras, Sweet Gum, Black Gum, Red Maple, Beech, and various hickories. Forests in Northampton County usually contain Red Bay and Yaupon, but these predominantly southern species become infrequent farther north in Accomack County. Tulip Poplar is rather frequent in Accomack County, but is virtually absent in Northampton County.

(Note: Source for much of the above information is from "Soil Survey of Northampton County, Virginia", USDA Soil Conservation Service, 1989.)

METHODS

To gain an overview of land use patterns within the two county area Division of Natural Heritage staff first evaluated the extent of the remaining forest land using Forest Survey data generated by the U.S. Forest Service. The natural area inventory then proceeded through the following five stages:

1) Review of aerial photographs and maps. Aerial photographs of the entire survey area were reviewed in detail to identify potential natural areas (PNAs) to be studied in the following stages. Where possible, both the oldest available photographs and the most recent ones were studied. Comparing these two sets of photographs provided insights into land use trends and past conditions. Topographic maps, wetlands maps, and soils maps were examined during this stage.

2) Gathering existing information. Museum collections were visited by Natural Heritage staff and specimen label information recorded for rare species. Publications and field notes were assembled and carefully read. Maps of public lands (federal, state and local) within the survey area were gathered, and the distribution of natural heritage resources examined. Local naturalists, soil conservationists, foresters, and college faculty were consulted for additional information. During this stage, some PNAs were eliminated from further consideration while others were added.

3) Initial ground survey. Field work during this stage verified ownership information, documented conspicuous element occurrences, and detected recent land use activities. As necessary, follow-up thorough inventories were planned.

4) Thorough inventory of the PNA. During this stage, detailed information was collected on the rare species or exemplary natural communities present at the site. Portions of a site not visited on foot were evaluated on the basis of aerial photographs and other information. The amount of land needed to protect the special biological features was determined. Threats and disturbances factors were noted. Element occurrence data were transcribed onto Division maps and entered into the BCD databases.

5) Compilation of results and preparation of final report. Division biologists reviewed the information gathered and prioritized the sites on the basis of biological significance, threats, and defensibility. Maps were drawn showing conservation planning boundaries. Protection and management recommendations were written, and all information combined into a final report.

RESULTS

Virginia's Eastern Shore is an area rich in natural heritage resources and an area providing critical stop-over habitat for a large number of neotropical migrant bird species. Many of these species utilize natural vegetation. Thus, the amount of forested land relative to non-forested (primarily agricultural) land in the area was examined first.

As of 1991, forest land in Northampton County covered an estimated 30,967 acres, or 21% of all land in the county, while in Accomack County forest land covered 96,630 acres, or 32% of that county's land area (Thompson 1991). Relative to the 1985 forest land statistics (Brown and Craver 1985), these values represent an apparent net gain of 1,035 acres in Northampton County and a net loss of 8,085 acres in Accomack County. However, because the sampling procedure used by the Forest Survey was intended primarily to furnish data for the entire Coastal Plain of Virginia, individual county estimates have limited and variable accuracy (Thompson 1991). Nevertheless, these data suggest that forest land may have declined as much as 2.4% in Accomack County during the six-year period between 1985 and 1991. Such a decline was not evident in Northampton County where a slight increase (0.7%) may have occurred. Throughout the 34-county region encompassing Virginia's Coastal Plain, timberland declined 2% from 1985 to 1991 (Thompson 1991).

The amount of forested land in Northampton and Accomack Counties indicates, in a general sense, the relative health and integrity of the natural terrestrial ecosystems present. These forests provide sustainable yields of wood products while maintaining biological diversity and providing ecosystem functions beneficial to human society. Unfortunately, the percentage of timberland in these two counties is far below 58%, the region-wide average for the Virginia Coastal Plain (Thompson 1991).

Figure 1 shows the location of the 11 natural heritage sites identified through the inventory. Each is individually described in site reports using the following standard reporting format:

SITE NAME: Most site names reflect a geographical locality or the prevalent type of vegetation.

SIZE: The approximate acreage included within the conservation planning boundary for the natural area.

BIODIVERSITY RANK: The overall significance of the natural area in terms of the rarity of the natural heritage resources and the quality of their occurrences. As discussed earlier, these ranks range from B1 (outstanding significance) to B5 (general biodiversity significance).

LOCALITY: The county.

QUADRANGLE AND QUADRANGLE CODE: The name of the USGS 7.5' quadrangle(s) on which the natural area occurs. The quadrangle code contains information on latitude and longitude, and identifies the location of the quadrangle.

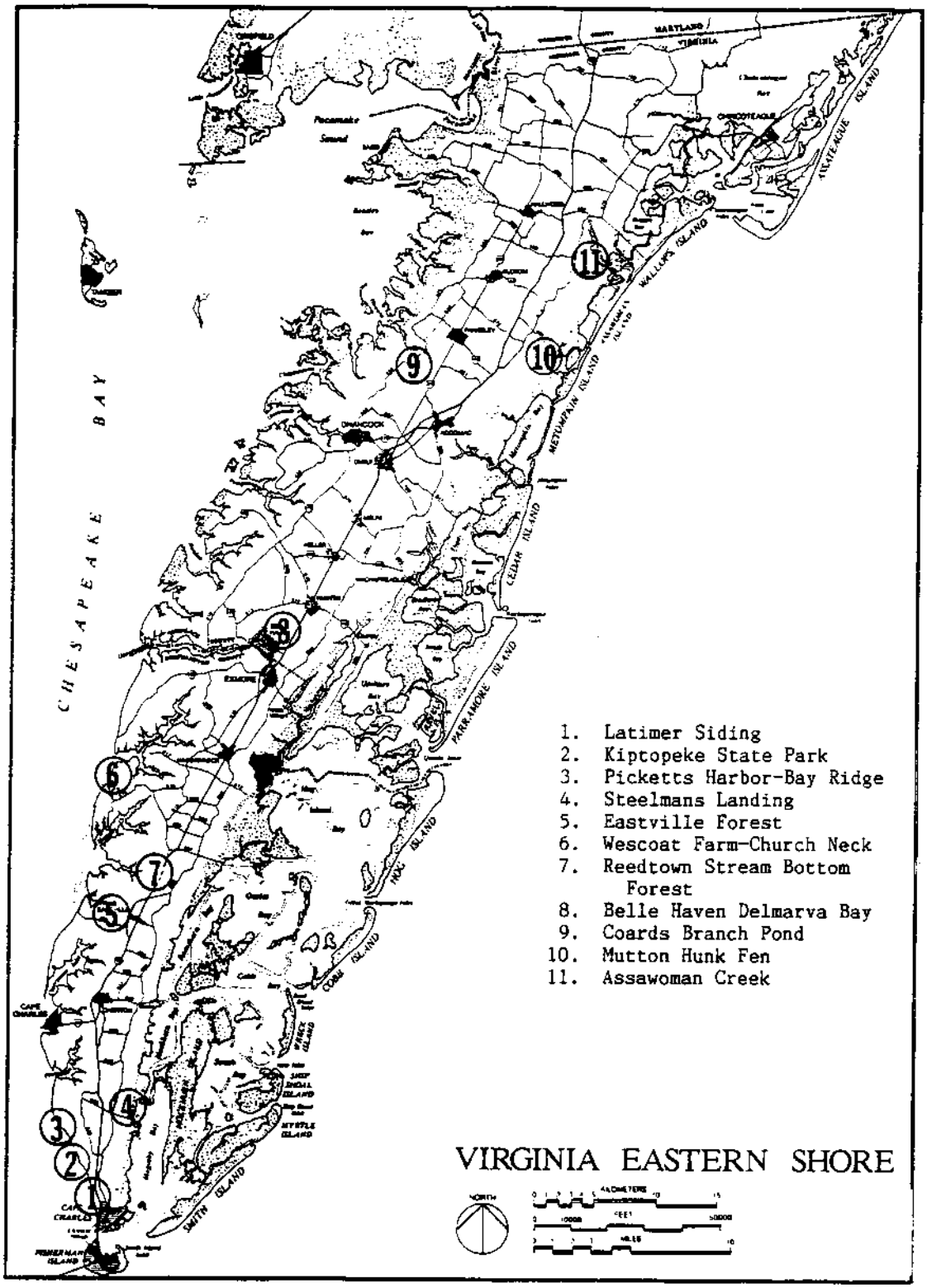


Figure 1. Map of Northampton and Accomack Counties showing the location of 11 natural heritage sites documented during the 1991 inventory.

LOCATION: Specific information on site location and directions to the site.

NATURAL HERITAGE RESOURCE SUMMARY TABLE: A synopsis of the rare species and significant natural communities that occur on the site.

SITE DESCRIPTION: A brief narrative describing the site, its significant elements, vegetation, habitat, and current land use.

BOUNDARY JUSTIFICATION: The preliminary conservation planning boundary delineated in this report includes all known occurrences of natural heritage resources and the adjacent lands required for their immediate protection. This information field explains the basis for particular boundaries.

THREATS: Potential and actual threats to the site and its elements.

MANAGEMENT RECOMMENDATIONS: A summary of the major issues and factors that should be considered in management of the site for its natural heritage values.

CURRENT STATUS: A summary of ownership and the degree of protection currently afforded the site.

PROTECTION RECOMMENDATIONS: The desired level of protection actions needed.

SITE MAP: The site map shows the conservation planning boundary which contains all known element occurrences and the land determined to be important for the long-term maintenance of these elements. The following factors are considered when drawing these boundaries:

- the extent of current and potential habitat for rare species and exemplary natural communities,
- species movement and migration corridors,
- maintenance of surface water quality within the site and the surrounding watershed,
- maintenance of the hydrologic integrity of the groundwater, e.g. by protecting recharge zones,
- land intended to mitigate off-site impacts,
- land or activities necessary to preclude or minimize invasive exotic species, and
- land necessary for management activities, such as prescribed burning.

The boundaries are intended for conservation planning purposes, and at the very least should prevent the inadvertent destruction of the natural areas. Many rare species are sensitive to disturbance, or may be sought out by collectors. Precise element locations within site boundaries are therefore not given in this report. Virginia law includes Natural Heritage Resources under a limited exemption to the requirements of the Freedom of Information Act.

Due to the limitations imposed by a one-year inventory, not all of the potential natural areas in the region were field checked. Future discoveries of significant natural areas in the study region are to be expected.

SITE REPORTS

LATIMER SIDING

SIZE: ca. 115 Acres **BIODIVERSITY RANK:** B5

LOCALITY: Northampton County

QUADRANGLE: Townsend **QUADRANGLE CODE:** 3707528

LOCATION: The site is located northwest of the intersection marked, "Latimer Siding", and south of Kiptopeke State Park.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Forest		-	-	-	-	BC

SITE DESCRIPTION: This site is significant because it contains an exemplary Loblolly pine - White Oak forest. The pines are nearly 100 feet tall, rising above the lower canopy of hardwood species. American Holly is common in the understory, and one large individual was 35 cm diameter-at-breast-height. The evergreen shrub, Yaupon, is present, which floristically unites this stand with the mixed hardwood forests farther south. The herbaceous layer is quite sparse and consists primarily of Partridge-berry, Strawberry-bush, Greenbrier, and Poison Ivy.

BOUNDARY JUSTIFICATION: The boundary encloses the oldest stand of trees plus the adjacent stand of younger trees. The young forest serves as a buffer, protecting the old stand from excessive wind-throw, invasion by exotics, and other edge effects.

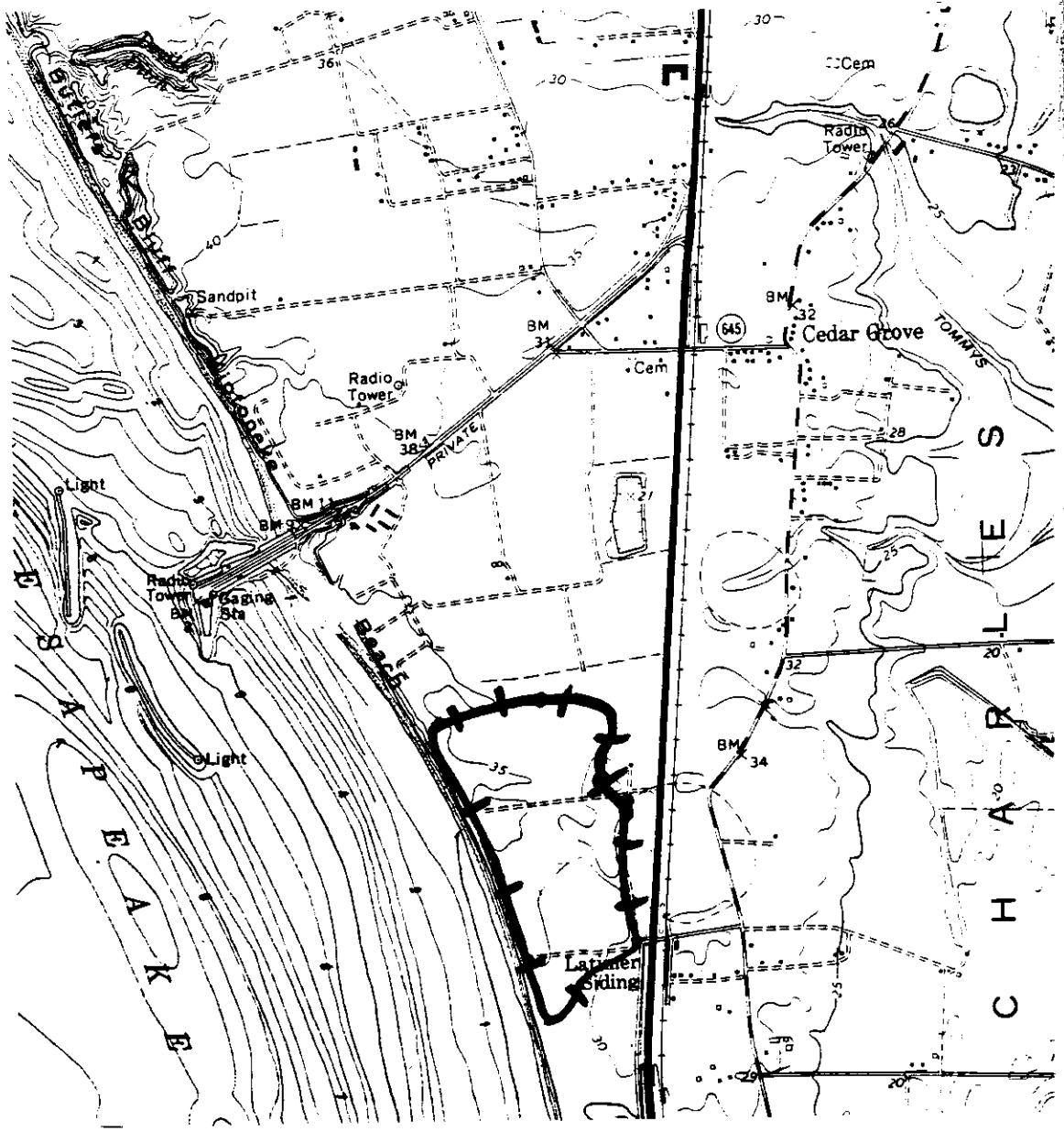
THREATS: The primary threat to this community is logging. Old stumps are present in the forest, so the stand was logged in the past. Development is also a threat.

MANAGEMENT RECOMMENDATIONS: No active management of the site is needed, although forests such as this probably burned periodically during precolonial times. Prescribed burning might therefore be practiced to simulate the original fire regime and create additional habitat for herbaceous species.

CURRENT STATUS: The site is in private ownership and unprotected.

PROTECTION RECOMMENDATIONS: Exemplary forests such as this are rapidly being cut or developed on the Eastern Shore. Therefore it is important to pursue protection action in the very near future.

LATIMER SIDING



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KIPTOPEKE STATE PARK

SIZE: ca. 10 Acres **BIODIVERSITY RANK:** B3

LOCALITY: Northampton County

QUADRANGLE: Townsend **QUADRANGLE CODE:** 3707528

LOCATION: The site is that portion of Kiptopeke State Park located south of the ferry terminal building and fishing pier, approximately 2 miles north-northwest of Kiptopeke.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Scrub		-	-	-	-	B
Oligotrophic Herbaceous Vegetation		-	-	-	-	B
animals:						
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2	S2	LT	-	B

SITE DESCRIPTION: In addition to being Virginia's newest state park, this site is noteworthy for its exemplary dune scrub and dune grassland vegetation. These two communities interdigitate, forming a vegetation mosaic which shifts continuously in response to sand movement and dune formation. The dune vegetation covers approximately 5 to 10% of the park property. Common woody species include Bayberry, Black Cherry, and Sassafras. The dune grassland supports Beach-grass, Seaside Goldenrod, Broomsedge,, and Panic-grass.

Globally rare Northeastern Beach Tiger Beetles inhabit the beach area adjacent to the dune field.

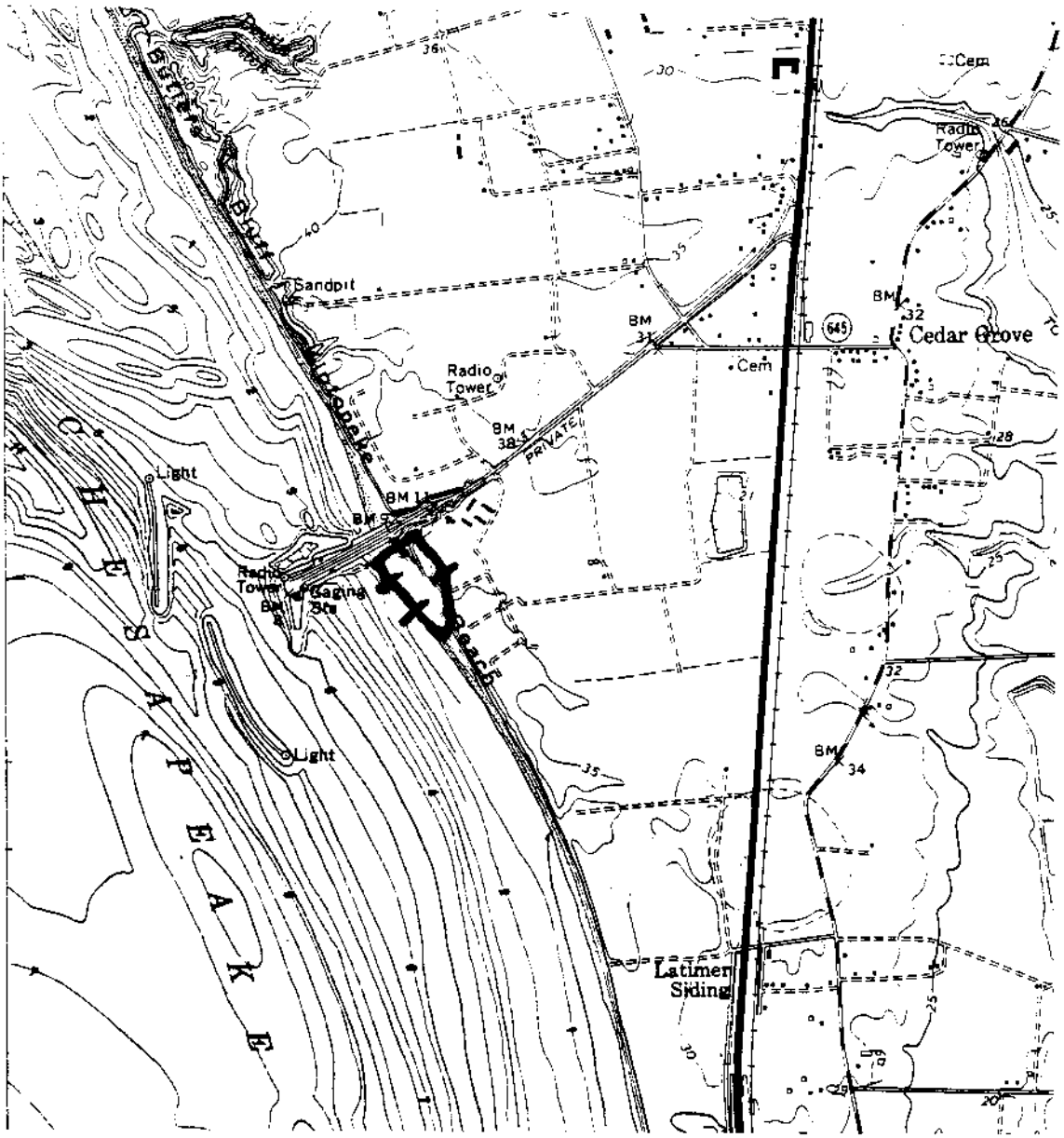
BOUNDARY JUSTIFICATION: The boundary encompasses that section of Kiptopeke State Park known to support the two exemplary communities.

THREATS: Threats at this time appear to be minimal. Two proposed boardwalks and an interpretive trail will have little impact on this natural system.

MANAGEMENT RECOMMENDATIONS: The primary management prescription for this area is to minimize recreational impacts, thereby maintaining the natural condition of the vegetation. The Kiptopeke State Park Resource Committee has developed special management plans for this sensitive area. Potentially invasive exotic plants will be monitored and, if necessary, controlled.

CURRENT STATUS: Protected within Kiptopeke State Park.

PROTECTION RECOMMENDATIONS: The site has been protected. Monitoring and management activities are planned.



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PICKETTS HARBOR - BAY RIDGE

SIZE: ca. 140 Acres **BIODIVERSITY RANK:** B2

LOCALITY: Northampton County

QUADRANGLE: Townsend, Elliots Creek **QUADRANGLE CODE:** 3707528, 3707621

LOCATION: The site includes a 2 mile long stretch of bayside shoreline and adjacent uplands extending from Picketts Harbor to Elliots Creek.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Scrub		-	-	-	-	A
Oligotrophic Herbaceous Vegetation		-	-	-	-	AB
Oligotrophic Forest		-	-	-	-	AB
plants:						
Galium hispidulum		G5	S2	-	-	AB
animals:						
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2	S2	LT	-	A

SITE DESCRIPTION: This site contains outstanding coastal dune vegetation. In addition, a Holocene dune ridge is significant as a rare geologic feature. One of the largest known populations of the Federally threatened Northeastern Beach Tiger Beetle occurs here.

The dune grassland contains Beach-grass, Panic-grass, and a rare northern colony of Sea-oats. Plants of the dune scrub include Loblolly Pine, Sassafras, Persimmon, Black Cherry, Shining Sumac, Beach Heather, and Greenbrier. The maritime forest occurs along the crest of a high dune ridge behind the dune scrub. Common trees here include Loblolly Pine, Southern Red Oak, White Oak, Black Cherry, Black Gum, and American Holly.

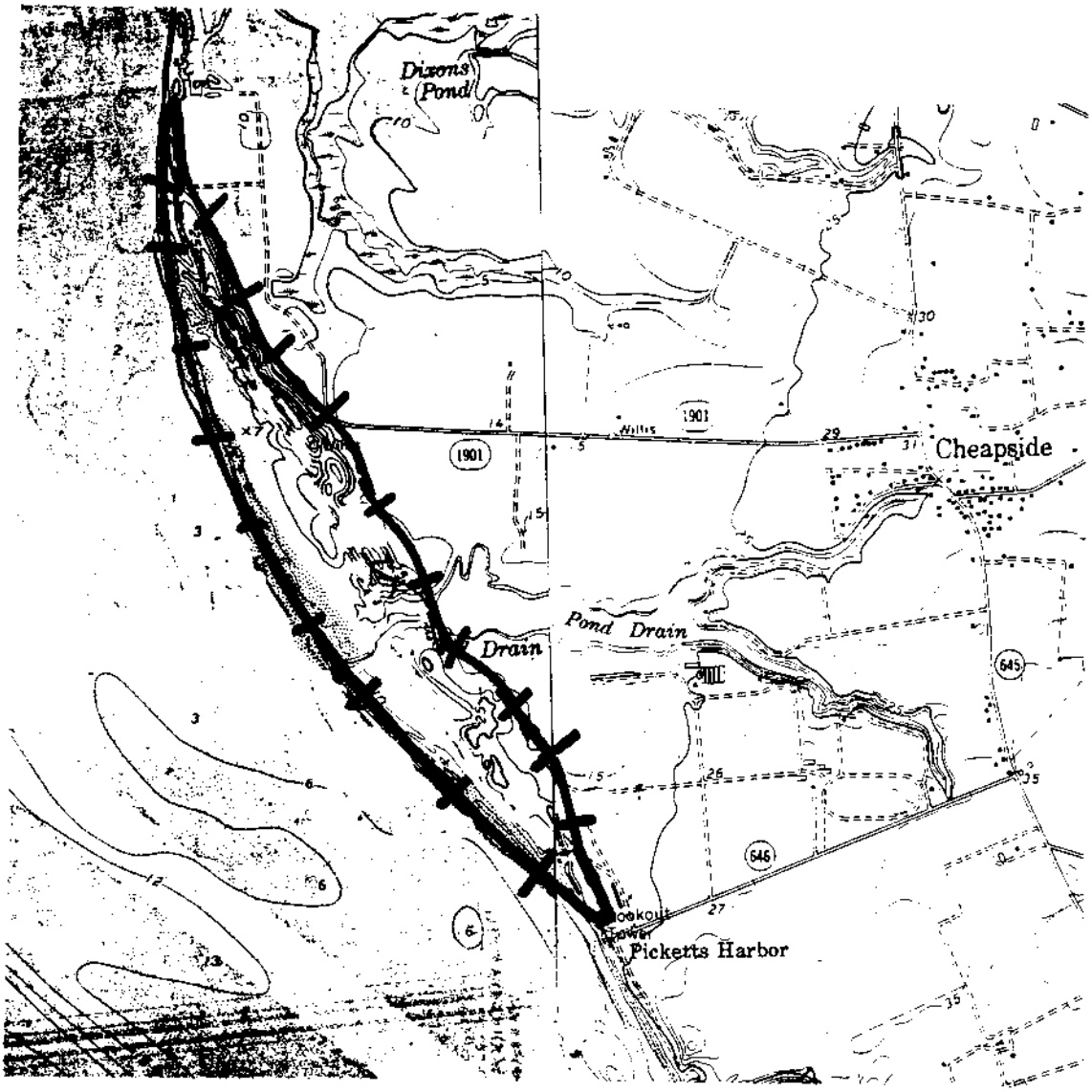
BOUNDARY JUSTIFICATION: The boundary encloses the three exemplary natural communities. A small amount of upland buffer land is included to mitigate future impacts from adjacent development.

THREATS: The primary threat to this beach-front property is intensive development and coincident alteration of the natural vegetation.

MANAGEMENT RECOMMENDATIONS: No active management of the site is needed, although in the future recreational impacts may need to be minimized by using additional board walks across the sensitive dune vegetation.

CURRENT STATUS: The site is in private ownership. Sara and Cooke Goffigon reside at the site.

PROTECTION RECOMMENDATIONS: This site represents one of the most significant natural areas on the Eastern Shore. It warrants strong protection.



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STEELMAN'S LANDING

SIZE: ca. 134 Acres **BIODIVERSITY RANK:** B4

LOCALITY: Northampton County

QUADRANGLE: Townsend **QUADRANGLE CODE:** 3707528

LOCATION: The site lies east of Townsend, north of Route 646 and south of Walls Landing Creek.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
community: Oligotrophic Seasonally Flooded Forest		-	-	-	-	AB

SITE DESCRIPTION: A mature and fairly extensive swamp forest is the primary feature of this site. The swamp was, in fact, the best example of its type encountered on the Eastern Shore during the inventory. Black Gum trees up to 80 cm dbh and 30 meters high dominate. Understory trees include Sweetbay Magnolia and American Holly. The herbaceous layer is rather dense, and is dominated by Virginia Chain-fern, Netted Chain-fern, Lizard-tail, and Cinnamon Fern. The trees in the swamp tend to grow from elevated hummocks, while most of the herbs occupy seasonally flooded mucky hollows.

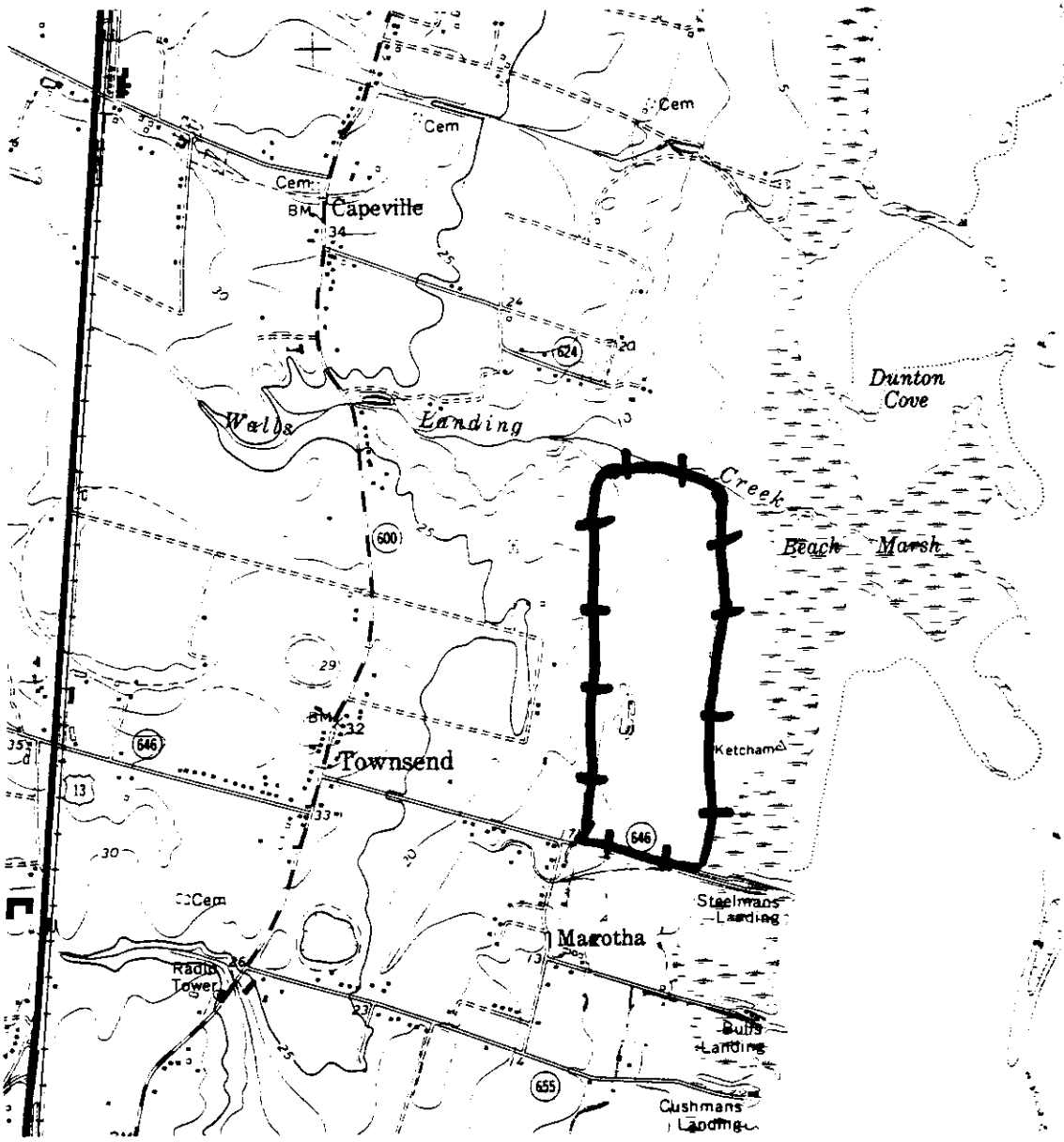
BOUNDARY JUSTIFICATION: At present, the boundary includes the wetland and the surrounding upland forest vegetation. However, additional information is needed to describe the hydrologic regime of the wetland. Ideally, the entire drainage basin should be protected from ditching and agricultural impacts.

THREATS: Threats appear to be minimal because the area is managesd as a natural area preserve. However, possible impacts from surrounding agricultural lands should be assessed.

MANAGEMENT RECOMMENDATIONS: No active management is needed. Fire is not necessary or even possible in wetlands such as this.

CURRENT STATUS: Protected and owned by The Nature Conservancy.

PROTECTION RECOMMENDATIONS: Determine whether the entire drainage basin is currently contained within Nature Conservancy land. If not, then additional lands may need protection.



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EASTVILLE FOREST

SIZE: ca. 149 Acres **BIODIVERSITY RANK:** B5

LOCALITY: Northampton County

QUADRANGLE: Cheriton **QUADRANGLE CODE:** 3707538

LOCATION: The site is located north of Route 634, approximately 0.5 mile west of Business Route 13 and 1 mile southwest of Eastville.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
community:						
Oligotrophic Forest		-	-	-	-	BC
plant:						
Tillandsia usneoides	Spanish Moss	G5	S3	-	-	D

SITE DESCRIPTION: Part of this forested tract was recently cut, but the remaining portion represents one of the better examples of a mature oak-pine forest on the Eastern Shore. Prevalent trees include Loblolly Pine, White Oak, Red Maple, Black Gum, and Sweet Gum. American Holly and Flowering Dogwood form a rather dense sub-canopy in the forest, while Sweet Pepperbush, Highbush Blueberry, and Greenbrier dominate the shrub layer. Herbaceous species are relatively scarce, due perhaps to the dense shade and thick mats of poorly decomposed organic matter on the soil surface.

A small population of Spanish Moss is of great interest at this site. This epiphytic plant, so typical of southern forests, occurs here very close to its natural northern range limit. As such, the few surviving plants afford a marvelous opportunity for research and monitoring. The plants did flower in 1991, but reproduction seems to be restricted to vegetative propagation. The spanish Moss was first documented on this site in 1935.

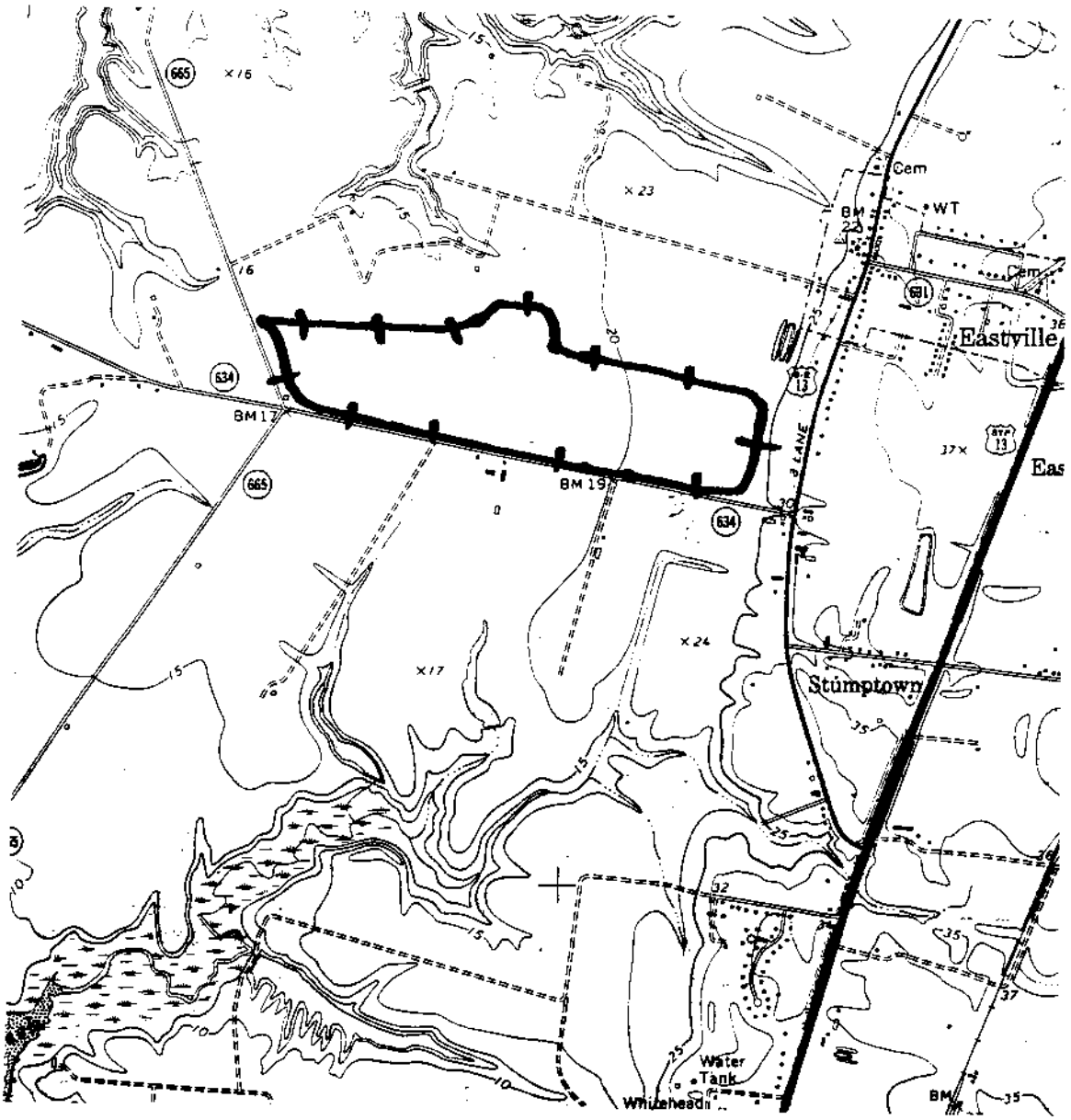
BOUNDARY JUSTIFICATION: The boundary encompasses the uncut and recently cut forest tracts. The cut forest may, with time, provide additional habitat for the Spanish moss. According to Eastville resident Robert Spady, the Spanish Moss was formerly found in the eastern end of the site before the logging took place.

THREATS: Logging is the most immediate threat to the site. Land development may also pose a threat.

MANAGEMENT RECOMMENDATIONS: No active management of the site appears needed.

CURRENT STATUS: The site is privately owned. Contact Alice D.T. Rawles, Portsmouth, VA.

PROTECTION RECOMMENDATIONS: This site should be protected as an example of increasingly rare indigenous forest vegetation. Throughout the Eastern Shore, fine forests such as this are being clear-cut and converted to pine monocultures.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Stumptown
Water Tank
Whiteheads
BM
3 LANE
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WESCOAT FARM - CHURCH NECK

SIZE: ca. 520 Acres **BIODIVERSITY RANK:** B2

LOCALITY: Northampton County

QUADRANGLE: Franktown **QUADRANGLE CODE:** 3707548

LOCATION: The Wescoat Farm on Church Neck is located south of Nassawadox Creek, and north of Westerhouse Creek.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Herbaceous Vegetation		-	-	-	-	B
Oligotrophic Scrub		-	-	-	-	B
animals:						
Haliaeetus leucocephalus	Bald Eagle	G3	S2S3	LE	LE	C
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2	S2	LT	-	A

SITE DESCRIPTION: The site contains a mile-long stretch of undeveloped bayside shoreline and two exemplary dune communities. The dune scrub is characterized by scattered shrubs and small trees, namely Eastern Red-cedar, Wax Myrtle, Shining Sumac, Loblolly Pine, Southern Red Oak, and Black Cherry. Herbaceous vegetation of the dune is composed of Beach-grass, Seaside Goldenrod, and Sand-spur.

A large population of the Federally threatened Northeastern Beach Tiger Beetle occurs along the beach. In 1991 a pair of Bald Eagles nested in a small forested tract near agricultural fields.

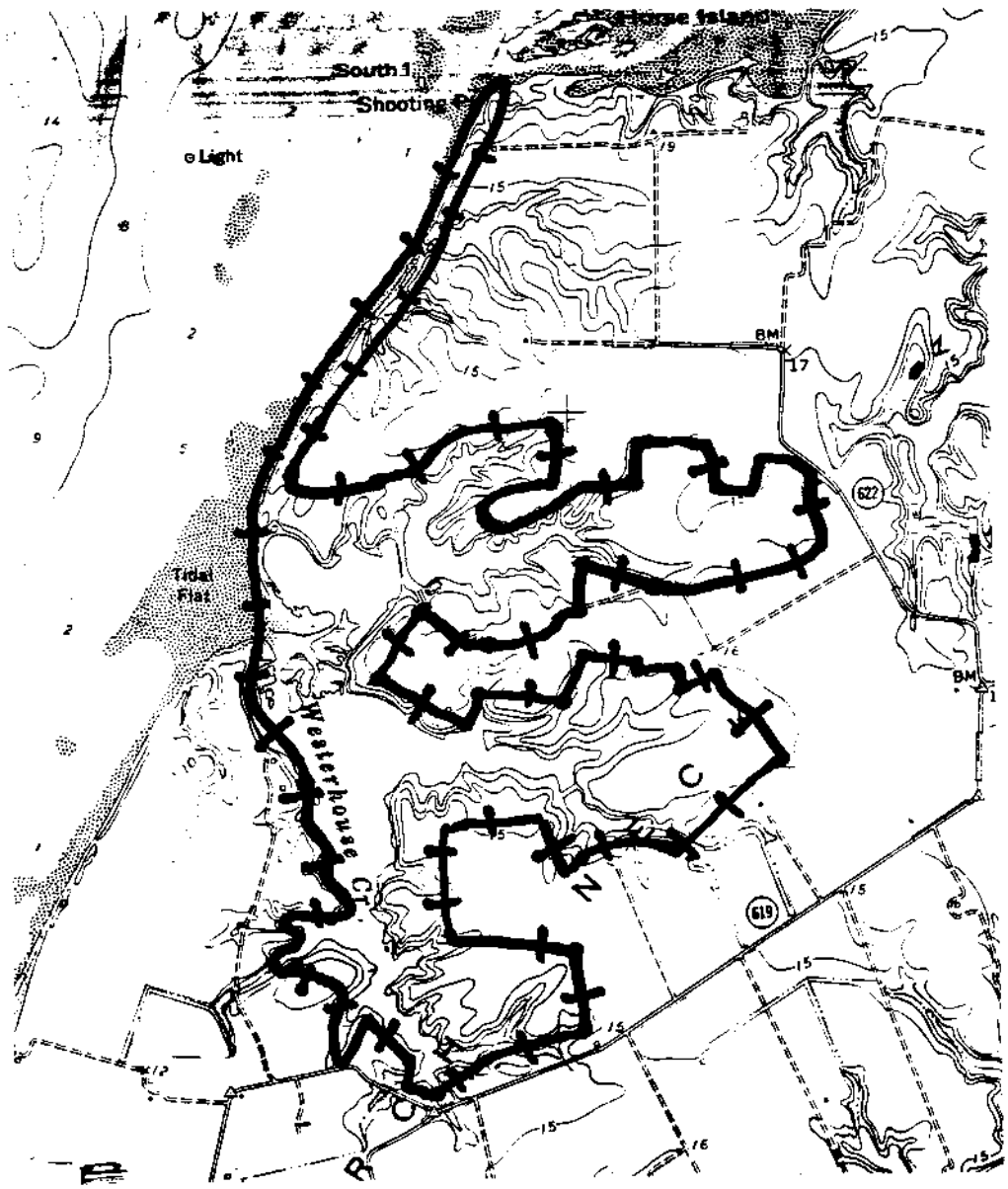
BOUNDARY JUSTIFICATION: The site boundary encompasses the undisturbed section of beach and dune, plus additional land intended to protect the Bald Eagle's nest site(s), roosting area, and, to a certain extent, feeding area.

THREATS: Threats are intensive shoreline development and accompanying disruption to the natural dune vegetation. Also, the Bald Eagles are threatened by frequent human contact or outright destruction of the forest habitat.

MANAGEMENT RECOMMENDATIONS: The beach and dune communities require little or no active management. The Bald Eagles should be managed by minimizing human contact during the eagles' critical nesting period.

CURRENT STATUS: The site is privately owned. Contact John and Suzanne Wescoat, Eastville, VA.

PROTECTION RECOMMENDATIONS: This site is most worthy of protection.



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DATUM IS MEAN SEA LEVEL

REEDTOWN STREAM BOTTOM FOREST

SIZE: ca. 48 Acres **BIODIVERSITY RANK:** B5

LOCALITY: Northampton County

QUADRANGLE: Franktown **QUADRANGLE CODE:** 3707548

LOCATION: The site is located west of Route 13 approximately 2 miles north of Eastville. The access point is the roadside park along Route 13.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
community: Oligotrophic Saturated Woodland		-	-	-	-	BC

SITE DESCRIPTION: This site encompasses an unnamed stream and a stream-side wetland situated in a steep, narrow valley. The wetland is maintained by continuous seepage of groundwater which profoundly influences the nature of the vegetation. Sweet-bay Magnolia is especially characteristic of the groundwater-saturated soils. Other species include Netted Chain-fern, Virginia Chain-fern, Sweet Pepperbush, Alder, Golden Saxifrage, and various sedges.

Wetlands such as this are fairly common alongside stream headwaters on the Eastern Shore, but this example is large and undisturbed.

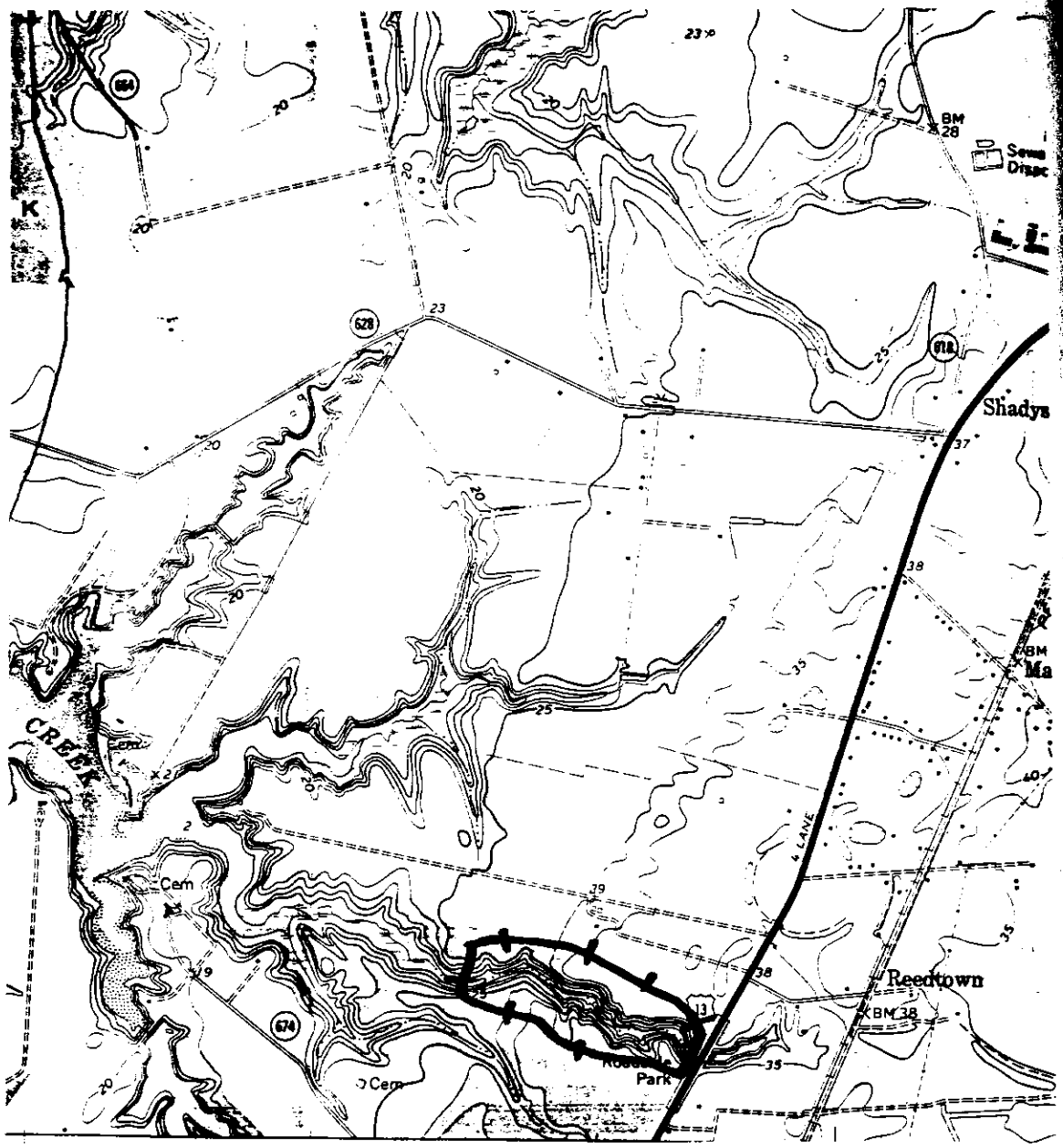
BOUNDARY JUSTIFICATION: Upslope land provides the groundwater which seeps out into the wetland. Therefore, the site boundary encompasses upland as well as wetland environments.

THREATS: Threats include ditching, imponding, and intensive upslope development. Logging of this fragile wetland habitat would also constitute a major ecological perturbation, as would nutrient enrichment or siltation resulting from adjacent agricultural activity.

MANAGEMENT RECOMMENDATIONS: The site and its exemplary wetland community require no active management.

CURRENT STATUS: The site is privately owned.

PROTECTION RECOMMENDATIONS: The site may warrant protection as one of the Eastern Shore's exemplary natural communities.


Shadys
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CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

BELLE HAVEN DELMARVA BAY

SIZE: ca. 280 Acres **BIODIVERSITY RANK:** B5

LOCALITY: Accomack County

QUADRANGLE: Exmore **QUADRANGLE CODE:** 3707557

LOCATION: The site is located immediately west of Route 13, northeast of the village of Belle Haven.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
community: Oligotrophic Seasonally Flooded Forest		-	-	-	-	C

SITE DESCRIPTION: The site supports a remnant portion of a Delmarva bay swamp. Due to drainage, bay swamps have become extremely rare on the Eastern Shore. This wetland once extended east of Route 13, but that area was drained many years ago.

The remaining wetland supports both mature pine forest and post-logging coppice. Loblolly Pine and Red Maple dominate the canopy while lower trees include Black Gum, Water Oak, Sourwood, and Sweetbay Magnolia. Sweet Pepperbush and Green-brier dominate the shrub layer while Virginia Chain-fern is common in the herb layer. The recently logged coppice is richer in herbaceous species, undoubtedly because of the increased amount of light.

Soils in the wetland have a very thick layer of organic duff (ca. 6 ") which has accumulated over the years in the absence of fire. Despite seasonal wetness, this vegetation is fire prone and past fires undoubtedly had an influence on the structure and composition of the vegetation.

BOUNDARY JUSTIFICATION: The boundary includes the remaining wetland and a small amount of upland buffer land intended to mitigate off-site impacts to the wetland vegetation.

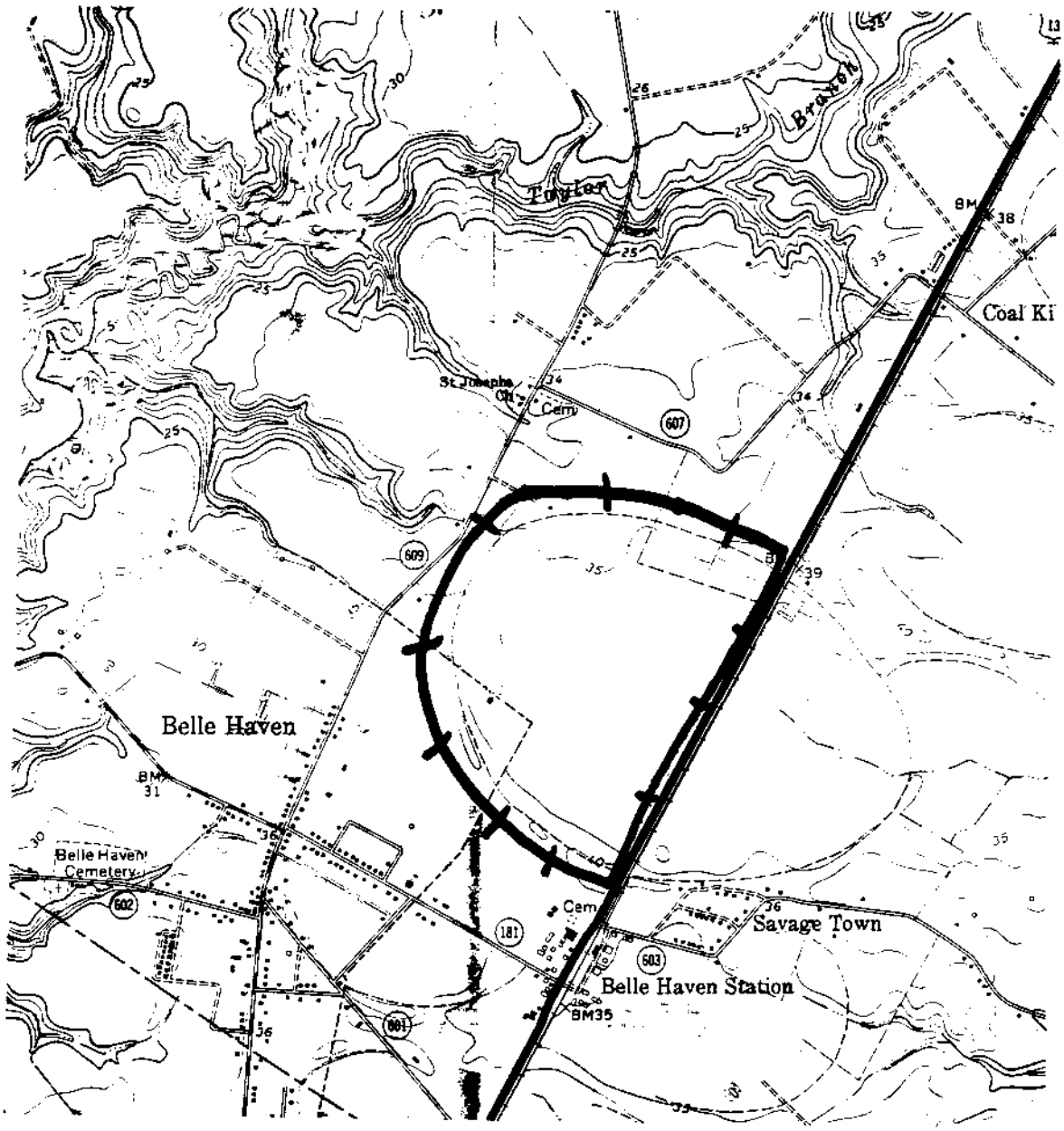
THREATS: Much of the wetland supports mature Loblolly Pine forest, and consequently, logging is an imminent threat. According to regional extension forester David Halley, wetlands such as this have been drained primarily to facilitate logging operations, rather than to improve the growth characteristics of the pine. Drainage activity should be discouraged here.

MANAGEMENT RECOMMENDATIONS: Fires once played a major role in shaping the structure and composition of Delmarva bay swamps, and consequently prescribed

burning would likely have a beneficial effect on this community. In particular, fire could create habitat for herbaceous species which presently are scarce and shade-stressed. A possible limitation to prescribed burning management here is the close proximity of Route 13, the major highway along the Eastern Shore.

CURRENT STATUS: The site is privately owned and unprotected.

PROTECTION RECOMMENDATIONS: Discourage ditching and promote prescribed burning management.


Belle Haven
Belle Haven Cemetery
Belle Haven Station
Savage Town
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St Joseph Ch
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CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

COARDS BRANCH POND

SIZE: ca. 92 Acres **BIODIVERSITY RANK:** B3

LOCALITY: Accomack County

QUADRANGLE: Parksley **QUADRANGLE CODE:** 3707576

LOCATION: Coards Branch Pond is located 2.1 air miles southwest of Parksley.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Saturated Scrub		-	-	-	-	BC
Oligotrophic Saturated Herbaceous Vegetation		-	-	-	-	BC
plants:						
Eleocharis equisetoides	Horse-tail Spikerush	G4	S1	-	-	B
Rhynchospora alba	White Beakrush	G5	S1	-	-	A
Nymphoides aquatica	Big Floating-heart	G5	S1	-	-	CD
Utricularia cornuta	Horned Bladderwort	G5	S1	-	-	-
Wolffia columbiana	Columbia water-meal	G5	S1	-	-	-
Eriocaulon aquaticum	White Buttons	G5	S1	-	-	B

SITE DESCRIPTION: Coards Branch Pond supports a bog-like wetland and one of the greatest concentrations of rare plants on the Eastern Shore. This pond is unlike all other mill-ponds on the Eastern Shore because it is profoundly influenced by groundwater seepage, as well as stream flow. Rare and unusual wildflowers abound at the site, perhaps none more striking than the Rose Pogonia Orchid which grows abundantly along the sphagnous pond margin. The Horse-tail Spikerush is known from no other site in Virginia.

The pond was created when the stream was dammed, originally in the 17th century. Presently, the rare plants and noteworthy communities are dependent upon the continued maintenance of the dam.

Much of the upland surrounding the pond has been modified by residential and agricultural activities, but the wetland vegetation remains relatively intact. Regular mowing and limited dredging activities currently affect part of the pond shore. To benefit the rare plants present, these activities should be halted, or conducted only on a very limited or very infrequent basis.

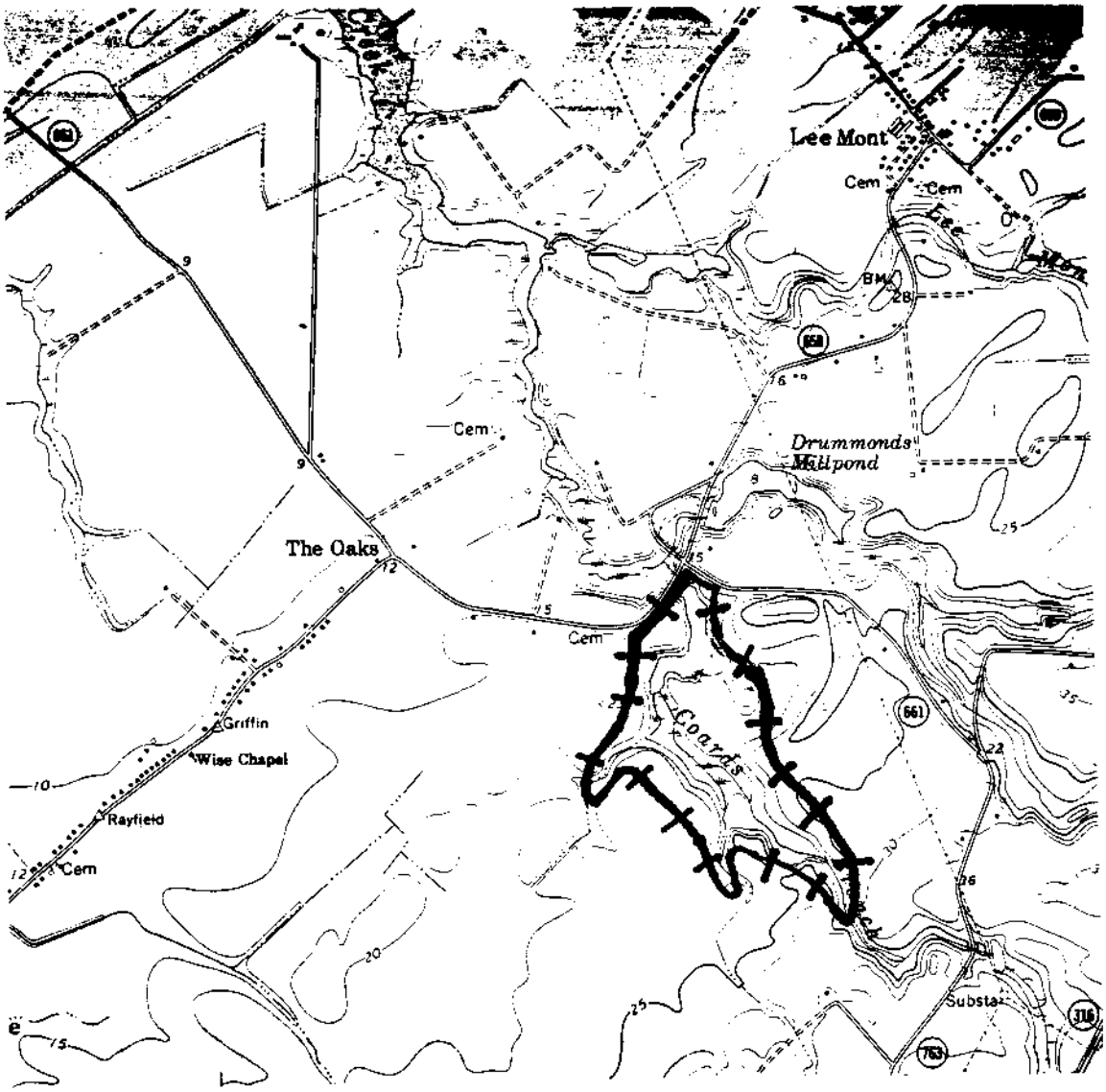
BOUNDARY JUSTIFICATION: The boundary includes the entire pond plus the upstream and upslope lands necessary to maintain surface water quality and sufficient groundwater seepage.

THREATS: Land bordering the west side of the pond is currently for sale, and residential development seems imminent. Such development would likely be accompanied by pond shore perturbations such as boat dock construction, dredging, or clearing of the native vegetation. These activities would have a negative impact on the many rare plant species present at the site. The peat mat is quite fragile and foot travel through the wetland can leave a lasting trail of altered soil and vegetation. At present this appears to have little or no effect on the rare plant populations, but frequent visits by large groups of botanists and wildflower enthusiasts should be discouraged.

MANAGEMENT RECOMMENDATIONS: The dam should be monitored and, if necessary, repaired to ensure the continued existence of the pond and the rare species.

CURRENT STATUS: The site is privately owned. ~~Henry~~ Herbert Fuller resides at the site.

PROTECTION RECOMMENDATIONS: Protection is urgently needed.



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CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

MUTTON HUNK FEN

SIZE: ca. 121 Acres **BIODIVERSITY RANK:** B2

LOCALITY: Accomack County

QUADRANGLE: Bloxom **QUADRANGLE CODE:** 3707575

LOCATION: The site lies approximately 1 mile east-northeast of Metomkin along Mutton Hunk Branch.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
communities:						
Oligotrophic Saturated Scrub		G2?	S1	-	-	AB
Oligotrophic Saturated Herbaceous Vegetation		G2?	S1	-	-	CD
plants:						
Erigeron vernus	White-top Fleabane	G5	S2	-	-	B
Eriocaulon decangulare	Ten-angle Pipewort	G5	S2	-	-	B
Eleocharis rostellata	Beaked Spikerush	G5	S2	-	-	B
Eleocharis halophila	Salt-marsh Spikerush	G4	S1	-	-	A
Rhynchospora alba	White Beakrush	G5	S1	-	-	BC
Utricularia juncea	Southern Bladderwort	G5	S2	-	-	C
Juncus pelocarpus	Brown-fruited Rush	G5	S1	-	-	C

SITE DESCRIPTION: This site contains the greatest concentration of rare plants found the Eastern Shore. All of the rarities occur in a linear strip of bog-like vegetation situated between salt marsh and upland forest. The wetland receives a constant supply of cold groundwater seepage, and muck soils predominate. Such wetlands are referred to as "sea-level fens". They are extremely rare.

Mutton Hunk Fen is significant not only for the number of rare species present but because of the site's biogeographic importance. Prior to 1991 and this inventory, Brown-fruited Rush was not known to occur south of Maryland. Mutton Hunk now represents the new southern range limit for the species. Similarly, Titi is a southern shrub never before documented north of southeastern Virginia. Mutton Hunk Fen marks the new northern range limit for this species; it occurs nowhere else on the Delmarva.

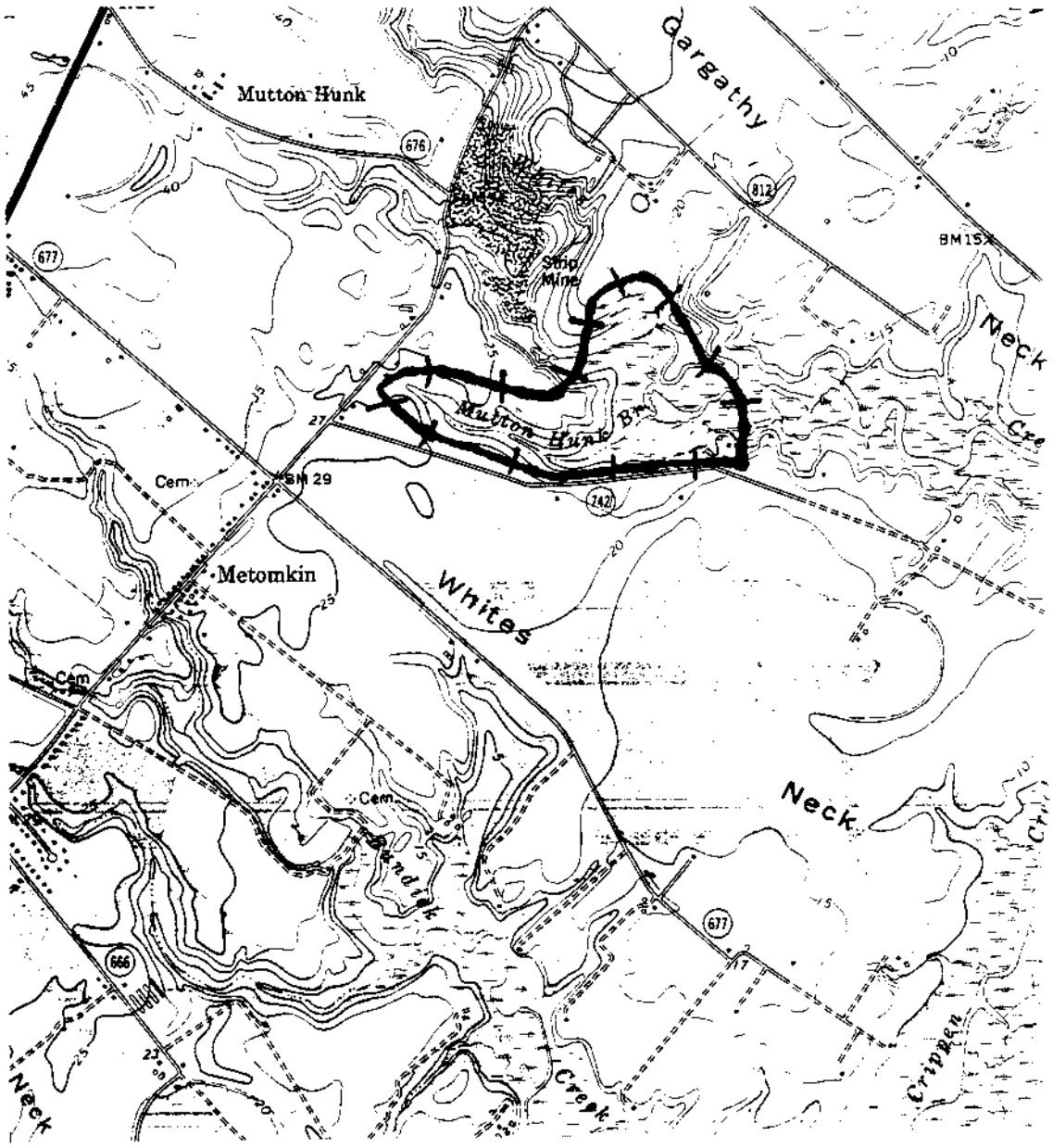
BOUNDARY JUSTIFICATION: The boundary includes the small significant wetland plus up-slope and upstream lands necessary to protect the supply and quality of groundwater seepage. The adjacent salt marsh and tidal creek are also included.

THREATS: Development of upslope land could alter the quality or quantity of the groundwater seepage. Also, over-collection of the rare and interesting plants is a real concern. Botanists should refrain from specimen collection here because several of the species occur as very small populations.

MANAGEMENT RECOMMENDATIONS: The wetland and the rare plant populations appear to require no active management. However, storm tides during the growing season might inundate this area with salt water, the effect of which is not known and should be determined.

CURRENT STATUS: The site is privately owned and unprotected.

PROTECTION RECOMMENDATIONS: Protection is urgently needed for this highly significant site.


Mutton Hunk
Gargathy
Strip Mine
Mutton Hunk Br.
Neck
Cem
BM 29
Metomkin
Whites
Neck
Cem
Cem
Bendik
Creek
Neck
Cripple
676
677
812
742
666
677
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
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CONTOUR INTERVAL 5 FEET
DATUM IS MEAN SEA LEVEL

ASSAWOMAN CREEK

SIZE: ca. 68 Acres **BIODIVERSITY RANK:** B2

LOCALITY: Accomack County

QUADRANGLE: Bloxom **QUADRANGLE CODE:** 3707575

LOCATION: The site is located along the west side of Assawoman Creek, south of Petit Branch.

NATURAL HERITAGE RESOURCES SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
community:						
Oligotrophic Saturated Scrub		G2?	S1	-	-	B
plants:						
Sclerolepis uniflora	One-flower Sclerolepis	G4	S1	-	-	B
Eleocharis rostellata	Beaked Spikerush	G5	S2	-	-	D
Eriocaulon decangulare	Ten-angle Pipewort	G5	S2	-	-	B
Erigeron vernus	White-top Fleabane	G5	S2	-	-	B

SITE DESCRIPTION: This site supports an extremely rare type of wetland vegetation referred to as a "sea-level fen". The wetland is situated between salt marsh vegetation and upland forest. Groundwater seepage emerges from the base of the upland and flows through the wetland, forming an ecologically stressful, bog-like environment. Rare plants thrive in this wetland, perhaps because they face little competition from larger, more common plants which are poorly adapted to the harsh soil conditions. Trees such as Loblolly Pine and Red Maple, which achieve great stature in other wetlands, are here present as stunted and somewhat chlorotic individuals which fail to form a closed forest canopy.

Like the nearby Mutton Hunk Fen site, this site is extremely important from a biological diversity perspective. One-flowered Sclerolepis was not known to occur in Virginia until it was discovered here during the 1991 inventory. Also, this site established a new northern range limit for the southern plant, White-top Fleabane.

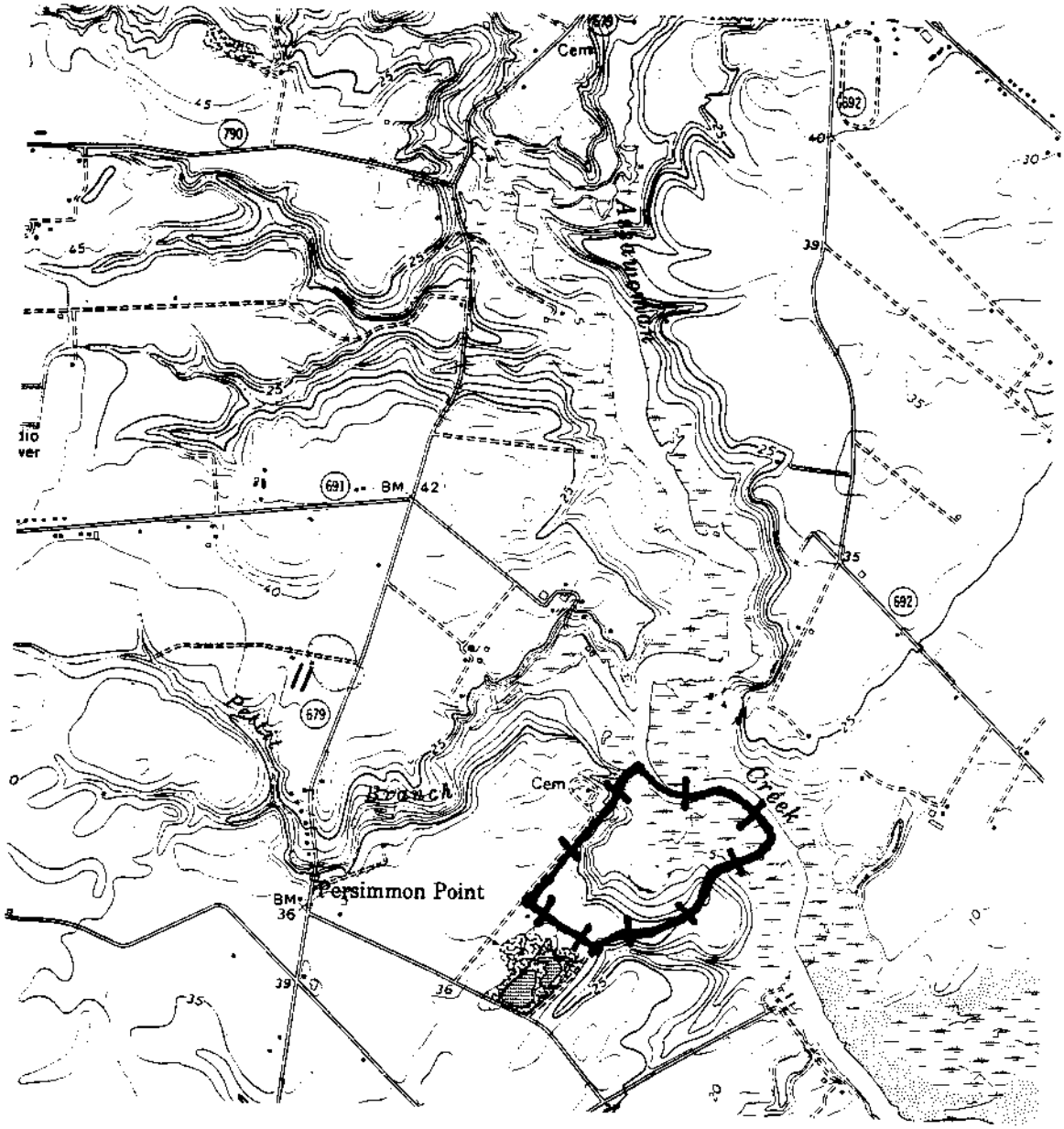
BOUNDARY JUSTIFICATION: The site encompasses the significant wetland, surrounding salt marsh, and the upslope lands necessary to protect the quality and quantity of groundwater seepage entering the wetland.

THREATS: Upslope development is the primary threat to the site.

MANAGEMENT RECOMMENDATIONS: No active management of this site is needed. However, storm tides during the growing season might inundate this area with salt water, the effects of which are not known and should be determined.

CURRENT STATUS: The site is privately owned and is unprotected.

PROTECTION RECOMMENDATIONS: This highly significant site should receive strong protection.



SCALE 1:24000

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DATUM IS MEAN SEA LEVEL

RECOMMENDATIONS

1. **Participate fully in the development of local protection tools.** Most of the 11 natural areas described in this report are unprotected. The Division of Natural Heritage and the Council on the Environment will continue to seek the advice and utilize the expertise of local officials in evaluating practical and effective protection options. Also, continued field work is necessary to refine site conservation planning boundaries and to identify new sites.

2. **Include the Division of Natural Heritage in the review of projects in or near natural areas.** The site boundaries contained in this report are provided for planning purposes only, and are not regulatory in nature. As proposed development projects come before the localities, project maps should be compared with the site maps in this report. The Natural Heritage staff offers its knowledge and expertise in reviewing project proposals that may affect a natural area. Since the early stages of the planning process typically offer the greatest flexibility, it is important to contact the Natural Heritage staff as soon as possible.

3. **Expand public awareness of the need for protecting natural areas.** Intensified land use activities throughout the Eastern Shore have placed natural lands in jeopardy. Natural areas not only provide biological diversity values, but they also provide recreational opportunities for the public and add to the quality of life in the region. The Nature Conservancy's Virginia Coast Reserve and the recently established Kiptopeke State Park are bringing needed attention to natural area values. A recent public opinion survey of 300 adult citizens in Virginia indicated that 82% were in favor of land conservation. Unprotected natural areas throughout the Eastern Shore can only benefit from the increased awareness of natural area values - citizens are realizing that inappropriate land use activities are steadily destroying <u>their</u> natural heritage.

4. **Increase cooperation among pertinent organizations.** Among the many groups and individuals that should be involved are those that own, manage, or have the authority to acquire natural areas. One goal should be to develop stronger ties among federal, state, local and private interests involved in the protection or management of natural lands.

5. **Properly manage natural areas.** The first step is to develop management programs for public and private conservation lands. The Department of Conservation and Recreation can assist local agencies in developing management plans. The Department's Division of Natural Heritage is interested in working with other agencies and organizations to conduct research and develop techniques for maintaining or restoring natural areas.

LITERATURE CITED

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Rawinski, T.J. 1992. A classification of Virginia's indigenous biotic communiti vegetated terrestrial, palustrine, and estuarine community classes. Natural Her Tech. Rep. 92-21, Virginia Department of Conservation and Recreation, Division Natural Heritage, Richmond. 25 pp.

Thompson, M.T. 1991. Forest statistics for the Coastal Plain of Virginia. Resou Bull. SE-122. Ashville, NC: U.S. Department od Agriculture, Forest Service, Southeastern Forest Experiment Station. 52 pp.

APPENDIX 1

A CLASSIFICATION OF VIRGINIA'S INDIGENOUS BIOTIC COMMUNITIES: VEGETATED TERRESTRIAL, PALUSTRINE, AND ESTUARINE COMMUNITY CLASSES

by

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Richmond, VA 23219

Natural Heritage Technical Report # 92-21

May 1, 1992

CONTENTS

INTRODUCTION:

The goal of this work is to create a framework for understanding and classifying Virginia's indigenous biotic communities. Achieving this goal has direct bearing on the success of the Division of Natural Heritage whose mission is to document the status, distribution, and ecology of native species and their habitats in the Commonwealth, protect these living resources by way of a system of natural area preserves, and provide information and technical advice to individuals, organizations, and agencies. Community classification and inventory represents a "coarse-filter" approach to biological conservation which secures the protection of a vast number of cryptic or poorly known species. Also, it brings needed attention to the aesthetic, scientific, and ecosystem function values of natural communities. The present draft of the classification deals with communities supporting vascular plant species within the Terrestrial, Palustrine and Estuarine Systems. It supplants appropriate sections of an earlier Division of Natural Heritage classification (Rawinski, 1990).

CLASSIFICATION PRINCIPLES AND METHODS:

A classification system is an organized form of cataloging based on fixed principles. Community classifications vary widely, largely because principles vary in accord with classification purposes. The ultimate purpose of this effort is to name, describe, and differentiate Associations - the basic systematic units. Unfortunately, these units have not yet been identified because of insufficient information. However, the upper levels of a hierarchy, described here, will help partition the great diversity of the natural world into logical units; this in turn will help us identify and understand relationships among the Associations. The hierarchical levels within the final draft of the Virginia classification will likely be:

SYSTEM
  CLASS
    ALLIANCE
      ASSOCIATION
        SUBASSOCIATION.

Communities of life are inextricably associated with the physical environment, and ignoring edaphic-ecological factors when constructing a "community" classification is difficult. When classifications use biotic and abiotic factors to differentiate the basic systematic units (e.g. Reschke, 1990; Schafale and Weakley, 1990), these units are best characterized as "ecosystems", or "ecosystem units". In the Virginia classification, the basic systematic units - the Associations - will be differentiated entirely on the basis of their biological characteristics, with edaphic-ecological factors used in a complementary manner. Consequently, this draft of the Virginia community classification does not require any prior formal or ad hoc classification of physiographic region, landform, or habitat. It also avoids the use of terms such as bog, marsh, and fen in community names because such terms tend to vary in meaning, or reflect an ecosystem or landform approach to classification. Judging by my use of edaphic-ecological terms in Class names, one might assume

that an ecosystem or landform approach was used; this is not the case. Each Class was defined on the basis of a specified floristic composition. Ideally, the Classes should have been named using a few diagnostic plant taxa, but because each Class encompassed many different kinds of vegetation, this was not possible.

Unavoidably, this classification focuses on vegetation, but it should not be viewed as simply a plant community classification. Among all forms of life, vascular plants are the easiest to work with because they are large and conspicuous, immotile, and superbly reflect subtle environmental conditions and site history. Classifying plant communities is therefore the key to describing and delimiting a full range of habitats utilized by animal and microbial life, at least within the vegetated Terrestrial, Palustrine, and Estuarine Systems. Principles of vegetation classification, namely those articulated by Westhoff and van der Maarel (1973) in their discussion of the Braun-Blanquet approach to community classification, are followed in the Virginia classification:

- "Plant communities are conceived as types of vegetation, recognized by their floristic composition. The full species compositions of communities better express their relationships to one another and environment than any other characteristic.

- Amongst the species that make up the floristic composition of a community, some are more sensitive expressions of a given relationship than others. For practical classification (and indication of environment) the approach seeks to use those species whose ecological relationships make them most effective indicators; these are diagnostic species (character-species, differential-species, and constant companions).

- Diagnostic species are used to organize communities into a hierarchical classification of which the association is the basic unit. The vast information with which phytosociologists deal must, of necessity, be thus organized; and the hierarchy is not merely necessary but invaluable for the understanding and communication of community relationships that it makes possible."

Character-species are more or less restricted to the stands of a given abstract community type, and therefore characterize it and indicate its environment (Westhoff and van der Maarel, 1973). These species may be used to identify syntaxa (named communities) within several levels of a classification hierarchy, from Subassociation to Class. Use of character-species is an extremely powerful tool in community classification, but very few plant species show strong fidelity to a given syntaxon, and this fact has seemed to hinder efforts to apply the Braun-Blanquet classification approach in eastern United States where the influential work of Whittaker (1953, 1962) and others emphasized continuous change in community composition along environmental gradients, resulting from the individualistic nature of species populations.

Continuous compositional change along environmental gradients does not, however, preclude the use of the Braun-Blanquet classification approach, and in fact continuous and predictable compositional change can be used to great

advantage. As long as species response along environmental and community gradients is reasonably well understood, character-species and certain differential-species may be used to classify communities. Differential-species are usually used to define only lower syntaxa (Westhoff and van der Maarel, 1973), but I have broadened their use and meaning to define Class-level syntaxa. To reflect the broadened application of the differential-species concept, I refer to these species as "conditional character-species". These plants closely resemble true character-species in their ability to identify various syntaxa, but their diagnostic ability is conditional on the absence of certain other species. Referring to these plants as "conditional character-species" and arranging them in a sequence reflecting a community gradient bring a more intuitive level of understanding to the classification approach, and facilitate the production of dichotomous keys.

The Terrestrial System:

To generate Classes within the Terrestrial System, trophic (nutrient) regime was identified as a major environmental gradient affecting floristic composition and community gradients. Five trophic regime descriptors were selected:

1) eutrophic
2) permesotrophic
3) mesotrophic
4) submesotrophic, and
5) oligotrophic.

Using floras, published and unpublished community literature, specimen label data, plot data, personal knowledge of plant habitat preference, and interviews with a number of botanists, I first generated a list of those plants restricted to the richest soil environments. These are true character-species and they are, almost without exception, instantly diagnostic of eutrophic communities. This method of selecting diagnostic species was very similar to that used by Reed (1988) who reviewed many floras and consulted with experts to generate lists of plant species diagnostic of wetland conditions. When the eutrophic indicators are not present in a given stand, other plants, the "conditional character-species", may become diagnostic of permesotrophic communities. These species have diagnostic qualities only when the eutrophic indicators are absent. Note that permesotrophic indicators may occur within eutrophic communities, but eutrophic indicators cannot occur in permesotrophic communities; the response of species populations along this community gradient is therefore unidirectional.

In the absence of both eutrophic and permesotrophic indicators, other plants become diagnostic of mesotrophic communities. Similarly, in the absence of eutrophic, permesotrophic, and mesotrophic indicators, certain plants become diagnostic of submesotrophic communities. Stands lacking the eutrophic, permesotrophic, mesotrophic, and submesotrophic indicators are classified as oligotrophic if any of the oligotrophic indicators are present. Finally, anomalous stands lacking the oligotrophic indicators may be assigned to a given class using other factors, e.g. soils, or simply called "unclassified".

Superimposed on the above trophic regime gradient is a light regime gradient. For this reason the mesotrophic, submesotrophic, and oligotrophic indicators were arranged by their relative shade tolerance. Stands containing only shade tolerant species will likely be forests, while stands supporting moderately shade tolerant or shade intolerant species will likely be woodland, scrub, or herbaceous-dominated types. The exception to this rule is applied to a short-term successional stage of vegetation resulting from infrequent or unusual episodes of disturbance. For example, a blown-down forest now dominated by blackberry should still be classified as forest despite the absence of trees. While this may seem awkward, it is a pragmatic solution to a difficult classification problem. Open-canopy vegetation maintained over the long-term through frequent disturbance (e.g. frequent fire, seasonal flood scour, repeated exposure to severe winds) should be regarded as distinct structural-floristic Classes. Implicit in the distinction between infrequent and frequent disturbance is the notion that the history of frequent disturbance has allowed light-demanding plants to persist at the site over a long period of time. There will certainly be instances in which disturbance factors cannot readily be characterized as infrequent or frequent, and in these cases I recommend the recognition of distinct structural-floristic Classes; this is a conservative measure that ensures that poorly known or problematic communities are not dismissed as seral stages. Users of this classification should be aware that the shade tolerant plants identified in the lists can occur in semi-forested and non-forested communities, but the shade intolerant plants will rarely, if ever, be found in forests. This implies another unidirectional gradient.

Eutrophic and permesotrophic woodland, scrub, and herbaceous vegetation will most often be the result of infrequent disturbance, such as blow-down. No light-demanding plants faithful to these nutrient regimes could be identified. Open canopy eutrophic and permesotrophic communities are therefore not recognized as distinct Classes at the present time, but rather as seral stages of the forests. If future field work documents naturally occurring open canopy eutrophic and permesotrophic communities in Virginia, the classification can be adjusted accordingly.

Lists of character-species and conditional character-species were derived from the Atlas of the Virginia Flora (Harvill et al., 1986), but nomenclature followed Kartesz and Kartesz (1980). A species was selected for a list only if its habitat preference was reasonably well known, and if it had distinct diagnostic value for the purpose of the classification. Approximately 900 diagnostic species were selected. Species of wide ecological tolerance, such as those growing in both upland and wetland soils, were generally excluded from consideration; they did not meet fidelity criteria at the System level. Some of the excluded species will, however, have diagnostic value in differentiating the lower syntaxa when these are classified in the future.

The Estuarine System:

Halophytes were used to define vegetated classes within the Estuarine System. A very few of the species also occur in inland saline wetlands; such wetlands should be classified within the Palustrine System for the time being and regarded as a rare, or anomalous condition.

The Palustrine System:

Classes within the Palustrine System were identified through the character-species/conditional character-species approach. I have not supplied detailed instructions for separating the Palustrine System from the Terrestrial because in most cases this difference will be readily apparent. However, when dealing with problematic transitional zones, I refer the user to Reed's (1988) list of plant species that occur in Northeastern wetlands. Only those plants with indicator status of Obligate or Facultative Wetland should be regarded as diagnostic of the Palustrine System, for the purpose of the Virginia classification. If necessary, other factors such as soils or flooding regime may also be used to assign stands to the Palustrine System. The Palustrine System of the Virginia classification has a broader definition than that used in Cowardin et al. (1979). The Virginia definition includes all freshwater (to oligohaline) wetland and aquatic environments supporting non-halophytic vascular plant life, thereby encompassing parts of Cowardin's Lacustrine, Riverine, and Estuarine Systems. Note that the Cowardin definition of the Estuarine System relies upon an average salinity measure (0.5 ppt.), and not halophytic plants, to define the upstream or landward limit of the System. Determining this salinity measure in the field is difficult, and as a consequence, some wetlands classified within Cowardin's Estuarine System support non-halophytic vegetation.

Hydrologic regime was identified as a major factor influencing floristic composition at the Class level. Four hydrologic regime descriptors were subsequently identified:

1) saturated,
2) seasonally flooded,
3) semipermanently flooded (including permanently flooded environments supporting emergents), and
4) permanently flooded (lacking emergents).

These descriptors were derived from Cowardin et al. (1979), but I've given numbers 2 and 3 broader meaning. Number 2 encompasses Cowardin's temporarily flooded category, while number 3 includes the intermittently exposed category and any permanently flooded environments supporting emergent vegetation. This was done out of practical necessity; too often the Cowardin hydrologic regime categories cannot be recognized in the field. Description number 4 also deviates from the Cowardin definition in the sense that it is exclusively reserved for those permanently flooded environments lacking emergents, i.e. communities composed entirely of submergents and/or floating-leaved species.

Plant species indicative of trophic regime were also used to generate Classes within the Palustrine System. Unlike the Terrestrial System, where five trophic regime levels were identified, only two trophic regime levels were selected for use in the Palustrine System. This difference in approach seemed unavoidable, given the fact that fewer plant species were strictly diagnostic of trophic regime within the Palustrine System. The two trophic regime descriptors were:

1) oligotrophic, and
2) eutrophic.

Note that the each of the above terms now connotes a relatively wide range of fertility conditions; use of these terms in the Terrestrial System is much more restrictive. While this might cause some confusion, it maintains a level of nomenclatural continuity between Systems.

Lists of character-species and conditional character-species serve to identify and differentiate Classes within the Palustrine System. As with the Terrestrial System, some of the lists are subdivided into shade tolerant, moderately shade tolerant, and shade intolerant species to aid in distinguishing the various structural types.

Keys to the Classes of the Terrestrial, Estuarine, and Palustrine Systems were developed. The character-species and conditional character-species that need to be examined when using the keys are given in appendices.

CONCLUDING REMARKS:

Character-species and conditional character-species play an important role in the classification of Virginia's indigenous vegetation. Relatively large lists of these species have been generated, and most stands of natural vegetation can be readily classified to the level of Class using this approach. The basic requirement is that a reasonably complete species list from a representative sample of the vegetation is collected and interpreted using the keys. Recommended plot size for forests and woodlands is 400 sq. m., and for scrub and herbaceous communities, 100 sq. m. As stand data sets accumulate and are analyzed, the Associations should become apparent.

The lists of character-species and conditional character-species serve another important purpose. They give an indication of the classification and inventory work which lies ahead. Each listed species needs to be observed in the field, and recorded as a component of a given community. This will ensure complete coverage of the final draft classification. Refinements and suggestions are definitely needed, and in fact, I eagerly await word of any unusual communities that aren't readily classified under the present system. Natural vegetation is exceedingly complex and trying to make sense of it using feeble human constructs will no doubt be a long, frustrating, and humbling endeavor.

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A KEY TO VEGETATED TERRESTRIAL COMMUNITY CLASSES

(Note: All Class names are understood to represent the Terrestrial System).

a. Eutrophic character-species (Appendix T1) present. . . . . [EUTROPHIC FOREST]

a. Eutrophic character-species absent.

b. Permesotrophic conditional character-species (Appendix T2) present. . . . [PERMESOTROPHIC FOREST]

b. Permesotrophic conditional character-species absent.

c. Mesotrophic conditional character-species (Appendix T3) present.

d. Moderately shade tolerant or shade intolerant species (Appendices T3, T4, & T5) present and conspicuous; woodland, scrub and herbaceous communities.

e. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [MESOTROPHIC WOODLAND]

e. Trees absent or cover less than 5% of the area.

f. Woody species between 1 and 6 m tall (scrub) cover more than 5% of the area. . . . . [MESOTROPHIC SCRUB]

f. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . . [MESOTROPHIC HERBACEOUS VEGETATION]

d. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . . [MESOTROPHIC FOREST]

c. Mesotrophic conditional character-species absent.

g. Submesotrophic conditional character-species (Appendix T4) present.

h. Moderately shade tolerant or shade intolerant species (Appendices T4 & T5) present and conspicuous; woodland, scrub and herbaceous communities.

i. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [SUBMESOTROPHIC WOODLAND]

i. Trees absent or cover less than 5% of the area.

j. Woody species between 1 and 6 m tall (scrub) cover more than 5% of the area. . . . . [SUBMESOTROPHIC SCRUB]

j. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . . [SUBMESOTROPHIC HERBACEOUS VEGETATION]

h. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . . [SUBMESOTROPHIC FOREST]

g. Submesotrophic conditional character-species absent.

k. Oligotrophic conditional character-species (Appendix T5) present.

l. Moderately shade tolerant or shade intolerant species present and conspicuous; woodland, scrub and herbaceous communities.

m. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [OLIGOTROPHIC WOODLAND]

m. Trees absent or cover less than 5% of the area.

n. Woody species between 1 and 6 m tall (scrub) cover more than 5% of the area. . . . . [OLIGOTROPHIC SCRUB]

n. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . . [OLIGOTROPHIC HERBACEOUS VEGETATION]

l. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . . [OLIGOTROPHIC FOREST]

k. Oligotrophic indicators absent. Use other factors (e.g. soils) to assign the stand to one of the above classes. If this isn't possible, refer to the stand as: . . . . . [UNCLASSIFIED TERRESTRIAL COMMUNITY]

KEY TO VEGETATED ESTUARINE COMMUNITY CLASSES

a. Estuarine character-species (Appendix E1) present.

b. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [ESTUARINE SCRUB]

b. Scrub vegetation absent or cover less than 5% of the area.

c. Herbaceous species other than submergents present. . . . . [ESTUARINE HERBACEOUS VEGETATION]

c. The only vascular plants present are submergents such as *Ruppia maritima* and *Zostera marina*. . . . . [ESTUARINE SUBMERGENT VEGETATION]

a. Estuarine character-species absent. Consider whether the stand could be classified using the Palustrine System key, or refer to the stand as: . . . . . [UNCLASSIFIED ESTUARINE COMMUNITY]

KEYS TO THE VEGETATED PALUSTRINE COMMUNITY CLASSES

(Note: All Class names are understood to represent the Palustrine System. Also, use of the terms, eutrophic and oligotr... is in the broad sense, each term encompassing roughly half of the range of community trophic conditions).

Character-species indicating saturated, eutrophic conditions (Appendix P1) present.	EUTROPHIC SATURATED Key P1
Conditional character-species indicating saturated, oligotrophic conditions (Appendix P2) present.	OLIGOTROPHIC SATURATED Key P2
Conditional character-species indicating semipermanently flooded, eutrophic conditions (Appendix P3) present.	EUTROPHIC SEMIPERMANENTLY FLOODED Key P3
Conditional character-species indicating semipermanently flooded, oligotrophic conditions (Appendix P4) present.	OLIGOTROPHIC SEMIPERMANENTLY FLOODED Key P4
Conditional character-species indicating seasonally flooded, eutrophic conditions (Appendix P5) present.	EUTROPHIC SEASONALLY FLOODED Key P5
Conditional character-species indicating seasonally flooded, oligotrophic conditions (Appendix P6) present.	OLIGOTROPHIC SEASONALLY FLOODED Key P6
Conditional character-species indicating permanently flooded conditions (Appendix P7) present (submergent/floating-leaved vegetation).	[SUBMERGENT/FLOATING-LEAVED VEGETATION]
None of the above species present. Use other factors to assign the stand to a Class. If this isn't possible, refer to the stand as:	[UNCLASSIFIED PALUSTRINE COMMUNITY]

Key P1: Eutrophic Saturated

a. Moderately shade tolerant or shade intolerant species (Appendices P1 & P2) present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [EUTROPHIC SATURATED WOODLAND]
b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [EUTROPHIC SATURATED SCRUB]
c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . . [EUTROPHIC SATURATED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [EUTROPHIC SATURATED FOREST]

Key P2: Oligotrophic Saturated

a. Moderately shade tolerant or shade intolerant species present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [OLIGOTROPHIC SATURATED WOODLAND]
b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [OLIGOTROPHIC SATURATED SCRUB]
c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . . [OLIGOTROPHIC SATURATED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [OLIGOTROPHIC SATURATED FOREST]

Key P3: Eutrophic Semipermanently Flooded

a. Moderately shade tolerant or shade intolerant species (Appendices P3 & P4) present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [EUTROPHIC SEMIPERMANENTLY FLOODED WOODLAND]
b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [EUTROPHIC SEMIPERMANENTLY FLOODED SCRUB]
c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . [EUTROPHIC SEMIPERMANENTLY FLOODED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [EUTROPHIC SEMIPERMANENTLY FLOODED FOREST]

Key P4: Oligotrophic Semipermanently Flooded

a. Moderately shade tolerant or shade intolerant species present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [OLIGOTROPHIC SEMIPERMANENTLY FLOODED WOODLAND]

b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [OLIGOTROPHIC SEMIPERMANENTLY FLOODED SCRUB]

c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . [OLIGOTROPHIC SEMIPERMANENTLY FLOODED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [OLIGOTROPHIC SEMIPERMANENTLY FLOODED FOREST]

Key P5: Eutrophic Seasonally Flooded

a. Moderately shade tolerant or shade intolerant species (Appendices P5 & P6) present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [EUTROPHIC SEASONALLY FLOODED WOODLAND]

b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [EUTROPHIC SEASONALLY FLOODED SCRUB]

c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . [EUTROPHIC SEASONALLY FLOODED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [EUTROPHIC SEASONALLY FLOODED FOREST]

Key P6: Oligotrophic Seasonally Flooded

a. Moderately shade tolerant or shade intolerant species present and conspicuous; woodland, scrub, and herbaceous communities.

b. Trees present (covering at least 5% of the area), but significant gaps exist among tree crowns. . . . . [OLIGOTROPHIC SEASONALLY FLOODED WOODLAND]

b. Trees absent or cover less than 5% of the area.

c. Woody species between 1 and 6 m. tall (scrub) cover more than 5% of the area. . . . . [OLIGOTROPHIC SEASONALLY FLOODED SCRUB]

c. Scrub vegetation absent or covers less than 5% of the area; herbaceous species prevalent. . . . [OLIGOTROPHIC SEASONALLY FLOODED HERBACEOUS VEGETATION]

a. Moderately shade tolerant or shade intolerant species absent or inconspicuous; trees form a more or less continuous cover; forest. . [OLIGOTROPHIC SEASONALLY FLOODED FOREST]

Appendix T1 Character-species of the eutrophic forest class

SHADE TOLERANT

Acer nigrum
Blephila ciliata
Carex albursina
Carex careyana
Carex hitchcockiana
Carex plantaginea
Diplazium pycnocarpon
Dryopteris goldiana
Erigenia bulbosa
Erythronium albidum
Floerkea proserpinacoides
Hydrophyllum macrophyllum
Jeffersonia diphylla
Matteuccia struthiopteris
Meehania cordata
Mertensia virginica
Milium effusum
Phacelia bipinnatifida
Smilacina stellata
Trillium cernuum
Trillium sessile
Uvularia grandiflora

Appendix T2 Conditional character-species of the permesotrophic forest class

SHADE TOLERANT

Allium tricoccum
Carex pedunculata
Carex sparganioides
Caulophyllum thalictroides
Chaerophyllum procumbens
Delphinium tricorne
Diarrhena americana
Dicentra canadensis
Dicentra cucullaria
Disporum maculatum
Gymnocladus dioica
Hepatica nobilis v. acuta
Hybanthus concolor
Hydrastis canadensis
Hydrophyllum canadense
Panax quinquefolius
Phlox divaricata
Phlox stolonifera
Polemonium reptans
Schizachne purpurascens
Trillium grandiflorum
Viola canadensis
Viola rostrata
Viola striata

Appendix T3 Conditional character-species of mesotrophic classes

SHADE TOLERANT

Acer floridanum
Aconitum reclinatum
Actaea pachypoda
Adiantum pedatum
Allium canadense
Apiectrum hyemale
Aralia racemosa
Aristolochia macrophylla
Asarum canadense
Asimina triloba
Astilbe biternata
Botrychium virginianum
Carex amphibola
Carex gracillima
Carex jamesii
Cimicifuga americana
Cimicifuga racemosa
Claytonia caroliniana
Claytonia virginica
Collinsonia canadensis
Cryptotaenia canadensis
Dentaria diphylla
Dentaria laciniata
Deparia acrostichoides
Desmodium cuspidatum
Desmodium glutinosum
Diphylleia cymosa
Dirca palustris
Dryopteris celsa
Festuca obtusa
Fraxinus quadrangulata
Galearis spectabilis
Geranium maculatum
Helianthus decapetalus
Hepatica nobilis v. obtusa
Hydrophyllum virginianum
Hystrix patula
Impatiens pallida
Laportea canadensis
Magnolia tripetala
Menispermum canadense
Mitella diphylla
Monarda clinopodia
Osmorhiza claytoni
Osmorhiza longistylis
Penstemon laevigatus
Polymnia canadensis
Polymnia uvedalia
Rubus odoratus
Rudbeckia laciniata
Sanguinaria canadensis
Sanicula canadensis
Sanicula gregaria
Sanicula marilandica
Solidago flexicaulis
Staphylea trifolia
Thalictrum coriaceum
Thalictrum dioicum
Thelypteris hexagonoptera
Tilia heterophylla
Trillium sulcatum
Triosteum angustifolium
Triosteum aurantiacum
Triosteum perfoliatum

MODERATELY SHADE TOLERANT

Adlumia fungosa
Astragalus canadensis
Baptisia australis
Blephilia hirsuta
Camassia scilloides
Campanula americana
Carex oligocarpa
Cassia marilandica
Clematis occidentalis
Eupatorium sessilifolium
Hackelia virginiana
Hexalectris spicata
Lathyrus venosus
Liatris spicata
Onosmodium hispidissimum
Oryzopsis racemosa
Pycnanthemum incanum
Salvia urticifolia
Silphium terebinthinaceum
Solidago rigida
Uniola latifolia
Zanthoxylum americanum

Appendix 14 Conditional character-species of submesotrophic classes

SHADE TOLERANT

Acer saccharum
Ageratina altissima
Anemone lancifolia
Anemone virginiana
Angelica triquinata
Antennaria plantaginifolia
Arabis canadensis
Arabis laevigata
Arisaema triphyllum
Asclepias exaltata
Asclepias quadrifolia
Asplenium resiliens
Aster macrophyllus
Athyrium asplenioides
Betula papyrifera
Brachyelytrum erectum
Callicarpa americana
Calycanthus floridus
Carex aestivalis
Carex digitalis
Carex laxiculmis
Carex laxiflora
Carex nigromarginata
Carex platyphylla
Carex virescens
Carex willdenowii
Carpinus caroliniana
Carya cordiformis
Chrysogonum virginianum
Clintonia umbellulata
Conopholis americana
Coreopsis auriculata
Cornus alternifolia
Cunilla origanoides
Cymophyllus fraseri
Cynoglossum virginianum
Dentaria heterophylla
Desmodium nudiflorum
Desmodium paucifiorum
Desmodium rotundifolium
Dichanthelium latifolium
Dioscorea villosa
Disporum lanuginosum
Galium circaezans
Galium concinnum
Galium latifolium
Hedyotis purpurea
Heracleum lanatum
Hieracium paniculatum
Hydrangea arborescens
Ligusticum canadense
Liparis liliifolia
Lonicera canadensis
Luzula acuminata
Magnolia acuminata
Obolaria virginica
Ostrya virginiana
Oxalis violacea
Phryma leptostachya
Platanthera orbiculata
Platanthera viridis v. bracteata
Poa cuspidata
Podophyllum peltatum
Polygonatum biflorum
Polygonatum pubescens
Polystichum acrostichoides
Prenanthes alba
Pyrularia pubera
Scirpus verecundus
Sedum ternatum
Senecio obovatus
Silene stellata
Smilacina racemosa
Solidago arguta
Solidago caesia
Solidago curtisii
Sphenopholis nitida
Stellaria pubera

MODERATELY SHADE TOLERANT

Agropyron trachycaulum
Aquilegia canadensis
Arabis patens
Aster infirmus
Aster oblongifolius
Aureolaria flava
Berberis canadensis
Bouteloua curtipendula
Bromus pubescens
Carex cephalophora
Carex eburnea
Carex meadii
Celastrus scandens
Clematis viorna
Cornus rugosa
Cuscuta coryli
Cystopteris fragilis
Echinacea laevigata
Fragaria vesca
Helianthus divaricatus
Helianthus strumosus
Lithospermum canescens
Lonicera dioica
Muhlenbergia sobolifera
Muhlenbergia tenuifolia
Myosotis verna
Parthenium auriculatum
Passiflora lutea
Pellaea atropurpurea
Penstemon calycosus
Penstemon hirsutus
Phacelia dubia
Polygala senega
Ranunculus fascicularis
Ranunculus micranthus
Rhamnus caroliniana
Rudbeckia triloba
Silene virginica
Silphium trifoliatum
Solidago ulmifolia
Tradescantia ohiensis
Viburnum rafinesquianum
Woodsia obtusa
Zizia aptera

SHADE INTOLERANT

Aster grandiflorus
Atriplex arenaria
Buchnera americana
Cakile edentula
Castilleja coccinea
Cirsium virginianum
Coreopsis tripteris
Eryngium yuccifolium
Helianthus angustifolius
Helianthus atrorubens
Polygonum glaucum
Psoralea psoralioides
Salsola kali
Sporobolus asper

Appendix 15 Conditional character-species of oligotrophic classes

SHADE TOLERANT	MODERATELY SHADE TOLERANT	SHADE INTOLERANT
Acer pensylvanicum	Ageratina aromatica	
Amianthium muscaetoxicum	Allium cernuum	
Antennaria virginica	Angelica venenosa	
Asimina parviflora	Arabis serotina	Agrostis elliottiana
Aster acuminatus	Aristida lanosa	Ammophila breviligulata
Aster divaricatus	Aster linariifolius	Anaphalis margaritacea
Betula lenta	Aster undulatus	Andropogon gerardii
Buckleya distichophylla	Aureolaria laevigata	Arabis lyrata
Carex brunnescens	Aureolaria pedicularia	Aralia hispida
Carex debilis	Baptisia tinctoria	Arctostaphylos uva-ursi
Carex pensylvanica	Calamagrostis porteri	Aristida curtissii
Carya glabra	Calystegia spithamaea	Aristida dichotoma
Castanea dentata	Campanula divaricata	Aristida purpurascens
Castanea pumila	Carex emmonsii	Aristida tuberculosa
Chamaelirium luteum	Carex polymorpha	Asclepias amplexicaulis
Chimaphila maculata	Carex umbellata	Asclepias verticillata
Chimaphila umbellata	Carya pallida	Asplenium montanum
Clethra acuminata	Centrosema virginianum	Aster spectabilis
Clintonia borealis	Cheilanthes lanosa	Bulbostylis capillaris
Comandra umbellata	Chrysopsis gossypina	Bulbostylis ciliatifolia
Convallaria montana	Clematis albicoma	Carex silicea
Corallorhiza odontorhiza	Clematis ochroleuca	Carphephorus bellidifolius
Coreopsis major	Clematis viticaulis	Carphephorus tomentosus
Cypripedium acaule	Cnidoscolus stimulosus	Cenchrus tribuloides
Deschampsia flexuosa	Comptonia peregrina	Cirsium horridulum
Draba ramosissima	Coreopsis verticillata	Corydalis sempervirens
Dryopteris campyloptera	Danthonia compressa	Cyperus granitophilus
Dryopteris marginalis	Desmodium paniculatum	Cyperus grayi
Epigaea repens	Dicentra eximia	Danthonia sericea
Galax urceolata	Diervilla lonicera	Danthonia spicata
Gaultheria procumbens	Eriogonum alleni	Desmodium sessilifolium
Goodyera pubescens	Euphorbia ipecacuanhae	Desmodium strictum
Gymnocarpium dryopteris	Galactia regularis	Diamorpha smallii
Hamamelis virginiana	Gaylussacia dumosa	Eragrostis hirsuta
Hexastylis virginica	Gymnopogon ambiguus	Eragrostis refracta
Ilex vomitoria	Helianthemum canadense	Eragrostis spectabilis
Isotria medeoloides	Heuchera americana	Euphorbia ammannioides
Isotria verticillata	Iris verna	Euphorbia polygonifolia
Lycopodium annotinum	Kuhnia eupatorioides	Festuca octoflora
Lycopodium clavatum	Liatris graminifolia	Haplopappus divaricatus
Lycopodium digitatum	Lilium philadelphicum	Helianthemum bicknellii
Lycopodium obscurum	Lupinus perennis	Helianthus hirsutus
Lycopodium obscurum v. dendroideum	Lycopodium prophilum	Hudsonia tomentosa
Lycopodium tristachym	Lycopodium selago	Isanthus brachiatus
Lysimachia quadrifolia	Ophioglossum engelmannii	Juncus secundus
Malaxis unifolia	Paronychia canadensis	Juniperus communis
Medeola virginiana	Paxistima canbyi	Krigia biflora
Melampyrum lineare	Pinus echinata	Krigia montana
Helanthium hybridum	Pinus palustris	Krigia virginica
Menziesia pilosa	Pinus pungens	Lechea maritima
Oxalis acetosella	Pinus virginiana	Lechea racemulosa
Oxydendrum arboreum	Pityopsis graminifolia	Lechea villosa
Pieris floribunda	Polygonum cilinode	Leptoloma cognatum
Polypodium virginianum	Prenanthes ronnensis	Liatris aspera
Prenanthes trifoliata	Pseudotaenidia montana	Liatris turgida
Pteridium aquilinum	Pyxidanthera barbulata	Manfreda virginica
Quercus coccinea	Quercus ilicifolia	Minuartia glabra
Quercus marilandica	Quercus incana	Minuartia groenlandica
Quercus montana	Quercus laevis	Minuartia michauxii
Quercus velutina	Quercus margarettae	Minuartia patula
Rhododendron calendulaceum	Quercus virginiana	Muhlenbergia capillaris
Rhododendron periclymenoides	Rhus aromatica	Muhlenbergia cuspidata
Rhododendron prinophyllum	Saxifraga michauxii	Oenothera humifusa
Sassafras albidum	Sedum telephioides	Opuntia humifusa
Symplocos tinctoria	Selaginella rupestris	Panicum amarulum
Tiarella cordifolia	Senecio antennariifolius	Panicum amarum
Trillium undulatum	Senecio pauperculus	Panicum flexile
Tsuga caroliniana	Silene caroliniana	Paronychia argyrocoma
Uvularia pudica	Smilax tamnoides	Paronychia fastigiata
Uvularia sessilifolia	Solidago bicolor	Paronychia riparia
Vaccinium arboreum	Solidago odora	Polygala verticillata
Vaccinium elliottii	Solidago rosmarinus	Polygonella articulata
Vaccinium erythrocarpum	Sorbus americana	Polygonella polygama
Vaccinium stamineum	Spiraea betulifolia ssp. corymbosa	Portulaca smallii
Vaccinium tenellum	Sporobolus clandestinus	Potentilla tridentata
Viburnum lantanoides	Stipa avenacea	Ruellia humilis
	Stylosanthes biflora	Salix tristis
	Tephrosia virginiana	Schizachyrium scoparium

Appendix E1 Character-species of vegetated classes within the estuarine system

Agalinis maritima
Aster tenuifolius
Borrichia frutescens
Distichlis spicata
Fimbristylis castanea
Iva frutescens
Juncus gerardii
Juncus roemerianus
Kosteletzkya virginica
Lythrum lineare
Puccinellia fasciculata
Ruppia maritima
Salicornia bigelovii
Salicornia europea
Salicornia virginica
Scirpus maritimus
Scirpus robustus
Sesuvium maritimum
Spartina alterniflora
Spartina cynosuroides
Spartina patens
Spergularia marina
Suaeda linearis
Suaeda maritima
Zostera marina

Appendix P1 Character-species of eutrophic saturated classes

SHADE TOLERANT	MODERATELY SHADE TOLERANT	SHADE INTOLERANT
	Caltha palustris	Acorus calamus
Carex scabrata	Carex stipata	Carex lacustris
Hexastylis lewisii	Carex trichocarpa	Carex lanuginosa
Ranunculus septentrionalis	Iris versicolor	Carex tetanica
	Lobelia siphilitica	Cyperus haspan
	Myosotis laxa	Eleocharis rostellata
	Veronica americana	Juncus balticus
	Veronica anagallis-aquatica	Lathyrus palustris
		Lysimachia quadriflora
		Lythrum alatum
		Mentha arvensis
		Pedicularis lanceolata
		Sabatia dodecandra

Appendix P2 Conditional character-species of oligotrophic saturated classes

SHADE TOLERANT

Cardamine bulbosa
Cardamine rotundifolia
Carex collinsii
Carex laevivaginata
Carex leptalea
Carex prasina
Carex styloflexa
Chamaecyparis thyoides
Chrysosplenium americanum
Cyrilla racemiflora
Dalibarda repens
Fraxinus nigra
Hedyotis michauxii
Helonias bullata
Listera smallii
Lyonia lucida
Ophioglossum vulgatum
Parnassia asarifolia
Platanthera clavellata
Platanthera psycodes
Poa paludigena
Saxifraga micranthidifolia
Saxifraga pensylvanica
Solidago patula
Symplocarpus foetidus
Thalictrum clavatum
Thelypteris simulata
Toxicodendron vernix
Veratrum viride
Viburnum nudum
Viola walteri

MODERATELY SHADE TOLERANT

Alnus incana ssp. rugosa
Asclepias rubra
Aster radula
Campanula aparinoides
Carex atlantica
Carex bullata
Carex trisperma
Carex venusta
Chelone cuthbertii
Cirsium muticum
Conioselinum chinense
Cypripedium reginae
Drosera rotundifolia
Eleocharis tortilis
Equisetum sylvaticum
Parnassia grandifolia
Platanthera ciliaris
Poa palustris
Rhamnus alnifolia
Sanguisorba canadensis
Sarracenia purpurea
Selaginella apoda
Solidago uliginosa
Sphenopholis pensylvanica
Zenobia pulverulenta

SHADE INTOLERANT

Aletris aurea
Calamagrostis cinnoides
Calopogon tuberosus
Carex buxbaumii
Carex conoidea
Carex hystericina
Carex interior
Carex prairea
Centella asiatica
Cladium mariscoides
Cleistes divaricata
Dichromena colorata
Drosera brevifolia
Drosera capillaris
Epilobium leptophyllum
Equisetum fluviatile
Eriocaulon decangulare
Eriophorum virginicum
Eryngium aquaticum
Filipendula rubra
Fimbristylis puberula
Iris prismatica
Juncus abortivus
Juncus nodosus
Juncus pelocarpus
Lilium catesbaei
Lobelia georgiana
Lycopodium alopecuroides
Lycopodium appressum
Lycopodium inundatum
Menyanthes trifoliata
Muhlenbergia glomerata
Nasturtium officinale
Platanthera blepharioglottis
Platanthera cristata
Pogonia ophioglossoides
Polygala cruciata
Rhynchospora alba
Rhynchospora capillacea
Sabatia calycina
Sarracenia flava
Scirpus expansus
Scleria reticularis
Scleria verticillata
Sclerolepis uniflora
Tofieldia glutinosa
Tofieldia racemosa
Utricularia cornuta
Utricularia juncea
Xyris ambigua
Xyris difformis
Xyris jupicai
Xyris torta
Zigadenus densus
Zigadenus glaberrimus

Appendix P3 Conditional character-species of eutrophic semipermanently flooded classes

SHADE TOLERANT	MODERATELY SHADE TOLERANT	SHADE INTOLERANT
Cardamine longii	Azola caroliniana	Aeschynomene virginica
Fraxinus caroliniana	Carex decomposita	Amaranthus cannabinus
Nyssa aquatica	Carex hyalinolepis	Asclepias lanceolata
Peltandra virginica	Echinodorus cordifolius	Aster subulatus
Ranunculus flabellaris	Heteranthera reniformis	Bacopa inominita
Ranunculus laxicaulis	Hydrocotyle ranunculoides	Bidens coronata
Rumex verticillatus	Limnobium spongia	Carex alata
Triadenum walteri	Pontederia cordata	Carex torta
	Ranunculus sceleratus	Cladium jamaicense
	Sium suave	Cyperus brevifolioides
		Echinochloa walteri
		Elatine minima
		Elatine triandra
		Eleocharis halophila
		Eriocaulon parkeri
		Isoetes riparia
		Juncus acuminatus
		Justicia americana
		Lemna trisulca
		Lilaeopsis carolinensis
		Lilaeopsis chinensis
		Lobelia elongata
		Nelumbo lutea
		Nuphar luteum ssp. sagittifolium
		Physostegia purpurea
		Sacciolepis striata
		Sagittaria calycina v. spongiosa
		Sagittaria rigida
		Sagittaria subulata
		Scirpus acutus
		Sparganium eurycarpum
		Spirodella polyrhiza
		Wolfiella gladiata
		Zizania aquatica

Appendix P4 Conditional character-species of oligotrophic semipermanently flooded classes

SHADE TOLERANT	MODERATELY SHADE TOLERANT	SHADE INTOLERANT
Itea virginica	Carex comosa	Bidens laevis
Taxodium distichum	Hottonia inflata	Brasenia schreberi
	Hydrocotyle umbellata	Carex canescens
	Hydrocotyle verticillata	Dulichium arundinaceum
	Orontium aquaticum	Eleocharis equisetoides
		Eleocharis quadrangulata
		Eleocharis robbinsii
		Eriocaulon septangulare
		Glyceria acutiflora
		Glyceria septentrionalis
		Isoetes engelmannii
		Panicum hemitomon
		Polygonum amphibium
		Polygonum hydropiperoides
		Sagittaria graminea
		Scirpus ancistrochaetus
		Scirpus subterminalis
		Scirpus tabernaemontanii
		Scirpus torreyi

Appendix P5 Conditional character-species of eutrophic seasonally flooded classes

SHADE TOLERANT

Arisaema dracontium
Carex crus-corvi
Carex frankii
Carex grayi
Carex oxylepis
Carex squarrosa
Carex typhina
Carya aquatica
Commelina virginica
Cornus foemina
Mimulus alatus
Populus heterophylla
Quercus bicolor
Quercus lyrata
Saururus cernuus
Scirpus divaricatus

MODERATELY SHADE TOLERANT

Carex gigantea
Hibiscus moscheutos
Justicia ovata v. lanceolata
Penthorum sedoides
Salix caroliniana
Salix nigra

SHADE INTOLERANT

Axonopus furcatus
Cyperus erythrorhizos
Cyperus filicinus
Cyperus strigosus
Eclipta alba
Eragrostis frankii
Eragrostis hypnoides
Glyceria grandis
Juncus torreyi
Lippia lanceolata
Phalaris arundinacea
Rorippa palustris
Scirpus atrovirens
Scirpus fluviatilis
Scirpus pendulus

Appendix P6 Conditional character-species of oligotrophic seasonally flooded classes

SHADE TOLERANT	MODERATELY SHADE TOLERANT	SHADE INTOLERANT
Carex crinita	Carex glaucescens	Boltonia asteroides
Carex louisianica	Carex joori	Calamagrostis canadensis
Carex lupulina	Carex walteriana	Carex albolutescens
Cinna arundinacea	Glyceria melicaria	Carex barrattii
Cornus amomum	Iris virginica	Cyperus dentatus
Quercus palustris	Juncus effusus	Drosera intermedia
	Scirpus cyperinus	Eleocharis baldwinii
		Eleocharis flavescens
		Eleocharis melanocarpa
		Eleocharis tricostata
		Eleocharis tuberculosa
		Erigeron vernus
		Eupatorium leucolepis
		Eupatorium recurvans
		Fimbristylis annua
		Fimbristylis autumnalis
		Fuirena pumila
		Glyceria canadensis v. laxa
		Helenium virginicum
		Juncus brevicaudatus
		Juncus caesariensis
		Juncus canadensis
		Juncus repens
		Juncus scirpoides
		Lachnocaulon anceps
		Lindernia anagallidea
		Lipocarpha maculata
		Lobelia puberula
		Ludwigia brevipes
		Ludwigia sphaerocarpa
		Lysimachia hybrida
		Panicum rigidulum
		Proserpinaca palustris
		Proserpinaca pectinata
		Pycnanthemum flexuosum
		Rhynchospora caduca
		Rhynchospora cephalantha
		Rhynchospora corniculata
		Rhynchospora macrostachya
		Scirpus purshianus

Appendix P7 Conditional character-species of the submergent/floating-leaved class

Cabomba caroliniana
Callitriche heterophylla
Ceratophyllum demersum
Ceratophyllum muricatum
Elodea canadensis
Elodea nuttallii
Heteranthera dubia
Myriophyllum heterophyllum
Myriophyllum humile
Myriophyllum spicatum
Najas flexilis
Najas gracillima
Najas guadalupensis
Nymphoides aquatica
Podostemon ceratophyllum
Potamogeton crispus
Potamogeton diversifolius
Potamogeton epihydrus
Potamogeton foliosus
Potamogeton illinoensis
Potamogeton nodosus
Potamogeton oakesianus
Potamogeton pectinatus
Potamogeton perfoliatus
Potamogeton pulcher
Potamogeton pusillus
Potamogeton spirilus
Potamogeton tennesseensis
Potamogeton zosteriformis
Utricularia biflora
Utricularia fibrosa
Utricularia inflata
Utricularia purpurea
Utricularia radiata
Utricularia vulgaris
Vallisneria americana
Zannichellia palustris